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AIR POLLUTION—1967

(Air Quality Act)

HEARINGS

BEFORE THE

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OF THE

[illegible]MITTEE ON PUBLIC WORKS

[illegible]UNITED STATES SENATE

NINETIETH CONGRESS

FIRST SESSION

ON

S. 780

AND RELATED MATTERS PERTAINING TO THE PREVENTION AND CONTROL OF AIR POLLUTION

WASHINGTON, D.C., FEBRUARY 8, 1967
DENVER, COLO., APRIL 3, 1967
ST. LOUIS, MO., APRIL 4, 1967

PART 2

Printed for the use of the Committee on Public Works

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AIR POLLUTION—1967

WEDNESDAY, FEBRUARY 8, 1967

UNITED STATES SENATE,
SUBCOMMITTEE ON AIR AND WATER POLLUTION
OF THE SENATE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met at 9:30 a.m., pursuant to call, in room 4200, New Senate Office Building, Senator Edmund S. Muskie (chairman of the subcommittee) presiding.

Present: Senators Muskie, Randolph, Tydings, Spong, Boggs, Murphy, Cooper, and Baker.

Also present: Richard B. Royce, chief clerk and staff director; Bailey Guard, assistant chief clerk (minority); Leon Billings, and Richard D. Grundy, professional staff members.

Senator MUSKIE. The committee will be in order.

Today we are beginning a series of hearings on the problems of air pollution which will be conducted in Washington and in several sections of the Nation. In the course of our hearings we shall consider the present status of our air pollution control and abatement programs, the nature of current and prospective dangers from air pollution and the need for new legislation. The principal legislative proposal before us is S. 780, the bill designed to implement the President's recommendations for an accelerated attack on the contamination of our air.

I will place a copy of S. 780 in the record at this point.

(The bill is as follows:)

[S. 780, 90th Cong., first sess.]

A BILL To amend the Clean Air Act to improve and expand the authority to conduct or assist research relating to air pollutants, to assist in the establishment of regional air quality commissions, to authorize establishment of standards applicable to emissions from establishments engaged in certain types of industry, to assist in establishment and maintenance of State programs for annual inspections of automobile emission control devices, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Air Quality Act of 1967".

RESEARCH RELATING TO FUELS AND VEHICLES

SEC. 2. (a) So much of subsection (a) of section 103 of the Clean Air Act (42 U.S.C. 1857b(a)) as follows paragraph (3) is amended to read as follows:

"(4) conduct and accelerate research programs directed toward development of improved, low-cost techniques for control of combustion byproducts of fuels, for removal of potential pollutants from fuels, and for control of emissions from evaporation of fuels;

"(5) provide for Federal payments to public or private agencies, institutions, or persons of part or all of the cost of acquiring, constructing, or otherwise securing devices, methods, or other means of preventing or controlling discharges into the air of various types of pollutants."

(b) Section 102(b) of such Act is amended to read as follows:

"(b) The Secretary shall cooperate with and encourage cooperative activities by all Federal departments and agencies having functions relating to the prevention and control of air pollution, and shall, to the maximum extent practicable, utilize the services, facilities, and resources of other Federal agencies in carrying out his responsibilities under this Act."

REGISTRATION OF FUEL ADDITIVES

SEC. 3. Section 103 of the Clean Air Act is further amended by adding at the end thereof the following new subsection:

"(f)(1) The Secretary may by regulation designate any fuel or fuels, or any classes or uses thereof, and, after such date or dates as may be prescribed by him, no manufacturer or processor of any fuel may deliver any such fuel for introduction into interstate commerce or to another person who, it can reasonably be expected, will deliver such fuel for such introduction unless any additive contained in such fuel has been registered with the Secretary.

"(2) Upon filing of an application, containing or accompanied by such information as to the characteristics and composition of any additive for any fuel as the Secretary finds necessary, and including assurances that such additional information as the Secretary may reasonably require will upon request be provided, the Secretary shall register such additive.

"(3) The Secretary shall make such provision, with respect to any additive, or any class or use thereof, or any information furnished in connection therewith, as in his judgment is necessary to protect any trade secret or is necessary in the interest of national security.

"(4) Any person who violates paragraph (1) shall forfeit and pay to the United States a civil penalty of $1,000 for each and every day of the continuance of such violation, which shall accrue to the United States and be recovered in a civil suit in the name of the United States, brought in the district where such person has his principal office or in any district in which he does business. The Secretary may, upon application therefor, remit or mitigate any foreiture provided for in this subsection, and he shall have authority to determine the facts upon all such applications.

"(5) It shall be the duty of the various United States attorneys, under the direction of the Attorney General of the United States, to prosecute for the recovery of such forfeitures."

STATE MOTOR VEHICLE POLLUTION CONTROL INSPECTION PROGRAMS

SEC. 4. Title II of the Clean Air Act (42 U.S.C. 1857 et seq.) is amended by redesignating section 208 as section 209 and by inserting after section 207 the following new section:

"ASSISTANCE FOR STATE INSPECTION PROGRAMS

"SEC. 208. (a) The Secretary of Transportation is authorized to impose, as a condition to approval under section 402 of title 23, United States Code, of the highway safety program of any State, a requirement that such program include, as part of vehicle inspection thereunder, procedures to assure the adequacy of performance of systems or devices in motor vehicles for control of emissions from them.

"(b) In establishing standards to be applicable in carrying out subsection (a), the Secretary of Transportation shall be subject to polluition emission standards established by the Secretary of Health, Education, and Welfare with respect to model years after 1967 and such earlier model years as the Secretary of Health, Education, and Welfare may prescribe; shall require that State vehicle inspection agencies consult from time to time with the air pollution control agencies in the States as to the administration of their respective inspection programs; and shall require that such State vehicle inspection agencies make such reports in such form and containing such information as he, after consultation with the Secretary of Health, Education, and Welfare, may from time to time reasonably require."

INDUSTRIAL EMISSION STANDARDS

SEC. 5. Title I of the Clean Air Act is further amended by redesignating section 107 (42 U.S.C. 1857f) as section 109 and by inserting after section 106 the following new section:

"EMISSION STANDARDS FOR CERTAIN INDUSTRIES

"SEC. 107. (a) The Secretary shall from time to time by regulation, giving appropriate consideration to technological and economic feasibility, establish emission standards for all or designated emissions which (1) are from designated industries which, because of their nature, are sources of substantial amounts of pollutants and (2) can, with reasonable efforts and expenditures, be prevented or substantially reduced. Such standards may be established only after reasonable notice and opportunity for interested parties to present their views. Any regulations hereunder, and amendments thereof, shall become effective on a date specified therein, which date shall be determined by the Secretary after consideration of the period reasonably necessary for industry compliance. The Secretary may exempt any industry or establishment, or any class thereof, from this section upon such terms and conditions as he may find necessary to protect the public health or welfare, for the purpose of research, investigations, studies, demonstrations, or training, or for reasons of national security.

"(b)(1) If the Governor of a State or a State air pollution control agency files, prior to the effective date of standards under subsection (a), a certification that it has adopted, or a letter of intent that such State will before the close of the sixth calendar month which beings after such effective date adopt, (A) emission standards applicable in the State to the emissions and industries specified by the Secretary, which standards he determines are substantially equivalent to or more stringent than the standards prescribed by the Secretary pursuant to subsection (a), and (B) a plan for the enforcement of the standards so adopted, and if such standards and plan are established in accordance with the letter of intent, the standards prescribed pursuant to subsection (a) shall thereafter not be applicable to such emissions and industries in such State.

"(2) If, at any time after standards prescribed under subsection (a) become applicable in a State, a State adopts standards and a plan for enforcement which meet the requirements of paragraph (1) of this subsection, such standards shall become applicable, instead of standards prescribed under subsection (a), in such State until the Secretary again makes the determination referred to in paragraph (3) with respect to such State.

"(3) (A) If a State does not file a letter of intent as provided in paragraph (1) or does not within six months after the effective date of the standards with respect to which it was filed, establish standards in accordance with such letter which meet the requirements of clause (A) of paragraph (1), or if, on the basis of evidence furnished to him or secured by him, the Secretary determines either that the standards so established have been changed so that they no longer meet the requirements of such clause (A) or that there is a substantial failure to enforce them adequately, the standards precribed pursuant to subsection (a) shall apply within such State to any factory, warehouse, office, or other business or service establishment in such industry which introduces or delivers for introduction into or receives in interstate commerce any materials.

"(B) If the secretary, after reasonable notice and opportunity for a hearing, determines that any such establishment is violating such standards, he shall issue an order requiring the establishment to cease and desist from continued violation of such standards within such time as may be specified in the order, but in no event less than sixty days from the date of receipt of such notice.

"(4)(A) Any person required by an order of the Secretary to cease and desist from violation of any such standards may obtain judicial review of such order by filing a petition for review, within sixty days after service of such order, in the United States court of appeals either for the circuit in which such person resides or has his principal place of business or for any circuit in which the violation is found to have occurred, or in the United States Court of Appeals for the District of Columbia Circuit. A copy of the petition shall

forthwith be transmitted by the clerk of the court to the Secretary or to any officer designated by him for that purpose and to the Attorney General, and thereupon the Secretary shall certify and file in the court through the Attorney General the record of the proceedings upon which the order is based, as provided in section 2112 of title 28, United States Code.

"(B) Upon the filing of such petition, such court shall have jurisdiction of the proceeding (which jurisdiction shall upon the filing of the record be exclusive) and shall have power to affirm the order of the Secretary, or to set it aside in whole or in part, temporarily or permanently, and to enforce such order to the extent that it is affirmed, and to issue such orders pendente lite as in its judgment are necessary to prevent injury to the public. The commencement of proceedings under this paragraph shall not, unless specifically ordered by the court, operate as a stay of the Secretary's order.

"(C) No objection to the order of the Secretary shall be considered by the court unless such objection was urged before the Secretary or unless there were reasonable grounds for failure so to do. The findings of the Secretary as to the facts, if supported by substantial evidence on the record considered as a whole, shall be conclusive, but the court, for good cause shown, may remand the case to the Secretary for the taking of additional evidence in such manner and upon such terms and conditions as the court may deem proper, in which event the Secretary may make new or modified findings and shall file such findings (which, if supported by substantial evidence on the record considered as a whole, shall be conclusive) and his recommendation, if any, for the modification or setting aside of his original order, with the return of such additional evidence.

"(D) The judgment of the court affirming or setting aside, in whole or in part, any order under this subsection shall be final, subject to review by the Supreme Court of the United States upon certiorari or certification as provided in section 1254 of title 28, United States Code.

"(E)(i) Any person who fails to file with the Secretary, in conformity with regulations issued under this subsection, any report, or who violates a cease and desist order of the Secretary after it has become final and while such order is in effect, shall forfeit and pay to the United States a civil penalty of $1,000 for each violation, which shall accrue to the United States and may be recovered in a civil suit in the name of the United States brought in the district where such person has his principal office or in any district in which he does business. Each separate violation of such an order or failure to file such a report shall be a separate offense, except that in the case of a violation through continuing failure to obey a final order of the Secretary each day of continuance of such failure shall be deemed a separate offense. The Secretary may, upon application therefor, remit or mitigate any forfeiture provided for in this subparagraph, and he shall have authority to determine the facts upon all such applications.

"(ii) It shall be the duty of the various United States attorneys, under the direction of the Attorney General of the United States, to prosecute for the recovery of such forfeitures.

"(F)(i) For the purposes of this subsection, the Secretary shall have the power to require by subpena the attendance and testimony of witnesses, and the production of all books, papers, and documents relating to any matter which is the subject of a hearing authorized by this section. Witnesses summoned by the Secretary shall be paid the same fees and mileage that are paid witnesses in courts of the United States.

"(ii) The attendance of witnesses, and the production of books, papers, and documents, may be required from any place in the United States at any designated place of hearing. In case of disobedience to a subpena, the Secretary or any party to a proceeding before the Secretary may invoke the aid of any court of the United States in requiring attendance and testimony of witnesses and the production of such books, papers, and documents under the provisions of this section.

"(iii) Any court of the United States within the jurisdiction of which an inquiry under this subsection is carried on may, in case of contumacy or refusal to obey a subpena issued to any person, issue an order requiring such person to appear before the Secretary (and produce books, papers, or documents if so ordered) and give evidence touching the matter in question; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

"(G) For purposes of enforcement of this section, officers or employees duly designated by the Secretary, upon presenting appropriate credentials and a written notice to the owner, operator, or agent in charge, are authorized (i) to enter, at reasonable times, any factory, warehouse, office, or other business or service establishment with respect to which there is reasonable ground to believe that it is causing, permitting, or otherwise responsible for discharges into air within the purview of this subsection, or that it is engaging in any act or practice which threatens a discharge in violation of any regulation under this section, and (ii) to inspect, at reasonable times and within reasonable limits and in a reasonable manner, such factory, warehouse, office, or other establishment, and all pertinent equipment, finished and unfinished materials, containers, and labeling therein, and all other things therein (including records, files, papers, and processes, controls, and facilities) bearing on such discharges or on such act or practice. A separate notice shall be given for each such inspection, but a notice shall not be required for each entry made during the period covered by the inspection. Each such inspection shall be commenced and completed with reasonable promptness.

"(H) The Secretary may upon request review and approve (subject to such conditions as the Secretary deems appropriate) facilities or devices, or designs therefor, for preventing discharges into the air in violation of this subsection."

REGIONAL AIR QUALITY COMMISSIONS

SEC. 6. Title I of the Clean Air Act is further amended by adding after section 107 (added by section 5 of this Act) the following new section:

"REGIONAL AIR QUALITY COMMISSIONS

"SEC. 108. (a)(1) Whenever so requested by the Governors of two or more contiguous States who allege that existing or threatened pollution of the air in any State or States is endangering, or is likely to endanger, the health or welfare of persons in one or more other States, the Secretary may, if he determines (A) that there does not exist an adequate air pollution control program or programs to control, abate, and prevent such pollution, and (B) that action under this section is necessary to protect the health or welfare of persons in the area, establish, after consultation with the States affected, an air quality region which shall encompass the area or areas involved in each of such States and any other areas which in his judgment have such characteristics as to warrant treatment as a unit for air pollution control purposes.

"(2) The Secretary may, after consultation with State officials of all affected States, also establish such an area whenever on the basis of reports, surveys, or studies he has reason to believe that such action is necessary to protect the health or welfare of persons therein.

"(b) Upon establishment of such an area the Secretary shall appoint a Regional Air Quality Commission consisting of an officer or employee of the Department of Health, Education, and Welfare, who shall serve as Chairman, and, if the Secretary determines it to be appropriate, of another officer or employee of the Department or, with the consent of the head thereof, of any other Federal department or agency, and of two residents of each of the States any part of which is included in the air quality region. The appointments from each State shall be made only after consultation with the Governor of the State. A vacancy in the Commission shall not affect its powers, but shall be filled in the same manner in which the original appointment was made. A majority of the members of a Commission shall constitute a quorum for the transaction of business. Appointees from any State shall serve, and the Commission shall exist, for such time as may be determined by the Secretary to be necessary or appropriate for purposes of this Act.

"(c)(1) The Secretary shall, within available funds, provide such staff for such Commission as may be necessary to enable it to carry out its functions effectively, and shall pay the other expenses of the Commission.

"(2) The Secretary may also accept for use by such Commission funds, property, or services contributed by the States involved or political subdivisions thereof.

"(d) Each appointee from a State, other than an official or employee thereof, or of any political subdivision thereof, shall, while engaged in work of the Commission, receive compensation at a rate fixed by the Secretary, but not in excess

of $100 per diem, including traveltime, and, while away from his home or regular place of business, he may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by law (5 U.S.C. 3109) for persons in the Government service employed intermittently.

"(e) A Commission appointed under this section shall, as soon as practicable, after reasonable notice and opportunity for interested parties to present their views, establish air quality standards for its air quality region, taking into consideration the various relevant aspects thereof, such as the concentration of industry, other commercial establishments, and population and the technological and economic feasibility of achieving such quality, as well as standards for pollutant emissions in order to achieve or preserve such air quality. Such air quality standards and emission standards shall be no less stringent than such standards prescribed or recommended by the Secretary under other sections of this Act and such standards of the Commission shall apply in its air quality region in lieu of State or Federal standards insofar as they are inconsistent with such standards of the Commission. The Secretary may, after reasonable notice and opportunity for interested parties to present their views, modify the standards of a Commission, and may exempt any industry or establishment, or any class thereof, from standards of a Commission upon such terms and conditions as he may determine, to the extent he finds such action necessary to protect the public health or welfare, for the purpose of research, investigations, studies, demonstrations, or training, or for reasons of national security.

"(f) Any such Commission shall prepare a system of alerts to avert situations in which there may be imminent and serious danger to the public health or welfare from air pollutants. The Commission shall notify the Governors of the States involved of any such situation or potential situation and of recommended actions by the States, political subdivisions thereof, and businesses and residents therein.

"(g)(1) If the Secretary, after reasonable notice and opportunity for a hearing, determines that any person in an air quality region is violating standards of the Regional Air Quality Commission for such region, he shall, subject to such limitations as the Secretary may prescribe, issue an order requiring such person to cease and desist from continued violation of such standards within such time as may be specified in the order, but in no event less than sixty days from the date of receipt of such notice.

"(2) Any person required by such an order of the Secretary to cease and desist from violation of any such standards may obtain judicial review of such order by filing a petition for review, within sixty days after service of such order, in the United States court of appeals either for the circuit in which such person resides or has his principal place of business or for any circuit in which the violation is found to have occurred, or in the United States Court of Appeals for the District of Columbia Circuit. A copy of the petition shall forthwith be transmitted by the clerk of the court to the Secretary or to any officer designated by him for that purpose and to the Attorney General, and thereupon the Secretary shall certify and file in the court through the Attorney General the record of the proceedings upon which the order is based, as provided in section 2112 of title 28, United States Code.

"(B) Upon the filing of such petition, such court shall have jurisdiction of the proceeding (which jurisdiction shall upon the filing of the record be exclusive) and shall have power to affirm the order of the Secretary, or to set it aside in whole or in part, temporarily or permanently, and to enforce such order to the extent that it is affirmed, and to issue such orders pendente lite as in its judgment are necessary to prevent injury to the public. The commencement of proceedings under this paragraph shall not, unless specifically ordered by the court, operate as a stay of the Secretary's order.

"(C) No objection to the order of the Secretary shall be considered by the court unless such objection was urged before the Secretary or unless there were reasonable grounds for failure so to do. The findings of the Secretary as to the facts, if supported by substantial evidence on the record considered as a whole, shall be conclusive, but the court, for good cause shown, may remand the case to the Secretary for the taking of additional evidence in such manner and upon such terms and conditions as the court may deem proper, in which event the Secretary may make new or modified findings and shall file such findings (which, if supported by substantial evidence on the record considered as a whole, shall be conclusive) and his recommendation, if any, for the modification or setting aside of his original order, with the return of such additional evidence.

"(D) The judgment of the court affirming or setting aside, in whole or in part, any order under this subsection shall be final, subject to review by the Supreme Court of the United States upon certiorari or certification as provided in section 1254 of title 28, United States Code.

"(E) (i) Any person who violates a cease-and-desist order after it has become final and while such order is in effect, shall forfeit and pay to the United States a civil penalty of $1,000 for each violation, which shall accrue to the United States and may be recovered in a civil suit in the name of the United States brought in the district where such person has his principal office or in any district in which he does business. Each separate violation of such an order shall be a separate offense, except that in the case of a violation through continuing failure to obey a final order of the Secretary each day of continuance of such failure shall be deemed a separate offense. The Secretary may, upon application therefor, remit or mitigate any forfeiture provided for in this subparagraph, and it shall have authority to determine the facts upon all such applications.

"(ii) It shall be the duty of the various United States attorneys, under the direction of the Attorney General of the United States, to prosecute for the recovery of such forfeitures.

"(F) (i) For the purposes of this subsection, the Secretary shall have the power to require by subpena the attendance and testimony of witnesses, and the production of all books, papers, and documents relating to any matter which is subject of a hearing authorized by this section. Witnesses summoned by the Secretary shall be paid the same fees and mileage that are paid witnesses in courts of the United States.

"(ii) The attendance of witnesses, and the production of books, papers, and documents, may be required from any place in the United States at any designated place of hearing. In case of disobedience to a subpena, the Secretary or any party to a proceeding before the Secretary may invoke the aid of any court of the United States in requiring attendance and testimony of witnesses and the production of such books, papers, and documents under the provisions of this section.

"(iii) Any court of the United States within the jurisdiction of which an inquiry under this subsection is carried on may, in case of contumacy or refusal to obey a subpena issued to any person, issue an order requiring such person to appear before the Secretary (and produce books, papers, or documents if so ordered) and give evidence touching the matter in question; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

"(G) For purposes of enforcement of this section, officers or employees duly designated by the Secretary, upon presenting appropriate credentials and a written notice to the owner, operator, or agent in charge, are authorized (i) to enter, at reasonable times, any factory, warehouse, office, or other business or service establishment with respect to which there is reasonable ground to believe that it is causing, permitting, or otherwise responsible for discharges into air within the purview of this subsection, or that it is engaging in any act or practice which threatens a discharge in violation of any regulation under this section, and (ii) to inspect, at reasonable times and within reasonable limits and in a reasonable manner, such factory, warehouse, office, or other establishment, and all pertinent equipment, finished and unfinished materials, containers, and labeling therein, and all other things therein (including records, files, papers, and processes, controls, and facilities) bearing on such discharges or on such act or practice. A separate notice shall be given for each such inspection, but a notice shall not be required for each entry made during the period covered by the inspection. Each such inspection shall be commenced and completed with reasonable promptness.

"(H) Nothing in this section shall be construed as superseding or limiting the authority and responsibility of the Secretary under any other provisions of this or any other law."

APPROPRIATIONS

SEC. 7. Section 306 of the Clean Air Act is amended by inserting ", other than section 103(d)," after "this Act". Such section is further amended by striking out "$66,000,000 for the fiscal year ending June 30, 1968, and $74,000,000 for the fiscal year ending June 30, 1969" and inserting in lieu thereof "$84,00,000 for the fiscal year ending June 30, 1968, and such sums as may be necessary for the next four fiscal years."

Senator MUSKIE. Today the subcommittee has asked the Secretary of Health, Education, and Welfare, John W. Gardner, and the President's Science Adviser, Mr. Donald F. Hornig, to present a general discussion on the purpose and intent of S. 780, the administration's proposed Air Quality Act of 1967. This legislation is designed to implement the proposals on air pollution contained in the President's message, entitled "Protecting Our Natural Heritage." The recommendations of that message include:

1. A national program of minimum emission levels for certain pollutants, coupled with regional applications of emission standards;
2. A program to establish regional airsheds to provide more effective, coordinated attacks on the problem;
3. A program of Federal matching grants for State inspection programs to insure maximum control of automotive exhausts;
4. Improved enforcement procedures;
5. Accelerated research on fuel additives; and
6. A 50-percent increase in Federal research funds on the causes and control of air pollution problems, including such specifics as motor-vehicle emissions, diesel exhaust, alternative methods of motor-vehicle propulsion, and sulfur emissions.

This legislation contains some imaginative and far-reaching opportunities for air pollution control and abatement and conveys a real sense of urgency, but the bill is complex as is the issue. Much time and effort will be required to thoroughly examine the proposal.

Also, today we will hear Dr. J. Herbert Holloman and Dr. Robert M. White of the Environmental Science Services Administration and Dr. Arthur Stern of the National Center for Air Pollution Control for the purpose of obtaining needed technical data on the relationship of weather to air pollution and to discuss problems associated with realistically defining "airsheds," a concept which is recognized in the President's message.

During the field hearings a good deal of testimony will be taken regarding the problems and progress associated with the automobile emission control devices which will be required on all 1968 model cars and which were installed on all 1966 model cars sold in California. Specifically the committee expects to receive information on the controversy in California regarding the effectiveness of those devices and later in Detroit the reaction of industry officials to the California reports.

During the field hearings we also hope to obtain needed information on those automobile emissions not presently covered by standards which have been promulgated either by the Secretary of Health, Education, and Welfare or the State of California, with special emphasis on oxides of nitrogen.

Finally, and perhaps most importantly, the committee intends to hear witnesses in St. Louis and possibly other cities regarding the institutional aspects of pollution control. The President has proposed the establishment of regional air pollution control commissions to maintain interstate air pollution control programs. Because the St. Louis situation epitomizes the serious need for an effective interstate mechanism, in addition to public officials, we have invited several well-known academicians to discuss the type of political institution which might most effectively police air pollution in an interstate airshed.

Coupled with the testimony we receive on the airshed concept already developed for Colorado, the committee should have a better understanding of the type of institution which is essential for effective management of our air resources when it returns to Washington to hear the administration discuss its proposal in more detail.

The subcommittee is conscious of the critical nature of the pollution problem, the public demand for action and the complex issues which surround alternative proposals for control and abatement. We shall be careful; we shall be responsible; and we shall be persistent in our efforts to develop effective legislation, so it is a pleasure and a privilege to reopen these hearings on air pollution which have been an almost constant chore of this subcommittee for the past 4 years.

It is a pleasure to have such good attendance on the subcommittee this morning and I would like to invite the Chairman of the full Committee on Public Works, who has been a stanch supporter of the subcommittee's work in this field, to address some commitments to the hearing record at this point.

Senator Randolph.

Senator RANDOLPH. Chairman Muskie, I wish to have the record reflect at the outset of these hearings the importance which all members of the Senate Committee on Public Works, particularly the members of the Subcommittee on Air and Water Pollution, attach to the testimony to be given on this vital subject.

I wish the record to reflect also my commendation of you, Mr. Chairman, for the very affirmative and constructive manner in which you have moved forward in the hearings in the past, in the advocacy of legislation, and in the bringing of that legislation to enactment.

It is important for all of us to approach these further hearings with the realization that there are not only opportunities for strengthening the law—these exist and I wish to join you in attempting to bring them to fulfillment—but there also are problems that undoubtedly arise. In fact, we know they have arisen. We must, in an effort to be reasonable in a realistic way, hear the evidence and attempt, as we have in the past under your leadership, to be responsive to what I believe to be the demand of the American people that the procrastination in this field be terminated. This procrastination is due in part to industry, sometimes slowness within industry—because industry too is searching for the answers. But bureaucracy and the legislative processes also must bear responsibility in part for these shortcomings.

I have been and continue to be a vigorous advocate of more and more abatement of air and water pollution. As a member, and now as chairman of the Senate Committee on Public Works, which has jurisdiction over legislation in the pollution abatement field, I have supported and will continue to support legislative measures to further the effort to abate and, hopefully, eliminate air and water pollution.

But I recognize the fact that, to achieve the objectives of clean air and clean water, much more must be done than to place new laws on the statute books and to issue and enforce regulations pertaining to pollution abatement.

As necessary as are laws, regulations, and enforcement to establish authority, to delineate goals, and to fix responsibility, they must

also be associated with accelerated research and development. It will be the ingenuity of American technology which will, in fact, provide the means for cleansing the air we breathe and the water we drink if the cleansing is to be done without wrecking vital segments of the economy and destroying jobs.

Because I hold this view, some of the most militant advocates of air pollution control programs charge that I am an opponent of the movement for clean air. This is a patently false allegation. I have supported all prior legislation in the Congress on air pollution abatement and control. And I have co-sponsored in the Senate the administration's new measure including significant amendments to the Clean Air Act.

This measure is receiving prompt hearings in the Senate Public Works Committee of which I am chairman. In that capacity, I also have approved and will participate in field hearings in several major cities of the United States during the next few days as we seek further information and background facts pertinent to consideration of the new legislation.

It is my judgment that industry, county and municipal incineration and other private and governmental sources of pollution—including automotive, locomotive and jet propulsion—must be prodded strongly to do everything possible to abate pollution of the air and to cease being sources of such pollution.

At the same time, I feel just as strongly that both governmental and private research must be accelerated in efforts to find the means to achieve abatement and control of gases and particulate matter which pollute the air.

There has been too much procrastination on the part of many of the sources of pollution and there has been too much slow-pace research and too little actual development of feasible methods for controlling or eliminating air pollution. There now is a feeling of greater urgency and I believe it will contribute to closer cooperation between government and industry as the effort continues to make substantial inroads on air pollution without destroying jobs and without seriously dislocating our economy.

I believe the government research programs are too proliferated, too small, and much too late and cumbersome for the most part in the non-nuclear fields. Neither industry nor our government is doing enough to keep technological development abreast of the emphasis being placed on regulations, compliance and enforcement.

Senator MUSKIE. Thank you very much, Mr. Chairman.

I would like to ask Senator Boggs, who as ranking Republican member of the subcommittee, has been of real and material help and assistance to us, to make a brief statement.

Senator BOGGS. Thank you, Mr. Chairman. You are very generous and very kind.

It is a great privilege to work with you and the members of this subcommittee.

Mr. Chairman, I wish to commend you and our distinguished chairman of the full committee on your opening statements and also for scheduling today's hearing and the field trips which begin next Monday. As we all know, the President has sent a needed and timely message on air pollution and has followed it up with specific recommenda-

tions. These recommendations are far-reaching in their effect on the problem of air pollution and will, I think, elicit some very valuable and interesting testimony in the months ahead.

Having been privileged to work with you and the members of the subcommittee since the beginning of this subcommittee, I have every confidence that worthwhile and meaningful legislation will be recommended for congressional action. I think we meet today in an atmosphere not of crises, but certainly an atmosphere of urgent need.

The interest throughout the Nation in this problem can best be evidenced by the fact that, in addition to the President's proposed legislation, House Members have introduced 16 other measures dealing with air pollution, and you, Mr. Chairman, have also introduced in the Senate a measure dealing with automotive pollution.

I look forward to these hearings, Mr. Chairman, and I am sure that when the subcommittee completes its work, we will once again be in a position to recommend for approval sound legislation designed to protect the interest of all our people and to give government and industry additional tools to help in the fight to control air pollution wherever it may occur.

I thank you, Mr. Chairman.

Senator MUSKIE. Thank you very, very much, Senator Boggs.

Senator Tydings.

Senator TYDINGS. Thank you, Mr. Chairman.

I would like to congratulate you for calling these hearings on air pollution. The leadership you provide is really the driving force in congressional recognition of this problem. I believe we all realize, having read the recent Time magazine articles and other such national periodicals, just how important the quality of the air is to all Americans. I think that last year 135 million tons of pollutants entered the air in the United States. Every day 360,000 tons of gaseous waste enter the air in the United States.

Each year we burn about 150 million tons of trash. The Public Health Service advises us that 7,300 communities in the United States have major pollution problems. Yet only 130 of these 7,000 communities have any type of pollution control programs.

Only 23 States out of the 50 have any type of legislation even acknowledging the problem of air pollution. I would hope that these hearings that you inaugurate today will bring public attention to the matter.

The January 27, 1967, issue of Time magazine estimated that air pollution in the United States causes over $11 billion of damage each year. Considering the amount of money we are now spending for air pollution abatement, it is questionable to me whether or not we have even begun to meet the problem, either at the local or the national level.

The President's proposed Air Quality Act of 1967, would appear to be heading in the right direction. I believe, however that we should wait before finally judging all of these proposals to see exactly how much research, how much money and what the standards will be. The standards are no good if they are all chewed up and we start getting political pulls in one direction or another. Then they won't do the job they are supposed to.

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Hopefully the hearings will bring out what these standards are, what they will do, and the money we are going to spend on the administration and research. Hopefully then we will all be able to support the proposal wholeheartedly.

Thank you very much, Mr. Chairman.

Senator MUSKIE. Thank you very much, Senator Tydings.

Senator Murphy.

Senator MURPHY. Mr. Chairman, I am pleased to be part of this most important committee and I congratulate you on starting the hearings immediately. This has been a problem in my area of the country for a long time. We have made some progress, not as much as we would hope, and I am impressed by the statistics that my good friend, Senator Tydings, has just read. Of all the questions facing the Congress of the United States, I think air pollution and water pollution are possibly two of the most important.

Therefore, I congratulate you and I look forward to the hearings which I am pleased to say I will accompany you on next week.

Thank you, Mr. Chairman.

Senator MUSKIE. Thank you very much, Senator Murphy.

Now the ranking Republican on the full Committee on Public Works, who has also shown tremendous interest and given great support to our efforts, Senator Cooper.

Senator COOPER. Thank you, Senator Muskie.

I just wish to join in noting the importance of the hearings which are beginning today. We all know that air pollution is one of the great problems in the country. There are many difficulties to be solved in connection with this issue, but I am confident that out of these hearings effective legislation will be developed, and I congratulate you, Senator Muskie, upon the leadership you have shown for several years in this most important field.

Senator MUSKIE. Thank you, Senator Cooper.

Senator Spong.

Senator SPONG. Thank you, Mr. Chairman.

I think everything has been said except that I, too, am delighted to be a part of this subcommittee. I think these hearings are very timely and I hope that the hearings that are going to take place will not only develop information for the subcommittee, but will focalize even more public attention upon this problem and will also encourage the States, who in many instances have lagged, to begin immediately regardless of the fate of this legislation that has been introduced.

Senator MUSKIE. Thank you, Senator Spong.

I might say there is never a point at which everything has been said in the Senate.

Senator Baker.

Senator BAKER. I have no comment.

Senator MUSKIE. I appreciate this expression of continued interest and support on the part of the members of the subcommittee, and now may I welcome a man whom I regard as an unusually effective spokesman for the public interest.

It has been a real source of reassurance to me to have a man of his caliber and effective leadership in the President's Cabinet and especially presiding over the functions of such a sprawling organization as the impossible Department of Health, Education, and Welfare. It is a pleasure, Mr. Secretary, to welcome you this morning.

STATEMENT OF HON. JOHN W. GARDNER, SECRETARY OF HEALTH, EDUCATION, AND WELFARE; ACCOMPANIED BY RALPH HUITT, ASSISTANT SECRETARY FOR LEGISLATION; DEAN COSTON, DEPUTY UNDER SECRETARY OF HEALTH, EDUCATION, AND WELFARE; WILLIAM H. STEWART, M.D., SURGEON GENERAL; VERNON MacKENZIE, DEPUTY DIRECTOR, BUREAU OF DISEASE PREVENTION AND ENVIRONMENTAL CONTROL; AND JOHN T. GRUPENHOFF, SPECIAL ASSISTANT TO ASSISTANT SECRETARY FOR LEGISLATION

Secretary GARDNER. Mr. Chairman, may I first introduce the people at the table here.

At your right, Vernon MacKenzie, Deputy Director of the Bureau of Disease Prevention and Environmental Control; next, Dean Coston, Deputy Under Secretary of the Department; Bill Stewart, Surgeon General; Ralph Huitt, Assistant Secretary for Legislation; and John Grupenhoff, who is Special Assistant.

Mr. Chairman, I am pleased to have the opportunity to discuss the need for enactment of the Air Quality Act of 1967, which embodies President Johnson's recommendations for strengthening the attack on air pollution and which rests on a foundation that this subcommittee has played a major part in constructing.

I described this as a constant chore of the subcommittee. It has also been a very effective chore. You have produced results.

In his message to the Congress on "Protecting Our Natural Heritage," the President pointed out that the Clean Air Act and its amendments enabled the Nation to take important steps toward a more effective attack on air pollution, but he made it clear that our efforts must be intensified if we are not to drown in a sea of dirty air.

The President warned that the Nation's air pollution problem is steadily worsening. These were his words:

> We are not even controlling today's level of pollution. Ten years from now, when industrial production and waste disposal have increased, and the number of automobiles on our streets and highways exceeds 110 million, we shall have lost the battle for clean air—unless we strengthen our regulatory and research efforts now.

Surely, in a nation that has scaled the peaks of technological achievement, where most people enjoy unprecedented standards of personal prosperity, it is not asking too much to insist on the right to breathe decent air. Yet for most Americans, getting a breath of fresh air is becoming more and more difficult.

We have had ample warning of what will happen if we continue to lose the battle against air pollution.

Last Thanksgiving, when a stagnant air mass blanketed the New York metropolitan area, pollution from sources in two States, perhaps in three, reached levels which caused the deaths of an estimated 80 persons. Thousands more were already afflicted with chronic respiratory diseases and were thereby threatened and millions were frightened. And this, ironically, was an episode in which we consider tragedy to have been averted.

More often than not, an ugly shroud of pollution hangs over the New York area. This shroud thins out a bit now and then—and here and there—but most of the time it covers most of the eastern seaboard.

Along the shores of the Great Lakes, from Buffalo and Cleveland to Chicago and Milwaukee, where one metropolis barely ends before another begins, dozens of communities are fouling their own and their neighbors' air. The boundary lines that divide city from city and State from State are no obstacle to the flow of polluted air.

In Florida, as your subcommittee found when it visited there 3 years ago, fluoride pollution from the manufacture of fertilizer threatens to wipe out the cattle and citrus industries that once flourished in Polk and Hillsborough Counties.

In Pittsburgh, St. Louis, Cleveland, and many other communities, people are beginning to recognize that their old-fashioned smoke-abatement programs are inadequate to cope with the more serious and complicated air pollution problems now confronting them.

There is not enough air in the big sky over Texas to thin out the pollutants which pour upward from many of that State's thriving metropolitan centers.

Air pollution is a growing problem in places such as Tucson and Phoenix, whose once salubrious atmosphere had long made them a haven for people afflicted with respiratory diseases.

And in California, the air pollution problem threatens to halt progress and growth, despite valiant efforts by the State government and particularly by the county of Los Angeles.

It is not only in our large urban areas that polluted air damages property and endangers health. It is a problem in many smaller communities as well, and its impact is felt in agricultural and recreational areas where it damages farm crops, timber, and plants of all kinds. The price of air pollution amounts to several billion dollars annually, and this does not include the toll exacted by such respiratory diseases as chronic bronchitis, asthma, emphysema, and lung cancer, all of which are associated with continuing exposure to polluted air.

As the President noted, air pollution worsens in direct proportion to the Nation's economic growth, increases in urban population, demands for heat and energy, use of motor vehicles, disposal of refuse, and production and consumption of manufactured goods. Given the fact that all these latter factors are trending rapidly upward, it will not be long before air pollution reaches truly critical proportions in many parts of the country.

As President Johnson suggested, we must strengthen both our research efforts and our regulatory activities. Strong regulatory programs are urgently needed to insure fuller application of existing technology for the control of air pollution sources. At present the Nation is not even close to employing all the economically and technically feasible methods available for reducing discharges of pollution into the air.

Accelerated research is needed to advance greatly our technical capability for control action. Between us and our goal of a pollution-free atmosphere lies a host of technological problems. If private industry will bring its great research and development capability to bear on these problems, we can expect rapid gains.

I want to emphasize the enormous contribution that industry can and must make to the technological advances necessary to air pollution control.

If American industry had addressed itself to this problem with the energy and imagination it has exhibited on many other fronts, we

would be very much closer to a solution today. Unfortunately, even the industries that will be most directly affected economically by air pollution control have done relatively little, and I speak particularly of relatively little in the field of research and development toward technological advance.

It is true that some industrial firms have made an outstanding effort, and I honor them for it. But on the whole, industry has tended to minimize the problem and to do only what public pressure required it to do.

In the long run it will be very much better for industry and for the American people if we can bring about a dramatic reversal in this situation. If industry will take leadership, with energy and imagination, if it will commit research and development funds on a large scale, if it will bring to bear its own great technical capabilities, we will move rapidly toward a solution of our problems of air pollution.

If we fail to take rational and deliberate control action now, we will soon face serious emergencies, and the American people will then insist on drastic measures of control, no matter how costly, disruptive, or inefficient such measures may be.

If we strengthen our control efforts now, we will not need to resort to more drastic measures later.

The proposed Air Quality Act of 1967, like the Clean Air Act as amended, is intended to accelerate both research and control activities.

Under the provisions of the Clean Air Act, we have been able, through Federal grants, to encourage and support an unprecedented expansion of air pollution control programs at State and local levels. But for the most part, increased staffs and budgets have not been translated into practical control action. Most States and cities have yet to adopt regulations for the control of their principal sources of air pollution.

The Clean Air Act also provided means of stimulating regional control programs and has resulted in many programs designed to serve two or more communities, usually in the same county. But in most instances, these programs serve only part of a larger area affected by a common air pollution problem, and none of them is intended to deal with regional air pollution problems in an interstate area anywhere in the country.

To attack interstate air pollution, the Clean Air Act authorized Federal abatement action, and we are now engaged in such action in nine areas. In four instances, abatement conferences have been held. Two were concerned with interstate pollution in large metropolitan areas—the New York-northern New Jersey region and the Kansas City area in Kansas and Missouri. But this activity is not—and was not intended to be—a means of insuring prompt development of interstate control programs in all the areas where such programs are needed.

The Clean Air Act Amendments of 1965 enabled us to begin attacking the problem of motor vehicle pollution, through the establishment of national standards applicable to new automobiles. Our initial standards, pertaining to crankcase and tailpipe emissions from gasoline-powered vehicles, will become effective in the 1968 model year.

In addition, I have just published proposed standards to control hydrocarbon losses resulting from evaporation of gasoline from fuel

tanks and carburetors. These standards will become effective in the 1969 model year.

Finally, the Clean Air Act has enabled us to mount an expanded research and development effort, focused in large part on improving the Nation's technological capability for controlling air pollution. In the 3 years since the Clear Air Act was passed, our annual expenditures for research have doubled and under the President's proposed budget for fiscal 1968, they will increase by another 50 percent. Ideally, the Federal effort should be the nucleus of a concerted research and development effort by both Government and industry. In practice, however, it has become apparent that new incentives are needed to enlist the talents and resources of industry.

The Clean Air Act and its amendments have been extremely useful. The proposed Air Quality Act of 1967 will enable us to take the additional steps that are needed.

First, emission control levels must be established for those industries which are major contributors to community air pollution problems in many parts of the country.

Currently, the responsibility for setting such levels is assigned almost entirely to State and local governments. But experience has proven that most States and cities will not take the initiative in requiring control measures beyond those required in other places; nor will industries support local or State control action which may place them at a competitive disadvantage.

By setting emission control levels that apply to all communities and all competitors in a given industry, we move toward pollution control in a manner that is fair to everyone, to all industries and to all communities.

The proposed Air Quality Act of 1967 would authorize the establishment of emission control levels for those industries which are nationally significant sources of air pollution. Following publication of the levels, each State would have an opportunity to adopt equivalent or more stringent levels. Federal action to enforce the standards would be authorized only in those States which fail to adopt adequate standards of their own.

Establishment of such nationwide emission control levels will undoubtedly provide an attractive economic incentive to the development of control technology, and will result in better, cheaper and, most important, widely applicable ways of reducing pollution from specific sources.

The second important step we will be able to take under the proposed legislation is to insure the establishment of regional air pollution control in areas where pollution from one State endangers the health or welfare of persons in another State. There are some 70 large interstate metropolitan areas where such problems exist.

The task of developing regional control programs is particularly complex where two or more States are involved. Currently, the only way an interstate program can be brought into being is through the development of an interstate compact and its ratification, both by the legislatures of the States involved and by the Congress. In the 3 years since the Clean Air Act was adopted, only one such compact has come to the Congress. Clearly, a new approach is called for.

The proposed Air Quality Act of 1967 would authorize the Secretary of Health, Education, and Welfare to designate those interstate areas where regional control programs are needed, but where adequate programs do not exist, and to establish a regional air quality commission in each such area. Each commission would include representation from the States involved and from the Federal Government.

Each of the commissions would determine the levels of air quality needed to protect public health and welfare within its jurisdiction and would establish emission control standards designed to keep total pollution from exceeding the established levels. The regional bodies, like State and local agencies, would use the published national emission standards for industrial sources as a minimum in their areas. If necessary, compliance with the regional standards could be achieved through enforcement action at the Federal level.

But the fact that enforcement can be at the Federal level does not mean that it must be. The establishment of regional commissions to deal with interstate air pollution problems is not proposed for the purpose of giving the Federal Government authority to take over a function of State and local agencies.

There will be ample opportunity for States to participate in the process of regional standard setting and in the works of enforcement. The existence of regional commissions will provide new opportunities for States to play a constructive role in controlling interstate air pollution. Federal action will be necessary unless the States fail to take advantage of this opportunity.

I want to comment briefly on three other provisions of the proposed Air Quality Act. The first would authorize the Secretary of Transportation to require that provisions for inspection of motor vehicle pollution control systems be included in State safety inspection programs, receiving Federal grant support, of course.

I have already referred to the need for such inspection machinery. We will be prepared to work with the Department of Transportation and State agencies in developing the necessary procedures.

The second is the provision for registration of fuel additives. It would require, after a date set by the Secretary of Health, Education, and Welfare, that such additives be registered before they are introduced into interstate commerce. The prime purpose of this proposal is to insure that we have full access to the technical information needed to evaluate the possible health hazards of such materials. Too often, new contaminants enter the environment and are widely dispersed before recognition that they may endanger human health. The lead additives used in gasoline are a prime example, but others are already in use, and still others will inevitably be introduced in the years ahead.

My final comment on the proposed legislation concerns the provision for Federal sharing of the cost of equipment to prevent or control air pollution. The purpose of this provision is to give us statutory authority to provide incentives for the demonstration of new or improved control technology.

Ordinarily, the relatively high cost and high degree of risk involved in putting new techniques into practice for the first time discourages industries from undertaking such projects. We believe that

Federal support for the demonstration of control techniques that may be widely applicable are a necessary and very worthwhile way of encouraging industries to make their specialized knowledge and skills available in the interests of better control of air pollution sources for which they are responsible.

In summary, Mr. Chairman, the proposed Air Quality Act is a logical and essential step in the Federal Government's efforts to mount a truly comprehensive national attack on air pollution. Every provision of the proposed legislation will permit us to make necessary improvements in the current pattern of control efforts across the country.

Mr. Chairman, I will be glad to answer questions.

Senator MUSKIE. Thank you very much, Mr. Secretary. I understand that you must leave before 11 o'clock.

Secretary GARDNER. Yes, sir.

Senator MUSKIE. I will then try to limit my questions so that every member of the subcommittee may have an opportunity to question you on the legislation.

First of all, the 1963 act, and indeed the amendments to it which we approved last year, were based on the assumption that the soundest initial approach at least to dealing with the problem was to provide incentives for State and local action.

To what extent have the States and communities responded to those incentives? How many States do have programs? Are they adequate? How many States are considering legislation in this State legislative year across the country?

Secretary GARDNER. I will give you a general answer and ask Dean Coston if he can give you the figures on the actual number of States.

We have been quite disappointed in the vigor with which the States have approached this problem, and there are complications in their approaching it which make it understandable, but it now appears clear that waiting for them to act is not going to get the job done.

Very few States and very few municipalities now have the kinds of provisions, the kinds of legislation, which would permit an attack on this problem, and of course particularly where it is an interstate problem. This is the point of the regional commissions.

Senator MUSKIE. In summary, the problem is growing faster than is the effort to deal with it at the State and local level?

Secretary GARDNER. Dramatically faster.

Senator MUSKIE. Dean Coston, did you want to amplify that?

Mr. COSTON. Senator, before the 1963 act there were very few States that had any significant activity at all. Only 17 States had budgets of as much as $5,000 for air pollution control. By 1965, after 2 years' experience with the Clean Air Act, 40 States had established some kind of air pollution program budgeting over $5,000 each, but only nine of those States had a regulatory program. Most of them were technical assistance, consultative, and advisory, so that even after 2 years of experience with the 1963 act, only nine States developed regulatory programs, and the per capita expenditure on the average in these States was less than 5 cents, which is an extremely small amount of money to deal with the problem.

Senator MUSKIE. Do you have any idea what additional legislation is being planned on the State level this year?

Mr. MACKENZIE. There has been considerable activity, Mr. Chairman, in State legislatures in the last 2 years. I think there has been an increase in the latest sessions in the State legislatures of about 10 or 12 new laws. There are many more that have been introduced, but these have not yet been enacted.

There is one other point I think that is pertinent to the discussion on this point and that relates to taking care of interstate problems.

I would point out that in the entire United States there is only one interstate agency that has any authority whatever in the air pollution field. This is the Interstate Sanitation Commission in the New York-New Jersey area, and its authority is limited to studies. It has no enforcement powers of any kind.

Senator MUSKIE. And it is clear that the pressing and crucial problems are in interstate areas. What efforts have there been in interstate situations on the part of the States involved to try to institutionalize a program for dealing with the interstate problem?

Mr. MACKENZIE. I think the attempts to date, Mr. Chairman, have been largely of an informal character. In the New York-New Jersey area, as an example, there has been established a voluntary committee, with representatives from both the States involved and from a number of the local governments that are concerned with the problem.

A similar activity has gone on in the Philadelphia area. There is one in the vicinity of Detroit of a similar character, and in the St. Louis interstate area there is a bi-State effort being made to develop cooperation, but up to now in no instances in any of these areas has this led to the development of an agency which has real authority to control pollution in the total area that is involved.

Senator MUSKIE. The picture that you paint suggests the absence, almost the complete absence, of a sense of urgency at the State level to deal with this problem. Is that a fair characterization?

Secretary GARDNER. I think it is in some cases a lack of a sense of urgency. I think in many cases it is just very difficult for the States to accomplish these interstate arrangements. There isn't precedent for it. There isn't the machinery for it, and I must say there are a lot of reasons why they may not have acted.

I think that when we get the kinds of machinery that will permit them to put their backs into it, they will.

Senator MUSKIE. Just two or three questions to clarify the President's program. First of all, with respect to the minimum emission levels by industry.

Now, it is the intention here to establish levels that would be enforced by the Federal Government in the absence of State action. Am I correct?

Secretary GARDNER. That is correct.

Senator MUSKIE. This would be true whether the industry were located in the midst of a current air pollution problem, like the New York Metropolitan area, or if it was situated out in the wilderness somewhere?

Secretary GARDNER. That is correct.

Senator MUSKIE. That industry, wherever it was located, if this legislation becomes law would be controlled in the absence of State regulations?

Secretary GARDNER. That is correct. The States are free to set up their own regulations and more stringent ones, if they wish.

Senator MUSKIE. The theory here is that industries that are thus identified by HEW, those industries are poisoning the atmosphere and whether or not they currently created an air pollution problem in an area, the potential for creating it is there and not to be inhibited before it develops.

Secretary GARDNER. That is correct, and just as it is difficult for a single State to take action in these interstate situations, so it is difficult for a single industrial firm to burden itself with expenses that will put it at a competitive disadvantage when it knows that others in the same industry are not doing so, so that this would make a fair arrangement for everyone. All the competitors would be faced with the same regulation.

Senator MUSKIE. In your prepared statement you did not cover the improvements in the enforcement program which the bill covers. Will you have someone who can touch upon that just to make the record complete?

Secretary GARDNER. The improvements in the——

Senator MUSKIE. Enforcement procedures.

Secretary GARDNER. Do you want to comment on that, Mr. Coston?

Mr. COSTON. Senator, we are not proposing any fundamental changes in the existing consultation, conference, hearings, court action system that was developed in the 1963 Act.

We do as a part of our request for new authority under the regional commissions and national standards ask for additional authority for such things as factory inspection, inplant examinations, a chance to look at records to see really what is going on.

One of the great problems that we have encountered in trying to deal with this problem is our inability to find out with any great precision exactly what is happening. Under the present law we can stand on the edge of a property line and sort of sniff at what is coming out of the stack as it gets across the line, but we are unable to get into the plant and see what is going on, to see the process and try to work with the industry people in order to get the information that is needed.

Senator MUSKIE. So that the enforcement provisions of the bill are aimed at beefing up the regional commission approach and to give the effective powers to deal with the regional air pollution problem?

Secretary GARDNER. Yes, sir.

Senator MUSKIE. Senator Randolph, I have taken a little more time than I intended initially.

Senator RANDOLPH. Mr. Chairman, you mentioned the minimum emission standards. I now address our distinguished witness: One of the problems, Mr. Secretary, with which the Congress of necessity will have to cope is the question of the degree of technological advance in this field. Could you state for the record of the subcommittee whether in your opinion there will be the so-called hand-in-hand procedure or whether the Federal standards would precede the technological advance?

I think it is important that we know whether the so-called state of the art, to use an expression, will go hand-in-hand with the emission criteria which properly should be set.

Secretary GARDNER. Yes, sir. It is perfectly clear, and it has been stated in the President's message, that we must take into consideration economic and technological feasibility in setting the standards. It is equally clear to me that the state of the art has tended to meander

along until some sort of regulation took it by the hand and gave it a good pull, so our effort will be to stimulate and go to the state of the art rather than wait for it.

There has been a long period of waiting for it and it hasn't worked very well. It seems to me that the problem we face here is that industries, which will face problems as a result of air pollution control measures, will face more severe problems if they fail to control air pollution, because they will be walking head on not into the Federal Government, but into the interests of the American people, and the concern of the American people, the visible, rising concern of the American people.

This has been quite a striking thing to all of us in the past couple of years. The concern of the public about air pollution, and the popularity of air pollution control measures, is something that industry must cope with. If we can stimulate more rapid development of the state of the art through setting the standards at a point which we really have to reach for them, so much the better.

Senator RANDOLPH. Mr. Secretary, I am in general agreement with what you say and I do believe that the legislation has been a stimulant. But I trust that regulations that are responsive to and consistent with actions authorized by the Congress will be reasoned and will go hand-in-hand with technological progress. As I said in my brief statement earlier, there is a partnership involved here between industry and government.

I don't think of either one of them as being the senior partner. I visualize and hope for a realistic relationship which, I think, can bear fruit. Admittedly, there must be a stimulation of industry and cooperation by industry and government to bring this partnership into a constructive program of action.

You mentioned that some industries, Mr. Secretary, are going ahead on their own and are spending huge capital sums for abatement control facilities at a competitive disadvantage with other companies within their same structure of manufacturing. You indicated that perhaps it might be slower than it should be, this action by different companies within one industry. I agree with you. We do recognize this as being a real problem.

I feel very strongly that the 7-percent tax credit which was to finance these capital outlays was a valid and useful provision in the tax laws. I regret that it is not in being today and I hope that it can be returned to our tax structure.

Would you comment on this, sir?

Secretary GARDNER. Yes, sir. We gave consideration to that. That is the kind of question that does come up in any serious discussion of possibilities of air pollution control, but the present position is not to endorse such an incentive now.

As I recall the President's message, he directed that we undertake a study of possible incentives of this sort.

Senator RANDOLPH. Mr. Secretary, I would think that perhaps Senator Cooper would like to discuss this. One incentive proposal I have been privileged to cosponsor is with Senator Cooper.

I will not proceed on this. I will defer to Senator Cooper. Now, I direct this remark to Mr. Coston: Dean, we have 2 problems in the interstate situation, as Senator Muskie has indicated. The Secretary, of course, has embraced that thinking also.

I understand that in the Ohio River Valley, industries in the States of West Virginia and Ohio have developed a compact proposal for the legislatures of those States to consider. Involved in this process are some 34 industries up and down the valley from East Liverpool, Ohio, to Huntington, W. Va.

Do you have knowledge of this affirmative action, Mr. MacKenzie?

Mr. MACKENZIE. I am not acquainted with it, Senator Randolph.

Senator RANDOLPH. Mr. Chairman, unless there is objection, I will place in the record developments in this regard. Responsible industries are involved in an attempt to help solve the pollution problem we have between these two States in that great industrial valley astride the Ohio River.

(The material submitted is as follows:)

TEXT OF TELEGRAPHIC MESSAGE FROM U. S. SENATOR JENNINGS RANDOLPH, CHAIRMAN, SENATE COMMITTEE ON PUBLIC WORKS, TO FRED E. TUCKER, CHAIRMAN, OHIO-WEST VIRGINIA INDUSTRY COMMITTEE ON AIR POLLUTION ABATEMENT

WASHINGTON, D.C., *December 19, 1966.*

I commend the founders and the participants in the Ohio-West Virginia industry committee on air pollution abatement. Please know that I will join the committee in urging the West Virginia legislature to take affirmative action on an Ohio-West Virginia compact on air pollution control which I understand the committee will propose. The legislature must be free, however, to work its will on such a compact both as to form and content. If the States of Ohio and West Virginia, through their legislatures, agree on a compact, I will be among its sponsors and proponents in the Congress of the United States. I do not share the pessimistic views of some of my Senate colleagues on the value of compacts between the States. Rather, as Vice President Humphrey said in an air pollution conference address in Washington last week, "while some people believe that the problem of air pollution can be solved locally and others suggest that we have come full circle, and that the federal government must assume the full responsibility, I submit that neither approach is adequate by itself. Needed is a working partnership among all levels of government and with private industry as well. Air pollution will not yield to anything less than a determined and coordinated effort by all sectors of our society. We need non-diffusion treaties between States that share the same airshed."

Committees of the nature and character of yours have done praiseworthy and effective work in the field of water pollution control. They are not the total answer, but the voluntary impetus such committees provide frequently results in major pollution problems being solved or substantially abated without the last resort actions of governmental control agencies being called into play. The impatient individuals who call for overnight solutions to air and water pollution problems through hurriedly devised uniform federal standards and rampant enforcement are unrealistic. There are no magic formulas and there is only enough enforcement force to scratch the surface, so we need to encourage and not deprecate voluntary efforts and interstate compacts.

JENNINGS RANDOLPH, *U.S. Senator.*

[Ohio-West Virginia Industry Committee on Air Pollution Abatement Press Release, December 20, 1966]

1967 OHIO, WEST VIRGINIA LEGISLATURES TO GET AIR POLLUTION CONTROL COMPACT

A proposed Ohio-West Virginia Air Pollution Abatement Compact will be presented to the legislatures of the two states at their 1967 sessions.

Over 34 major industries with plants on both sides of the Ohio River from East Liverpool, O., to Huntington, W. Va., sponsors of the Ohio-West Virginia Industry Committee on Air Pollution Abatement, revealed that the Compact proposal will be submitted to the legislators in January.

The committee unveiled its plans for the Compact at joint, simultaneous briefings for legislators, mayors and the press held today in Parkersburg, W. Va., and Steubenville, O.

The group—representing, among others, the power, chemical and metal industries—said it has been quietly at work since early this year on the proposed Compact and that the final draft is now ready for presentation to the legislatures when they convene next month.

Fred E. Tucker of Weirton, chairman of the committee, said that the Compact was drafted in accordance with the intent of Congress and the provisions of the Federal Clean Air Act.

"It is designed to control only interstate—not intrastate—air pollution and, therefore, deals only with pollution originating in Ohio or West Virginia which crosses the Ohio River into the other state," Tucker pointed out.

"For that reason, the powers of the Commission which this Compact would establish would be confined to air pollution problems originating in or affecting counties bordering on the Ohio River between Cabell and Wayne Counties in West Virginia and Lawrence County, Ohio, on the south and Columbiana County in Ohio and Hancock County, West Virginia, on the North."

If the Compact agreement is adopted by both the Ohio and West Virginia Legislatures in substantially the same language and signed by the respective governors, it would then go to Congress for approval. The industry committee is hopeful of winning congressional approval of the Compact during the 1967 session of Congress.

Once the approval of Congress is received, Ohio and West Virginia would then be authorized jointly to form the Ohio-West Virginia Interstate Air Pollution Control Commission.

The Federal Clean Air Act—orginially passed by Congress in 1955 and last amended in 1965—encourages the making of such compacts.

Under the proposed Compact, the Interstate Air Pollution Control Commission would have 10 members, five from each state, appointed by the governors of Ohio and West Virginia.

Of the five from each state, one member would be the state officer responsible for air pollution control; the second would be the state director of health; the third and fourth members would be persons experienced in the field of municipal government and industrial activities; while the fifth member would represent the general public.

Each commissioner would serve a five-year term, except for the heads of the two state agencies who would serve during their terms in those positions.

Each member would be entitled to one vote on any action. In the event of a tie, the Secretary of Health, Education and Welfare or his representative would cast the tie-breaking vote.

The Commission would annually elect a chairman and Vice-chairman and appoint an executive director to perform the administrative duties.

"The proposed Compact," said Chairman Tucker, "does not limit or otherwise affect the powers of either state or their subdivisions to enact and enforce their own air pollution control laws or ordinances."

Financing of the Commission's activities would be shared by the federal and two state governments. The Clean Air Act provides for grants of up to three-fourths of the total operating budgets of such commissions, while the remaining one-fourth would be shared equally by Ohio and West Virginia.

The Commission would be empowered to establish standards consistent with standards that may be adopted by state air pollution control agencies.

When the Commission finds interstate air pollution, it would investigate the problem and prepare a report. But before the report becomes final, owners or operators of offending installations would be notified and given a reasonable opportunity to correct the condition.

In the meantime, all existing state and local air pollution control agencies in the state where the pollution is originating, furnished with the Commission's report of the problem and recommendations for eliminating it, could be considering the matter and appropriate action.

If, after a reasonable time, the owner or operator of the pollution source or the state or local agencies have not taken sufficient action to eliminate the problem, the Commission would hold a hearing for the offender before issuing a final order to correct the problem.

Should the offender then fail to comply with the order and timetable for correction of the air pollution problem, the Commission would be empowered to take action in the appropriate state or federal court.

Under the provisions of the Compact, the Commission may establish advisory and technical committees to assist in the correction of interstate air pollution problems.

Member firms of the Ohio-West Virginia Industry Committee on Air Pollution Abatement which is sponsoring the Compact include:

Ohio Power Co., Weirton Steel, Union Carbide, Allied Chemical, Wheeling Steel, Koppers, Triangle Conduit & Cable, Shell Chemical, Ormet Corp., Signode Corp., Monongahela Power, Vanadium Corp., Ohio Ferro-Alloys, Johns-Manville Fiber Glass, American Viscose Division of FMC.

Owens-Illinois, Holland-SUCO Color, American Cyanamid, Titanium Metals, Barium and Chemicals, Inc., Huntington Alloy Products Division of INCO, Mobay Chemical, Marbon Chemical, Chemical Division of Pittsburgh Plate Glass, Continental Can, Ohio Edison, duPont, Ohio Valley Electric Corp., Blaw-Knox, Appalachian Power, B. F. Goodrich, Bloch Brothers Tobacco, Goodyear Chemical and Stauffer Chemical.

OHIO-WEST VIRGINIA INDUSTRY COMMITTEE
ON AIR POLLUTION ABATEMENT,
Weirton, W. Va., December 21, 1966.

Hon. JENNINGS RANDOLPH,
U.S. Senator, New Senate Office Building,
Washington, D.C.

DEAR SENATOR RANDOLPH: Your telegram offering support of our efforts toward enactment of an Ohio-West Virginia Air Pollution Control Compact was read and distributed at our press and legislative briefings in Parkersburg, West Virginia and Steubenville, Ohio on December 20, 1966. We of the industry committee deeply appreciate your endorsement of the compact and the thoughts expressed in your communication.

Our proposal was well received by the people of the two states and we received many offers of support by legislators of both parties in each state. We will proceed to have identical bills presented to the legislatures of both states early next month. I am optimistic that sometime during the 1967 legislative year we will have a bill ready for you to present to the U.S. Senate.

Very truly yours,

F. E. TUCKER, *Chairman.*

OHIO-WEST VIRGINIA INDUSTRY COMMITTEE
ON AIR POLLUTION ABATEMENT,
Weirton, W. Va., January 24, 1967.

Hon. JENNINGS RANDOLPH,
U.S. Senate,
Washington, D.C.

DEAR SENATOR RANDOLPH: For your information, the Ohio-West Virgina Air Pollution Control Compact legislation has been introduced into both the Ohio and West Virginia Legislatures. We are receiving excellent bi-partisan support for this legislation. I am enclosing a copy of the West Virginia bill as introduced during the week of January 23, 1967.[1] We appreciate your outspoken support of this effort in the Ohio River Valley.

Very truly yours,

F. E. TUCKER, *Chairman.*

Senator RANDOLPH. Mr. Coston, West Virginia was an early State in the adoption of an air pollution control law, and in the activation of a control commission.

Mr. COSTON. Yes, sir.

Senator RANDOLPH. Would you give us your opinion as to the effectiveness of our commission? I am sure we have shortcomings. But I would hope you would indicate if the commission and the West Virginia Legislature and others have faced up to this responsibility.

Mr. COSTON. That is quite correct, Senator. West Virginia did take very early leadership in this whole area. As are most of these State commissions, your State is under-financed and under-staffed. In view

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[1] The compact referred to appears in the printed hearings of May 8, 1967 (Part 3), following the statement of Mr. Tucker.

of all the priorities that the Governor and legislature have there, this hasn't gotten the kind of support that it needs to be truly effective.

Secondly, West Virginia as much as any State I can think of is really faced with a host of interstate problems. You have severe pollution problems all along your borders with both Ohio and in Kentucky. A State commission simply cannot deal effectively with an interstate pollution problem, particularly as you look at the vast industrial complex that stretches up and down the border and rivers of West Virginia.

Senator RANDOLPH. And in the Kanawha Valley as well within the State.

Mr. COSTON. Yes, sir. As you know, we have already instituted some Federal consultations in various areas of West Virginia. We are finding excellent cooperation from the State Commission of West Virginia. They have been very helpful. We think we have built a very good relationship and I am hopeful that these abatement actions, slow though they are, will eventually result in considerable improvement along the Kanawha Valley and the West Virginia industrial complex.

We are very pleased with what the State of West Virginia is doing.

Senator RANDOLPH. Thank you, Mr. Coston. Thank you, Mr. Chairman.

Senator MUSKIE. Senator Boggs.

Senator BOGGS. Thank you, Mr. Chairman.

I know there are a lot of questions and I am watching that clock, too, Mr. Secretary. I appreciate your statement, but I wonder if you have given any thought and would care to comment on the problem that faces some of the areas right now that already have a regional authority on water resources and water pollution.

In these informal meetings that are going on, Mr. MacKenzie, they are discussing whether or not the regional approach to air pollution should be in this same organization. There are pros and cons. I don't know whether your department has given any consideration to that or not.

Secretary GARDNER. Senator, we have talked about it and I will ask Dean Coston to comment because he has followed the water pollution problem closely, too.

Mr. COSTON. One of the problems, of course, in developing joint programs in air and water, which has been considered by this committee and by our department and by the executive branch, is that the problems really aren't the same. They are quite different problems technologically.

The boundaries of the problems are not coterminus. River basins and air pollution problems are related because often industrialization tends to center along rivers, but the boundaries are not coterminus. It is hard to define an area which would include all of the water problems and all of the air problems and still have a rational institutional organization to deal with them.

Also, water problems are more capable of public solution than are air problems, because you can treat water as a resource in a system which can be developed at public expense. You can't do this with air.

There is no way you can collect the air around a community and run it through a waste treatment facility. The developments involved are largely private developments. You have to treat the problem, work with air pollution at the source of that pollution. The two different

mechanisms by which you deal with them don't really fit together in any rational way. We have not arrived, at least at this time, at any institutional arrangement which will permit the two to be operated under the same kind of leadership.

Senator BOGGS. Thank you. I am inclined to share your views on that, too, and it is a matter under discussion up our way at the present time and I am glad to have your views on it.

Mr. Secretary, just hurriedly, and I say hurriedly, although I have been over it several times—the request for authority on mere written notice to an owner or operator to enter a factory, warehouse, office, or business for the purpose of inspection of those premises, including equipment, finished or unfinished materials, records, files, papers, processes, controls, and so forth, facilities stood out, of course, and I realize how much authority that maybe a local fire marshal in a community, or even the State fire marshal under urgent circumstances has. And I can see some justification for that, but really maybe as we go on, more consideration will be given to the need, or urgent situation pending before we take this great liberty with private property?

Secretary GARDNER. No, sir.

Senator BOGGS. I have a concern about that, sir.

Secretary GARDNER. We would certainly be willing to surround that provision with the reasonable conditions and the orderly process that would guarantee that it were only done where we had grounds to believe that it was necessary, but I would hate to see it limited to emergency situations. It seems to me it should be broader.

Senator MUSKIE. Will the Senator yield at this point?

Senator BOGGS. Yes.

Senator MUSKIE. In last year's water pollution control amendments we wrote a modification of this proposal. I wish that you would have your technical people look at that and comment on it as perhaps a way of modifying this proposal, if it seems wise.

We would simply like to get your reaction to it.

Secretary GARDNER. Good. Would you like that for the record, Senator?

Senator MUSKIE. Yes; I would.

Secretary GARDNER. We will insert that in the record.

(Subsequently the following information was submitted:)

THE UNDER SECRETARY OF HEALTH, EDUCATION, AND WELFARE,
Washington, D.C., April 27, 1967.

HON. EDMUND MUSKIE,
Chairman, Subcommittee on Air and Water Pollution, U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: During Secretary Gardner's testimony concerning S. 780 on February 8, you requested that this Department comment on the suitability of the reports requirement contained in recent amendments to the Federal Water Pollution Control law as a means of securing the information contemplated by the inspection provision in Section 5 of S. 780.

We have examined the provisions of the Federal Water Pollution Control Act, as amended, Sections 10(f)(2) and 10(k)(1) and find that these provisions are similar to Section 105(i)(1) of the Clean Air Act, as amended. The Sections provide authority to require any person causing or contributing to air or water pollution to file a report, based on existing data, furnishing such information as may reasonably be required as to the character, kind, and quantity of pollutants discharged and the use of devices or other means to prevent or reduce the emission of pollutants by the person filing the report.

On the question whether the authority afforded by these sections of the Federal Water Pollution Control Act is adequate for its purposes we defer to the Department of Interior which has responsibility for administering that Act. Whatever the answer be, we do not regard such authority as adequate for enforcement of the air pollution control standards provided for in S. 780.

The authorities necessary for effective control of air and water pollution are not identical in every instance because the circumstances relating to each are different. Pollutant discharges which contribute to water pollution are commonly channelled through a limited number of outlets into a body of water which is part of the public domain. Under such conditions, a control agency has sufficient access to acquire measurement of at least the total discharge. With respect to air pollution sources, however, absent an *in situ* continuous monitoring device to measure actual discharges from individual stacks, or the right-of-entry to premises for inspections, it is impossible with the present state of the art to obtain information on sources of pollution with sufficient accuracy to support enforcement actions.

Moreover, our limited experience to date with reports requirement under the Clean Air Act has not been entirely satisfactory. In the two abatement actions in which we invoked the reporting requirement (involving pollution sources on a considerable number of private premises) the information obtained thereby was not in many instances adequate for the purpose.

From our knowledge of State air pollution control laws, we can report that no fewer than 25 such laws contain provisions to permit entry and inspection of suspected sources of air pollution. The Committee may find of particular interest the laws of the members' respective States in this regard. We are enclosing such provisions for the Committee's convenience. Similar authority is necessary in Federal law if Federal activity in this matter is to be fully effective.

Since Los Angeles County, California, has achieved notable success in controlling emissions from stationary sources, we find its experience instructive. Therefore, the comments of Los Angeles County Supervisor Dorn before your Committee on February 13, 1967 are of considerable interest. In response to a question by Senator Tydings concerning the need for right of entry, Supervisor Dorn stated that such authority is essential for effective enforcement.

The primary purpose of the power to enter and inspect is to make available information concerning the quantity and characteristics of those discharges subject to Federal regulatory authority. We recognize that such authority may involve discovery of information not pertinent to air pollution control, such as trade secrets, which the proprietor thereof may not wish disclosed to competitors. However, we do not believe any change in the bill is required since the provisions of 18 U.S.C. § 1905 would provide protection for these trade secrets. (Those provisions provide for penalizing any Federal employee who discloses any information, coming to him in the course of his duties, which relates to "trade secrets, processes, operations, style of work or apparatus", among other things, except as authorized by law.) Should your Committee decide nevertheless that some additional protection of the proprietary interests in trade secrets and other data is desirable we would be happy to provide such technical assistance as the Committee may desire in arriving at a satisfactory provision.

Sincerely yours,

WILBUR J. COHEN,
Under Secretary.

RIGHT OF ENTRY PROVISIONS IN LAWS OF STATES REPRESENTED BY MEMBERS OF THE SENATE SUBCOMMITTEE ON AIR AND WATER POLLUTION

California—West's Annotated California Codes, Health and Safety Code

Section 24246. The air pollution control officer, during reasonable hours, for the purpose of enforcing or administering this chapter, or any provisions of the Vehicle Code relating to the emission or control of air contaminants, or of any order, regulation or rule prescribed pursuant thereto, may enter every building, premises, or other place, except a building designed for and used exclusively as a private residence and may stop, detain, and inspect any vehicle, designed for and used on a public highway but which does not run on rails. Every person is guilty of a disdemeanor who in any way denies, obstructs, or hampers such entrance, or such stopping, detaining, or inspection of such vehicle or who refuses to stop such a vehicle upon the lawful order of the air pollution control officer.

Delaware—Delaware Code Annotated, 1953, Title 7

Section 7.6203. The Commission in regulating air pollution pursuant to this Chapter: . . . (10) May enter at reasonable times upon any private or public property for the purpose of investigating conditions relating to air pollution; . . .

Hawaii—Revised Laws of Hawaii, Title 47

Section 47–64. The department shall control air pollution in accordance with any rule or regulation promulgated by it and for this purpose shall have, but shall not be limited to, the following powers: . . . (e) To enter and inspect, during reasonable hours, any building or place, except a building designed for and used exclusively for a private residence, for the purpose of investigating an actual suspected source of air pollution and ascertaining compliance or noncompliance with any rules and regulations of the department and to make reasonable tests in connection therewith. . . .

Indiana—Burn's Indiana Statutes, Annotated, Title 35

Section 35–4604(B). . . . [The state board of health] is hereby empowered to: . . . (9) Enter at all reasonable times in or upon any private or public property except private residences for the purpose of inspecting and investigating conditions relating to the pollution of the air of this state. . . .

Kentucky—Kentucky Acts 1966, House Bill No. 259, Approved March 8, 1966

Section 9. Any duly authorized officer, employee, or representative of the Commission may enter and inspect any property, premise, or place at any reasonable time for the purpose of investigating either an actual or suspected source of air pollution or of ascertaining the state of compliance with this Act and regulations enforced pursuant thereto. No person shall refuse entry or access to to any authorized representative of the Commission who requests entry for purposes of inspection, and who presents appropriate credentials; nor shall any person obstruct, hamper, or interfere with any such inspection.

Maryland—Annotated Code of Maryland, 1957 (1965 Replacement Volume), Article 43

Section 696. When in discharge of the responsibilities of the Department under this subtitle, personnel designated by the Commissioner of the Department may, with the consent of the property owner, have entry at all reasonable times to all property, real and personal, and may inquire into and receive information as to any device, process, material, and any other fact deemed necessary by such designated personnel for evaluation of the condition. If the property owner refuses to consent to the entry of the Circuit Court of any country in which all or any part of the property is located or the Baltimore City Court, if all or any part of the property is located in Baltimore City, may upon petition of the Department and for good cause shown, issue an order granting such right of entry on such terms and conditions as the Court may deem appropriate.

Tennessee—Tennessee Code Annotated, Health and Safety

Section 53–3405. The Commissioner or his duly authorized deputy shall have the authority to:

(a) Enter at reasonable times and inspect any building or equipment, for the purpose of investigating a known or suspected source or contributing factor to air pollution. Any person obstructing such entry shall be in violation of this chapter. Nothing in this chapter shall authorize entry into dwelling structures used exclusively for human habitation. . . .

Virginia—Act of Assembly 1966, Chapter 497, House Bill No. 420, Approved April 4, 1966

Section 13. Whenever it is necessary for the purposes of this act, the Board or any member, agent or employee when duly authorized by the Board may at reasonable times enter any establishment or upon any property, public or private, for the purpose of obtaining information or conducting surveys or investigations.

West Virginia—West Virginia Code, 1961

Section 1409(132). The Commission is hereby authorized and empowered: . . . (9) To enter at reasonable times upon any private or public property for the purpose of investigating an alleged statutory air pollution . . .

Senator MUSKIE. Senator Tydings.

Senator TYDINGS. Mr. Secretary, how comprehensive is that list of industries selected for the establishment of air quality standards going to be?

Secretary GARDNER. It is not intended to be comprehensive. We will proceed with the studies which will determine which industries we will look into.

Senator TYDINGS. How long are you going to take?

Secretary GARDNER. Well, we haven't set a time limit.

Senator TYDINGS. How long do you think you are going to take?

Secretary GARDNER. Mr. MacKenzie, what is your estimate?

Mr. MACKENZIE. What we have in mind, Senator, is to provide minimum standards for emissions for those industry processes that are of broad significance nationally. The intent is to apply controls that are technically feasible and that in our opinion should be incorporated as a matter of common decency and cleanliness regardless of where these are located.

Senator TYDINGS. I followed all that and I commend you for it, but the question I am directing is—how long?

Mr. MACKENZIE. With respect to the specific industries to which this could apply, we have some such data already on hand, so that I think it could be made applicable very quickly to a number of industry processes and I would include in that category those activities concerned with the manufacture of sulfuric and nitric acid, the manufacture of cement, oil-refining activities, heavy metallurgical processes—in general, the large heavy industries that are major sources of pollution in many places throughout the country.

Senator TYDINGS. Will you be able to designate the list, say, within 3 months after enactment, assuming the bill is passed and the President signs it?

Mr. MACKENZIE. I think we can designate an initial list certainly, sir. I have a number of publications here that the committee might be interested in in which there are technical data concerning the procedures that are available for controlling emissions from such industries.

One of these is concerned with emissions from petroleum refineries. Another concerns air pollution from iron and steel manufacture, and still others the manufacture of nitric acid, sulfuric acid, the kraft pulping process, and so on.

Senator TYDINGS. You have already done really the basic work. When you get the authority, your authorization, you could really almost swing into action at once?

Mr. MACKENZIE. I think we could make a significant start, Senator.

Senator TYDINGS. Mr. Secretary, how much progress has been made in the establishment of air pollution standards for diesel engines, that is, buses and trucks, and so forth and so on?

Secretary GARDNER. As you know, we have had a good deal of difficulty with the problem of diesel exhaust emissions. Part of the diffi-

culty is that it is a problem of maintenance of the vehicle itself, and partly a problem of the operation of the vehicle.

If you had perfect maintenance and if you had proper engine adjustment, you would be able to diminish greatly this problem of diesel emissions.

Senator TYDINGS. It is a major problem; isn't it?

Secretary GARDNER. It is, but the experts do not rank it as one of the top problems except in a public-relation sense. It makes everybody angry because they get behind a bus and it smells bad, but in the ranking of the emissions that really produce air pollution and smog and the like, this is not as high on the list.

Senator TYDINGS. You already have the authority, though, don't you, established?

Secretary GARDNER. Yes.

Senator TYDINGS. You can push this area. You don't need any legislation from us.

Secretary GARDNER. That is right. We cannot control the operation and maintenance.

Senator TYDINGS. So the public really can look for you already. Along the lines that Senator Randolph brought up about the state of the art insofar as cleaning up the air, isn't it true that the state of the art is rather advanced already and that, if industry had sufficient incentives and really wanted to clean up the air, conservatively over 50 percent of the gaseous and solid pollutants that go into our atmosphere today could be cleaned up with the knowledge of the art we already have now?

Secretary GARDNER. I think that it is fair to say that, but I do believe that great technological advances are still possible. I think that the coal industry is gravely in need of some technological gains in taking the sulfur content out of their fuels.

I think that the cost of control could be reduced greatly with some advances in technology.

Senator TYDINGS. Following up on Senator Randolph's questions, wouldn't it appear to be commonsense, if you already have a great deal of technology which could be used, that you are going to need some sort of incentive for industry to use it and that the tax incentive would be a tremendous acceleration factor in getting industry itself to clean up their own air and their own pollutant causes?

Secretary GARDNER. Well, as I pointed out to Senator Randolph, the President has directed us to study the possibility of such incentives and that we intend to do.

Senator TYDINGS. You read different magazines, articles in the New York Times, and other papers, and you see that if you really wanted to do the job of cleaning up air pollution in the United States it would cost about $55 or $60 per person, and today we are spending maybe across the United States less than 50 cents. Since you need a tremendous effort to clean up the air and as industry is contributing already, you can approach the problem in a number of ways.

The Federal Government can authorize funds, perhaps a billion-dollar program, or you can approach it from another tact and provide tax incentives to try and get industry to move ahead themselves.

I would think that you ought to have some recommendations to us on this type of incentive very shortly.

Secretary GARDNER. May I read you the relevant paragraph from the President's message? He said:

I am asking the Chairman of the President's Council of Economic Advisers and the Secretary of Health, Education, and Welfare to explore appropriate measures to encourage industry and local governments to abate pollution. I have asked them to meet with business and local government leaders and present their recommendations to me.

Senator TYDINGS. One final question, Mr. Secretary.

Would you say that there is a problem insofar as the emission of gaseous and solid waste from Federal reservations and buildings owned or controlled by the GSA?

Secretary GARDNER. We have recognized that that problem existed. The President issued an Executive order last year and I have set standards under that order and we hope that that will greatly diminish as a problem.

Senator TYDINGS. Is there anything being done insofar as new buildings that are leased by the GSA, are constructed by the GSA, to take advantage of the technology which has been perfected to clean up the air so that when you build a new building, at least you build in the best protection to the community that can be built.

Secretary GARDNER. I will have to ask Mr. MacKenzie to answer that.

Mr. MACKENZIE. The regulations apply to all Federal facilities that are controlled by Federal departments.

Senator TYDINGS. I am talking about new buildings. Are you doing anything affirmatively to require that the GSA has it in its plans and specs?

Mr. MACKENZIE. Yes, sir.

Senator TYDINGS. You are?

Mr. MACKENZIE. Yes, sir. This is fully operative with respect to all new Federal facilities and the Bureau of the Budget has issued a directive to the departments and agencies that appropriate provisions should be made in their financial planning for incorporating such provisions.

Senator TYDINGS. Thank you very much, Mr. Chairman.

Senator MUSKIE. Thank you, Senator Tydings. I understand you should leave in 5 minutes, Mr. Secretary. I would say that we expect to have you back about April 18 or 19 for further discussion of this. Now may I ask my colleagues to ask questions within this time limit. Senator Murphy?

Senator MURPHY. First of all, hasn't most of the development in this area been done on a local basis rather than statewide simply because the effect has been on the local community?

Secretary GARDNER. That is correct, sir.

Senator MURPHY. In other words, we might presume then that there has been more done than the figures just quoted by the gentleman to your left?

Secretary GARDNER. I think coming from Los Angeles you are more conscious of local activity than you would be if you were looking at the nation as a whole. I don't think many communities stand out for the vigor with which they have done this.

Senator MURPHY. Isn't this the reason that it has been difficult? For instance, there are areas in Los Angeles which have been affected. Many

other areas of the State are not affected. In fact, a very small percentage of the sky over the State is affected. Other areas have no problem. Isn't this one of the reasons why the States possibly have been slow to act?

Secretary GARDNER. This is no doubt one of the reasons.

Senator MURPHY. I would like to ask a question. We have had in Los Angeles some tests on equipment put on new automobiles and there have been conflicting reports in the press. Do you have any figures or any information as to the effectiveness of that in carrying out the problem of exhaust?

Secretary GARDNER. Again I would like to ask Mr. MacKenzie to give you a technical answer to that.

Mr. MACKENZIE. Yes, sir. We have been following with great interest the emission control systems that have been incorporated on new automobiles sold in the State of California beginning with the 1966 models.

We have also made arrangements with the General Services Administration that such controls are installed in a number of automobiles operated in the Federal motor pools in various locations throughout the country. In evaluating the performance of these, therefore, we are now getting information from the State of California through a contract and also by direct measurements of federally operated vehicles in a number of places. We are somewhat concerned over the fact that the effectiveness of the pollution control systems now incorporated in cars in California seem to be deteriorating at a more rapid rate than had been anticipated.

The Federal standards require that the pollution control systems be effective over the entire lifetime of the vehicle, which is estimated at 100,000 miles, and for this purpose requires durability testing. We think we have the problem in hand.

Senator MUSKIE. May I interrupt a moment.

Senator MURPHY. Yes.

Senator MUSKIE. I think that Secretary Gardner's assistants could stay and answer questions. Couldn't we release Secretary Gardner at this point?

Senator MURPHY. I would like to ask just one question of the Secretary before he leaves. I think this is important.

We have now discussed for a period of 2 years that I know of providing industry with an incentive to move ahead with the equipment and the facilities necessary. I have had some experience in these areas aside from the situation in Los Angeles. I happen to know that it is very expensive and that that places an industry in a very tough competitive position.

I would think that the first thing I would hope would be that these studies which are yearly promised would be accelerated. I have heard so much of studies since I have been in Washington. When you get down to the concrete facts sometimes the study seems to go all around the bush and doesn't get right to the point.

Would it be practical to suggest that you separate the added cost to industry, for funds spent exactly on air pollution, and that the industry be given tax credit for this? Would this be a proper suggestion to add to the administration's bill?

Secretary GARDNER. It would be a proper subject for study, Senator, and since I am now directed to undertake this study I would certainly regard that as the top of the list.

Senator MURPHY. Would you say it is going to be forthcoming? I think it is most necessary. We who have been in industry know that the margin of profit is often very fine in many industries. We know that the problems have become more complex, and I think that there are many industries that would like to do this. I don't think it is because they are being unmindful of their community spirit or anything else.

In many cases, industry just can't afford it. Two considerations are involved. First, the state of the art, and, second, the necessity of granting industry a tax on the credit. We all agree something must be done, for if we don't get it done, we are going to be in a mess in this great country of ours.

Secretary GARDNER. Senator, we will certainly move that study ahead on as fast as possible a schedule. I have a clear impression of the interest of the committee and yourself in this and we will move ahead.

Senator COOPER. I understand that Secretary Gardner must leave. I will be glad to direct my questions to his assistants.

Senator SPONG. I will defer mine until after our field trips and upon the Secretary's return.

Senator MUSKIE. Then if we may have the continued attendance of your assistants, Mr. Secretary.

Secretary GARDNER. Thank you, sir.

Senator MUSKIE. Thank you very much.

Now the target has narrowed.

Senator Murphy, would you like to continue this line of questioning you were pursuing with Dr. MacKenzie?

Senator MURPHY. No, I finished. I think that one other approach that I have seen shows that in the studies made in Los Angeles 80 percent of the pollutants are created by traffic; in other words, the burning of the present fuels, is this in your judgment a fair statement?

Mr. COSTON. I think that is a pretty fair approximation in Los Angeles today. Los Angeles County has done a superb job of controlling fixed sources of pollution over the years, and have come to grips with the problem that is now being recognized in other major metropolitan areas as very serious. I am sure when your committee is out there next week you will hear some very exciting things about what the county has been able to accomplish in the area of fixed-source pollution.

They haven't yet, and with the increased rate of vehicle population in Los Angeles, they may never fully control pollution from the automobile unless they have much more effective controls than we now see on the horizon.

Senator MURPHY. Would the reduction of the lead content reduce the smog?

Mr. COSTON. I don't believe, Senator, that lead content is an effective agent for the creation of photochemical smog, but I will let Mr. MacKenzie speak to that question.

Mr. MacKenzie. Mr. Coston's answer is correct in this regard. We would not expect that decreasing the lead content in gasoline would have any major effect on the pollution emitted except with respect to the lead itself.

Senator Murphy. I have one other question. I have read in many of the areas, on the east coast particularly, where the burning of fossil fuels for power has been a chief cause of pollution. Will not the increased use of atomic energy and the further spread of atomic energy to replace the burning of fossil fuels in a short time take care of this particular problem?

Mr. MacKenzie. The estimates of fuel consumption and electric power generation would not indicate this to be the case, sir. Inevitably I think it can be expected that there will be increasing use of fossil fuels—coal, oil, gas—over the next certainly three decades or so.

During this same time, there will also be increasing use of nuclear power, the nuclear power will not replace fossil fuel use according to the expert opinions of all in this field.

Senator Murphy. Thank you very much.

Senator Muskie. Senator Cooper.

Senator Cooper. One of the important provisions of S. 780, the proposed Air Quality Act of 1967, is that section which would authorize the establishment of national emission standards or control levels, for industries which are, in the terms of the bill, "sources of substantial amounts" of air pollution.

I believe Secretary Gardner was asked a while ago if he could name some of these industries. He said it would take some study before a list could be prepared.

Now, can't you today name some of the industries to which the emission control levels would be directed?

Mr. Coston. Senator, I think Mr. MacKenzie did name a number of industrial areas that would be considered very early.

Senator Cooper. He named——

Mr. Coston. He named a number of industries that would be considered very early for inclusion—acid manufacturing, cement manufacturing, pulp mills, oil refineries, steel mills, heavy metallurgical installations. Theye would certainy be among the first that we would consider for the establishment of such levels.

Senator Cooper. Power generating plants?

Mr. Coston. Power generating plants would certainly be considered. I would point out, however, that the present state of the art in terms of sulfur emissions probably would not permit an early application of that standard nationally. We just don't have the technology yet to deal fully on a national basis with the problem of sulfur emission.

Senator Cooper. The Secretary emphasized also the necessity for increased research by private industry. Now may I ask whether the "state of the art," to which reference has been made time after time, has reached such a stage that it is possible for the secretary to promulgate any reasonable emission control levels?

He began his statement and has emphasized the necessity for more research. You just stated that research has not yet reached the point at which these sulfur oxides from generating plants can be controlled.

How at this time, or until research has provided better solutions, could you promulgate control levels? Would it be rational or appropriate to try to do so?

Mr. COSTON. Senator, I think it is perfectly obvious today that you can control the emission of particulate matter. There is just no reason in the world for anybody to throw out great clouds of dust and dirt. The technology is available. It is readily at hand. It is not inordinately expensive and control of particulate matter is one that is perfectly appropriate for standard setting, and those standards could be applied now.

There are more exotic pollutants. There are more difficult problems where our capability to set standards is more limited. The oxides of sulfur is one of these.

Senator COOPER. That is the distinction I wanted you to make. That being true, would it be the purpose of the Secretary to issue control levels on emissions such as sulfur oxides? And if so, would that be done at the same time that control levels would be promulgated with respect to the particulates?

Mr. COSTON. I think you would first promulgate levels of emission for those substances which you now know how to control and which are technologically capable of being controlled. You might at the same time propose guidelines and criteria—objectives—for substances for which the technology does not now exist, but for which the technology simply must be found.

So I would see two processes going on. One would be a process of objective setting, and I think most people, including industry, recognize in the sulfur area, for example, that as an objective we just have to reduce the amount of sulfur in the atmosphere in our major metropolitan areas.

I don't think that it follows from that that you can at this time promulgate a binding standard, but certainly proposing an objective as a goal to be sought will stimulate the additional research and development that is necessary in order to reach a standard setting operation at some time in the future, and I hope very sincerely it will be in the very near future, but this remains to be seen.

Senator COOPER. I appreciate your answers, Mr. Coston, because I think we have to draw a distinction between emissions which are now controllable, and those which are not controllable. With respect to the latter, you would propose first an objective or goal to be set, toward which industry could make progress.

The Secretary talked a great deal about the necessity for research by private industry. In your judgment, how could that be accomplished? By groups of industries joining together or establishing research bodies? In what kind of an institutional way, organized way, would you suggest that be done?

Mr. COSTON. I think one of the most admirable things about this country is the ability of the private sector of this economy to make new discoveries about important new things. I think they are perfectly capable within the private sector of organizing research programs to achieve desirable objectives and I would not want to suggest how they should do that.

Industry certainly has been able to accomplish miracles in developing new products, in developing new markets, in developing new uses, in building enormous scientific capabilities in other fields, and I just cannot believe that industry cannot organize itself to deal with this problem which is now a matter of highest public urgency.

Senator COOPER. I agree with you.

Reference has been made here several times to the tax incentive to industry. Again, I think there are two separate problems. First, you have just been speaking of research by private industry to find ways to control pollution—perhaps by treatment of the emission or of the fuel itself. But second, there are other types of emissions for which facilities can now be constructed to help control these pollutants. I would like to say that again and again in the last 3 or 4 years the Congress has indicated its approval of incentives for the construction of facilities to control air and water pollution.

Several years ago Senator Ribicoff introduced an amendment to a tax bill which provided an investment tax credit to industries to control water and air pollution. It passed the Senate; it did not pass the House. Last year a number of bills were introduced. Senator Ribicoff introduced one for accelerated tax depreciation, Senator Randolph and I one for investment tax credit for air and water pollution control facilities. When the Congress suspended the investment tax credit late last year, it did not suspend the tax credit with respect to air and water pollution facilities: I recall that I testified before the Finance Committee and supported retention of the investment tax credit for pollution facilities. The distinguished Chairman of this subcommittee, and of the full committee, in their reports to the Congress have emphasized that one instrument should be a tax incentive.

I know this is apart from research, and there may be many larger problems in this bill, but it would seem to me that with all these indications of interest in this approach having been given by the Congress, it should be of some interest also to the administration and to your department.

One other question, Mr. Chairman. I think the second most important provision of this bill is the proposal to establish Regional Air Quality Commissions. We know there are watersheds which are appropriate areas for the control of water pollution. But, how would you determine an air area?

It may be a technical question. You probably will need to study that too, but what would be the factors that would determine an air area? Would it just be the fact of air pollution, or that industries in a certain area are polluting the air, or do you actually think you can logically determine and fix or establish an air area? It seems to me that would be rather difficult.

Mr. COSTON. The 1963 act required us to define areas for the purposes of our enforcement actions. We have defined a number of such areas already and instituted enforcement actions.

I think the considerations that would go into delimiting the boundaries for a commission jurisdiction can be established and can be pretty carefully spelled out.

We have been able to do it for enforcement procedures. The same considerations that went into that will go into questions of establish-

ing the geographic limits of a clean air region. We will, as we testify further on this bill, go much more extensively into the precise techniques for defining these areas.

Senator MUSKIE. May I suggest on that point, Senator Cooper, that we have a witness later this morning who will testify on the relation of weather to air pollution, who might be able to give us more detail from that point of view at least.

Senator COOPER. I have just one other point. I would like to express my concern, too, in the section of the bill to which Senator Boggs and Senator Muskie referred, on page 12. It seems to give to the Secretary and to employees of the Department of HEW an almost unlimited power of search and seizure.

I thought I should direct your attention to that.

Thank you, Mr. Chairman.

Senator MUSKIE. Thank you, Senator Cooper.

Senator Spong.

Senator SPONG. The Clean Air Act of 1965 calls for national standards for automobile vehicles beginning in 1968 and then some in 1969. When will these standards be finally determined?

Mr. MACKENZIE. The standards applicable to the 1968 vehicles were issued early in 1966, Senator Spong. They will be legally required on vehicles that will come on the market for sale in the fall of 1967.

There is another regulation which has just been issued in proposed form that would apply additional requirements on vehicles for the 1969 model year with respect to control of evaporative losses from fuel tanks and carburetors.

Senator SPONG. You mentioned in response to Senator Murphy the experience in Los Angeles. There would be no opportunity to profit from this in terms of the standards that will be initially used?

Mr. MACKENZIE. I am sure there will be because in the applications for certification that we have received from the motor vehicle manufacturers there already are being incorporated a number of changes which will be, we hope, improvements from their initial attempts in the 1966 model year.

Senator SPONG. The Air Quality Act through incentives calls for State inspection after 1967. Some disappointment has been expressed here about the actions of the States thus far, particularly in regional matters.

Do you think there are sufficient incentives in this legislation for the States to come into this immediately?

Mr. MACKENZIE. Well, the authority in the proposed legislation would authorize the Secretary of Transportation to require this as an element in the highway safety program. Under the Highway Safety Act there are provisions that would penalize the States unless they adopt highway safety programs as set forth in that act.

If I remember correctly, the penalties for nonestablishment of such programs amount to as much as 10 percent of the allocated highway funds.

Senator SPONG. Thank you.

Senator MUSKIE. Thank you, Senator Spong.

Senator Baker.

Senator BAKER. Mr. Chairman, I would like to ask just for a minute or two a few apparently basic questions about the whole situation.

Let me start the first by saying I strongly subscribe to the Federal necessity for doing something about the decontamination of the air envelope, but for the sake of establishing a reference point has—and these may be technical or semi-technical questions that are better answered by other witnesses—your department or has your series of studies established some arbitrary level of pollution that is an acceptable level within the contemplation of our present knowledge of the physiological and scientific concern?

Mr. MacKenzie. We are directed under the Clean Air Act to issue criteria of air quality. We have not formally issued any such criteria to date, but these are now being worked on and we confidently expect that the first document of this kind will be issued.

Let me point out that this is or will be a compendium of scientific information which will relate the effects from exposure to air pollution of various concentrations and time duration—relate such exposures to the effects on people, on vegetation, on materials. This scientific information will be available for guidance in the establishment of legal standards by whatever agencies have the authority to promulgate such standards.

Senator Baker. I take it, then, in establishing an acceptable level of pollution, so to speak, that there probably will be several criteria or several guidelines, one for solid matters, one for gaseous matters, and the like.

Mr. MacKenzie. This is quite true. As a matter of fact, Senator, there also have been, of course, many jurisdictions that have adopted air quality standards already. We would be glad to provide a list of these for the record if the committee would so wish.

Senator Baker. The point I was trying to strive for was not so much a definition of what the present state of the art may be or the present development of your thinking is, but to try to underscore the fact that some place in the course of trying to solve the problem we have to state what the problem is and what we are satisfied with as an answer. Because in my view obviously the atmosphere is always theoretically polluted to one extent or another, whether it is related to what the situation was 30 years ago or 5 years ago, or in terms of so many grains per million cubic feet of atmosphere or whatever. But, as I understand, you related it to the physiological effects on the human environment?

Mr. MacKenzie. In considerable part, certainly.

Senator Baker. All right. Now, you also stated or it was stated by the Secretary and by others that among the list of principal contributors to the contamination of the atmosphere would be the cement industry, acid manufacturing, refining, power, metal working, pulp and paper.

This calls for an early and I am sure premature conclusion, but do you have any idea or any projection of how much improvement of the atmosphere would be accomplished if satisfactory control measures were promptly enacted for these particular industries? In another way, would this solve half the problem for us or would it not? How far along the way would this put us?

Mr. MacKenzie. I think it would take care of many of the most prominent pollution problems. I would not want to say that this is going to solve half of the pollution, however, because if you look

at pollution in terms of tonnage emitted into the air which is one way of looking at it, then more than half of all the pollution being discharged comes from motor vehicles and the only way to deal with that is by controlling the emissions from the motor vehicles.

Senator MURPHY. May I help with an answer to that?

In Los Angeles some years ago they did away with all backyard burning. Now, there were literally thousands of burners that were just taken out of service and all the rubbish and papers were handled in a different way and the smog got worse.

I don't mean to imply that that didn't help, but I believe that the addition of the automobile fuel not only made up for what was saved by this backyard burning, but I think that in that area unquestionably the automobile is the main source of things and it is a very difficult one to sit and ask these general questions.

I can take you over the San Fernando Valley and one day you will find it over here, and the next day for no apparent reason it is over there, and one day it is over the hill in Pomona, and it is now getting in to Palm Springs, which is usually 50 miles from our farthest reach. So it is not easy.

Mr. MACKENZIE. I think what Senator Murphy is saying points up one characteristic of air pollution problems; namely, that these vary from one community to another. The problem in Los Angeles is not the same problem that you have in Gary, Ind. It is not the same problem that you have at Jacksonville, Fla.

You must look at the problems in the specific areas and in one instance the overwhelming problem or the major problem may be from a type of industry, steel manufacturer or wood pulping for paper, or in the case of Los Angeles, where they have cleaned up most of the stationary sources, the automobile.

Senator MURPHY. May I ask another question?

Senator BAKER. Yes, sir.

Senator MURPHY. I was interested in this issue of Time magazine which I am sure you have all seen. Here it has a picture of the Kenilworth Dump, and that has been there for 25 years. Last year, I pointed out the pollution problem in the District of Columbia. I wonder if it would be fair to ask couldn't somebody in the Government or in the District do something about the Kenilworth Dump? I think this would be a good sign if we clean up our Federal city.

Senator MUSKIE. May I say to the Senator if we didn't have that dump we wouldn't have a backdrop for these air pollution pictures that are taken.

Senator BAKER. Mr. Chairman, continuing just for a moment, I am not trying to have you now establish from the stand some mathematical extent of accomplishment by these factors, but what I am trying to find out is whether or not the control of these industries that you have enumerated will substantially contribute to the solution of the problem or whether, for instance, the emission of sulfurous compounds in the air is just as important or more important to the total problem?

Mr. MACKENZIE. Senator, if we did not think that this would produce a significant and substantial improvement, we would not have proposed it.

Senator BAKER. I am sure that is so.

Mr. MacKenzie. I think that the industry emissions to which this authority would be made applicable are very important in large numbers of communities across the United States.

Senator Baker. I am sure that is quite right and I certainly commend you for trying to control what we can now control, but what I am trying to find out is how badly off we are going to be with those things we can't control and thereby determine the necessity for developing the new technology and the new techniques for coping with it.

Mr. MacKenzie. One of the elements in this total program which is being proposed is a material and significant expansion in the research, development, and demonstration aspects of the total Federal program on air pollution control.

There is without question a real need to accelerate research and control of the emissions from several types of sources, here, principally motor vehicles and from the combustion of sulfur-containing fuels. I think if these problems are going to be solved within a reasonable time, there is a great deal of additional effort that will have to be put on these problems both by private industry and, in my opinion, by the Federal Government as well.

The proposal pending here would make provision for enlarging this effort and would also, by the specific authority to enter into demonstration contracts with industry, shorten the time between the research and development phase that is conducted in the laboratory and the application of new procedures in actual full-scale practice.

Senator Baker. I think that is all, Mr. Chairman.

Senator Randolph. Mr. Chairman, may I ask one further question?

Senator Muskie. Yes, indeed.

Senator Randolph. This follows the queries in part on the comment of the Senator from Tennessee. It is my understanding, Mr. MacKenzie, that later this month you will publish the criteria for sulfur dioxide. Also, could you give us an estimate of the schedule for the release of the criteria for other major pollutants?

Mr. MacKenzie. I will be glad to put this in the record, Senator Randolph, if this would meet the purpose. I will mention, however, that the next criteria document scheduled for issuance probably will deal with photochemical oxidant type of pollution. We have progressed to the point where this draft document has been reviewed by expert consultants. We intend to have some further reviews before it will be issued, but this should not take too long.

Senator Randolph. And you have counseled, have you not, with representatives of the coal industry?

Mr. MacKenzie. Yes, we have.

Senator Randolph. In reference to the sulfur dioxides?

Mr. MacKenzie. We have attempted to give opportunity to all interested parties to review our conclusions before we make the final issuance, sir.

Senator Randolph. Mr. MacKenzie, I commend you for that and I am sure that all industries involved appreciate the spirit of understanding with which you undertake this task.

It is not an easy job for you. I know that. But I feel that you do want to have not the obstructionists come and talk with you, but those persons who come to you and counsel with you purposefully in reference to criteria.

Mr. MacKenzie. We do appreciate it, Senator.

Senator Randolph. Thank you, sir.

Senator Muskie. May I ask one or two more questions.

One, the administration's airshed commission proposal mentions Federal and State participation, but does not mention local government involvement.

Do you think effective regional air pollution control programs can be developed and implemented without local involvement?

Mr. Coston. Senator, I think that is a question that is well worth opening and examining in some detail. Certainly in our experience the contributions of local government in this field have been most helpful to us. It may well be that as you consider this legislation you will want to recognize the capabilities and the contributions of local governments as well as State governments.

I would point out, however, that as the bill is presently drafted the appointments to the commission are made by the Secretary and are not representatives of the States in the traditional sense that they are State officials. They must come from those States, but they do not necessarily represent those States. But I think your question of local government participation is an extremely important one and should be carefully considered.

Senator Muskie. We did not expect that, with as many witnesses as we have, we could get into an exhaustive discussion of this legislation this morning. I wanted primarily to open up areas of your further inquiry and I think that the members of the subcommittee have done very well indeed in doing just this.

We will press these areas of inquiry, so lest we overlook one may I address a question to the Surgeon General. We have not touched upon the health aspects of air pollution control and I suspect you might like the opportunity now to spend a few minutes making your record on that point because this of course underlies all of this legislation.

Dr. Stewart. Thank you, Mr. Chairman. I think it does underlie all of this and I think it is what the public has in mind when they raise their concern about air pollution.

There is no question in our minds that the pollutants in the air are contributing factors to the chronic respiratory diseases, lung cancer, emphysema, bronchitis, and asthma.

If you look at the causes of mortality in our country it is this group that are showing a rapid rise as a cause of death and if you look at disability factors emphysema, chronic bronchitis are beginning to be the causes of a great portion of the disability that one can measure.

Our conclusion that air pollution is a contributing factor in increased incidence of these diseases is based on extensive clinical studies, epidemiological studies, and laboratory data which I think support this conclusion very thoroughly.

I think from the standpoint of public health, the information that we have concerning the acute air pollution episodes that have occurred and the laboratory evidence of the effects of exposure to various pollutants that are in the air puts an exclamation mark by the word "urgency" in relation to this problem.

Senator Muskie. Let me ask one question. It has been suggested in hearings before this committee that there is not enough evidence yet of the relationship of health and air pollution to justify a national

approach to the problem, that unfortunate health impact is so localized that we ought still to rely on local action.

In your judgment I take it you don't think we need further research to demonstrate that there is a health problem and a national health problem related to air pollution?

Dr. STEWART. We do not need further research to demonstrate that. I think we need further research to continue to refine our knowledge. Part of the reason why this is so is that we are dealing here with chronic disease causation. This is quite different than the infectious diseases where we can put a finger on a specific cause for each disease. In dealing with the chronic diseases, however, we have learned that they are probably caused by multiple insults or injuries over a long period of time to a human being. This is why we use this word "contributing factor."

In any given instance, there may be several reasons why a particular situation of chronic disease occurs. The evidence that we have at the present time on air pollution strongly supports our conclusion that it is a contributing factor in regard to respiratory diseases. I think we would be negligent in our approach to protecting the health of the people of this country if we didn't push for action in controlling air pollution at the present time.

Senator MUSKIE. So that from a health aspect you support the legislation which the President has sent here?

Dr. STEWART. I certainly do.

Senator MUSKIE. Any further questions any of the members of the committee would like to press of the Surgeon General? We will have him up again. I simply wanted to make sure this part of the problem was in the record.

Thank you very much, gentlemen. We have taken longer than we expected but we do have to make a record. Thank you very much.

Mr. COSTON. Thank you, Mr. Chairman.

Senator MUSKIE. Our next witness is Dr. Ivan L. Bennett, Jr., Deputy Director, Office of Science and Technology, testifying for Dr. Donald F. Hornig, Special Assistant to the President for Science and Technology.

Dr. Bennett, will you proceed.

STATEMENT OF DR. IVAN L. BENNETT, JR., DEPUTY DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY, EXECUTIVE OFFICE OF THE PRESIDENT

Dr. BENNETT. Mr. Chairman and members of the subcommittee, I am glad to have this opportunity to discuss some of the scientific and technologic aspects of the problem of air pollution.

I must begin by transmitting Dr. Donald F. Hornig's regrets at being unable to attend this morning's hearings. The Office of Science and Technology, as you know, advises and assists the President and the Congress on the major scientific and technologic programs of the Federal agencies as they relate to national security, foreign policy, and general welfare.

We are also closely concerned with the integration and coordination of Federal scientific activities. This morning, however, we are concerned mostly with coordinating our own activities—at this moment,

Dr. Hornig is testifying before the House Appropriations Subcommittee concerning our budget and is apologizing to those gentlemen for my absence from those proceedings.

On 364 days of the year we look upon air pollution as a problem of highest priority. On the 365th day, which is today, we regard air pollution as a problem second in importance only to one other, the problem of the budget of the Office of Science and Technology. Hence, Dr. Hornig, the Director, is there and I, the Deputy Director, am here.

Dr. Hornig, of course, is interested in and concerned about what I say here on the subject of air pollution, and you can be quite sure that I am interested in and concerned about what he says there on the subject of our budget.

My discussion this morning, indeed, all of the discussion at today's hearings centers around a single fact, albeit a complicated one. It is this:

The existence of man and of all the biological universe, the so-called biosphere, which sustains his life and makes it pleasant by bringing delight to his mind and his senses, is threatened as never before in history.

We have long known that natural processes of dilution, dispersion, and degradation enable our land and our water to purify themselves after contamination. Just as we once made the mistake of looking upon all of our natural resources as a limitless gift of nature, however, we overestimated the capacity of our lands and our waters to cleanse themselves of manmade wastes. Having recognized our error, we are now well launched into the difficult task of restoring the quality of the lands and waters which we had neglected for so long.

More recently, although premonitory signs had been present and largely disregarded for more than two decades, we have come to realize that even the air around us has passed the limit of its capacity as a receptacle for the byproducts of our civilization.

The demonstration that we can befoul the atmosphere beyond its ability to cleanse itself has brought home forcefully the realization that, in the same way that land and water are natural resources, and must be conserved, the ambient air is a natural resource, that it is limited in quantity and quality, that it should be utilized carefully, efficiently, and prudently, and that it must be conserved.

From this moment in history we must accept the incontrovertible reality that the voluminous waste products generated by the technological processes that have brought about a steady increase in living standards for a steadily increasing population are now eroding the quality of the most precious and essential resource of all, the air that we breathe.

From this moment in history we must accept the incontrovertible reality of the dire conflict between the technical uses of the atmosphere and its biological uses.

From this moment in history we must accept the incontrovertible reality that the problem of air pollution is neither local nor temporary. It is a universal problem, perhaps the first truly universal problem faced by mandkind and, so long as our standard of living continues to increase, it will be a permanent threat to the well-being of us all.

Unless we are successful in eliminating the obstacles that, until now, have made us either unable or unwilling to engage in the far-ranging

activities that will be required to restore the quality of our atmosphere, then it is beyond peradventure that humanity will be slowly and inexorably asphyxiated in the effluents of its affluence.

As is true of most major problems of modern society, air pollution cannot be regarded as an isolated scientific or technological matter for there are important and inextricable social, economic, and political factors to be weighed in the decision-making process.

The scientist or the engineer, in his specific role, however, can be of great help. He can chart the boundaries and the dimensions of the problem, can offer alternative approaches to abatement, and can assist in the formulation of realistic programs for both the near term and the long term.

The data collected from systematic surveys of physical damage, from precise monitoring of airborne pollutants, from extensive epidemiologic surveys, from detailed chemical analyses, and from laboratory experimentation in many scientific disciplines can be summarized and interpreted.

The predictions and the alternative possibilities for the future that derive from these interpretations can be laid before those who are charged with setting our goals and who bear the heavy responsibility of crucial decisions, tactical or strategic, specific or general.

It is surely unnecessary and, perhaps, inappropriate for me to rehearse here the estimates of the enormous economic costs of air pollution. The administrative and jurisdictional difficulties which have stimulated the proposed Air Quality Act of 1967 are well-known to you. There is, as you know, abundant evidence of increasing public concern about the quality of our air and growing apprehension among our citizens about the effects of pollution. This is giving rise to a swelling demand for abatement programs.

There are some aspects of this complex problem that seem ironical and paradoxical. The arousal of the public has come late in the course of the problem, after the establishment of patterns of technical activity in transportation, industry and energy production that involve huge amounts of capital and an important fraction of our economy. The possibility of disruption of these is not to be taken lightly. In face of the severity of the problem, however, the record demonstrates clearly that action on the required scale will be accomplished only if incentives and sanctions are made available and used wisely.

Even now, the wave of public concern which, though tardy, is welcome and is a prerequisite for concerted action, is stimulated in large degree by rather superficial aspects of the problem, by discomfort such as irritation of the eyes and throat, by annoyances such as poor visibility on our highways, the dirt and sludge caused by soot and cinders, and disgusting odors, or by the expenses of repainting the house or replanting the shrubbery, rather than the real dangers, many of which are not easily visible and not clearly definable.

Science and technology have an important bearing upon the problem of abatement of air pollution at all levels of consideration, including:

1. The identification of sources of pollution and the characterization of specific pollutants.
2. The delineation of the biological and physical effects of air pollution.
3. Monitoring and surveillance.

4. Prediction of serious episodes such as have occurred in many major cities.

5. Providing the technologic base for the development of standards and regulations.

6. Research and development in the broad area of devices and processes that will diminish or eliminate the emission of pollutants, whether by recycling, by in-process alterations, by substitution of new technology, or by the trapping and removal of effluents at the end stage of the process.

In addition to specifically directed efforts in these areas there are many serendipitous contributions from scientific and technologic enterprises that are not concerned primarily with the quality of the air or any other aspect of environmental pollution.

This type of "spin off" or "fall out," of course, is not unexpected when one is dealing with a problem as large and as complex as the one we are considering today. I mention it merely to emphasize that it makes it extremely difficult to achieve precision in analyses of the total relevant research effort in this broad field.

Much of the information concerning these several levels of scientific and technologic endeavor in relation to air pollution is common knowledge, easily available in nontechnical and popular publications.

I would like to touch briefly on several aspects of science and technology that seem particularly relevant to the Air Quality Act of 1967 which has been proposed for enactment.

The subjects that I have chosen are:

1. The application of existing technology and the stimulation of innovation.

2. Scientific and engineering manpower for the future.

3. The biologic and medical effects of air pollution.

4. The technological strategies of abatement.

Effective techniques for the reduction of air pollution from industrial sources of several types are known. Indeed, the Department of Health, Education, and Welfare has published several technical manuals on this subject. These technologies, however, have been incompletely utilized and have not come into general use. This unsatisfactory but understandable state of affairs is attributable mainly to the lack of firm guidelines and uniform standards.

The establishment and enforcement of uniform standards will undoubtedly amelioriate this situation. Furthermore, the establishment and enforcement of standards can be expected to have additional beneficial results. The development of standards requires research and, as technology improves, standards will be upgraded. Things will finally begin to move in a field where, until now, evidence of progress has been discouragingly slow.

Competition to produce new and improved technology and to devise new instrumentation for monitoring and surveillance can be expected to increase as our activities gain momentum. The establishment and enforcement of standards will also be an important boost toward alleviating the shortage of scientific and engineering manpower in the field of air pollution.

Scientists and engineers are human beings and they want to associate themselves with real enterprises that mean business. The "unglamorous, unrecognized, and unrewarded" status of the pollution abate-

ment specialist will be replaced by the dignity, pride, and feeling of accomplishment that accompanies progress in an important endeavor.

The availability of research funds and training grants, the demand for new technologies, and the recognition of the field, a factor important in recruitment of any type, will be additional attractions. But basic to these will be the establishment and enforcement of standards, giving the stamp of approval to a group of professionals by showing them that the American people finally mean to utilize and to apply their knowledge and that the Nation is depending upon their skills to undergird the restoration of our atmosphere.

One of the most incongruous aspects of all of the problems raised by air pollution, as has already been mentioned, is the wide discrepancy in interpretations of the significance of existing knowledge of its effects on the health of man. Last year's report by the House Subcommittee on Science, Research and Development, entitled "Environmental Pollution, a Challenge to Science and Technology," pointed out how much it would simplify decisions concerning abatement if there existed a clear, organic health hazard.

The report goes on to say:

> Unfortunately, there is no agreement on many specific issues. Testimony ranged from "devastating" and "terrible calamity" to "not demonstrated any very significant deleterious effects."

Our knowledge of the effects of pollutants upon man are drawn primarily from epidemiological studies. In contrast to an experiment in which variables are artificially controlled in sequence, epidemiology studies naturally occurring phenomena relating to the health of groups of individuals. By observing repeated episodes in the same or different groups under which conditions vary in different ways, and correlating these conditions and incidence of illness, reasonable conclusions concerning the causes of illness can be drawn.

One of the best examples, still argued by some, is the correlation between cigarette smoking and lung cancer—still not absolutely proved because absolute proof is virtually impossible. Utilizing such techniques, an increasing number of studies have been done. These have shown:

(1) Under conditions of heavy pollution, there is an excess number of deaths, particularly among elderly individuals with preexisting lung disease or heart diseases.

(2) In England, after correction for such factors as smoking, the incidence of chonic bronchitis among urban workers is higher than among rural groups and varies with the degree of atmospheric pollution.

(3) After correction for smoking habits, the occurrence of lung cancer is still more frequent among urban than rural residents.

(4) In New Orleans, Minneapolis, Tokyo and London there have occurred regular outbreaks of asthma among individuals not subject to this disease in its usual form. These so-called epidemics are regularly associated with severe pollution conditions, but a specific pollutant cause has yet to be identified.

(5) Interviews in many locales have elicited complaints of aggravation of cough or breathlessness during pollution alerts and these have been shown to be accompanied by measurable abnormalities in lung function.

(6) More recently, in Los Angeles, patients with chronic respiratory disease were studied in a room which could be ventilated by ambient air or by filtered air from which most of the pollutants had been removed. Significant, measurable worsening was noted repeatedly among 50 percent of these individuals when unfiltered air was introduced.

Where is the doubt? The doubt stems from the fact that in no instance has the atmospheric pollution been shown to be the cause of a disease nor has a specific chemical pollutant responsible for worsening of symptoms or increased mortality been demonstrated absolutely.

Other known effects of pollutants include: (1) destruction of crops including citrus trees and ornamental shrubs and flowers, (2) crippling and killing of cattle, and (3) experimentally, a lowering of resistance to bacterial infection of the lung in animals exposed to pollutants.

Several members of this committee, I believe, are familiar with the devastating effects of the fluoride emissions of high-phosphate fertilizer plants upon the cattle industry in Polk and Hillsborough Counties in Florida.

In December of 1952, the city of London underwent a period of extreme pollution of the type that now is occurring periodically in cities all over the world. During this 5-day episode, there were 4,000 excess deaths.

Not as well known is the fact that the Smithfield Cattle Show was being held in London at that time and that many of the prize animals became ill, died, or had to be destroyed.

Many of the chemicals that pollute our air are known to be highly toxic, even lethal when inhaled in large amounts over a short period of time—sulfur oxides and carbon monoxide are familiar examples. However, what the long-term effect of exposure to low concentrations of these substances, 24 hours a day, 7 days a week, for years on end will be is not known.

Furthermore, it will not be known with the scientific exactness that we would hope eventually to achieve until we have had opportunities to make the long-term observations, under appropriate conditions, that will give the definitive answer. And by the time that answer is available, the critical decade that lies ahead will have passed long since.

The question, then, is this: How much do we have to know before we begin to act?

Without denying at all the urgent need for increased research to sharpen our knowledge and understanding of the physical effects of pollutants, I submit that we cannot wait until we have absolute and elegant proof before initiating action programs.

I am a biomedical scientist. It is time that we need to broaden the base of our understanding of the effects of air pollution. It is true that we are knowledge-limited in many areas, but these facts need not delay the initiation of action based on what we already know.

As a pathologist, a specialist in the study of disease in the laboratory and in the autopsy room, I can best summarize the point that I am trying to make by quoting three old definitions that are familiar to medical students:

The surgeon knows nothing but does everything.

The internist knows everything but does nothing.

The pathologist knows everything and does everything—but too late.

The excellent report by the Committee on Pollution of the National Academy of Sciences, published last year under the title of "Waste Management and Control," describes 11 techniques that can be employed in pollution control: (1) recovery and resue, (2) waste treatment, (3) product modification, (4) process change, (5) elimination, (6) dispersion, (7) dilution, (8) detention, (9) diversion, (10) environmental treatment, and (11) desensitization.

In our present state of knowledge, our approach to air pollution is clearly prevention.

It is highly impractical at present to approach the problem by methods of purification at point of utilization (gas masks, or filters on building intakes, et cetera). To assure a supply of potable water is technologically feasible in the midst of contamination and pollution, but the only approach to assuring a supply of clear air to breathe is to maintain the quality of the ambient atmosphere.

We know almost nothing about neutralizing pollutants and toxins, once they have been released and are airborne.

The separation of contaminants is most difficult when they are present in low amounts and when their composition (solid, liquid, or gas) is the same as the environmental component into which they are discharged. Hence, particulate pollutants such as soot pose less of a problem than gaseous effluents. What I am saying, of course, is that it is much easier to remove the olive from a martini than it is to remove the vermouth, once it has been added.

We have only the most rudimentary understanding of the self-cleansing mechanisms of air and, until our understanding improves, we must rely on prevention rather than decontamination.

Biologically, man's survival has been dependent upon his physiologic and cultural adaptability. His intellect and the techniques of science have enabled him to understand his environment and to adapt his activities to this knowledge. He now faces, or rather we face the need to adapt our attitudes to the stringent necessity of preserving the very breath of life.

Senator MUSKIE. Dr. Bennett, thank you for an excellent statement. I have not yet read or heard a better 15-page statement of the reasons why we need to act in this field of air pollution.

It is very helpful. It establishes a commonsense, if not a philosophic, base for the action which this committee is contemplating.

The only question you didn't answer as far as I am concerned is: do you support the legislation the President has sent up?

Dr. BENNETT. My answer is, "Yes." I would emphasize, as I tried to in my statement, that the establishment of standards will have many effects that will be beneficial in addition to the simple regulatory activity.

Senator MUSKIE. May I say that this subcommittee in the hearings we have held over the last 3 years has not had enough testimony from your agency and we expect to get more.

Dr. BENNETT. On any one of the other 364 days of the year, Senator.

Senator MUSKIE. Except this one.

Let me ask you one question, and that is on the question of lead additives in gas alone. We had hearings last year on this subject, which may or may not have come to your attention. But during that dis-

cussion Dr. Richard Prindle indicated that it would take probably 5 years to develop the kind of information needed by the Public Health Service to take a position on problems associated with lead air pollution.

That seemed to us at the time a long period of time. Would you have any comment on that? Have you addressed yourself to the question of lead in gasoline?

Dr. BENNETT. Mr. Chairman, I would say only this: That there once again one is dealing with this problem of the chronic accumulation of low amounts of an element that is known to be toxic in large amounts and we feel that this is probably not a good thing. But we simply have no basis for stating that this is the cause of any disability.

One can project and say that at some distant date in the future those of us who survive until that time may have accumulated enough lead that the effects will be apparent as they are when we accumulate it suddenly at the present time.

Since the evidence that lead is an important element in the overall question of air pollution is lacking, and we know just from present analyses of pollutants that we have better evidence that others that are more plentiful in our atmosphere have more immediate importance, I would say that Dr. Prindle's answer, if anything, was conservative.

Senator MUSKIE. Is there any evidence of the accumulation of pollutants in the atmosphere of which the atmosphere cannot or is not likely to purge itself?

Dr. BENNETT. I would say that if one could cut off the present entry of pollutants into the atmosphere, it is highly probable that eventually there would be a catchup phase. The atmosphere is able to cleanse itself through various diluting mechanisms, but we have simply been putting too much into the pipeline and I don't think that there has ever been the opportunity to find out should one stop addition completely, whether it will be possible for the cleansing to take place.

At the present time, though, the evidence is that the reason that the problem is increasing is because of the increasing amounts of pollutants going into the atmosphere.

Senator MUSKIE. It is not likely we can shut off the emission of pollutants into the atmosphere. Is there an accumulation now under current conditions and of what kind?

Dr. BENNETT. There is some evidence if one looks at the long-range problem that there actually is an accumulation of carbon dioxide in the atmosphere.

The appropriate measurements to confirm this evidence should be available within the next 3 years. Certainly by 1970 one should be able to confirm this. This is of some interest because carbon dioxide itself is not particularly toxic and indeed many of the processes such as after-burning of effluents to get rid of carbon monoxide result in the production of carbon dioxide.

There is some evidence and there are some calculations to indicate that this carbon dioxide might produce the so-called greenhouse effect, that this might result in an inability of the earth to reflect back the heat of the sun's rays, and I am sure that this type of thing has been brought out before the committee before.

This would happen in the very long range, but it is certainly the type of thing that we need to learn more about. On the other hand, if the amount of carbon dioxide that is emitted into the atmosphere were to be cut down appreciably, there is good evidence that it would be absorbed as it is at the present time by the ocean and so on and I would think that it might drop back off to its normal level.

Senator MUSKIE. Senator Boggs.

Senator BOGGS. Yes, Doctor, I certainly appreciate your statement, too, and am glad to have you. As you pointed out and has been pointed out already this morning, much more research is certainly needed, of course, to unravel many of the things we don't know. But we do know much can be done right now and we should get started. That is what we are trying to do.

However, I don't believe it is possible to try to take advantage of all the knowledge we have by writing it necessarily in legislation.

Has your office considered the possibility of this White House conference type of approach and building up from the local levels, the State, their conference at each State level, and then on at the national level, as looking at this whole air pollution problem in its entirety and what from the individual on to the Fedreal Government we can properly do and what we can get underway, and many times just with the knowledge, not with necessary legislation or enforcement powers?

Have you given any consideration to that?

Dr. BENNETT. It has been mentioned a time or two, but it has been our feeling up to now that the problem has not been a lack of information. The problem has not been a lack of concern. It really has been a lack of guidelines as to how far one should go and whether other people would go along with one and so forth.

And when I referred to the present state of affairs as unsatisfactory but understandable, I was implying all of the things that had been previously discussed here this morning, the fact that the States simply have not moved in the way that we would hope that they would move and that the incentive of matching grants has not succeeded in bringing about the results that it had been hoped would be achieved.

The fact that there is obvious competition between States to have industry come in is evident. In some, I would say that it is our feeling that not the White House Conference mechanism, but, in essence, the setting of a new baseline for competition among the States is needed. And this would be the minimum emission standards so that one could not offer an industry the opportunity to come in unrestricted as to pollution.

Senator BOGGS. Thank you.

Senator MUSKIE. Senator Cooper.

Senator COOPER. Doctor Bennett, you have characterized this problem of air pollution as a universal problem—not just a national problem, but a universal problem. I would like to ask you, then, if you believe the provisions in this proposed act which would create regional air pollution control areas, would be really effective? Or should it be treated as a national problem, without dividing it up into specific areas throughout the conutry?

Dr. BENNETT. I can answer that question only philosophically and that is that it seems to me that for most programs it is easier to control them at a local level or a State level than it is to manage these things

directly from Washington. I think that the setting of standards at the national level will succeed in doing on a nationwide basis the minimum that we believe is feasible.

It would also offer the opportunity to certain States to set even more stringent standards and to avoid encroaching on their jurisdiction, if they want to do better than what is set at the Federal level. When I refer to this as a universal problem, the proper word would have been global, but problems similar to those that have occurred in New York City have occurred in Durban, South Africa, and in Tokyo, and a long list of cities that I believe are known to the committee.

As a matter of fact, in the article in Time magazine, this list is given. It is striking to see how much similarity there is between the problems in these very distant places and the problems that we are concerned with here in our country.

Reference was also made by Secretary Gardner to the fact that this is becoming a rural problem. It is not only a problem of the big cities in this country.

Senator COOPER. It is your answer, then, that you believe it would be effective to have these regional commissions dealing with regional areas?

Dr. BENNETT. I think that this is the most practical way that we have been able to devise up to the present time to cross the State line the way the pollutants do.

Senator MUSKIE. Thank you very much. We do appreciate your statement and your testimony, and look forward to further discussions and exchanges with you, Dr. Bennett.

Senator COOPER. And we appreciate his literary style.

Senator MUSKIE. And his literary style; yes.

Dr. BENNETT. Thank you.

Senator MUSKIE. Our next witness is Assistant Secretary of Commerce, J. Herbert Hollomon, accompanied by Dr. Robert M. White, Administrator of the Environmental Science Services Administration.

STATEMENT OF J. HERBERT HOLLOMON, ACTING UNDER SECRETARY OF COMMERCE; ACCOMPANIED BY DR. ROBERT M. WHITE, ADMINISTRATOR; DONALD PACK, ACTING DIRECTOR, AIR RESOURCES LABORATORY; AND ROBERT ELLERT, SENIOR STAFF ATTORNEY, ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION

Mr. HOLLOMON. Mr. Chairman, good morning, sir.

Senator MUSKIE. Good morning.

Will you identify the gentlemen with you?

Mr. HOLLOMON. Yes. On my left, Mr. Chairman, is Dr. Robert White, Administrator of ESSA, the Environmental Science Services Administration. On his left is Mr. Donald Pack, who is Acting Director of the Air Resources Laboratory of ESSA. On my right is Mr. Ellert, who is the senior staff attorney for the ESSA organization.

Mr. Chairman, I appreciate this opportunity to present this testimony, if you will, and answer questions, and if I may then introduce Dr. White who will describe the relationship of weather to air pollution. I would appreciate that, if that is satisfactory.

Senator MUSKIE. Fine.

Mr. HOLLOMON. Mr. Chairman and members of the subcommittee, I am pleased to be here today to have the opportunity to discuss the relationships of weather to pollution of the atmosphere. The question these hearings can illuminate and help answer is how we can achieve a coherent national program for research and action leading to reduction of the air pollution threat. The Department of Commerce strongly supports sound steps toward such a national program.

We are all painfully aware that as our population increases and our economy grows, the space available for each person and the waste products of our society becomes smaller. As the American standard of living continues to increase, each person consumes more, and industrial consumption increases as well. The problems of coping with the increased waste affecting our environment are not idle or casual concerns. They are urgent public problems for all society.

President Johnson again this year—in his state of the Union message and in his recent special message—has expressed the mood of the entire country that swift action must be taken to restore the quality of our environment. The President's leadership and foresight, and the actions of this committee particularly, are seen in the proposal for the Air Quality Act of 1967.

Let me help clarify our goals by pointing out the relevance of weather to air pollution. Weather patterns responsible for trapping pollutants have been with us for a long time. The really vital point is that increase in the amount of pollution that man is generating causes the more frequent number of dangerous pollution incidents and possible long-term effects of pollution on weather and climate.

Recent reports of the President's Science Advisory Committee and the National Academy of Sciences have served to document the dangerous national pollution situation.

For example, the Academy of Sciences report indicates that the emission of principal pollutants to the atmosphere over the United States totals about 125 million tons per year. Even with assumptions of severe controls in the future the emission of particular pollutants is expected to continue with increasing rapidity.

How do we use the weather sciences to help us solve this public problem? Vice President Humphrey recently said of another public problem, that concerning our cities, "Old ways of doing things simply won't do the job." He suggests a "systems approach" to that problem which would marshal the resources of Government, industry, labor, and the university in restoring the quality of our cities. In the past such a constructive partnership in the space program, for example, has overcome scientific and technological obstacles in a remarkably short time. The Vice President believes that solving a public problem by use of analysis of the larger system rather than particular parts of it, "may prove to be the way in which our rich Nation may finally be able to overcome economic and social problems which have been generations in the making."

There is no reason why the resources of all society, including the great competence within the private sector cannot be directed to improving the quality of our atmosphere in a systematic way. I believe that private enterprise can be motivated to help reach society's goals. I think people are concerned and want to do something realistic and effective and now. They need only leadership.

The Government and others also could capitalize on the resources and competence of universities and well-motivated private corporations by means of major research and development contracts to act positively to restore the quality of our air and not only to prevent further contamination. In this effort, meteorology is one of the most essential parts.

Although the Department of Commerce has long been active in seeking to understand environmental pollution through its competence in meteorology, I should like to make clear that pollution abatement and control is the responsibility of other Federal agencies. The air pollution activities of the Department of Commerce are centered in the Environmental Science Services Administration which was formed by Reorganization Plan No. 2 of 1965.

The President stated that this new agency is to provide a single national focus for efforts to describe, understand, and predict the state of the oceans, the state of the lower and upper atmosphere, and the size and shape of the earth.

ESSA's capabilities couple environmental data collection, data processing, and prediction services in its principal operating units, the Weather Bureau and Coast and Geodetic Survey, with advanced research techniques available in its Institute for Environmental Research. These advanced techniques apply to the study of atmospheric, river, estuary, and near-shore oceanic circulations.

By coupling these functions we have developed a resource which constitutes a vital asset in the national effort to describe and predict, and thus to obtain better understanding of environmental pollution—which is essential if we are to alleviate it.

Our coherent long-range national program to combat air pollution will depend on ESSA's environmental scientists, both for control and for abatement. ESSA's activities in regard to air pollution, which are centered about research into and forecasting of meteorological conditions associated with pollution situations, will be described to you in more detail by Dr. Robert M. White, the Administrator of ESSA. His statement will cover the relationships of weather factors to pollution conditions. He will describe ESSA's main programs, as well as those programs ESSA conducts for the Department of Health, Education, and Welfare, and for the Atomic Energy Commission.

Parenthetically, Mr. Chairman, with respect to those cooperative programs, there has been the most effective cooperation of any that I have seen since I have been in the Government. They work well together. They support each other and there is little competition between them.

If you wish, I would be happy to answer any questions at this time, Mr. Chairman, before Dr. White begins his testimony.

Senator MUSKIE. I have just two. First of all, has there been a close liaison between you and pollution-control agencies in developing knowledge?

Mr. HOLLOMON. Yes, sir.

Senator MUSKIE. And policy?

Mr. HOLLOMON. Yes, sir; there has been close cooperation both with respect to the technical aspects of what can be done, for example, in certain regions, how you define regions, what the levels need to be, and how they can be measured, as well as general policy coordination

particularly between HEW, Mr. MacKenzie's operation, that of my Office, and Dr. White's Office.

Senator MUSKIE. Is this governed by any interagency agreement or is it simply an informal arrangement which has developed into a pattern?

Mr. HOLLOMON. We have a definite interagency agreement with respect to funding and cooperative research with HEW and AEC. They transfer funds to us and we work colsely with them in a rather formal cooperative arrangement.

There has been a substantial amount of informal cooperation at the policy level. There is no formal document of agreement between the two agencies on policy questions, but there is a substantial degree of agreement formally with respect to cooperative technical work.

Senator MUSKIE. Does weather modification research relate to control of air pollution at all?

Mr. HOLLOMON. Yes, sir; in many ways. One is that it is quite possible, as Dr. Bennett already pointed out, that changes in the level of carbon dioxide (CO_2) in the atmosphere, for example, may have long-range climatic effects. This is an inadvertent weather modification, if you want to look at it this way.

I think it is a good way to look at it. More particularly, particulates in the atmosphere certainly affect, in ways which we don't thoroughly understand, the onset of rain, snow, and the atmosphere's ability to hold water.

Thirdly, there are specific effects, particularly in cities, where the change in cloud cover, the lack of sunlight, change in the heat balance, substantially affects the whole climate. As you well know, for example, the amount of ice and snow that stays on the streets in Washington is substantially different from that which is only 10 miles out.

Each major city is a sort of heat island for two reasons: One is it generates heat in itself, but in addition there are changes in the overall weather of the city. We are just beginning to begin to recognize the degree to which a city has its own weather and measure it on a local as well as a broad basis.

Senator MUSKIE. By that you mean that the fact of the existence of the city in effect changes the weather in the location?

Mr. HOLLOMON. Exactly, sir, exactly. And the changes are quite dramatic. There are changes in average temperature of a very substantial amount and there are obvious changes in the general climate. There are other factors.

As you know, the technique of weather modification which is used involves either adding dry ice to the atmosphere, which is not a pollutant in a normal sense because it disappears, or adding silver iodide. Other particulates, such as certain kind of clays, also instigate snowfall and possibly change the character of storms.

We do not know enough about this in detail, but it is certainly quite possible and it is a question which we need to further examine.

Senator MUSKIE. Is it out of the realm of reasonable speculation to suggest that we might find ways to wash the atmosphere over the city as an alternative means to dealing with the air pollution?

Mr. HOLLOMON. You ask me the question. As a practical fellow I would rather try the other technique first. I think, as everyone else has said, that the way we now know to get at the pollution problem is to get at the source. The atmosphere is an extraordinarily large and diffuse body. I know of no practical techniques either now or in the near future that would permit any substantial amount of cleansing of the atmosphere other than by the fact that it is large and extremely diffuse.

Dr. White may have a comment on this at a later time.

Senator MUSKIE. Senator Boggs.

Senator BOGGS. No questions at this time, Mr. Chairman.

Senator MUSKIE. Senator Murphy.

Senator MURPHY. No questions.

Your last question, Mr. Chairman, interested me. I thought for a long time as they built highways that there might be a possibility of a washing situation as well as contaminants on highways, the manner of the construction of the highway, where it is taken down and controlled at the highway level as it comes out of the exhaust.

We have even talked in Los Angeles of ways of building great fans so you create what is needed there. We have a unique geological situation. You need a wind movement of about 6½ miles an hour at all times to clear the atmosphere.

Senator MUSKIE. It seems that California politics are producing that.

Senator MURPHY. I am glad to say that after November it settled down and the atmosphere is much clearer.

Mr. HOLLOMON. The amount of energy involved in creation of such wind over a considerable period of time, considering the stagnant nature of the atmosphere, is simply enormous.

Senator MURPHY. It goes back on the old story of supply of water. When Mr. Mulholland talked about bringing it down from the high Sierras they wanted to throw a net over him and take him away, but they have done it. Now they have improved on that. Now we are talking about bringing water from the Columbia River, so with my great belief in the capabilities of the private sector I don't think anything is impossible and I refuse to get amazed at anything that is suggested as it might touch water.

Senator MUSKIE. Senator Cooper.

Senator COOPER. I have no questions at this time.

Senator MUSKIE. I have just one other question of you. You wanted to leave, Mr. Secretary.

Mr. HOLLOMON. Yes, sir; if I may.

Senator MUSKIE. The January 7 Evening Star, Dr. Hollomon reports that the depth of commerce, and I think these are the words, is shrouding with secrecy its first high-level study on the electric car. Would you want to comment on that?

Mr. HOLLOMON. First, we are not shrouded in secrecy, Mr. Chairman. We established some few months ago a special panel to compare various aspects of electric vehicles and alternatives, what the technical problems were with regard to the possibilities of reducing pollution from various kinds of engines.

The charter to that group was to examine the technical feasibility of various approaches to the problem, to determine what research and development, what activities, ought to be undertaken and what the appropriate role of the Federal Government was.

This group is made up of people from industry, from universities, with a diverse background, people who have expertise in air pollution, in combustion engines, in batteries, in electrochemistry, and so forth.

The group, I think, indicating the kind of importance that is attached to this, is supported by—I want to be sure that I get them all—the Department of Defense, the Federal Power Commission, the Department of HEW, the Department of Housing and Urban Development, Department of the Interior, the Department of Transportation, and even the Post Office Department. Each of these agencies has agreed with the Secretary of Commerce to support this panel study of citizens.

No Government employees are on it except the service staff. We announced the formation of that panel prior to the article to which you refer and it appeared in the New York Times about 7 hours preceding. So I can demonstrate that it wasn't secret. It is true that after I left the meeting and had introduced the panel to its problem and had said, "Now, gentlemen, get at it." We discovered in the confusion of so many new people coming together that there was a reporter in the room. The chairman of the panel said he didn't know how to get organized to exchange views and what they should do with the reporter there, and he asked him to leave.

That is how this story got about. The panel was publicly announced. It will make its report public when it completes its considerations.

We have asked it to report by the fall of this year and to give an interim report hopefully this spring. It is to get to this problem of industrial cooperation with the Government to solve what we believe is a key problem and which I think all of the witnesses here have agreed, which is to try to see what can be done about the major source of pollution of the atmosphere, that which comes from combustion engines.

Senator MUSKIE. Thank you, Mr. Secretary.

We will have joint hearings with the Senate Committee on Commerce, I think, beginning on March 13, on the whole problem of the electric automobile, so I won't go into further detail here. But I thought you might like to comment on that one point this morning.

Mr. HOLLOMON. Yes, sir. Thank you very much for the opportunity.

Senator MUSKIE. Thank you very much, Mr. Secretary.

Mr. HOLLOMON. I would like to introduce Dr. White.

Thank you.

Senator MUSKIE. We will look forward now to Dr. White.

May I say, Dr. White, that I personally have looked forward for a long time for the opportunity to get into this subject which you are about to open. I don't think we have been educated enough on this subject matter, on the question of the weather and the meteorology of air pollution. So I hope you will treat us as a class and undertake to enlighten us.

STATEMENT OF DR. ROBERT M. WHITE, ADMINISTRATOR, ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Dr. WHITE. Thank you.

Mr. Chairman and members of the subcommittee. It is a pleasure to appear before this subcommittee to discuss the relationships between weather and air pollution, and some of the activities that the Environmental Science Services Administration is conducting in this field.

ESSA has been assigned, as Dr. Hollomon has pointed out, the responsibility for providing a national focus for efforts to describe, understand, and predict the state of the geophysical environment as required to provide for enhancement of commerce, industry, agriculture, and the public safety and welfare.

Because of this broad responsibility, ESSA is vitally concerned with the current state and quality of the total environment, including the atmosphere, and is equally concerned with the changes that occur in the air, water, and land due to man's activities. I should make it clear at the start of my statement that ESSA's role in atmospheric pollution is that of describing and predicting associated meteorological conditions; pollution abatement and control, of course, are the responsibilities of other Federal agencies.

First, I would like to review the influences of meteorology on air pollution. The atmosphere is characterized by its variability which, incidentally, provides the challenge to our weather forecasters. Hour-to-hour and day-to-day shifts in wind direction and windspeed are common—these provide much of the excitement of the weather.

These wind changes also change the capacity of the atmosphere to mix and dilute contaminants emitted into it. This capacity of the atmosphere to dilute pollutants is not unlimited. Most of the pollution created by man is confined to the lower layer of the atmosphere—below heights of about 30,000 to 40,000 feet.

This represents an enormous air reservoir of about 180 billion billion cubic feet for the entire globe. But—and this is the big "but" in air pollution—at different places, and for varying lengths of time, only a small fraction of this volume of air is available for the dilution of locally released contaminants.

A study of previous air pollution episodes, or disasters, such as those in London, Belgium, Donora, Pa., and along our eastern seaboard has shown that the presence of a large slowly moving high-pressure center reduces the dilution capacity of the atmosphere. This comes about because of two related meteorological events.

First, the horizontal windspeed is reduced much below its average level and air pollutants are not moved away from their source as quickly as usual. In such light wind conditions the pollutants seldom travel away in a straight line, but often double back on their source, gradually filling up the area with more and more pollution.

Second, within these high-pressure areas a large mass of air gradually descends, warming as it descends, and creating a temperature lid. This lid, or "inversion," as we call it technically, is a layer in

which the temperature increases with height instead of decreasing, as is normal.

Such an inversion—a warm layer of air overlying a relatively cool surface layer—effectively caps the pollution and confines it in a shallow layer, sometimes less than 500 feet deep. If the emission of pollutants into this relatively shallow, slowly moving layer of air continues at its regular rate—the pollutant concentration increases and grows far beyond its usual level.

As an example, an analysis made after the November-December 1962 air pollution episode showed that, in some of our larger cities, the population was subjected to more than half of its total 2-month exposure to sulphur dioxide in less than 5 days.

Senator MUSKIE. Is the temperature inversion condition of a given area predictable? Secondly, does it establish patterns that repeat themselves so that you can say that in a given city the degree of risk of such heavy concentrations of pollutants?

Dr. WHITE. Yes. I will be commenting on that further in my testimony, Mr. Chairman. I will have some charts which address themselves to this topic.

Senator MUSKIE. Good.

Dr. WHITE. It is ironic that these situations are also those that give rise to the formerly beautiful Indian summer of late fall and early winter. The sparkling skies and crisp air that were typical of these delightful interruptions of winter's arrival are now, far too often, characterized by a dirty pall that obscures the sky, the hills, and even the tops of the buildings, due to the smoke and fumes that the wind cannot carry away.

These situations do not occur uniformly over the country but are concentrated in particular geographical areas. An ESSA research study found that the most frequent occurrences are in the Southeastern United States where such episodes lasting 4 days or more can be expected about three times a year.

However, even the southern New England States can expect about one or two such episodes every 2 years. A recent extension of this study to cover a 30-year period shows that the pattern has remained stable over these three decades, and I have a chart here to show this. (Figure 1.)

Senator MUSKIE. Incidentally, Doctor, these charts will be included in the hearing record. I think they can all be reproduced, can't they?

Dr. WHITE. Yes, they can, sir. This chart, Mr. Chairman, shows the number of "stagnation days" occurring in the 30-year period. In the area within the contour lines, the lines in red, marked "300," for example, an average of 10 such days were observed each year. This will give you some idea of the way in which these stagnation days occur, at least in the eastern part of the United States.

We must remember that, while the atmospheric dilution is highly variable over short periods of time, the average weather patterns show little change over tens of years—it is the increase in pollutant emissions that has caused an increase in pollution—not a change in weather.

A similar study for the western portion of the United States showed that the Great Basin States of Utah, Nevada, and southern Idaho are most prone to long periods of reduced atmospheric ventilation. How-

Number of days with stagnant weather conditions during the 30-year period, 1936-1965.

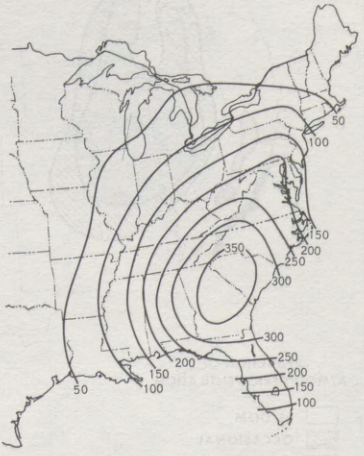


FIGURE 1

ever, in contrast to the eastern seaboard, these occur primarily in mid-winter rather than in the fall and early winter as along the east coast.

In addition to these large-scale meteorological effects there are local situations, usually created by major topographic features such as mountain ranges, that can reduce the average ventilation or dilution of an area. The best known of these is probably southern California. Here a combination of the nearly encircling mountain ranges and the persistent inversion lid due to the Pacific high-pressure center restricts the amount of air available for pollution dilution. The San Joaquin Valley in California and the Appalachian valleys of Pennsylvania and West Virginia are other examples.

Through studies of the winds, inversion frequency, and the movement of high-pressure centers a general picture of the atmospheric ventilation potential of the United States is beginning to emerge. This is shown in a figure published in the report of the National Academy of Sciences, "Waste Management and Control." It is shown on the next chart. (Figure 2.) This chart shows qualitatively the zones of reduced atmospheric ventilation in the eastern part of the country during the fall, and the reduction in the western part during the winter, and generally the color scheme is related to the persistency of these conditions.

Senator MUSKIE. In other words, these are the areas, the more intensely colored areas——

Dr. WHITE. That is correct.

Senator MUSKIE. In which the risk of concentration of pollutants is greatest?

Dr. WHITE. That is correct, sir.

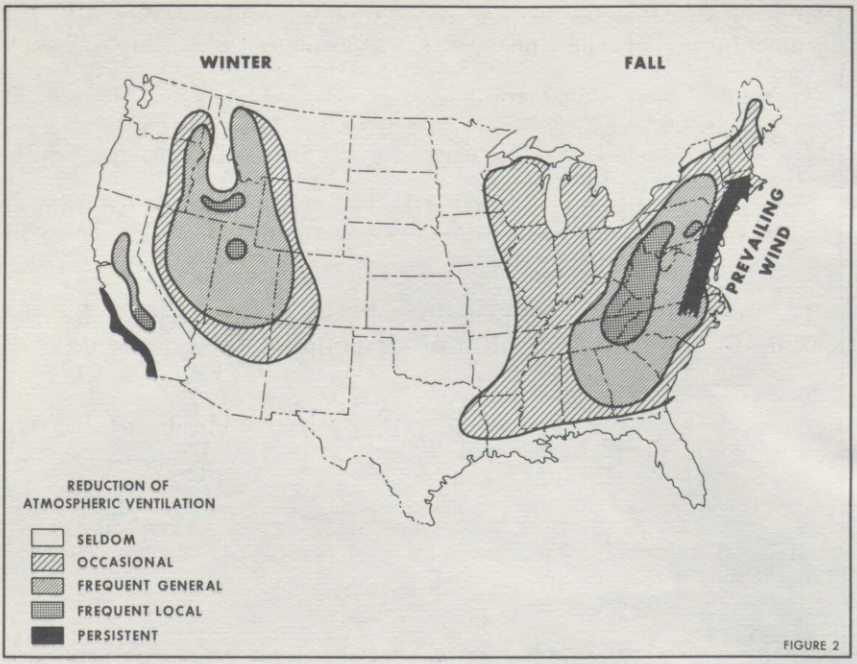


FIGURE 2

Average atmospheric ventilation for the United States. Shaded areas (see Key above) have reduced ventilation which may result in adverse atmospheric pollution conditions. Note that the areas with the worst condition, "persistently reduced" atmospheric ventilation is Southern California. The prevailing winds along the East Coast during the fall, when ventilation tends to be reduced, move pollutants within the "megalopolis."

Of course, these represent only the meteorological conditions which favor such concentration.

Senator MUSKIE. Yes. To the extent they overlap the industrial areas of the country that is where the point of greatest danger is?

Dr. WHITE. That is correct, Mr. Chairman.

In addition to these direct effects of the weather on pollution there are other more complicated and therefore less well understood effects. These are primarily the interactions of various pollutants as they travel through regions of the atmosphere where both the relative humidity and the amount of sunshine are highly variable. The photochemical smog, originally typical only of Los Angeles, but now observed in almost every major city, is a particular example. With the same amount of mixing—photochemical smog may or may not form, depending on the amount of cloudiness, and therefore the intensity of ultraviolet radiation reaching the pollution mixture.

There is a growing body of evidence that the character of the sulphur dioxide emitted from burning fossil fuels will be influenced by the relative humidity. With high relative humidity sulphur dioxide is transformed rapidly into what my technical staff insists I call "anhydrous sulphurous acid" (SO_3) and then to sulphuric acid (H_2SO_4). The reaction rates for this process, the critical humidities, and the need for catalytic agents, are largely unknown. Research programs in the National Center for Air Pollution Control of the U.S.

Public Health Service are addressed to this problem. Obviously the documentation of the concurrent meteorology is a part of such research.

This has been a brief statement covering the general aspects of meterological air pollution. I would like to submit for the record reprints of two technical papers by staff members of our organization dealing with air pollution.

Now I would like to turn, Mr. Chairman, to a brief description of the ESSA meteorological activities related to air pollution. For the purposes of this presentation our work can be conveniently divided into three parts.

The first is the Weather Bureau's public service activities, directed specifically toward the problem of air pollution. This program is of relatively recent origin.

The second is the long-standing activity conducted by ESSA for the Atomic Energy Commission related to the environmental safety aspects of nuclear energy, particularly global fallout and nuclear power production.

The third major segment of our program is conducted with the support of the National Center for Air Pollution Control, Public Health Service, and is specifically directed toward the influence of meteorology on urban air pollution. Let me discuss these programs in reverse order.

In 1955 the Weather Bureau, now a major component of ESSA, agreed to work with the Public Health Service on research to define the meteorological influences on urban air pollution. An office was established at the Public Health Service's facility in Cincinnati. This program now has a staff of 42, which includes 21 professional meteorologists, and support from the Public Health Service to ESSA of approximately $615,000, in fiscal year 1967. The activities conducted by this office include studies of the relatively small-scale airflow within cities, and development of mathematical models of pollutant dispersion for these areas, the conduct of tracer experiments within a city, for example, St. Louis, Missouri, to examine the effect of the city itself on the dilution of contaminants, relations between visibility and pollution, the intra- and inter-city movement of air pollutants, evaluation of the national air sampling network data and the continuous air monitoring programs of the Public Health Service in terms of meteorological variability.

Two additional program activities should be mentioned. The first is the establishment of a network in the continental United States to measure atmospheric turbidity. This program measures the reduction in solar radiation brought about by small particulates, or—simply—dirt, in the atmosphere.

This is the first program of its kind on such an extensive basis in the United States and is unique in utilizing small, portable, and inexpensive instruments. This relatively unsophisticated measurement program has produced important data showing a trend toward increasing amounts of particulates in the atmosphere over the 5 years it has been in operation.

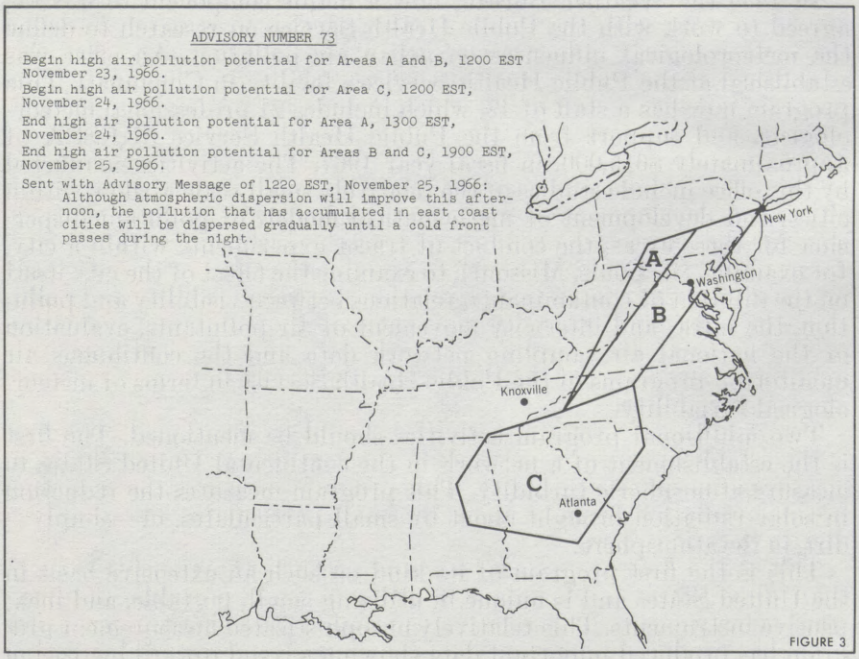
It is of interest to note that these phenomena could potentially be as significant, or even produce greater effects on climate, than an increase in carbon dioxide.

The other major program has been the development of a prediction method to anticipate reduced ventilation by the atmosphere, the air pollution potential advisory program. This program was initiated for the eastern portion of the United States in 1960 and has been nationwide since October 1963. It is the result of 8 years of intensive research.

At present these advisories are based on computer-produced charts giving the depth of the atmosphere available for the vertical mixing of pollutants, and the average wind speed within this layer. The advisories for large areas of reduced dilution, are issued daily at 12:20 p.m. eastern standard time as required, and made available through several hundred Weather Bureau offices via the meteorological teletypewriter circuits.

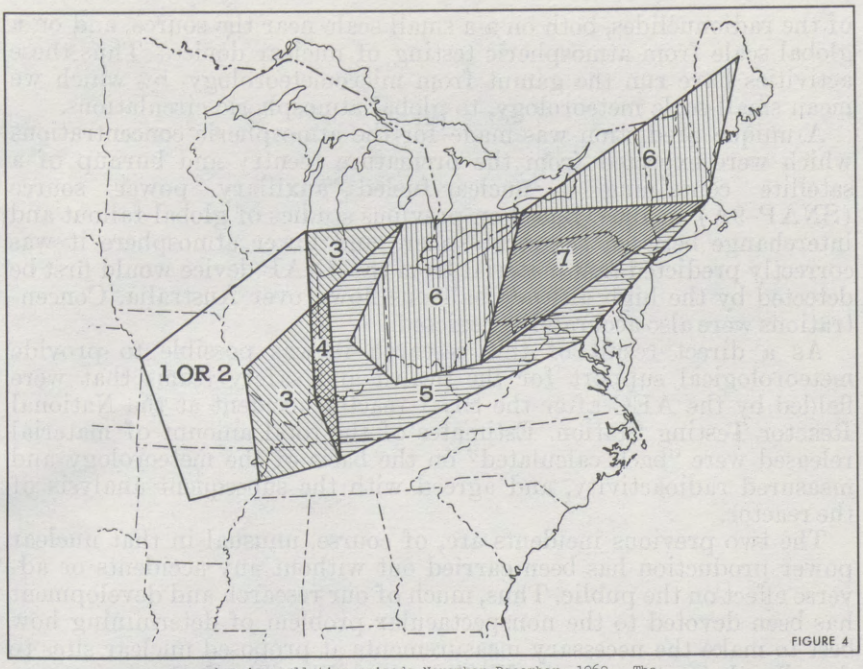
As of January 1, 1967, 75 of these advisories had been issued—an average of about 12 per year. The 73d advisory was for the recent Thanksgiving episode which resulted in the heavy pollution in New York City. This advisory predicted the onset of this condition and, in conjunction with local forecasts by the ESSA air pollution specialists and other staff members of our New York Weather Bureau Office, predicted the increased ventilation which terminated the episode.

The next chart on the easel shows the advisory issued for this Thanksgiving period (fig. 3). As you can see, the chart shows the start and end of the advisory for the particular areas indicated.



The air pollution potential advisory that correctly predicted the start and end of the meteorological conditions responsible for the intense atmospheric pollution in the New York City area during the Thanksgiving weekend, 1966.

For comparison, I would like to show a much more persistent episode which occurred in 1962; this is shown on the next chart (fig. 4). This episode occurred in connection with the movement of a very



A major pollution episode November-December, 1962. The numbers indicate the number of days reduced atmospheric ventilation existed within each area.

large high pressure area across the United States. The chart indicates the areas for which advisories were issued and the number of days for which the reduced ventilation condition persisted in various areas of the United States.

Senator MUSKIE. Did that prove to be an accurate prediction?

Dr. WHITE. Let me refer this to Mr. Pack here.

Senator MUSKIE. I notice you call them advisory, not prediction.

Dr. WHITE. We are using the word, Mr. Chairman, "prediction" for a routine forecast which we issue every day. These are issued only when the conditions warrant.

Hence, we are calling them advisory.

Senator MUSKIE. A difference in terminology has nothing to do with a relative difference in their accuracy?

Dr. WHITE. No, Mr. Chairman.

Don, would you?

Mr. PACK. That was a good series of forecasts. It was also the one in which half the 3-month dose of sulfur dioxide was obtained in some of the cities.

Dr. WHITE. Turning now to ESSA activities for the Atomic Energy Commission—these began in 1948 and have included detailed studies for diffusion and transport at the Oak Ridge National Laboratory, the Nevada Test Site, and the National Reactor Testing Station in Idaho, to mention the major locations.

The purpose of our program has been to develop measurement techniques for atmospheric variables to provide quantitative estimates of atmospheric dilution. We have also conducted research on fallout

of the radionuclides, both on a a small scale near the source, and on a global scale from atmospheric testing of nuclear devices. Thus these activities have run the gamut from micrometeorology, by which we mean small-scale meteorology, to global atmospheric circulations.

A unique prediction was made for the atmospheric concentrations which were expected from the premature reentry and burnup of a satellite containing a nuclear-fueled auxiliary power source (SNAP–9A) in 1964. Based on previous studies of global fallout and interchange between the stratosphere and lower atmosphere it was correctly predicted that material from the SNAP device would first be detected by the high altitude balloons flown over Australia. Concentrations were also accurately predicted.

As a direct result of this research it was possible to provide meteorological support for the health and safety teams that were fielded by the AEC after the SL–1 reactor accident at the National Reactor Testing Station. Estimates of the total amount of material released were "back calculated" on the basis of the meteorology and measured radioactivity, and agreed with the subsequent analysis of the reactor.

The two previous incidents are, of course, unusual in that nuclear power production has been carried out without any accidents or adverse effect on the public. Thus, much of our research and development has been devoted to the nonspectacular problem of determining how best to make the necessary measurements at proposed nuclear sites to describe their atmospheric dilution capability. This information was summarized in "Meteorology and Atomic Energy" in 1955, a handbook prepared by ESSA for the AEC. More than 10,000 copies of this document were sold. We are currently completing an updated version of this work.

Again, two special programs should be mentioned in our research for the Atomic Energy Commission. The first is the development of a prediction technique for global fallout. This program identified the spring maximum that occurs due to vigorous interchange between the stratosphere and the lower atmosphere during that season. We predicted, with satisfactory accuracy, average fallout levels over the past several years.

The second program is the development of a unique tracer technique utilizing a small balloon which floats at a constant height above the ground and which can be tracked with great accuracy by radar, including our weather radars. Extensive experimentation with this technique has shown the recirculation of air masses within the Los Angeles basin and in and around New York City.

Next, I should like to describe the internal ESSA programs. Our major program is in the public service area and includes the development of computer-produced air pollution potential advisories for the United States. This differs from the on-going program in placing heavier reliance on the computer and on numerical weather prediction techniques. We expect to extend the forecast period and to provide earlier advisories and hence more leadtime.

The computer system is now under test—we plan to transfer the present operational forecast program from our Cincinnati research office to the National Meteorological Center in Suitland this summer.

The next chart (fig. 5), is an example of the output produced by the computer. In this chart, Mr. Chairman, we are showing the output of the computer at the National Meteorological Center which now automatically produces information dealing with the meteorological conditions affecting air pollution. This provides the information on the depth of the atmosphere which is available for the mixing of pollutants and the average wind speed within the layer.

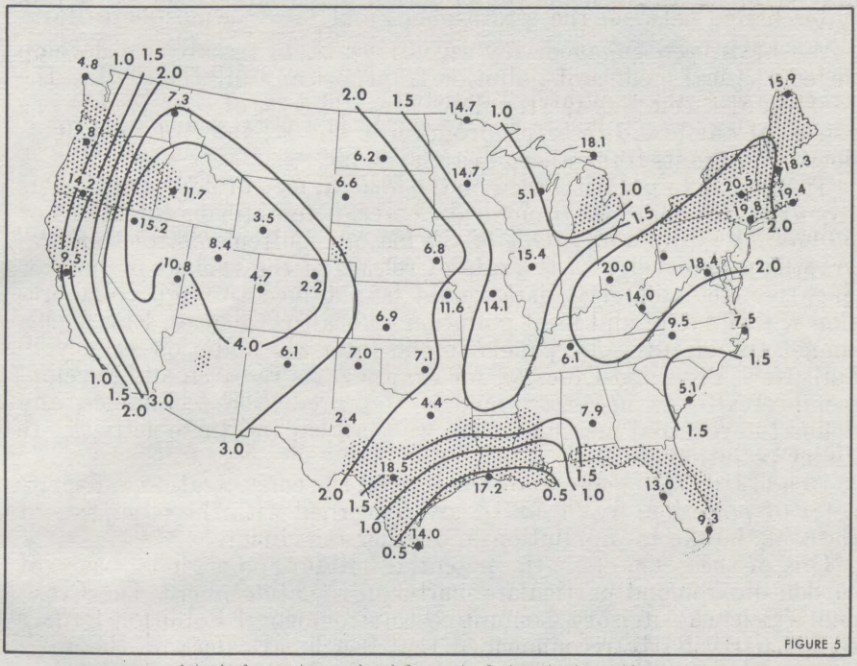


FIGURE 5

A typical computer-produced forecast of atmospheric ventilation used in preparing the pollution potential advisories. Solid lines indicate (in kilometers) the depth of the layer through which pollutants would be dispersed. The numbers shown at special weather stations give the average wind speed (in meters per second) within this layer. The shaded areas are those for which precipitation is forecast. Combinations of low values of the "mixing layer" and wind speed, with no precipitation, indicate potentially unfavorable conditions. For this chart conditions throughout the United States are generally favorable.

Senator MUSKIE. What is the significance of the green areas which in black and white would be the shaded areas?

Dr. WHITE. The green (shaded) areas indicate precipitation. This chart is produced for the current weather—the conditions existing at the time the computer starts its calculations—as well as for the forecast conditions 12 and 36 hours later. Such forecast charts are now used by the air pollution meteorologists in preparing their advisories—a combination of low mixing depth and low wind speed indicates a potentially dangerous pollution situation. As the system is improved the actual pollution advisories may be produced by the computer.

In support of this overall program we have assumed the operational and funding responsibility for the regional air pollution meteorologist currently stationed in New York City. We plan to station one of these specialists at each regional center in the continental United States during the next fiscal year.

I think that this is a good place for me to point out that the activities I have been describing would be impossible without the support provided by ESSA's basic weather service system. This "system" collects the basic meteorological data for the United States; gets additional inputs from the rest of the Northern Hemisphere, and processes the data on high-speed digital computers, which prepare our basic weather forecasts. This system provides the intermediate products and the know-how needed to make the pollution potential advisory program "go."

We have been engaged, for several years, in research to develop meteorological models of pollution transport and dilution within the confines of a complex metropolitan area. This is, of course, only one aspect of our broad research program in the behavior of the atmosphere, and profits from other research results.

The goal is to predict, based on the general meteorological forecasts from the National Meteorological Center, potential concentrations of pollutants within a city. One of the major requirements for this program is a knowledge of the rate of release of the various pollutants. Such nonmeteorological data would be obtained through collaboration with Federal and local pollution or health Agencies. ESSA personnel are on advisory panels to the local air pollution agency in both New York and Chicago, for example. As research and developments create the necessary models and prediction techniques, and define the required measurements, we shall expand these activities to major pollution areas.

In addition to the effects of weather on the concentration and character of pollution, we in ESSA are concerned with the other side of the coin, the effects of pollution on weather and climate.

One of these aspects is the potential buildup, on a global basis, of carbon dioxide and particulate matter in the atmosphere. The President's Science Advisory Committee Environmental Pollution Panel's report particularly recommended that benchmark data on the environment be established and specifically mentioned the need for better documentation of the carbon dioxide distribution in the atmosphere.

ESSA takes precise carbon dioxide measurements at its Mauna Loa, Hawaii, observatory. This is the only long-term measurement program in the world having the necessary precision to document a possible buildup of carbon dioxide in the atmosphere. We are developing simplified sampling methods to expand this obviously inadequate single measurement to, first, a continental U.S. measurement program, and, eventually, a global carbon dioxide monitoring program.

Our program is concerned primairly with the long-term trends of what we call "clean" air. This requires measurements in areas which are not only remote from human activities now but which can be expected to remain uncontaminated for many years to come. Because of this requirement we do not intend to duplicate the extensive monitoring program operated by the Public Health Service or by any State and local agencies. We will conduct an entirely different long-term program. However, we are coordinating our efforts with these other agencies, particularly in the analytical field, so that there can be mutual interchange of new techniques and laboratory methods.

The collection of specialized data related to pollution is supported by the maintenance of long-term climatological records by ESSA's

Environmental Data Service, including our advanced data storage and retrieval facility at Asheville, N.C. Such data will be used, in conjunction with the pollution data, to document long-term climatic changes.

This study of the possible global deterioration of clean air must include analysis of the effects of these changes on climate and weather. There has been much speculation on the long-term effects of increasing atmospheric carbon dioxide on the world's climate. Recent evaluations raise some question about the significance of this effect, but we would be the first to admit that our global weather computer models used in studying this problem may not be sufficiently complete. We are therefore increasing the exchange between our air pollution research specialists and the staff of our Geophysical Fluid Dynamics Laboratory to mate the results of the two fields of research.

The advantage of using the sophisticated global computer models developed in our Geophysical Fluid Dynamics Laboratory is that we can simulate increasing global industrialization and examine both the short- and long-term implications of the effects of a highly industrialized world on the climate.

There are, however, much better-defined effects of pollution on our weather. These have been described in considerable detail by Dr. Helmut Landsberg, the recently retired director of our environmental data service. He showed that pollution can result in a loss of solar radiation in city air from 11 to 34 percent; that the probability of low visibility in the city is markedly increased; and that more frequent precipitation may occur in the cities due to pollution. We are all aware that the city may change a rural snowfall into urban slush. The effect of the city "heat island" is to increase minimum temperatures in the downtown area by as much as 5° to 10° Fahrenheit.

As the level of pollution in the atmosphere increases, we must examine its effect on local weather conditions and to determine, in turn, what this does to the well-being of the people who live in cities. ESSA is planning to expand its urban weather service, which directly supports our local forecasts of wind, fog, and snow. We also plan to initiate research to improve techniques for small-scale weather forecasting. Better urban meteorological measurements will be made, including detailed measurements of the vertical temperature structure with sounding balloons designed specifically for city use.

No discussion of meteorology today is complete without consideration of weather modification. I would like to spend a moment discussing the possibilities for man's intervention with the weather to decrease the level of air pollution.

Dr. Morris Neiburger of the University of California, Los Angeles, discussed a number of proposals along these lines in "Science" a few years ago. In one of his examples he pointed out that the energy required to eliminate a Los Angeles-type inversion would require the burning of over 1 million tons of oil even if the atmosphere stayed in place during the heating.

To maintain an artificial 9-mile-an-hour wind over the Los Angeles Basin would require the energy output of 12 Hoover Dams. Although the estimates were made only for the Los Angeles area, the order of magnitude is probably valid for other urban areas. We are therefore forced to the conclusion that the "brute force" approach is impractical, if not impossible.

There is, however, recent evidence that certain types of weather modification may be possible. If we develop techniques to change the behavior of major storms, and the associated wind fields, we may be in a position to explore methods of modifying weather conditions related to pollution buildups.

ESSA is now expanding its activities in weather modification research, and as results become available they will be shared with our air pollution researchers.

ESSA's plans include field experiments and digital computer simulations of special meteorological situations. Techniques are not available today for reduction of pollution by modifying the associated weather conditions, but study should be expanded in this vital area. There may also be possibilities of indirect intervention by accelerating the removal of pollutants from the atmosphere. This might be done by increasing their rate of growth and hence fallout. So far we don't know how to do this.

Too little is known of the size of particulates that normally exist in the polluted atmosphere, and their natural rate of growth. We have to learn much more about atmospheric chemistry—in the real atmosphere—rather than in the laboratory. This does not mean, however, that we should not continue to conduct research on the problem. We plan to do this on a long-range basis.

There are two points I would like to make in concluding my statement. First, I would like to take this opportunity to state that our relationships with the Department of Health, Education, and Welfare and with the Atomic Energy Commission in the conduct of air pollution research have been most rewarding. The exchange of ideas and program plans, and discussion of problem areas has been of great value in developing work responsive to broad national needs.

We hope that these agencies have benefited from our work. We know that our staff has benefited from the on-the-job collaboration with the physicists, chemists, and physicians of these agencies. We have integrated our meteorological efforts with other scientific areas for the interdisciplinary approach required in the total attack on the growing air pollution threat.

Second, let me summarize those areas where further effort is needed to restore the quality of our air environment. On the very large scale we need to establish a measurement program to document the global trends in atmospheric composition. This program has been initiated and is being expanded.

We need to use these data in global weather computer simulations to evaluate their effect on weather and climate. This requirement is supported by much of our general circulation research effort, as well as by expanded specialized studies.

On a very different scale we must do additional studies on the meteorology of cities. These studies must include better measurements of the effect of the city on airflow and weather. We plan to expand our urban weather service to provide this data, as well as to meet urban user requirements.

We must devise models to describe the dynamics of the urban boundary layer, including the changes in the nature and amount of pollutants as they interact in the city air. Preliminary research efforts are already underway, with expansion planned.

Finally, we must accelerate our development of methods to predict urban pollution concentrations. This means creating models of airflow, incorporating pollution emission data, and substantiating the results with air pollution observations. This program is a major challenge to our scientific and organizational abilities.

Thank you.

Senator MUSKIE. Thank you very much, Dr. White. I have just one question that I will take the time to ask at this late hour. The President has introduced the concept of regional airsheds as a basis for air pollution control. From the meteorological point of view, does this have any meaning?

Dr. WHITE. Semantically it has relation to the watershed. The watershed can be well defined by physical boundaries. There are certain parts of the country where you could define an airshed; that is, where the air is contained in a manner similar to which the water is contained in a watershed.

The Los Angeles Basin is a good example of such an airshed. When you come to areas of the country, principally east of the Rocky Mountains, where there are no barriers to the air motion, then we must conceive of an airshed not defined exclusively in terms of the physical boundaries of the atmosphere, but a combination of the climatological effects of the atmosphere and the locations of those regions which produce the contaminants.

If we use a combination of these two factors: The region where the pollutants are being produced, and their effects downstream, and combine this with the climatological information about the atmosphere, I think we can probably define something that you can deal with on a regional basis.

Senator MUSKIE. In the case of an area like the New York metropolitan area, as you said, it would have application?

Dr. WHITE. Yes, sir.

Senator MUSKIE. Probably in that instance it is the source of pollution that would define the extent of the area rather than meterological conditions? Is that an accurate statement?

Dr. WHITE. Well, I think it would be the source of pollution and the normal wind fields that occur. We would want to know, for example, how far downstream the pollutants do have an effect before they are dissipated. So that you have to bring both factors into account.

Senator MUSKIE. The answer to that question would change, wouldn't it, as the concentrations or as the quantity of pollutants increased over the years?

Dr. WHITE. Yes, the area would change from time to time, but it should be possible to define an area which would be useful most of the time.

Senator MUSKIE. So it does have meaning then?

Dr. WHITE. I think it has meaning if you take these two factors into account.

Senator MUSKIE. You have two papers or articles attached to your statement. You would like these included in the record?

Dr. WHITE. Yes, Mr. Chairman, if that is possible.

Senator MUSKIE. Yes, they will be. They seem to me to be useful, but I have not had an opportunity to evaluate them.

Thank you very much, Doctor White. I am sorry that the morning has advanced to the point where we didn't have time for questioning that we might like to have, but we will get another crack at you sometime.

Dr. WHITE. Thank you, Mr. Chairman.

(The papers submitted by Dr. White are as follows. Text resumes on p. 830.)

AIR POLLUTION—SOME METEOROLOGICAL ASPECTS

(By R. A. MCCORMICK, U.S. Weather Bureau Research Station, Laboratory of Engineering and Physical Sciences, Robert A. Taft Sanitary Engineering Center, Division of Air Pollution, Public Health Service, U.S. Department of Health, Education, and Welfare, Cincinnati, Ohio)

On 10–12 December 1962 the second National Conference on Air Pollution called by the Surgeon General of the U.S. Public Health Service is to be held in Washington, D.C. The conference, which will be open to the lay public as well as to all representatives of particularly interested groups, has as a major objective ". . . to explore ways of utilizing the technical methods we now have for the control and abatement of air pollution." While the role of meteorological science in the abatement of air pollution is not one that provides direct technological methods for control in an engineering sense, it can provide substantial support and thus enhance the effectiveness of such efforts.

On the eve of the conference, it is the purpose of this note to present a brief accounting of the present status of "air pollution meteorology," a designation frequently used by workers in the field. Unfortunately this designation is misleading, since it implies a limitation of scope of scientific interest far greater than that which actually exists. As a matter of fact, the range of *immediate* concern of air pollution meteorologists is probably as wide as that of any group of workers in the atmospheric sciences, chiefly because of the inter-disciplinary nature of the subject and the scale range, micro to macro, of the problems that arise.

While in most areas of meteorological investigation the variation in water-vapor content is about the only compositional change (in the troposphere) of importance to be dealt with, the additional variation in the amounts of trace substances—usually unlisted in meteorological texts—is the central problem in air pollution meteorology. These trace substances, in addition to providing cause for anxiety for the health and economic welfare of large masses of our population, also have meteorological consequences that must be investigated and accounted for. It seems appropriate now to list some of the more important trace substances or air pollutants and tell a little of how they come about.

MAJOR AIR FORCE

Atmospheric "pollutants," "contaminants," or "impurities"—no precise objective definition exists—might be variously classified according to their (a) physical state, i.e., aerosol or gas, (b) chemical nature, i.e., organic or inorganic, or (c) mode of entry, i.e., direct emission into the atmosphere from a specific source or produced *in the atmosphere* by physical, chemical, or photochemical reactions among pollutants or "natural" air constituents. Further sub-classes may then be specified, but, as brought out by Chambers (1962), the exact quantitative descriptions of air quality in terms of such classifications is not reliable because ". . . few, if any, of the polluting entities retain their exact identities after entering the atmosphere." An excellent review of the physical and chemical aspects of air pollutants for non-specialists has been written by Katz (1961).

No criteria have been established in terms of which the major air pollutants can be identified. The following, then, is an arbitrary enumeration of those substances most frequently sampled for by air pollution control and research agencies over the country at the present time. In each case the pollutant is known, or strongly suspected, to have an adverse effect, directly or indirectly, on the health and welfare of the public.

1. Fine particulates ($<50\mu$ radius) These are usually unburned products of combustion or dusts arising from grinding, drying, and similar processes from a host of industrial sources. They are primarily responsible for the soiling of clothing, furniture, and other goods, and those smaller than about 1μ are important in visibility reduction, the one sensory effect of air pollution which is univer-

sally acknowledged. The organic fraction of the total particulate matter collected on filters is usually determined by extraction of the sample with benzene. This broad separation into inorganic and organic classes is indicative of the sources on the particulate; in addition the organic fraction contains a number of compounds that are of particular health interests because they are potential carcinogens. The concentrations of total particulates in very clean and very dirty urban air range from less than 50 to over 300 micro-grams per cubic meter, respectively, of which 5 to 10% are benzene-soluble organics.

2. Sulfur dioxide. The most common source for this gas is the burning of fossil fuels, particularly coal, for industrial purposes and space heating; mineral processing, although not so widespread, also results in major local concentrations of this compound. The evidence seems to be quite conclusive that it has irritant effcts on humans (Heimann, 1961) which, together with its recognized corrosive and phytotoxic properties, has resulted in its being monitored longer and in more places than probably any other pollutant. This gas and its oxidation product, i.e., the very irritant sulfur trioxide, characterize the "London-type smogs" with their chemically reducing effects on other atmospheric constituents. Concentrations from virtually nil to the order of 3 ppm (parts per million by volume) have been reported in urban areas at various locations and for sundry averaging times. Twenty-four-hour average values of as much as 1 ppm, however, might be expected only under the most adverse conditions.

3. Carbon monoxide. The toxic properties of this gas in high concentrations, >100 ppm. on human beings is well known, i.e., interference with oxygen transport by blood. It is formed by the incomplete combustion of any material containing carbon but the most common source appears to be automobile exhaust. Concentrations in urban areas vary greatly in a manner nominally proportional to the density of automotive traffic. Twenty-four-hour average values of less than 5 to about 10 ppm are commonly reported in downtown urban areas and peak values of 100 ppm do occur. As an interesting and cautionary aside, a recent study [Rose *et al.*, 1961] demonstrated that in "bumper-to-bumper" traffic conditions the CO concentrations in closed passenger compartments may reach the order of 300–400 ppm. The California State Department of Public Health has set the "serious" level standard of carbon monoxide for ambient air as 120 ppm for 1 hour at which ". . . there will be alteration of bodily function . . ." (Goldsmith, 1962).

4. "Photochemical smog" reactants. So far as is known the primary reactants are *hydrocarbons*—a class of thousands of organic compounds containing only hydrogen and carbon, as the name imples, and *oxides of nitrogen*—mainly nitric oxide and nitrogen dioxide (Weisburd (Ed.), 1926). These constituents are also significant products of automotive exhausts. The status of knowledge on the interesting problems of the chemistry and photochemistry of "Los Angeles-type smogs" can hardly be reviewed here. Suffice to say that stemming from the pioneering identification studies of Dr. A. J. Haagen-Smit at the California Institute of Technology in the early 1950's, it has been established that oxides of nitrogen and hydrocarbons react in sunlight to produce effects, e.g., eye irritation and plant damage, similar to those caused by the smog. The simultaneous presence of both constitutents is apparently required. Typical urban concentrations of these pollutants are in the range of 0.1 to 2 ppm.

5. Total oxidant and ozone. The concept of "total oxidant" represents an attempt to quantitatively characterize the oxidation potential of a polluted atmosphere—particularly that of "photo-chemical smog" type. It is usually measured in terms of the amount of iodine released by the exposure of a stream of contaminated air to a buffered neutral potassium iodide reagent (Weisburd (Ed.), *op. cit.*), although other procedures are also used. Ozone, one of the compounds included in "total oxidants," is known as an agent for rubber cracking. A total oxidant concentration of 0.15 ppm for 1 hour is set in California as the "adverse level," defined as the "level at which there will be sensory irritation, damage to vegetation, reduction in visibility or similar effects" (Goldsmith, *op. cit.*).

6. Radioactve pollutants are another category of contaminants under close surveillance. Most radioactive pollutants are derived from nuclear device testing, and so are not amenable to standard control methods. Radioactive contaminants associated with relatively minor industrial utilization of nuclear power up to the present, or with releases by the atomic energy industry itself have not yet raised problems comparable in magnitude to those of conventional pollutants. Historically, however, it was the advent of this industry in the late 1940s that fostered, under the aegis of the Atomic Energy Commission, the rapid expansion

of meteorological studies of atmospheric transport and diffusion of pollutants from discrete sources, i.e., the real beginning of a comprehensive air pollution meteorology. The Community Air Pollution program initiated 7 years ago under the sponsorship of the U.S. Public Health Service has provided support for a complementary meteorological effort on transport and diffusion within urban areas from indefinite or multiple sources.

7. Other pollutants. Although important, *carbon dioxide* and *aeroallergens* are not considered to be in quite the same problem category as those in the above list. The potential build-up of atmospheric CO_2 and its conseqeunces are usually considered to be of long-range geophysical rather than of public health or economic concern. The seriousness of the health problems assoicated with aeroallergens, e.g., ragweed pollen, is clearly recognized and much effort is being expended in the medical sciences area toward their alleviation; however, the control of sources of these as well as other "natural" pollutants are not amenable to standard engineering control measures, but rather by the control of ragweed growth.

AIR POLLUTION MONITORING

Until the Community Air Pollution Program was set up, the record of air sampling and analyses for pollutants over the country was sporadic. (For information the interested reader can refer to U.S. Public Health Service 1958, and 1961.) At the present time several important national networks are in operation under that program. The National Air Sampling Network (NASN) makes 24-hour collections of particulates on filters every 2 weeks by means of high-volume air samplers at about 140 urban and 40 rural locations. The particulates are weighed and analyzed for a variety of organic and inorganic constituents, and the gross B-radioactivity is determined. At 50 of the urban sites the concentrations of the gaseous pollutants sulfur dioxide, nitrogen dioxide, and total oxidants over 24-hour periods are also determined on the same time schedule as for particulates.

The most comprehensive analytical network, just now getting well underway, is called the Continuous Air Monitoring Program (CAMP). The stations are established and operated on a cooperative basis by Federal and local agencies. Stations are now operating in Chicago, Cincinnati, Detroit, Los Angeles, New Orleans, New York City, Philadelphia, San Francisco, and Washington. These stations are equipped with automatic continuous analyzers for the measurement of carbon monoxide, hydrocarbons, nitric oxide, nitrogen dioxide, sulfur dioxide, total oxidants, and ozone. Below is an interior view of one of the stations showing the bank of automatic analysis equipment. Total particulates are also sampled (24-hour basis) and assayed as indicated above, and chemical analyses of the precipitation occurring at the station are made on a monthly accumulation basis. Hourly values of the transparency of the atmosphere, i.e., turbidity, are also determined during the daytime when there are no clouds obscuring the sun.

The precipitation chemistry and atmospheric turbidity programs are conducted as components of additional networks of about 30 stations. These programs are cooperative ventures of the Public Health Service, Weather Bureau, universities, and other public and private agencies. Of particular interest in terms of air pollution are the effectiveness of precipitation in cleansing the air pollutants and the characterization of the aerosol loading of entire urban pollution envelopes (as against surface-level concentration measurements by more conventional means) as manifest in the attenuation of visible light.

METEOROLOGICAL EFFECTS ON SOURCES AND RECEPTORS

The importance of atmospheric properties, and hence meteorological science, in the transport and dispersion stage of the air pollution cycle is obvious. Not quite so obvious perhaps, but equally significant, is the importance of meteorological factors in the emission and reception stages. Pollutant sources arising from fuel burning for space heating are closely related to temperature. Pollens, most important pollutants to those allergic to them, are not released unless certain temperature and humidity ranges occur. The entrainment of dust into the air from ground surfaces is related to wind speed. The effective stack heights of sources emitting from chimneys are highly dependent upon wind speed, temperature, and atmospheric stability. The effects of air pollutants upon certain receptors, e.g., the corrosion of metals, are greatly affected by atmospheric humidity.

The sensitivity of some plants to air pollution depends upon the intensity of the incident sunlight, the relative humidity, and the temperature.

A number of chemical reactions involving the creation of secondary atmospheric pollutants are affected by meteorological elements. As already noted, the availability of sunlight in the "near" UV spectral band for the creation of Los Angeles-type photochemical smog, is a critical factor that depends in turns upon the amount and thickness of daytime cloudiness. The amount of moisture in the air also affects atmospheric reactions, particularly the conversions of sulfur dioxide to sulfuric acid droplets.

TRANSPORT AND DIFFUSION OF AIR POLLUTANTS

For most practical points of view the situation with respect to the estimation of atmospheric dispersion from discrete sources in open terrain is fairly well in hand. Certainly all diffusion models or working formulations carry implicit theoretical restrictions, e.g., to uniform fields of motions, which are unlikely to ever be realized in the real atmosphere. Nevertheless there is abundant experimental evidence (see Pasquill, 1962, for example) to indicate that in all but the more extreme situations of weather and topography the models are capable of providing suitable estimates of atmospheric diffusion over travel distances as great as several miles in some instances. A "Gaussian plume" dispersion model, i.e., the pollutant elements are assumed to be normally distribute within the diffusing plume, forms the basis for almost all practical working equations. The determination of appropriate dispersion coefficients has been the object of a number of experimental projects over the past decade. The work of Cramer (1957) leading to practical estimates of the coefficients from wind fluctuation data alone considerably simplified the mechanics of the problem. More recently Pasquill (1961) has proposed another very straightforward scheme, which does not require special meteorological observations.

The most important deficiencies in dispersion-estimate capabilities are those involving dispersion from discrete sources (a) within and just over the surface roughness elements, as in an urban area, (b) in transitional states, such as across shore-lines, and (c) over long distances, i.e., more than 10 miles, where inter-city transport of pollution may be significant. Encouraging progress has been reported (Pooler, 1961; Tuner, 1962) with respect to the formulation of models that represent the dispension of a gas from indefinite sources over an urban area on time scales of 2 hours to 1 month, with experimental validation. Mile-square source areas were assumed in their models, and while this approach gets at the larger problem of city-wide pollutant distribution, the experiments were not designed to investigate the discrete-source situation. Investigation of this matter, by the Public Health Service and Weather Bureau has just begun and, if plans materialize, will be extended in time to the long-range inter-city transport problem.

Recent theoretical studies of atmospheric diffusion mainly follow the "statistical theory" approach. This method concerns itself with the description of statistical properties of dispersing fluid elements on air contaminants, requiring an intense focus upon the structure of atmospheric turbulence. Reports of two major international symposia (Frenkiel, (Ed.), 1962; Frenkiel and Sheppard, (Eds.), 1959) summarize the rapid strides that have been made in the past few years in the understanding and description of the pertinent features of turbulent flow and diffusion, both from experimental data and by theoretical evolutions. Of particular import is the progress toward formulations that encompass the dynamical properties of the flow (e.g., Gifford, 1962) and thereby remove restrictive boundary conditions of atmosphere stability.

EFFECTS OF AIR POLLUTION ON WEATHER ELEMENTS

Concern with the transport and diffusion of air pollutants arise mainly for the prediction of concentrations in time and space which might adversely affect human health. To meteorologists in particular there are other considerations also of interest. In addition to the obvious effect of air pollutants on visibility reduction, there are other more subtle influences brought into play. While their effects have not been studied exhaustively, the following data from Landsberg (1961) are very revealing. The changes cannot all be attributed to air pollution, of course, but it probably enters into the majority of them.

TABLE I.—CLIMATIC CHANGES PRODUCED BY CITIES

Element	*Comparison with rural environs*
Contaminants:	
Dust particles	10 times more.
Sulfur dioxide	5 times more.
Carbon monoxide	25 times more.
Radiation:	
Total on horizontal surface	15 to 20 percent less.
Ultraviolet, winter	30 percent less.
Ultraviolet, summer	5 percent less.
Cloudiness:	
Clouds	5 to 10 percent more.
Fog, winter	100 percent more.
Fog, summer	30 percent more.
Precipitation:	
Amounts	5 to 10 percent more.
Days with <0.2 in	10 percent more.
Temperature:	
Annual mean	1 to 1.5° F more.
Winter minimum	2 to 3° F more.
Relative Humidity:	
Annual mean	6 percent less.
Winter	2 percent less.
Summer	8 percent less.

AIR POLLUTION POTENTIAL—VARIABILITY

The phrase "air pollution potential" concerns the ability of the atmosphere to disperse air pollutants. This ability is a function of meteorological and topographical parameters, and hence the air pollution potential of a given location or region can be discussed quite correctly without regard for the presence or absence of air pollution sources, information not usually available to meteorologists.

Over periods of years, the air pollution potential of a given site probably does not change. Changes in air quality on this scale will then merely reflect changes in the emission of air pollutants. Long-term increases due to the addition of numerous industrial and domestic sources are a common complaint. Fuel changes, such as the general conversion from coal to oil or gas for space heating in many cities, have brought on improved visibility trends; this does not necessarily mean, however, an improvement in the "total" air pollution situation.

The greatest variations in air pollution potential are those of short duration due to both the random turbulent motions of the air and the systematic variations of wind and stability between night and day. Except for accidental releases, the emission of air pollution does not vary greatly from day to day, whereas concentrations of pollutants in the air often vary by several orders of magnitude in response to the weather factors. For example, studies in Nashville and Cincinnati (McCormick and Xintaris, 1962) show that although auto exhaust is the dominant source of carbon monoxide, the variation in the air concentration of the gas is more strongly related to variation in air pollution potential than to traffic density.

There are marked differences in the climatology of air pollution potential over the country. Table II shows statistics of the regional distribution of two contributing elements. The average annual wind speed gives some idea of one dimension of the volume of air available for dilution. The annual low-level inversion frequency gives an indication of vertical dispersion capabilities (the table lists the frequency of inversions based at or below 500 feet above the ground).

TABLE II

Region	Annual average wind speed [1] (miles per hour)	Annual low-level inversion frequency [2] (percent of total hours)
Atlantic coast	10–15	10–35
Appalachian Mountains	7–11	30–45
Great Lakes	9–15	20–30
Gulf coast	9–12	10–35
Central plains	8–15	25–40
Rocky Mountains	5–11	35–50
Northwest Pacific coast	6–9	25–30
West coast	5–9	35–40

[1] From Visher (1954).
[2] From Hosler (1961).

Important seasonal variations also occur within regions. A striking example is taken from Holzworth (1962), which indicates the seasonal variation of the estimated mean maximum mixing depths over San Antonio, Texas, and coastal Southern California. The mixing depth is defined as the thickness of the neutral (dry adiabatic) or unstable layer based at the surface. Since the atmosphere normally has a slightly stable vertical temperature gradient, the daytime heating of the ground can establish a layer in which pollutants are usually well mixed (i.e., the vertical profile of the pollutant is relatively uniform from the surface to the top of the mixing depth). The maximum mixing depth is estimated by extending the dry adiabatic lapse rate from the surface maximum temperature to its intersection with the ambient temperature profile taken from a radiosonde observation.

AIR POLLUTION POTENTIAL—FORECASTING

Meteorological forecasts of atmospheric dispersion conditions may, in principle, form the basis for decisions of voluntary control of contaminant discharges or of the invocation of regulatory procedures and precautionary measures. Gosline, *et al.* (1956), point out that the efficacy of "meteorological control" methods cannot always be taken for granted because of economic and other considerations in some individual cases.

In addition to those forecasting and advisory services that are provided industrial and other clients by private meteorologists in the interests of air pollution control, two larger-scale public services are in operation. One service, for the Los Angeles basin, was established in 1952 by the meteorology unit of the Los Angeles County Air Pollution Control District. Upon their forecasts dealing with expected pollution levels in terms of governing meteorological conditions, both voluntary measures and regulatory procedures may be implemented to alleviate or prevent excessive smog conditions (Kauper, *et al.*, 1961). Beginning in the fall of 1957 an experimental program of forecasting air pollution potential for the eastern portion of the United States was initiated by the Weather Bureau Research Station at Cincinnati under the sponsorship of the Public Health Service. The success of the experiments during the succeeding fall seasons led to the extension of the program to a year-round basis beginning in August 1960. Based on the "stagnating anticyclone" model (Korshover, 1960), notices are issued when meteorological conditions over a minimum area of about 5,000 to 6,000 sq mi are estimated to be favorable for the accumulation of air pollutants over a time period of at least 36 hours. These bulletins are available through local Weather Bureau offices and at the present time are prepared as appro-

priate, for all sections of the United States east of the Rocky Mountains (Miller and Niemeyer, 1962). In general, control measures would not be based on these forecasts alone. They provide a regional or national alerting mechanism within which framework actions could be taken, if required, consistent with local conditions and meteorological evaluation.

SUMMARY

In the preceding sections it has been the writer's intent to present brief glimpses of the various ways meteorology enters into the description and understanding of air pollution problems. There is an old adage in science that once a problem is completely understood the solution is always relatively simple. Hence to the extent that air pollution control solutions stem from understanding, meteorology is an indispensible if indirect contributor.

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METEOROLOGY OF AIR POLLUTION—THE NEED TO PRESERVE OUR AIR RESOURCES CHALLENGES OUR UNDERSTANDING OF THE ATMOSPHERE'S CAPABILITIES

By Donald H. Pack [1]

The obvious solution to our widely discussed air-pollution problem is to prevent all the pollutants from reaching the atmosphere. Ultimately we may have the technical ability and legal authority to accomplish this in an economical fashion. However, it is quite logical and reasonable to use the atmosphere for the disposal of gaseous and particulate wastes, if we know the effects of this use and keep them within acceptable limits. The layer of air (about 10 kilometers thick) which is readily available for the dilution of pollution represents an enormous reservoir, about 5×10^{18} cubic meters, which can be used for this purpose.

Atmospheric diffusion is ultimately accompanied by the wind movement of pollutants, but the character of the source of pollution requires that this action of the wind be taken into account in different ways.

These sources can be conveniently grouped into three classes: point sources, line sources, and area sources. In practice, the first two classes must be further divided into instantaneous and continuous sources.

The instantaneous point source is essentially a "puff" of material created or ejected in a relatively short time, as by a nuclear explosion, the sudden rupture of a chlorine tank, or the bursting of a tear-gas shell. The wind of immediate importance is, of course, that occurring at the place and time at which the pollutant is created. Since the wind is highly variable, the initial direction of movement of the puff is also variable and difficult of prediction; a soap-bubble pipe and five minutes' close observation of the initial travel of successive bubbles will convincingly demonstrate the difficulty of predicting the exact trajectory of the next bubble. In addition, dilution of a puff source is a very strong function of time after its release. At first, the small-scale fluctuations of the wind cause it to grow rather slowly and the larger-scale wind variations simply carry it along on erratic paths. But as the puff grows, larger-scale motions can get a "hold" on it to tear it apart and dilute it more rapidly. Thus, the unique feature of the instantaneous point source is its increasing dispersion rate with time, whence the necessity to consider successively larger scales of meteorological phenomena in calculating its spread.

Continuous point sources (the smoke plume from a factory chimney, the pall from a burning dump) are the most familiar, the most conspicuous, and the most studied of pollution sources. The meteorology of the continuous source must take into account the time changes of the wind at the point of emission. The behavior of a plume from a factory chimney is very much like that of water from a hose being played back and forth across a lawn. It is evident that if the hose is steady the same area will be continually exposed to the water. But if the hose (wind) moves back and forth in an arc, the water (pollution) will be distributed over a wider area, hence the concentration will be less. For a truly continuous source there are other changes of great importance—primarily the diurnal and seasonal cycles.

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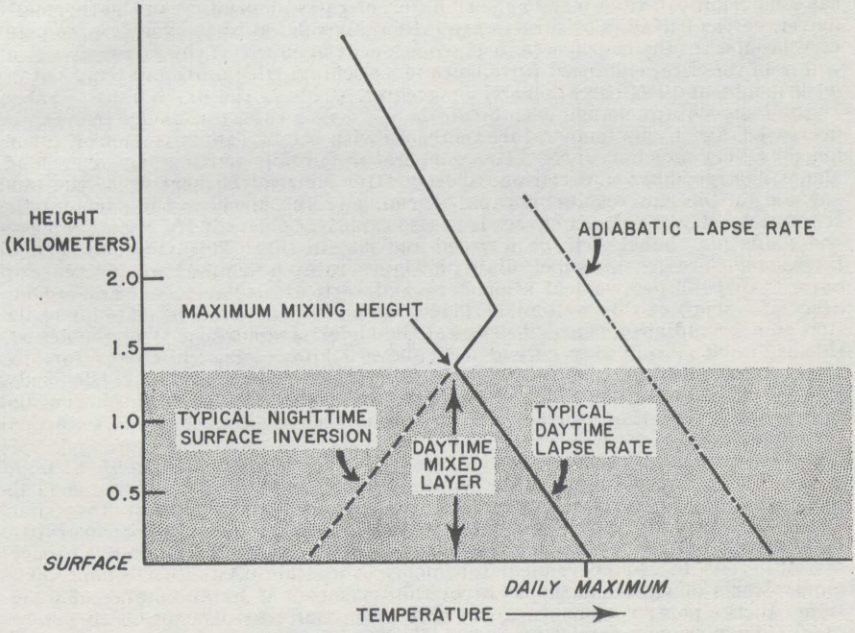
[1] The author is deputy director of the Air Resources Laboratory, Department of Commerce, Weather Bureau, Washington, D.C.

The isolated line sources is less common and therefore of less general interest, with two important exceptions—heavily traveled highways, and the swath of chemicals emitted by crop-dusing apparatus. In both these examples, if the line of pollutant is uniform and is long enough, the dispersion of the pollution must be attained in only two dimensions, along the wind and in the vertical. If the line source is a continuous one, as might be the case of a freeway in rush hours, spreading in the downwind direction becomes ineffective (at a particular downwind location), so that only the vertical dimension is left to provide dilution. This behavior of the continuous line source has been exploited by meteorologists in field experiments with controlled tracers to permit the detailed study of vertical diffusion, uncomplicated by effects in the other two coordinates.

The area source can vary enormously in size. It may be distributed over several square kilometers, as in an industrial park, over tens or hundreds of square kilometers, as in a city, or over thousands of square kilometers, exemplified by the almost continuous strip city (the "megalopolis" or "megapolitan area") along the eastern seaboard of the United States. These area sources usually include combinations of all the single-source configurations. A large city will include many thousands of home chimneys, thousands of factories and shops, hundreds of kilometers of streets, open dumps, burning leaves, evaporating fumes from gasoline storage or from cleaning plants and paint factories, and everywhere the automobile. The weather problem of the city area source becomes, in the aggregate, quite different from that of a single source. Here we are concerned not with the increasing rate of wind dispersion with increasing scale, or with the behavior of wind with time at a single point, but rather with the replenishment rate of the air over the city. We must consider the total movement of a large volume of air as it "ventilates" the city. Anything that reduces this ventilation rate, whether it be the confining effect of surrounding mountains or the reduced velocities of a slow-moving anticyclone, is of concern.



Schematic representation of the effect of vertical temperature gradient on atomspheric mixing

In the construction of cities man has modified the weather. The volume of effluent injected into the air has reduced the solar radiation. The absorption characteristics of cement and asphalt instead of grass and trees create urban "heat islands." These effects must be considered in the meteorology of urban air pollution.

The atmosphere disperses pollutants because, like the sea, it is in constant motion, and this motion is always turbulent to some degree. There is as yet no fully accepted definition of turbulence, but empirically it can be described as random (three-dimensional) flow. There is as yet no complete explanation for the complexities even of controlled wind-tunnel turbulence, hence it is not surprising that the understanding of turbulent diffusion in the atmosphere has progressed largely through empirical treatments of controlled tracer experiments. It would be an injustice to the reader and to a fascinating and challenging subject to try to condense turbulent-diffusion theory to a few paragraphs. The current tendency is to deal with turbulence through statistical concepts derived from aerodynamics and fluid dynamics. This treatment, with its emphasis on the detailed properties of the turbulence, is in contrast to earlier theories which centered around a vitual-diffusivity concept based on analogy with molecular diffusion. In the practical application of computing pollution concentrations, it is more usual to employ the statistical method for distances to perhaps 150 kilometers from the source, and equations based on virtual-diffusivity ("K") theory for longer distances, particularly for calculations on a hemispheric or global scale.

VERTICAL TURBULENT DIFFUSION

To all intents and purposes rapid atmospheric diffusion in the vertical is always bounded: on the bottom by the surface of the earth and at the top by the tropopause. The tropopause—the demarcation between the troposphere, where temperature decreases with altitude, and the stratosphere, where the temperature is relatively constant or increases with altitude—is lowest over the poles, at about 8 kilometers, and highest in the tropics, about 20 kilometers. The detection of radon products throughout the troposphere is conclusive evidence of the eventual availability of the full depth of the troposphere for vertical dispersion, since the radon source is exclusively at the earth's surface. Utilization of this total vertical dimension can take place at very different rates, depending on the thermally driven vertical wind. These rates are intimately related to the vertical temperature profile. On the average (and if we neglect the effects of the phase change of water in the air), enhanced turbulence is associated with a drop in temperature with height of 10°C per kilometer or greater. (This is the dry adiabatic rate.) If the temperature change with height is at a lesser rate, turbulence tends to be decreased, and if the temperature increases with height (an "inversion"), turbulence is very much reduced. The temperature profile, particularly over land, shows a large diurnal variation. Shortly after sunrise the heating of the land surface by the sun results in rapid warming of the air near the surface; the reduced density of this air causes it to rise rapidly. Cooler air from aloft replaces the rising air "bubble," to be warmed and rise in turn. This vigorous vertical interchange creates a "superadiabatic" lapse rate—a temperature decrease of more than 10°C per vertical kilometer—and vertical displacements are accelerated. The depth of this well-mixed layer depends on the intensity of solar radiation and the radiation characteristics of the underlying surface. Over the deserts this vigorous mixing may extend well above 3 kilometers, while over forested lake country the layer may be only one or two hundred meters thick. Obviously, this effect is highly dependent on season; in winter the lesser insolation and unfavorable radiation characteristics of snow cover greatly inhibit vertical turbulence.

In contrast, with clear or partly cloudy skies the temperature profile at night is drastically changed by the rapid raditional cooling of the ground and the subsequent cooling of the layers of air near the surface. This creates an "inversion" of the daytime temperature profile, since there is now an increase in temperature with height. In such a situation the density differences rapidly damp out vertical motions, tend to reduce vertical turbulence, and stabilize the atmosphere. The longer hours of winter darkness favor the formation and maintenance of inversions. In the polar regions, in areas relatively unaffected by storms, inversions of 20°C or more may persist for weeks. Under such extreme circumstances, vertical mixing is very slow and the surface layers of the atmosphere can almost be considered as decoupled from the air above. Such a situation may also occur in middle latitudes, but surprisingly winter is not the time of most intense and persistent surface-based inversions. The greater frequency and intensity of large-scale storm systems, with their higher wind speeds and extensive cloud cover, tend to prevent the frequent formation of this very stable situation. It is in autumn, with its combination of relatively long nights and fewer storms, that inversions are most frequent and persistent.

Two other temperature configurations, on very different scales, have important effects on vertical turbulence and the dilution of air pollution. At the smaller end of the scale, the heat capacity of urban areas, and, to a lesser extent, the heat generated by fuel consumption act to modify the temperature profile. The effect is most marked at night, when the heat stored by day in the buildings and streets warms the air and prevents the formation of the surface-based temperature inversion typical of rural areas. Over cities it is rare to find inversions in the lowest 100 meters, and the city influence is still evident 200 to 300 meters above the surface. The effect is a function of city size and building density, but not enough observations are yet available to provide any precise quantitative relations. Although the effect even for the largest cities is probably insignificant above a kilometer, this locally produced vertical mixing is quite important. Pollution, instead of being confined to a narrow layer near the height of emission, perhaps only 100 meters in thickness, can be freely diluted in more than double the volume of air, the concentrations being reduced by a similar factor.

On a much larger scale the temperature profile can be changed over thousands of square kilometers by the action of large-scale weather systems. In traveling storm systems (cyclones the increased pressure gradients and resulting high winds, together with the inflow of air into the storm, create relatively good vertical mixing conditions. On the other hand, the flat pressure patterns, slower movement, and slow outflow of surface air in high-pressure cells (anticyclones) result in much less favorable vertical mixing. This is primarily due to the gradual subsistence of the air aloft as it descends to replace (mass-continuity requirement) the outflow at the surface. During this descent the air warms adiabatically, and eventually there is created a temperature inversion aloft inhibiting the upward mixing of pollution above the inversion level. As the anticyclone matures and persists, this subsidence inversion may lower to very near the ground and persist for the duration of the particular weather pattern. This pattern is typically associated with the beautiful weather of "Indian summer," but it has also been associated with all the major air-pollution disasters (Donora, Pennsylvania, in 1948, London in 1948, 1952, and 1962, and others).

The action of mechanical turbulence in the vertical requires rather less discussion. It is obvious that if a moving mass of air reaches an obstacle it cannot penetrate, it must go over or around the obstacle. If the obstacles are numerous (blades of grass, rows of trees, or streets of buildings) the air will be constantly rising and falling. Thus, vertical mechanical turbulence is the response to the roughness of the underlying surface and has the most effect in the first few hundred meters above the surface.

HORIZONTAL TURBULENT DIFFUSION

The most important difference between the vertical and horizontal dimensions of diffusion is that of scale. In the vertical, rapid diffusion is limited to about 10 kilometers. But in the horizontal, the entire surface of the globe is eventually available. Even when the total depth of the troposphere is considered, the horizontal scale is larger by at least three orders of magnitude, and the difference, say during a nocturnal inversion which might restrict the vertical diffusion to a few tens of meters, is even greater since the lateral turbulence is reduced less than the vertical component. Mechanically produced horizontal turbulence is, on a percentage basis, much less important than the thermal effects; its effects are of about the same order of magnitude as the vertical mechanical effects.

The thermally produced horizontal turbulence is not so neatly related to horizontal temperature gradients as vertical turbulence is to the vertical temperature profile. The horizontal temperature differences create horizontal pressure fields, which in turn drive the horizontal winds. These are acted upon by the earth's rotation (the Coriolis effect) and by surface friction, so that there is no such thing as a truly steady-state wind near the surface of the earth. Wind speeds may vary from nearly zero near the surface at night in an anticyclone to 100 meters per second under the driving force of the intense pressure gradient of a hurricane. Perhaps the absolute extreme is reached in the thermally driven vortex of a tornado, where speeds of 200 meters per second or more (they have never been accurately measured) may occur. The importance of this variation, even though in air pollution we are concerned with much more modest ranges, is that for continuous sources the concentration is inversely proportional to the wind speed. Consider a source emitting one unit of pollution per second in a wind of one meter per second. If the wind increases to two meters per second, the volume of air passing the source is doubled; hence the

concentration is halved. It is not quite so simple for multiple emissions in a large area source, but the variation of wind speed is still a fundamental factor in the dilution of air pollution.

The variation of turbulence in the lateral direction is perhaps the most important factor of all and certainly one of the most interesting. In practice this can best be represented by the changes in horizontal wind direction. We have the basic wind currents of the globe—the polar easterlies, the mid-latitude westerlies, the easterly trades of the subtropics, and so on. These are manifested in the semipermanent pressure systems with a super-position of traveling cyclones and anti-cyclones. Within each of these systems, which may be several thousand kilometers across, the wind is not steady but is varied by the temperature contrast between ocean and land, mountain and plain, city and field. These create local land-sea breezes, up- and downslope flows, and even in special cases rural-to-city drifts of air. The situation is succinctly described in a parody of a verse by Swift attributed to the meteorologist L. F. Richardson: "Great whirls have little whirls, that feed on their velocity; And little whirls have lesser whirls, and so on to viscosity."

The net effect of these systems is a constantly varying wind direction. Within a few minutes, the wind may fluctuate rapidly through 90 degrees or more Over a few hours it may shift, still with much short-period variability, through 180 degrees, and in the course of a month it will have changed through 360 degrees numerous times. Over the seasons, preferred directional patterns will be established depending upon latitude and large-scale pressure patterns. These patterns may be very stable over many years, and thus establish the wind climatology of a particular location.

The emitted pollution travels with this ever-varying wind. The high-frequency fluctuations spread out the pollutant, and the relatively steady "average" direction carries it off—for example, toward a suburb or a business district. A gradual turning of direction transports material toward new targets and gives a respite to the previous ones. Every few days the cycle is repeated, and over the years the prevailing winds can create semipermanent patterns of pollution downwind from factories or cities.

ATMOSPHERIC TRANSPORT

It is convenient to distinguish the turbulent diffusion of pollution from the bulk transport of pollution away from its source. In fact, the statistical theories of diffusion speak of a steady mean flow and the turbulent fluctuations about this mean. This separation, however, is very dependent on the time and space scale of interest. Five hours of southwest wind may become only statistical fluctuations about a mean monthly northwesterly flow, which is in turn a portion of the annual wind frequency distribution. Nevertheless, this division of wind behavior into turbulent fluctuations and mean flow is of practical value, because it permits the use of average wind statistics (the mean flow) to describe the "ventilation" of an area. Certain features of the physiography and meteorology of particular areas can seriously reduce this transport or ventilation. Two of the most effective mechanisms for this reduction are topographical barriers and semipermanent subsidence inversions.

Topographical barriers are best described by examples. The semicircular ring of hills and mountains around the Los Angeles Basin slows the flow of air in and out of the area and acts to form a catch basin for pollutants. On a much larger scale, the Great Basin of Utah and Nevada functions in the same way, particularly in winter, providing a huge bowl which can contain a stagnating air mass with very light winds of variable direction. The narrow valleys of western Pennsylvania also act to slow the flow, but in this instance air movement is constrained to follow the contours of the valley, so that the natural variability of the wind is largely ineffective and pollution repeatedly follows the same path. Again on a larger scale, the San Joachin Valley of California has much the same effect. The persistent surface fogs of the winter season attest to the reduced air transport in the surface layers of air in this area.

The semipermanent inversion is a feature of west coasts of continents throughout the world; Africa, the Iberian Peninsula, South America, and the southwestern coast of the United States all have this typical vertical-turbulence lid created by the subsidence associated with the semipermanent high-pressure areas of the eastern subtropical oceans. If, as in the case of southern California and Chile, there is also a mountain barrier, the meteorological stage is set for man and his technology to create a persistent air-pollution problem.

It was a military weapons system, in this instance the use of gas in World War I, that led to the early quantitative meterological studies on the dilution of pollutants by the atmosphere. Application to military technology has continued and has provided much valuable information for application to more general and widespread civilian problems.

The major U.S. effort in the meteorology of air pollution began with the Manhattan Engineering Project and the construction of the Hanford Works in the state of Washington. It is a credit to the acumen of this predecessor of the Atomic Energy Commission that it recognized, at a very early stage, the need to study atmospheric dilution near such plants. A group of meteorologists, under the direction of Phil E. Church of the University of Washington, set the pattern by measuring, in detail, the variations, wind speed, and direction throughout the Hanford area, and used a 125-meter instrument tower to measure vertical wind and temperature profiles. This early program was followed by similar efforts at the National Laboratories at Brookhaven, Oak Ridge, and Argonne, at the National Reactor Testing Station, and at the Nevada Test Site. Other nuclear sites have had similar meteorological studies.

Such a study usually begins with recording the small scale (1-to-50-kilometer) variation of the dilution in order to identify diurnal and seasonal patterns and any combination of meteorological parameters that would complicate effluent releases (for example, a persistent wind direction occurring simultaneously with a persistent inversion). The various data are organized as background statistics for engineering design. A model compendium of the type was ORO–99, "A Micrometeorological Study of the Oak Ridge Area," prepared by J. Z. Holland and collaborators in 1953. It remains a useful guide.

Most of the larger installations have supplemented the measurements of meteorological parameters with direct measurements of atmospheric diffusion through the analyses of concentration measurements from "sources of opportunity." Intensive measurements of argon-41 from the stack of the Brookhaven air-cooled reactor and of iodine isotopes from the chemical processing plants at Hanford and the National Reactor Testing Station, combined with the concurrent meteorological data, have been used to determine average long-period concentration patterns around such installations and the quantitative relation between concentration and averaging time. This latter information, the "peak-to-mean" concentration ratio, is of great practical importance in evaluating biological effects of acute versus chronic exposures to pollutants, and also makes possible the extrapolation of sampling data taken over fixed, and usually short, times to a wide variety of conditions.

As understanding of the diffusion process has become more exact, meteorological information has been used more frequently in the design of experiments involving the release of radioactivity, both in order to optimize safety and to increase the efficiency of the experiment. Knowledge of the seasonal and diurnal frequency of necessary wind directions and trajectories helps in scheduling experiments so as to minimize weather delays. Knowledge of the existing meteorology during experiments is often indispensable for the correct evaluation of test results. This requirement was particularly pertinent in the determination of fallout from atmospheric nuclear detonations. Comparison of fallout from different devices, with different yields, and perhaps exploded under different conditions, required the "normalization" of the meteorology. The intensive system developed for the Nevada Test Site of measuring and forecasting wind and temperature profiles was designed to provide not only operational data for safety purposes but also the documentation needed to evaluate the scientific experiments.

On a much larger scale, knowledge of global circulation patterns, long-range diffusion, and atmospheric removal processes, part of it gained by using the radioactive debris of previous tests as wide-ranging meteorological tracers, has permitted accurate forecasts of the time and space distribution of global fallout to be expected in various parts of the world.

Still another use of air-pollution meteorology, is in the analysis of an accident, particularly in the determination of the amount of material released. In the two major reactor accidents that have occurred, one at Windscale, England, in 1957 and the other at the National Reactor Testing Station in 1961, perhaps the best estimates of the amount of radioactivity released to the air were obtained by calculating the diffusion equations backward, from the observed concentrations through the existing meteorological conditions to the source strength. These re-

sults were particularly interesting because they required spatial and temporal integration of observed concentrations, extrapolation of weather information from only a few points, and the use of reasonable models of diffusion.

There is a very strong motivation to deduce generalized information, as well as empirical results, from these essentially "free" sources of opportunity, and very useful results have been obtained. Useful as such analyses have been, they cannot, however, entirely substitute for well-designed experiments where the atmospheric conditions can be selected with care, the source is controlled, and the sampling procedures are commensurate with the experimental goals. Thus, most of the advances in understanding diffusion have been due to careful field experiments with gaseous or aerosol tracers, concurrent with elaborate measurements of atmospheric turbulence, wind, and temperature gradient. The technology that has developed around these tracers, which range from natural spores to Kleenex lint and soap bubbles, is an interesting one. One of the more recent developments is the use of alpha-particle excitation of the filter samples of a fluorescing particulate to permit automated analysis of the sample concentration. Free balloons have traditionally been used as meteorological tracers. This technique has been given new impetus by the use of new materials and low-cost electronics to provide a nearly-constant-volume balloon and a lightweight radar beacon system, the position of which can be continuously measured by radar to ranges of more than 100 kilometers.

The information thus developed facilitates one of the most important uses of air-pollution meteorology, the planning of the location of pollution surces in relation to sensitive areas (people, animals, and vegetation). Proper site selection makes possible the use of the average features of the weather to minimize the effects of air pollution. Preplanning can be applied to problems of all sizes—choice of location for a rendering plant, selection of a site for a nuclear or coal-fired power plant, urban industrial zoning. The meteorology involved can be as simple as determining the direction of the most prevalent wind or so complex as to require three-dimensional wind statistics, temperature profiles to several kilometers, and data about air trajectories for tens of kilometers from the site. The most efficient solutions must take into account not just meterology alone, but the entire process, including the economics.

METEOROLOGY AND URBAN AIR POLLUTION

In the applications previously discussed, the pollution source is usually discrete, readily identifiable, and, with sufficient effort, amenable to individual study and analysis. In fact most diffusion theory and experiment have been directed to such sources. These problems are important and will remain so. Air pollution meteorology is being increasingly applied, however, to the growing problem of urban air pollution, and here the number and variety of pollution sources prohibit individual study. Indeed, one of the major sources, the automobile, does not even stay put. Another complication and one of the most interesting features of this entire problem is that, while in the short term the meteorology of diffusion shows great variation and pollution emissions stay relatively constant, over periods of several years it is the meteorology that becomes stable and the pollution sources that vary.

To deal with these factors, two different approaches have been used. For the short term—and to answer such questions as: What is the statistical distribution of pollutant concentrations? Do different pollutants behave differently in the atmosphere? What are the effects of pollution on weather?—the meteorologist has inverted the problem; instead of calculating the field of concentration from a known source (source-oriented approach), he examines the measured field of concentration and the concurrent weather, and through standard statistical techniques relates the two (receptor-oriented approach). This technique has produced interesting results concerning the atmospheric "half-life of pollutants, the seasonal variability of pollution, the role of sunlight in the production of photochemical smog, the reduction of solar radiation in cities, to mention only a few examples.

In fact, one of the most recent applications of meteorology completely ignores the source. Several years ago the Weather Bureau, on the basis of a statistical evaluation of the concurrent relation of high air-pollution values and large-scale meteorology, found that persistent high values of air pollution were associated with large areas of light wind, at the surface and aloft (slow horizontal ventilation), and sufficient atomspheric stability to inhibit vertical motion. These conditions are most often associated with a slowly moving or stagnant anticyclone; hence the designation of this condition as a "stagnation" model. In 1963, after

several years of successful testing, the Weather Bureau began issuing "Air Pollution Potential Forecasts" for the United States when meteorological conditions satisfy the stagnation model and are expected to persist for at least 36 hours. These are area forecasts and are currently limited to situations where at least 90,000 square kilometers are affected. This limitation is necessary because of the significant role played by very local meteorological variations such as sea breezes or mountain-valley winds and local pollution emissions, neither of which can be adequately predicted from the large-scale meteorology. In particular the designation "Pollution Potential" is required. If a stagnation area occurs in the Great Plains (as has happened) the air pollution levels should be very different from those in a similar weather pattern over the industrialized Atlantic States (and they have been). These forecasts, by making advance preparation possible, provide unique opportunities for examining high pollution levels through medical studies, special sampling programs, and so on. Eventually they may contribute to the reduction of pollution levels through control of emissions during these unfavorable periods.

Other applications require a "source-oriented" viewpoint for answers to the questions: What is the origin of this particular pollutant? What are the effects of new pollution controls? Given a specific growth rate, what are the likely future concentrations of pollution? In this approach the sources within a city might be grouped into, for example, industrial, domestic, transportation; then subdivided according to constituents—sulfur dioxide, carbon monoxide, and so on; and further divided by allocation to specific geographical areas. One of the most promising developments of recent years has been the success of mathematical models of urban diffusion, which can accept such source information and calculate the field of urban pollution concentration. The initial field test of such a model was carried out in Nashville, Tennessee, in conjunction with an intensive program of pollution measurements and medical surveys conducted by the Public Health Service and Vanderbilt University. City-wide concentrations of sulfur dioxide were computed for periods as short as 2 hours, and these values were summed to obtain average daily levels. The model, which incorporated an SO_2 "half-life" and treated all the sources within a 2.5-square-kilometer source area as if they were centered in the middle of this area, was not very sophisticated meteorologically, although it did, by virtue of the two-hour time step, allow for diurnal variability. Crude as this first atempt at prediction was, it gave results that were very similar to the observed values and that in fact had a smaller variability than the sampling values with which the computations were compared. Source inventories are under way which will permit testing and refinement of the model in other locations. At the same time additional measurements of the diffusion within cities and studies of the best way to measure city ventilation rates will enable the meteorological portion of this and other models to be more sophisticated and more realistic. This work was, as one would expect, performed on a high-speed computer. As in so many other scientific problems, the required calculations (about 10^6 for the 24-hour average concentration field) became feasible only with such assistance.

The use of mathematical models for computer solution appears to promise much in the quantitive determination of pollution concentrations. As we learn more about the meteorology of cities and the distribution of pollutant emissions, it may be possible to predict expected concentrations routinely and to take into account the changes in the patterns that would occur if the emissions were changed. The auto-exhaust pollution from the Sunday-driver pattern could be differentiated from that of the weekday rush-hour regardless of the variation in the atmospheric dilution. On a larger scale, it is expected that computer-produced "Air Pollution Potential Forecasts" will replace the present techniques, which require both manual data analysis and personal judgment, and will extend both the time period and detail of these forecasts.

FUTURE PROBLEMS

Much remains to be learned about how the atmosphere acts to dilute materials and eventually to rid itself of them. The problem is particularly acute within cities, since there now exists no adequate model to describe, in quantitative terms, the movement of air through such a complex structure as an entire city, and since most industrial pollution originates within the city itself. In the near future a major effort will be required to determine the cumulative effect on air purity of the complex of cities that are expanding and combining to create the megalopolis. Here the problem requires consideration of weather patterns over several days

and hundreds of kilometers, if we are to determine the extent to which pollution from "foreign" sources 100 to 500 kilometers upwind adds to the locally emitted pollution. On this scale, chemical interactions of pollutants and their "half-lives," the effects of sunlight and humidity, the effects of depletion of pollutants due to deposition, and so on, must be known. None of the these problems appears to defy practical solution, but a program of research, probably culminating in extensive, long-range tracer experiments, will be required.

In the longer, and larger, view perhaps the most important future problem is to achieve better understanding of the geochemistry of atmospheric pollutants. It has been pointed out that there are probably no undisturbed atmospheric conditions left in any of the mechanized areas of the world. The possible "greenhouse" effect of carbon dioxide is not known precisely, yet extrapolation of present measurements indicates a global increase in this constituent of about 40 percent by the turn of the century. Sulfur is emitted to the atmosphere in ever-increasing amounts, but we know neither its fate nor its rate of addition with any precision. We cannot be certain whether massive additions of air pollutants could affect our climate and, if they can, in what fashion. A careful, long-term program of measurement, probably of global extent, of the most important pollutants, additional research to increase our understanding of the self-cleansing mechanisms of the atmosphere, and more knowledge about the relation between air pollution and climate are required if we are to safeguard the air reservoir in which we live and breathe.

Senator MUSKIE. Our final witness this morning is Mr. Arthur C. Stern, Assistant Director of the National Center for Air Pollution Control in the Public Health Service. Mr. Stern, can you summarize your testimony?

Mr. STERN. Mr. Chairman, I have three short versions, a 10-minute version, a 5-minute version, and a 0-minute version. Which would you prefer?

Senator MUSKIE. Well, why don't we try the 5-minute version.

STATEMENT OF ARTHUR C. STERN, ASSISTANT DIRECTOR, NATIONAL CENTER FOR AIR POLLUTION CONTROL, PUBLIC HEALTH SERVICE; ACCOMPANIED BY ROBERT A. McCORMICK, CHIEF, METEOROLOGY PROGRAM

Mr. STERN. I am Arthur C. Stern, Assistant Director of the National Center for Air Pollution Control. With me is Mr. Robert A. McCormick, Chief of the National Center's meteorology program, who is an ESSA employee assigned to the National Center.

I appreciate the opportunity of appearing before the Public Works Committee of the Senate to discuss the problems involved in using meteorology as a tool in the control of air pollution, to describe what we have done to date in the field, and to set forth in general terms how we intend to proceed in the future.

More specifically the technical subjects I will discuss are: Our concept and definition of airsheds; the effects of pollution in modifying the weather; the prediction of atmospheric conditions conducive to pollution buildup; the prediction of pollutant concentration levels; and systems for using such prediction as an air quality management tool.

AIR QUALITY SHEDS AND REGIONS

The terms "airshed" and "air quality region" have recently entered our vocabulary to mean a geographic region subject to common air pollution sources and meteorological dispersive factors. An airshed is a neighborhood of communities having a common air resource. They

share a common air resource when the "downwind" of one community is the "upwind" of another. In the concept of airsheds or, what is synonymous, air quality regions, we are dealing with the interrelationship of sources, meteorology, and land use. Were we to define the trajectory of a molecule or particle of pollutant, we could establish the probability at any time of its being 1 mile, 5 miles, or 20 miles from its source. Summations of all such trajectories establish areas around communities having varying probability of any given pollution level. We must use such concepts to define airsheds and air quality regions. Airsheds are easy to visualize when they have characteristics similar to watersheds—bounded, for instance, on one side by a range of mountains, on the other side by oceanic influences which, of course, describes the coastal region of southern California.

Definition becomes more difficult for relatively flat inland terrain, such as characterizes, for instance, St. Louis.

Here, the airshed would be delineated, not by the terrain, but by land utilization—the familiar core city surrounded by its residential and industrial suburbs which continue to encroach on the surrounding rural area. This type of airshed has several attributes.

Its size is not immutably fixed by physical barriers but rather expands as the land area affected by its sources expands. The effects of the pollution extend beyond the source area into the rural hinterland in all directions. Adjacent airsheds may overlap, and future expansion of airsheds that presently do not overlap may cause them to do so in the predictable future. Those which merge, we must consider as one large air quality region or airshed for purposes of rational air pollution control.

In fact, we should base regional control areas on the predicted size of the overall region 10 or so years hence, rather than have to revise control agency structure several times during the intervening years.

The boundaries of a regional control area should be such that all sources of pollution and the interests adversely affected thereby are included within the region. The objective should be to establish a community of common concern and afford those within the community, whether pollutor or receptor, a form of common resource to resolve conflicting interests.

These matters are discussed in greater detail in the paper Dr. Morris Neiburger, recent past-president of the American Meteorological Society, presented last December at the National Conference on Air Pollution, entitled, "What Factors Determine the Optimum Size Area for an Air Pollution Control Program," a copy of which is appended to my written presentation.

Every community has a year-round wind direction of most frequent occurrence. However, for any specific month, day or hour, the prevalent wind can be from any direction. The wind blows from all directions part of the time and the pollution from a community is dispersed in all directions from the community. Therefore the annual pollution concentration in an airshed is highest in its center and approaches nonurban background concentration levels at the regional boundary.

There is thus a relationship between our definition of nonurban background concentration level and regional extent. The higher the former, the smaller the latter, and vice versa.

In most of the United States nonurban air is diluted urban air. When we can attribute the pollution in the diluted mixture to a specific metropolitan area, we are in the airshed of that metropolis. When we get so far into the hinterland that the pollution in the diluted mixture is unattributable to any source area, we are in the open countryside between airsheds.

If we clean up the air quality region, we automatically decrease the pollution in the area between regions. Our efforts should be to make regions compact enough to be administratively manageable and still accomplish their purpose.

The delineation of an air quality region can be put to several tests. Can uniform air quality standards be reasonably applied in it? Can an air pollution potential and concentration prediction system be developed for it? Can an air quality management model be applied to it? If the answer to all these questions is yes, the airshed has been correctly delineated.

WEATHER MODIFICATION

Weather modification is primarily concerned with deliberate attempts to change the weather. There are, however, effects on the weather caused, without deliberate intent, by man's activities, including his introduction of pollution in the atmosphere.

We believe that the role of the National Center for Air Pollution Control in this field should be to translate findings of any modifying influence of pollution on the weather into the required effort to limit the introduction of such modifying substances into the atmosphere.

The National Center is engaged in studies of atmospheric aerosol sources, formation and properties. The aerosol we are studying forms the nuclei on which atmospheric water vapor condenses to form clouds and precipitation. A concern for atmosphere aerosol pervades much of our work, including our studies on biological and economic effects of atmospheric particulate matter and on the surveillance and monitoring of particulate matter in the air.

We have read with interest the recent report in "Science" of the nucleating properties of lead iodide, and will follow this lead to determine whether it should influence our Federal automotive emission requirements.

In addition to influencing aqueous condensation, pollutants, both gaseous and particulate, absorb and reflect radiant energy in and beyond the visible spectrum, thereby causing diminution of visibility through the atmosphere and diminution of solar energy reaching the earth.

Much has been written about one particular aspect of this problem—a rise in temperature theorized to result from a rise in atmospheric carbon dioxide content. For the disastrous results predicted to occur—the polar icecaps to melt and our seacoast cities to be inundated by the rise in sea level—two things would have to occur: the atmospheric CO_2 content must rise substantially and this rise cause an ambient temperature rise.

Neither of these hypotheses is yet on firm scientific ground. We are not sure whether the increases in atmospheric CO_2 levels are real or are artifacts of the measurement situations heretofore employed, and we are not sure that the temperature rise hypothesis is correct. Documentation of a worldwide rise in CO_2 levels requires global monitoring at remote locations which ESSA has agreed to do.

Mr. McCormick, who is with me today, has been responsible for developing and testing a hypothesis of more immediate concern to us, namely, that the particulate matter man is now discharging to the atmosphere may be responsible for the worldwide decrease in air temperature observed since the 1940's.

AIR POLLUTION FORECASTING

The National Center is proud of its accomplishment over the last decade in developing and making operational the present air pollution potential advisory system that ESSA will soon incorporate as one of its routine weather prediction services. However, neither the National Center nor ESSA is satisfied that this is the ultimate air pollution prediction system. The joint National Center-ESSA team that developed the present system is already at work on the development of a second-generation system that will:

(*a*) Give some leadtime. The present advisory says that the air pollution potential situation starts now—on receipt of the advisory. The second-generation system should say, "At x hours from now an air pollution potential situation will develop in your area."

(*b*) Give a more precise estimate of duration. The present advisory is called only when the estimated duration is at least 36 hours. The second-generation system should include the estimated duration with more specificity, whether it be greater or less than 36 hours.

(*c*) Give a more precise definition of area involved. The present system calls advisories for areas at least the size of the State of Oklahoma. The second-generation system should pinpoint smaller areas and call attention to differences within larger areas. It should be capable of predicting for the airshed areas designated as air quality regions.

(*d*) Give information on air pollution situations other than the stagnation situation. The present system is limited to stagnation prediction. The second-generation system should also alert the recipient to moderate and high wind problem situations.

(*e*) Predict relative pollutant concentration. The present system is limited to prediction of impaired atmospheric ventilation. The second-generation system should combine this information with generalized urban diffusion models to yield pollutant concentration prediction. It should be capable of providing a national system of air pollution alerts.

We are looking forward to the eventual development of third-generation regional systems which will directly communicate with computers, programed with regional airshed control models and having access to emission inventory data, whose output will include

probability of occurrence of certain pollutant concentrations and recommended alternative control actions.

APPLICATION OF FORECASTING TO CONTROL

The key element in any plan to control pollution when there is agreement that it is likely to rise to unsafe levels is the time required to put each step of the plan into effect. An exclusively coal-burning public utility powerplant might require several hours to shift from high sulfur to low sulfur coal, whereas a residual fuel oil-burning plant could be engineered to shift to distillate fuel or gas in a matter of minutes.

The recent power blackout in the Northeast has taught us that time and planning are required for load shifting from one plant to another, from one power system to another. Our principal industrial sources of pollution are associated with processes whose rapid shutdown would wreck havoc with the pollution-causing equipment.

How many hours would be required to get word to a substantial section of the population to curtail heating or incineration; to get back to their homes those who went to work, school or play in automobiles or buses?

A community's air pollution control agency can expect understanding and a tolerant attitude by its public utility and key industrial sources that some meteorological situations which trigger fuel, load or output switching or curtailment will not mature as predicted. It cannnot expect the same toleration on the part of unnecessarily inconvenienced citizens.

This argues for an air pollution concentration prediction system which predicts with a stated probability of occurrence. Public utility and major industry fuel, load or capacity switching or curtailment might be called for at probability-of-occurrence A; whereas curtailment of activities requiring the response of a large population would be reserved for higher probability-of-occurrence B. Taking the suggested action at A decreases the likelihood of action being required at B.

Triggering action when pollution levels reach certain critical values is not prediction. However, when critical values are reached, steps can be taken more intelligently if there are available predictions as to whether, when and how much values are going to rise or fall. Although the steps taken may be the same as those taken in response to an advance prediction scheme, the rationale for triggering them should not be confused.

NEEDS FOR THE FUTURE

The road to the second- and third-generation systems will be a long and costly one, but quite feasible. From the meteorological point of view, we must develop a more thorough understanding of dispersion and depletion of pollutants through horizontal and vertical diffusion by atmospheric turbulence, washout by rain, and sedimentation and impaction on surfaces.

We must also understand dispersion over great distances. Most of our present studies have been limited to distance of a few miles, and we have only begun tests to find out what happens to pollutants as they

travel for distances of 75 or a hundred miles. With megalopolis growing, the pursuit of this knowledge is no academic matter.

We must get a more thorough understanding of dispersion over rough terrain. Most of our dispersion experiments have been held over flat and uniform terrain, in the interest of minimizing one of the variables in our complicated equation. Unfortunately, however, relatively few severe air pollution problems arise in such ideal surroundings.

We need to develop our ability to use natural means to aid us in air pollution control—to understand better the role of greenbelts, forests and other vegetative cover in modifying the adverse influence of pollution on human and animal populations. We may at the same time increase the natural beauty of our land and better protect our people from air pollution.

Among the tools we need are small-scale mathematical models for air pollution concentrations. Such models are being developed, and I would like to tell you something about them. We are working on urban models with which we can predict the concentration of a pollutant at any point downwind from the emitter under almost any meteorological condition.

In this model the effect of winds, geographical configurations, city buildings, and mixing depth are all taken into consideration. Mixing depth, I should say, is the depth of atmosphere in which pollutants are free to diffuse. It varies greatly from day to day and from day to night. During a temperature inversion, the mixing depth is often quite limited.

We are working on another model with which we shall be able to predict the average concentrations of pollutants expected to occur over a city. And we are working on a third model, the receptor-oriented model, with which the concentration of pollutants from all sources can be predicted at any point in the city.

To make these, or any models work, the input information on both weather and sources must be better than it is now. This will require on the one hand a more comprehensive and dense weather data network than now exists. More dense in both space and time, particularly in the case of upper air data for the lower few thousand feet of the atmosphere. On the other hand, it will require greater density, also both in space and time, and greater reliability of emission inventory data.

Since the effectiveness of predictions of pollution levels must depend on the accuracy of the information about sources, even supposing our meteorological input data and our models are perfect, we need to be able to plot the location of every considerable source of pollution in an area, including the distribution of mobile sources.

Since emissions from some sources—some of them major—vary from season to season (space heating), with the day of the week (weekend traffic), and even with the hour of the day (both space heating and traffic), measurements must be made in sufficient quantity to supply the necessary information to cover all these cycles, including the formation of photochemical pollutants in the air itself. The job, therefore, is a large one and a continuing one. It is one which will require numbers of trained persons and sophisticated equipment.

The air pollution potential advisories, like the one issued for the east coast area at Thanksgiving, stand at one end of the spectrum of our air pollution control efforts. We are interested in all weather conditions, not simply in the stagnation conditions which are favorable to the episodes that have attracted the greatest attention, because air pollution concentrations can reach serious levels under almost any condition of the weather. And I would like to add to this that, however serious or dangerous occasional episodes may be, and however great our concern with them, routine everyday levels in any large city in the country are of serious concern to us, and it is these normal—for want of a better word—concentrations which now receive and will continue to receive the major part of our attention.

Senator MUSKIE. I am glad to have you emphasize that point, Mr. Stern. I think it might otherwise be lost in our focusing on the dramatic instances of maximum danger.

Mr. STERN. Nevertheless, it is important for us to be able to predict the episodes, and to predict them with an even greater degree of reliability than we are now able to do.

If we are to implement this program, there is a danger which we must take care to avoid. A tremendous amount of work is involved, most of which will have to be done by people not yet trained to do it. All this will take a lot of public money.

And the expenditure of public money is generally accompanied by demands to see the results. We must educate the public to the length of time that will be required to avoid the danger to the whole program that would ensue if the issuance of detailed advisories, followed by restrictive and expensive control measures, proved to be unwarranted because our information was inadequate.

DHEW PROGRAM IN METEOROLOGY

When the Federal air pollution program was initiated in 1955, we knew that meteorology was one of the first programs that should be started. We faced the decision whether to hire meteorologists as DHEW employees or to negotiate an arrangement with the Department of Commerce to provide us with Weather Bureau meteorologists. We chose the latter route because Commerce could offer meteorologists a career in meteorology whereas DHEW, at the time, could not. We have never regretted this decision. I am appending herewith a tabulation showing the growth of this arrangement from 1955 to date.

We now have 40-odd meteorologists and meteorological technicians working on problems connected with air pollution. Most are engaged in the chemical and physical research and development that is the province of our meteorology program. The rest support the abatement, technical assistance, research and training activities administered by our abatement and control programs and our health effects and economic effects research programs.

As is apparent from the foregoing, we use our meteorologists extensively in operations as well as research. Our meteorologists are an integral part of all our activities and take part in all our planning and decision-making processes. We now have the capability to offer a NCAPC career service to air pollution meteorologists. However, as

long as we can continue our past reciprocal relations with ESSA, we do not propose to change present policy in this regard.

The meteorological services we receive from ESSA assignees, excellent as it is, constitutes only a part of our total meteorological program. We support by research grant to universities a substantial research program in air pollution meteorology, aerosol technology, biometeorology, and studies of visibility through the atmosphere—specifically this year 38 projects costing $1,397,288. A list of these projects is appended.

A portion of our financial aid to State and local air pollution control agencies goes for their air pollution meteorological activities, including the employment of meteorologists, the acquisition and operation of meteorological equipment, the development and implementation of State and local air pollution alert, potential advisory, and dispersion model systems and the storage and analysis of data.

The recipient States and localities contract some of this work to private organizations. We estimate that about 23 agencies are spending $175,000 of their grant funds on meteorological activities. This is matched by about another $75,000 of their own funds.

We have for the past 8 years contracted with TVA for studies on stack plume diffusion, rise and fumigation. The annual funding level has been about $25,000. We have also contracted with private industries for studies and developmental activities which have special applications to meteorological problems.

By way of conclusion, DHEW is represented on the Interdepartmental Committee on Atmospheric Sciences, the Federal Council on Meteorology and the Interdepartmental Committee on Applied Meteorological Research; and has contributed to the recent pollution studies of the President's Science Advisory Panel and the National Academy of Sciences/National Research Council.

In the international area, we represent the United States in the air pollution meteorological activities of the Organization of Economic Cooperation and Development, and in cooperative programs with Japan and Germany.

That ends my statement.

Mr. McCormick and I would be glad to answer any questions.

Senator MUSKIE. It is an excellent paper, Mr. Stern, a very useful part of the record, and I think it deserves greater attention and time than we are in position to give now.

I particularly like your discussion of air quality sheds and regions. It is obvious that this concept is of great interest to the committee from the questions that have been asked already this morning and I think that you have done an excellent job defining an airshed and spelling out the concept which ought to be very useful to us.

It supplements what has been said earlier and I like your development of the second-generation prediction system which you hope to develop. This is within reach, you say?

Mr. STERN. Yes. We believe it is within reach.

Senator MUSKIE. Within what period of time?

Mr. STERN. I will ask Mr. McCormick to comment on that.

Mr. McCormick. Certain phases of this program we hope to put in on an experimental basis within the coming calendar year. With good luck in perhaps 2 years some of the elements can be operational, perhaps not.

Senator Muskie. It is my impression that in order to make its fully effective you are going to need well-developed and viable programs at the State and local level to provide the source information, aren't you?

Mr. Stern. We must have good source information in order to fully utilize any form of advisory.

Senator Muskie. So that your prediction on the time when you may have developed a second-generation system depends upon an assumption as to how rapidly State and local governments will move to provide the programs and the information upon which your system would have to be based?

Mr. McCormick. Sir, in development of our second-generation programs—this development does not depend upon knowledge of precise sources in States and local communities. This is the third generation.

Senator Muskie. I see. What would we be able to do with the third-generation system?

Mr. McCormick. We hope to predict air pollution concentration, not air pollution potential or relative concentrations of air pollution, but actually air pollution concentrations.

Senator Muskie. I hope that by the time we reach the third-generation system we will have so controlled the sources of pollution that the number of concentrations you will be predicting will be less.

Mr. McCormick. It would greatly simplify our job.

Senator Muskie. Thank you very much, gentlemen. I am sure we will hear from you again. It is a most fascinating part of the total program that hasn't received the attention it ought to and we hope to give it that attention.

The committee will recess subject to the call of the Chair.

(The documents attached to Mr. Stern's statement are as follows:)

U.S. Department of Health, Education, and Welfare—Growth of meteorology program

Year	Meteorologists	Budget amount
Year:		
1956	3	$150,000
1957	8	160,000
1958	7	220,000
1959	8	260,000
1960	9	265,000
1961	9	281,000
1962	9	315,000
1963	9	336,000
1964	10	452,000
1965	13	522,000
1966	19	593,000
1967	23	735,000

U.S. Department of Health, Education, and Welfare

Grant No.	Title	Amount
	AEROSOL	
AP-00012-08	Formation and decay of atmospheric aerosols	$20,137
AP-00048-05	Physical chemical studies of aerosols	25,080
AP-00136-06	Generation and decay of small ions	31,738
AP-00186-05	Sprays and aerosols bibliography and abstracts	24,400
AP-00319-02	Studies of the behavior of the atmospheric aerosol	11,024
AP-00345-02	Hysteresis in smog and fog disappearance	19,970
AP-00345-02S1		4,800
AP-00351-02	A study of vibrating-capillary atomizers	16,633
AP-00367-02	Physical chemistry of aerosols	24,894
AP-00372-01	Analysis of atmospheric dust by electron optics	58,463
AP-00373-02	Air cleaning by high speed inertial impaction	29,551
AP-00421-02	Coalescence of drops in a gaseous medium	25,350
AP-00425-02	Fundamentals of the optical measurement of aerosols	42,000
AP-00425-02S1		16,800
AP-00431-02	The shape of atmospheric particles	66,900
AP-00449-01	Investigation of ice fog problems	49,379
AP-00453-01	Urban aerosol count-size related to meteorologic data	15,095
AP-00468-01	Studies on aerosols of sizes down to 0.05 micron	8,160
AP-00479-01	Dynamical theories of Knudsen aerosols	14,177
AP-00480-01	Study of atomizer aerosol generators	18,556
AP-00493-01	Behavior of aerosol particles	21,579
AP-00511-01	Controlled source of uniform liquid droplets	32,939
	BIOMETEOROLOGY	
AP-00080-10	Diurnal investigations of airborne fungi	14,074
AP-00080-10S1		11,195
AP-00137-05	Viable species of algae and protozoa in the atmosphere	4,787
AP-00456-01	Changing vegetation and atmospheric pollen	15,339
	METEOROLOGY	
AP-00081-08	Travels of airborne pollen	46,350
AP-00091-06	Diffusion in shear flows with thermal stratification	29,989
AP-00216-03	A study of denver air pollution	42,982
AP-00222-03	Air pollution forecasting techniques for Pennsylvania	16,201
AP-00224-03	Meteorological analysis Pennsylvania air quality data	12,904
AP-00281-04	Analysis of the marine layer—A mesometeorological study	48,303
AP-00292-03	Mesowind patterns in the Central California Valley	11,595
AP-00328-03	Mathematical models of urban air pollution dynamics	232,524
AP-00335-01	Vertical distribution of air pollution	91,620
AP-00359-02	Atmospheric diffusion in the inertial subrange	29,850
AP-00380-02	Mesoscale wind systems around the Great Lakes	73,744
AP-00413-03	A study of atmospheric turbulence over a city	26,629
AP-00433-01	Radar measurements of the mixing layer over cities	62,524
	VISIBILITY	
AP-00285-03	Potential visibility in air quality measurement	14,755
AP-00336-03	Influence of aerosol characteristics on visibility	25,310

[Science, Dec. 23, 1966]

Ice Nuclei From Automobile Exhaust and Iodine Vapor

Abstract. *When exposed to a trace of iodine vapor, the submicroscopic particles of lead exhausted by automobiles produce nuclei for the formation of ice crystals. Concentrations of particles exceeding 10^6 per liter can be directly sampled from the exhaust pipe of an idling motor. Concentrations of from 10^4 to 10^5 per liter have been found in rural air downwind of auto roads; the concentration at one rural site has increased by an order of magnitude in 13 years. The phenomenon may provide a method of modifying clouds, and of determining (and monitoring) the percentage of automobile exhaust in a polluted atmosphere. It may be an important factor in inadvertent modification by man of the climate.*

A newly discovered phenomenon produces concentrations of ice-crystal nuclei (see cover) as high as 10^6/liter in the free atmosphere where automobiles have been operating. The phenomenon may provide an important new technique for extensive overseeding in supercooled clouds; it may also present a highly sensitive and simple method for detecting submicroscopic particles of lead in auto exhaust, and thus provide a practical technique for establishing an auto-exhaust index in polluted air. It may also elucidate in an unexpected way the manner in which man is inadvertently modifying atmospheric clouds over extensive areas of the United States.

In the simplest terms, the phenomenon depends on the formation of less than a monomolecular layer of iodine on the surface of submicroscopic particles of lead oxide emitted profusely in auto exhaust as a result of the nearly universal use of tetraethyllead in gasolines to prevent knocking.

In a typical experiment, a 5-second collection (about 80 liters) of exhaust from an idling automobile engine produces more than 10^8 ice crystals in air saturated with water at −15°C. The sample is caught in a plastic bag placed over the exhaust pipe and then expelled into a 100-liter chamber having an air temperature of −20°C. Moisture from combustion of the gasoline produces a supercooled cloud and warms the air to −15°C. When this exhaust cloud alone is in the chamber, the ice nuclei observed amount to less than one crystal per liter. About 0.1 liter of air from a bottle containing crystals of iodine, having a temperature of 25°C, is then introduced into the chamber. Within less than 10 seconds the supercooled cloud disappears and is replaced by an ice-crystal cloud containing more than 10^8 crystals—a concentration of 10^6 ice nuclei per liter at −15°C.

Measurement of the concentrations of Aitken and cloud nuclei in the 80-liter sample of auto exhaust 5 minutes after cloud formation showed concentrations of 10^9 and 5×10^7 per liter, respectively. Thus there appear to be about 50 times more cloud nuclei, and 1000 times more nuclei of all sizes, in the sample of exhaust than those available for ice-crystal formation.

In a residential area of Fresno, Calif., on 24 October 1966, under conditions of light pollution, a cold chamber operating at −20°C showed less than one crystal per liter when a supercooled cloud was formed. Ten seconds after the cap was removed from a bottle of iodine crystals held in the chamber, more than 10^7 crystals per liter appeared.

Since the iodine reaction occurs within a few seconds in the presence of a supercooled cloud, it is obvious that the particles that react with the iodine are not cloud nuclei, since the latter would be immersed or dissolved in the cloud droplets. The ice nuclei thus activated must act to form ice crystals by water-vapor deposition.

Earlier (*1*) I showed the effect of liquid water on silver and lead iodide, and the manner in which such particles behave when exposed to varying degrees of water equilibrium and supersaturation. As with silver iodide, there is variation in crystal form, temperature threshold of activity, and number of particles in the aerosol that are active at various temperatures.

Thus the sample of auto exhaust that I have just described, which after 5 minutes showed a concentration of 10^9 Aitken nuclei per liter (all being invisible and thus less than 0.1 micron in diameter), and which showed less than one ice crystal per liter before iodine vapor was introduced, showed concentrations of ice nuclei approximating 10^2, 10^4, 10^6, and 5×10^6 per liter at −3°, −7°, −15°, and −20°C, respectively. These are conservative values, since ice crystals continue to appear for many minutes after the first appear and fall out.

It is interesting that the concentration of naturally occurring ice nuclei in the free atmosphere at −20°C ranges from less than 10^{-2} to 10^1 per liter in most parts of the world where measurements have been made. Occasionally the values reach or exceed 10^2 per liter, but such unusual instances can often be related to volcanic activity, massive dust storms, or similar phenomena.

It is likely that only a few thousand iodine molecules serve to form an effective patch of lead iodide on the surface of a particle of lead oxide. In fact, the formation is probably most effective when only small molecular patches occur, since it is likely that their edges are the most effective nuclei for formation of ice crystals.

The reaction of free iodine with microscopic particles of silver ovide was first developed by Vonnegut (*2*) as a method of generating large numbers of particles of silver iodide for the seeding of clouds. He used electric sparks, with silver electrodes in the presence of iodine crystals, as one of a number of techniques for producing silver iodide nuclei. This reaction was subsequently cited by Schaefer (*3*) to explain a strange residual effect of production of ice-crystal nuclei in the laboratory.

During the intervening 13 years, my observations in a rural community (site of my laboratory) have shown an increase per liter from 10^4 to at least 10^5 particles of lead in the air that react with iodine vapor to form ice nuclei at −20°C. In a ponderosa pine forest, 5 km north of Flagstaff, Arizona, on 29 August 1966 I measured a concentration of 10^5 per liter at −18°C. During early November I have made 20 measurements in eastern New York, most of them in

open fields 5 km northwest of Schenectady, using a portable cold chamber operated at −20°C; concentrations of ice crystals formed on nuclei exposed to iodine vapor have ranged from 5×10^5 to more than 10^6 per liter.

There has been no adequate study of the concentration of free iodine vapor in the atmosphere, but values cited by Junge (*4*) range from 0.05 to 0.5 $\mu g/m^3$ as typical background levels. More recently Duce *et al.* (*5*) reported similar values in air over the Hawaiian Islands. Iodine in the atmosphere comes from the burning of fossil fuel, as effluent from growing plants, and as residues from airborne particles of soil; sources more closely related to man are the burning of seaweeds, the processing of natural nitrates, the effluent of nuclear reactors, and the operation of silver iodide burners.

All these sources produce localized effects, but detailed aerial and ground measurements are needed in such areas to establish the degree to which molecules of iodine vapor, absorbed on surfaces of aerosols, trees, and precipitated globules of water, can again evaporate to affect other surfaces. Four years ago I found that 10 drops of hydroiodic acid (HI), dissolved in 250 cm^3 of water and placed in the bottom of a cold chamber, produced the same ice-nucleation activation of the then-unknown metallic particles in my laboratory air as did the vapor from iodine crystals.

While I have not yet conclusively established that all the nucleation effect that I report is caused by lead residues from auto exhaust, the evidence so far strongly favors this conclusion. My experiments indicate that extremely small amounts of iodine can produce striking effects, and it is important that this subject should receive more attention.

To establish the fact that the iodine reaction was due to lead particles from the exhaust, a grounded lead wire of 0.05-cm diameter was sparked by passing it a distance of 1 cm five times across the 22.5-volt terminal of a dry battery. After the formation of a supercooled cloud at −20°C, about one ice crystal per liter was observed after 20 seconds. When iodine vapor was introduced into the cloud, more than 10^7 ice crystals per liter were observed after the same period—five to ten times the number formed (as I have mentioned) from the auto exhaust. The type of ice crystals observed and the relation between the numbers produced by various ambient temperatures were essentially the same as the exhaust experiments had shown.

The vast amount of automobile exhaust rising throughout North America could profoundly influence supercooled cloud systems if the atmosphere also contained free iodine vapor. There is a strong possibility that Grants (*6*) "carry over" effect can be explained by this mechanism; small amounts of free iodine released by the decomposition of silver iodide could easily activate large numbers of lead particles (from auto exhausts) drifting across the mountains where this phenomenon was observed.

The massive glaciation of cumulus clouds, occurring at relatively warm temperatures (−6° to—15°C), also may be caused by this effect. Since 1 g of iodine probably suffices to activate at least 10^{18} submicroscopic particles of lead, it is obvious that such activation may be an important procedure for making large numbers of ice numclei available in free atmosphere containing engine exhaust.

Iodine vapor may be introduced in many ways because of the high vapor pressure of crystalline iodine and the relatively easy decomposition of many of its chemical products. Although the iodine molecule adsorbs readily on atmospheric particulates, it can also transfer easily from one compound to another, especially in the presence of sunshine.

Such a new method of seeding clouds wherever auto exhaust diffuses into the atmosphere is obviously important, but other potentially important aspects need exploration. The method might be developed, in conjunction with an ice-nucleus detector, as a technique for monitoring the auto-exhaust component of poluted air. Since the automobile engine is probably the greatest source of lead particles in most urban smog, spot or continuous monitoring could indicate its contribution to the total mass of particles and show whether control methods are effective. And experiments might use this reaction to assess the effect of these hitherto-undetectable particles on respiratory ingestion.

The conversion of the particles of lead oxide to lead iodide, which then serves as a nucleation center for formation of ice crystals, is so sensitive that it is difficult to visualize its effectiveness. With the initial particle of lead iodide having an effective diameter of 0.01μ when introduced into a supercooled cloud, it will grow to 100μ within 30 seconds—four orders of magniture, like a golf ball swelling to the volume of the Empire State Building.

The importance of this tremendous rate of growth is that particles that normally remain airborne for long periods, and cannot be seen or detected chemically, can be "trapped" in the centers of visible ice crystals; thus they can be collected on slides as fallout or counted by an acoustic or light signal. By replication of the crystals (7), the particles subsequently can be viewed under the electron microscope.

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WHAT FACTORS DETERMINE THE OPTIMUM SIZE AREA FOR AN AIR POLLUTION CONTROL PROGRAM

(By Morris Neiburger, Professor, Department of Meteorology, University of California, Los Angeles, Calif.)

The motions of the atmosphere, and therefore the movement of pollutants which are put into the air, have no regard for political or jurisdictional boundaries. This fact, which at one time was known only to meteorologists as students of atmospheric motions, is now conspicuous to everyone who has flown in an airplane or driven in an automobile across city, county, and state boundaries. Whereas in early years we had to use meteorological data to demonstrate that the smog-laden air from the San Francisco Bay area is carried into the interior valleys of California and that the pollution from the Los Angeles area goes over the mountains and through the passes into the desert regions, today the pollution is so concentrated and extensive that its movement is readily seen directly, and the visual evidence is both more vivid and more convincing. It shows clearly that the inland counties of California cannot control the pollution levels they experience. The similar movements of pollution from New Jersey to New York and vice versa are also clearly evident, showing that these states cannot individually solve their pollution problems. Everywhere in the United States (and elsewhere in the world) where pollution enters the atmosphere it is carried with the wind from city to city and state to state. The pollution from one political sub-division may thus affect many others. This fact is lent statistical validity by the results of a questionnaire circulated in 1961 by the Philadelphia Department of Public Health to all local control agencies in the United States. (Purdom, 1962). Of the respondents more than half reported that pollution from sources outside their jurisdiction affected the pollution level in their areas. Under these circumstances, what are the factors which determine the desirable size for the area covered by an air pollution control program?

In addressing myself to this question I am aware that in addition to meteorological factors there are political, legal, and jurisdictional ones, and also economic and social factors related to the distribution of industrial and commercial activities and population. Inevitability all these factors are inter-related, and although I shall be principally concerned with the physical and meteorological factors, I shall point out questions concerning the political and economic factors in the hope that answers to them will come from others present at this conference.

The meteorological factors are concerned with the processes which tend to transport, disperse, and dilute pollutants after they have entered the atmosphere, to transform them physically and chemically, and ultimately to remove them from the air. With respect to these factors we have a very good idea of those which determine the rate at which pollutants are transported, dispersed, and diluted. We have some information about how and how fast they are transformed. But we have almost no knowledge of how and at what rate they are removed. We know, however, that large fractions of the pollutants remain in the air for periods of days or even weeks, during which they can be transported across state and national boundaries, and even across oceans.

Because of this persistence of pollutants after they have been introduced into the air, it is clear that no local political boundary, say a city or county line, forms a natural jurisdictional limit for air pollution control regulation or enforcement. What, then, are the considerations which determine the optimum areas for pollution control from the meteorological standpoint?

Frequently reference is made to air sheds or drainage basins, in analogy to the corresponding concepts in the flow of water. There are indeed times when air does flow downslope like a river, and there are places where at certain times the air is confined in a basin in the same way as the water is in a lake. To the

extent that the periods and places of high pollution input coincode with these places and these times it is quite reasonable to use these natural drainage areas as a basis for control programs. However, even in the case of an area which has such natural drainage characteristics, variations of weather influences produce a variety of flow patterns so that frequently the pollution is carried in a different manner than that suggested by the topographic considerations, and pollution from the area concerned will move in high concentrations to other places, and pollution from locations outside of the drainage basin will be carried into it. Air drainage basins thus cannot be defined as an adequate basis for delineation of pollution control programs.

Another basis for setting the limits of an air pollution control program lies in the rate at which pollution from a given source is diluted as it moves away from it. Figure 1 shows the variation of concentration at the ground of a pollutant

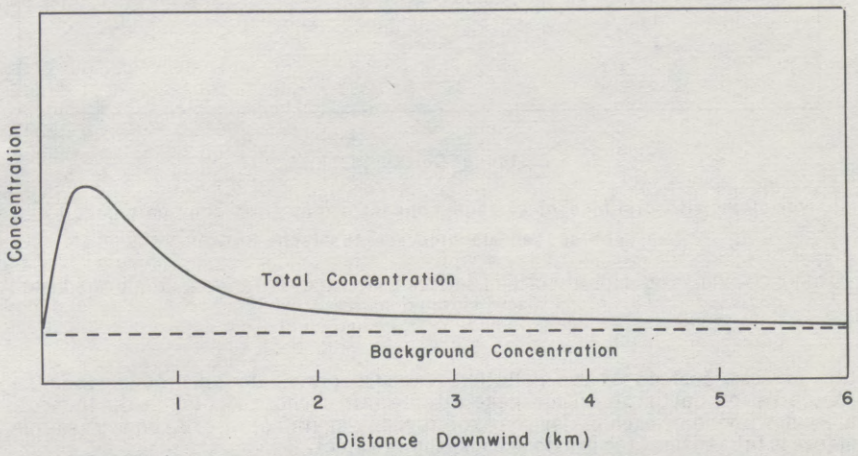
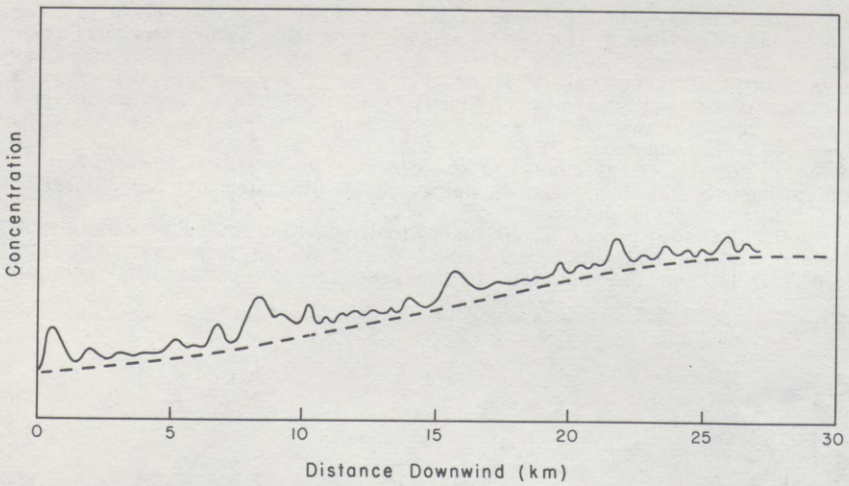


FIGURE 1.—Variation with distance of total concentration at surface downwind from an elevated source (schematic).

emitted continuously at a steady rate from a smokestack into a steady wind. The peak concentration at the ground is some distance in the lee of the stack, since the pollution requires time to diffuse downward from the stack top to the ground. Farther downwind from that point the concentration drops off and eventually, at a large enough distance from the stack it reaches a value only slightly above the initial background concentration. Thus, in the case of an isolated stack, the area of concern from the standpoint of control is limited to the region within a moderate distance downwind of the stack. The actual value of the concentration and the rate of decrease with distance downwind depends on a variety of factors, but principally on the atmospheric stability, which depends in turn on the variation of temperature in the vertical, and on the strength of the wind, which on the one hand gives the speed with which the pollution is carried away and on the other hand controls the amount of turbulence and thus the rate at which the pollution mixes with outside air. When the wind is light and there is an inversion (a layer of air in which the temperature increases with height instead of its usual decrease) the concentrations will be higher than in strong winds with normal lapse of temperature. If the pollution were confined to a single source the boundary of the control area could be defined in terms of the distance to which objectionable concentrations might reach under adverse meteorological conditions.

In reality it is rare that one must confine the pollution control measures to a single individual source. Instead the pollution in a metropolitan area comes from many sources of many types. The emissions are superposed, so that for the wind in any particular direction the pollution from one source is added to the pre-existing concentrations from all the others upwind of it. Figure 2 illustrates



Variation with distance of surface concentrations from randomly sized and spaced elevated sources (schematic).

FIGURE 2.—Variation with distance of surface concentration from randomly sized and spaced elevated sources.

this process. Instead of the pollution decreasing with distance downwind, the concentration fluctuates with a generally upward trend, reaching peaks immediately downwind of each major source, but rising again because of the next source before it falls to near the previous background value.

A similar result is obtained if the pollution sources are assumed to be distributed uniformly over the metropolitan area. In Figure 3, copied from a diagram in a paper by Hilst (1962), the rising part of the curve represents the increasing concentration due to an area source of constant intensity of pollution emission. The falling part of the curve shows the effect of dilution downwind of the source.

For a metropolitan area, whether represented by multiple sources or a smoothed area source theory shows that the concentration continually increases in a downwind direction, with the peak concentration reached at the downwind end of the source-containing area. Beyond this the concentration falls off, but more slowly than in the case of a point source. The peak concentration may reach very high levels under conditions of high emission rates, large source regions and adverse meteorological concentrations. The rate of decrease under adverse meteorological conditions may be so slow that places at distances several times the diameter of the source region—the metropolitan area—may experience objectionable concentrations of pollution.

The control program for a metropolitan area thus properly should include a region much larger than the metropolis if all the persons who are affected are to be considered. The specific dimensions would vary from instance to instance, but as a rough guide I would suggest a diameter for the control program region three times the largest dimension of the fully developed metropolitan area.

If, before the pollution concentration accumulated over one metropolitan area falls to its original background level the air reaches another metropolis, an accumulative effect will occur. The pollution from the second metropolis adds to higher initial value, and on continued passage over metropolitan areas the background concentration of pollution in the air will build up in a fashion similar to the case multiple point sources but on a larger geographical scale.

To illustrate this effect schematically there is presented in Figure 4 a view of what the concentration of pollutants might be as the air flows across the United States from Los Angeles to New York. As the air comes in from the Pacific Ocean the heavy emissions and poor diffusion over Los Angeles leads to a very high peak in the concentration. After the air leaves the Southern California

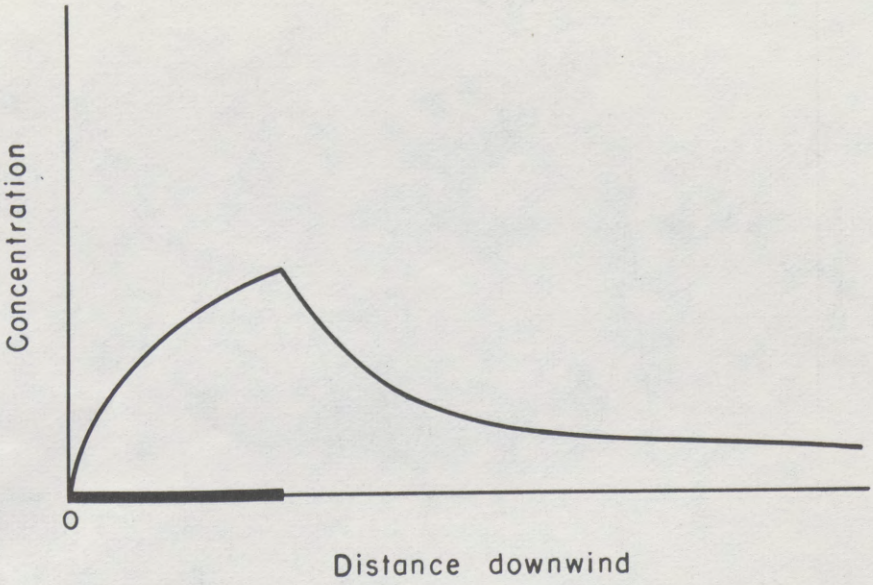


FIGURE 3.—Variation with downwind distance of concentration due to an air source of finite length.

metropolitan area the improved diffusion and the removal processes cause the concentration to fall and by the time it has crossed the desert and mountains it has decreased almost to the original background value. The Denver area, Kansas City and St. Louis all cause individual peaks, with the farmland between allowing decreases, but once the air starts crossing the close-together metropolitan areas east of the Mississippi the effects of each area add to residual effects of the ones upwind of it. The highest peak is thus at the East Coast. The concentration after that falls off as the air proceeds over the source-free Atlantic Ocean. Presumably by the time it reaches Europe it will have fallen to the same low background level as the air coming to the United States from the Pacific, and by the time the air has crossed the Pacific again the pollution added while it passed over Europe and Asia will have been removed and we start the same cycle again.

From these considerations we see that when metropolitan areas are close together their pollution levels are not independent of each other. If Area A has very high standards of pollution emission control it still may be subjected to objectionable pollution levels if Area B upwind of it does not have adequate controls. Since winds are variable, there will be occasions when B is affected by A as well as vice versa, and it is to the interest of both metropolises that they mutually coordinate pollution control to protect themselves and each other. This coordination may involve joint action by separate control agencies by means of agreements or compacts, or joining together in a unified control agency. The

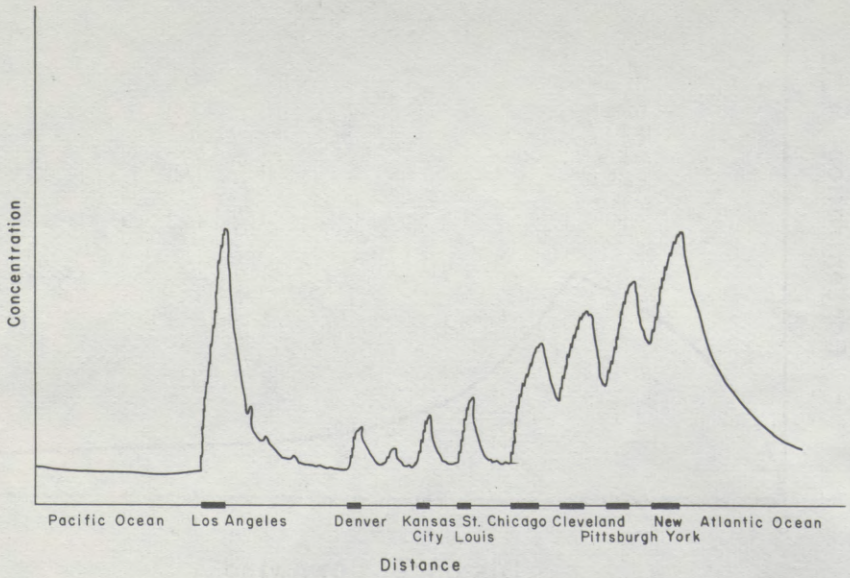


FIGURE 4.—Schematic representation of pollution concentration in air crossing the United States.

jurisdictional bodies concerned may include cities, counties or states. In some instances the state or the national government could serve as the control agency.

We have the impression that at the present time the general picture represented by Figure 4 is correct: the pollution from neighboring source areas affect each other, but at large distances the dilution and removal processes bring the levels down to the original background. In particular we think that each batch of air entering the country from the Pacific Ocean is as clean as the previous one. But we can visualize that if the rate of emission of pollution continues to increase we will reach the stage in which the dilution and removal processes do not completely bring the concentration back to its beginning value after a circuit of the earth. Then the situation on successive passages of air across the United States would be as shown schematically in Figure 5. At each later circut the concentration starts from a higher background value and reaches higher peaks. In the course of time even the concentration over the oceans will be higher than the highest values presently attained, and the values reached in metropolitan areas will be indeed unbearable. Eventually, under these circumstances, the concentration would exceed the levels of toxicity tolerable by humans. If pollutants were poured into the atmosphere at such a rate all mankind throughout the earth would perish.

To insure that this rate of emissions on a world-wide scale is not reached prompt national and international action is essential. Studies of the rate at which pollution removal occurs and the atmosphere cleanses itself must be carried out, in order to determine the allowable rates of emission of various pollutants for the earth as a whole. International agreements must be arrived at to provide that these rates are not exceeded, and methods of policing these agreements must be set up. Even before complete knowledge of the allowable rates is available it is necessary that we take the first steps toward international control.

I want to remind you that Figures 4 and 5 are strictly schematic. The wind never follows a path directly across the country from Los Angeles to New York, but instead twists and turns, so that air crossing one metropolitan area may be moving southward or northward and miss all the others. Furthermore, conditions of light winds and inversions do not occur continuously in a parcel of air as it moves across the country. In one place there may be these bad condi-

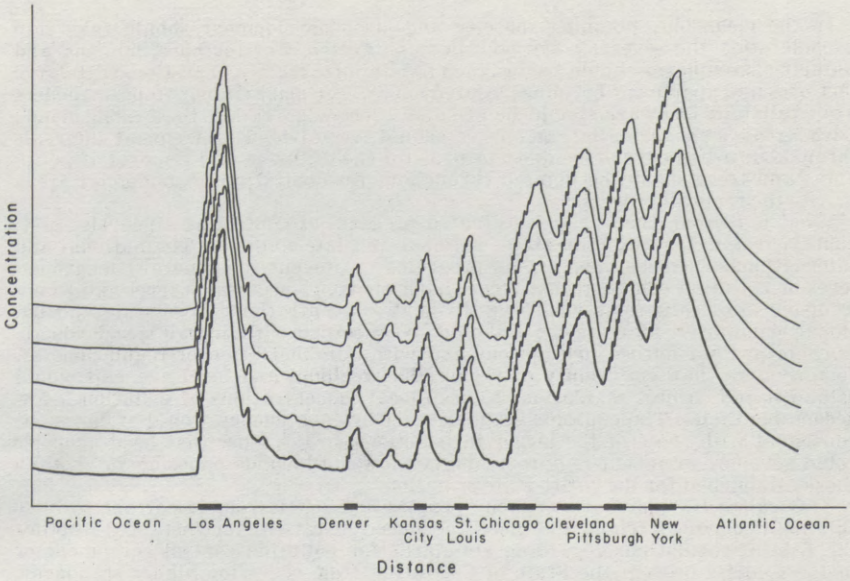


FIGURE 5.—Schematic representation of pollution concentration in successive traverses of air over the United States.

tions, but in another the conditions may favor strong mixing of air through the entire troposphere.

Nevertheless the main points derived from a consideration of these figures are valid: The pollution levels at any one place are determined not by the local sources alone, but by the contributions of sources at large distances, and in the future they may be significantly affected by all sources throughout the world.

Under these circumstances it is clear that what is required is not delineation of an optimum area size for air pollution control programs. What is required is a coordinated program in which local, regional, state, inter-state, federal, and international agencies all cooperate in the effort to maintain a healthful clean atmosphere for everyone on earth.

It is also clear that this coordinated program should be of a more fundamental and general nature than has been applied heretofore to the air pollution problem. Up to now, for many years, we have been treating the problem piecemeal, in terms of particular localities, single sources, or specific pollutants, and the problem has continued to become more severe and wide-spread. Instead of this piecemeal attack, the concept of pollution control must be incorporated into the basic fabric of our economic and social life. All urban and rural planning, all industrial and domestic development, indeed all national planning and development, must incorporate consideration of their air pollution aspects.

The first and foremost principle must be that all industrial, domestic, and vehicular operations should be carried out with essentially no emissions into the atmosphere. With respect to industry we have seen in Los Angeles that this goal can be approached if stringent efforts are exerted. The refinery operations there are an outstanding example of what is possible. The domestic incinerator was eliminated there, not without resistance, in accord with this principle. These steps can be taken everywhere, if adequate motivation were applied.

For control of emission from vehicles the situation is different because the technology has not yet been developed. However it is my contention that if the federal, state and city governments were to adopt laws setting a date, say January 1, 1980, after which no vehicle injecting any hydrocarbons, carbon monoxide or oxides of nitrogen into the atmosphere may be operated on the highways, roads and streets under their jurisdictions, industry would develop the technology to meet this requirement.

In the meantime, planning for city and state development should take into consideration the several ways pollution is affected. For instance, housing and industrial complexes should be designed to minimize traffic congestion, with large factories and apartment buildings located only where mass transit stops or feeders are available; freeways should be oriented cross-wind rather than along wind; park areas with vegetation and trees should be provided at frequent intervals throughout urban developments to provide for the diffusion and removal of pollutants; and trees should be planted throughout residential and commercial areas to help the removal process.

What is needed, then, is a coordinated program of control at all levels: city, county, regional, state, inter-state, national and international. The national and international agencies must set up programs to prevent the general background level of pollution concentration from rising above an acceptable level and to administer those situations where locally high concentrations cross state and national boundaries. State agencies should be concerned with overall standards applicable to their entire jurisdictions and with administration of regulations affecting more than one county or region. The regional and local agencies would establish and enforce regulations to keep local concentrations of pollution below acceptable limits. The emission standards set by each agency would of course be consistent with those of the larger jurisdictions, in the sense that local agencies could set more stringent requirements, i.e., lower allowable emission rates, than those established for the entire state or nation.

This raises the point of so-called "pre-emption". It is very important to have this point clarified. There has been the question raised, for instance, whether the federal regulations regarding standards for pollution control equipment or motor vehicles prevent the State of California from requiring higher standards, i.e., lower allowable emission rates. There is every reason to make sure that states and localities retain the authority to establish more rigorous standards. National standards will tend to be set at a level acceptable to all interested parties. Locally severe meteorological conditions lead to local requirements which may be considerably more restrictive than those which would be accepted nationally. The right of local communities to protect the health of their citizens must not be infringed.

Doubtless the coordinated program hereby suggested is fraught with difficulties from the political standpoint. It is one of the challenges which scientific and technological progress presents Society. The dangers are comparable with those of nuclear war or the population explosion. The solution to all these problems must be found. The costs of not doing so in time are too great.

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(Whereupon, at 1:05 p.m., the subcommittee hearing was concluded.)

AIR POLLUTION—1967

MONDAY, APRIL 3, 1967

UNITED STATES SENATE,
SUBCOMMITTEE ON AIR AND WATER POLLUTION
OF THE COMMITTEE ON PUBLIC WORKS,
Denver, Colo.

The subcommittee convened at the University of Denver Law Center, Senator Edmund S. Muskie (chairman) presiding.

Also present: Senator Dominick of Colorado; Leon G. Billings and Richard D. Grundy, professional staff members; and William Hildenbrand, legislative assistant to Senator Boggs.

Senator MUSKIE. The Subcommittee on Air and Water Pollution today opens the third in a series of four field hearings which have taken us to Los Angeles and Detroit and will conclude tomorrow in St. Louis.

As most of you are no doubt aware, the subcommittee was to have visited Denver nearly a month ago but had to cancel because of unexpected Senate business. I deeply regret that situation and apologize for the entire membership of the subcommittee, especially to those of you who were scheduled to appear.

A little over 3 years ago our subcommittee held a field hearing in Denver. At that time the Federal fight for clean air was young and not too vigorous. Today the effort is still young, but I hope being pursued with a great deal more vigor.

We are here in Denver for two purposes. First, while we on a national level have taken great strides over the past 3 years, I understand the State of Colorado and the city of Denver have taken equally great, if not greater, strides. The State of Colorado is a leader in the development of the airshed concept, a matter with which the subcommittee must deal later this year. The State of Colorado is a leader in the establishment of ambient air quality standards for a variety of pollutants. This, too, is a matter which must be considered by the subcommittee.

The second reason for coming to Denver is the existence of the National Center for Atmospheric Research. We hope to get from the testimony of representatives of the Center a better insight into automobile emission problems which are not presently covered by Federal standards.

As most of you know, the President recently proposed the Air Quality Act of 1967. This legislation is designed to implement the proposals on air pollution contained in the President's message on protecting our natural heritage. The recommendations of that message include—

1. A national program of minimum emission levels for certain pollutants, coupled with regional applications of emission standards;

2. A program to establish regional airsheds to provide more effective coordinated attacks on the problem;

3. A program of Federal matching grants for State inspection programs to insure maximum control of automotive exhausts;

4. Improved enforcement procedures;

5. Accelerated research on fuel additives; and

6. A 50-percent increase in Federal research funds on the causes and control of air pollution problems, including such specifics as motor vehicle emissions, diesel exhaust, alternative methods of motor vehicle propulsion, and sulfur emissions.

The legislation contains some imaginative and far-reaching opportunities for air pollution control and abatement and conveys a real sense of urgency, but the bill is complex as is the issue. Much time and effort will be required to thoroughly examine the proposal.

I am sure that the information the subcommittee receives today will expedite examination of that legislation and make possible effective, strong, and reasonable Federal legislation.

I think this is the first time in history that we began a hearing in advance of the time set. We ought all to welcome that. We have two distinguished members of the Colorado Legislature who are with us this morning. I am delighted that they can be with us and we are happy to accommodate their present schedules by beginning this hearing early. I understand they are concerned about votes coming up and I can appreciate that. I may miss a few today and tomorrow as I go ahead with these hearings.

Our first legislative witness is the Honorable Don Friedman, State representative, State of Colorado Legislature. Mr. Friedman, won't you please come up?

STATEMENT OF DON FRIEDMAN, A REPRESENTATIVE IN THE COLORADO LEGISLATURE

Mr. FRIEDMAN. Senator Muskie, members of the committee, thank you for this opportunity to appear before your committee today. I am proud to have been the prime sponsor of all of Colorado's air pollution control laws, and we in Colorado are appreciative of the Federal Government's concern with this problem and its desire to help the States.

As you know, Colorado's present air pollution control program is based on the basin concept. In essence, the Colorado law gave to local government the full authority and power to control air pollution. If the ambient air in any area, however, fails to meet State standards, the State has the authority to enforce these source standards. The philosophy behind this approach is that the best air pollution control can be accomplished by local government. Thus we are not required to have the same set of State standards for an isolated area in eastern Colorado as we have for the Denver metropolitan area.

It is our sincere hope that this program which we believe meets Colorado's needs will receive the full financial assistance from the Federal Government, even though it may differ slightly from your concept of the perfect control program. Our law in Colorado was greatly influenced by two constitutional limitations: (1) that the State legislature may not delegate policymaking power to another agency such as a control board or the State department of health.

I wish to digress for a minute on that. We have had the problem in Colorado, when we refer to a standard written by an agency or by, for example, the automobile standards, we must refer specifically to the printed copy of the October 1960 edition. So we were faced, in the air pollution problem, with writing a State standard, not just saying we would have standards to control sulfur dioxide and things of this sort. So this is the reason why we came to this combination approach. We wrote very tight standards. The standards we used were the standards recommended by the Regional Air Pollution Control Agency of the metropolitan area and these were incorporated in the State law but specifically mentioned.

Senator MUSKIE. So they cannot be set administratively.

Mr. FRIEDMAN. That is correct.

Senator MUSKIE. At either State or local level?

Mr. FRIEDMAN. The local level can set their own, but they cannot enforce the State standard unless the State standard is spelled out. The only way for them to apply a State standard locally is to adopt it as their own.

The second problem is that municipal or county enforcement agencies cannot go across jurisdictional boundaries with enforcement powers, and to divert for a moment, this has led——

Senator MUSKIE. May I go off the record long enough to welcome my distinguished colleague from Colorado, Senator Dominick.

Senator DOMINICK. I want to say how delighted we are that you are out here. We all recognize the importance of this. You have done a great deal of work in this particular field, and in my opinion, it is time we stopped making our own air a kind of empty sewer for all the waste that is created in this country. I was intrigued the other day with the problem that was created in England by the *Torrey Canyon* and all the things that they tried to do to get rid of the pollution, and they never got rid of it no matter what they tried. It seemed to me that this symbolizes in some way some of the problems we have in air and water pollution here. But I know this hearing is going to be fruitful for you, and it is good to see my good friend, Don Friedman here, who, I know, has been very active in this field.

I will be most interested, if it is all right with you as chairman of this subcommittee, if I just sit in today and listen to the hearing.

Senator MUSKIE. We will be delighted to have you.

Peter and I, you know, have been travelers abroad together and I found him to be excellent company, even though he is a Republican, and a public servant of real substance and worth.

I know that this eats into the time you might have set for other purposes and that you are not a member of this committee, Senator Dominick, so we are delighted to have you here. I don't know that we are doing Denver any particular favor by publicizing Denver and air pollution in one and the same story across the country. But we are delighted to be here in Denver. I think being here and exposing your concern about this problem demonstrates to the country as a whole that air pollution is a problem that ought to be of concern not only to every industrialized, obviously polluted metropolitan areas like New York and Chicago, but so-called tourist areas like Denver and my own State.

Senator DOMINICK. I assure you, Ed, this is a problem here in the Denver area and I have no hesitation in saying so. We have got less pollution than, obviously, Chicago and New York and a lot of other

areas have, but nevertheless it is a problem, a problem that we have got to do something about, in my opinion.

Senator MUSKIE. Now, Don, after this colloquy between the two Senators we will let you have the floor.

Mr. FRIEDMAN. I am always happy to be interrupted by Senator Dominick.

Unfortunately, like the *Torrey Canyon*, we can't sink some of our problems, so we have to go ahead and try to solve them.

The other area of constitutional problem we have in Colorado relates to the relationship of local government interjurisdictional powers. When our first Clean Air Act was passed we had a great deal of confusion in this area as far as having applicability to acquire the areawide funds. The interpretation of the words "power" and "authority" created a great deal of difficulty. The Colorado constitution does not allow local governmental units to have interjurisdictional power. So what we had in our area was the power to adopt the same resolution but each one to enforce it within their own area.

Unfortunately, the Government did not see fit to give them the full benefit of the funds. I thought this was too bad, because to qualify for the Federal funds we would have had to change the whole massive concept of local government in Colorado.

Senator MUSKIE. Have you given consideration to something that has been adopted increasingly in other States, of permitting local governments to enter into cooperative arrangements for dealing with problems of this kind, even with shared enforcement powers?

Mr. FRIEDMAN. We have. Our present constitution does not allow it. The whole problem of local government is fraught with other problems, other frictional areas, between the corporate city and the suburban areas, and the solution to air pollution cannot be separate and apart from the overall solution of metropolitan government. So we were faced with the situation that we constitutionally couldn't qualify, we couldn't make the minor constitutional change that appeared on the surface to quality for the funds. So, as a result, the Federal funds were not fully available to us, and as I said in my remarks, I am certain that it is not the intention of the U.S. Congress to rewrite State constitutions for the purpose of pollution control, but rather to obtain the control. I think we did as much as we could do within the constitutional limitations that we had.

Senator MUSKIE. How difficult is constitutional change?

Mr. FRIEDMAN. This type of constitutional change? Well, having been a cosponsor of a resolution to try and get at the problem of local government, it is a massive one, because we are now going into the field of education, we are going into the field of annexation, we are going into the field of urban police and fire protection, we are going into the role of the suburban county, the unannexed suburban area, and it has to be a total solution, in my opinion, you can't just go in and say, "Let's solve the air pollution problem."

Senator MUSKIE. Well, many States, and it is difficult for me to react to your problem except in this way, that many States, to get around that kind of complex constitutional problem, have authorized either by a relatively simple constitutional amendment, or by statute, these cooperative arrangments. This does not require fundamental changes in the structure of local government but does enable them to work to-

gether cooperatively. It seemed to me if this might be an avenue which you haven't explored, it might be profitable.

Mr. FRIEDMAN. Actually, we have gone away from the old concept of police districts because the police district in itself caused a great many problems. So we are now trying to solve it on a more total complex. The State senate has passed a call for a constitutional convention. There is before both houses of the State legislature effort toward solving the problem, but I don't believe it is either possible or desirable, frankly, to solve it just for pollution, because very often, the fear we have, you take the goodies out.

Senator MUSKIE. I wasn't speaking of the cooperative arrangement.

Mr. FRIEDMAN. Air pollution is, frankly, one of the goodies, this is one of the highly desirable things that everybody wants. I personally feel if you solve that problem without going to the basic differences between local governments, you may be further away from that solution. In other words, if you don't go to the problems that create and cause the frictions involved but just go to the things such as air pollution control, or let's say water and sewer, you are still going to have that basic friction. Everybody agrees that there ought to be metropolitan water control, there ought to be metropolitan sewage control, metropolitan air pollution control, and I think we ought to build our solution around those rather than picking them off and hoping to solve the other problems later.

Senator MUSKIE. Sometimes you get a tough concept acceptance, you make it work in relatively noncontroversial areas, then go on from there. I am glad to have this brought to my attention and have it on the record.

Mr. FRIEDMAN (continuing). In Colorado we recognize the great need for added Federal help with the control problems caused by the automobile. A State as small as ours has neither the financial resources for testing nor the position in the market to demand new technology with regard to the automobile industry. I believe it is fortunate that the Federal Government is active in this field. However, greater immediate emphasis should be placed on the development of testing devices to determine if the exhaust control is effective. It appears to us that the Federal Government feels that States should include the exhaust control in their automobile inspection programs. I believe it would be a serious mistake for Colorado to do this at the present time. There is now no known, economically feasible method for testing the effectiveness of these devices. If the inspecting agent makes a visual observation merely to see if the devices are still on the car, a mockery would be made of our strong inspection program. The motorist in Colorado has a right to assume that when he receives his sticker all the parts and devices under the inspection program are in working order. At my instigation, Colorado was one of the first States to require inspection of the blowby device. This program is working effectively. However, we must wait on the exhaust systems until a similarly effective program can be set up.

This is something which has caused a great deal of problems, because all the people involved in pollution control have been very ready to sit back and say, "Let's do more with the automobile," and many suggestions were made to us this year as to including in our inspection program the exhaust control. The only thing we could have had would

have been visual, and as I understand it, on the Chrysler products that wouldn't have worked, so I think we would have sold out a pretty strong inspection program merely to have had something on the books. I know last year when we were toying with this idea, the people from the California Motor Vehicle Department expressed to us the great deal of difficulties they anticipated in the inspection area.

Senator MUSKIE. Well, there is not now available, as you suggest, the technology which would permit you to say you will examine the exhaust and determine what the pollution emissions are for a given automobile. The standards that have been set by the Federal Government would not insure that each and every automobile will meet those standards. The best you can do is to make sure that the average performance of a given make and model will meet those standards. It is an averaging concept and you don't know whether the standards are being met until you have tested enough automobiles of a given make and model to form a judgment.

Senator DOMINICK. Isn't it also true you have some doubt as to whether the standards themselves are sufficiently tight to solve the problem?

Senator MUSKIE. That's right. The standards have been set with regard to what is considered to be available technology, but we certainly have to tighten it up. I think the hearings in Los Angeles and Detroit disclose they could be the subject of meaningful inspection. The Chrysler system, as you know, has to do with basic engine design as well as certain adjustments involving the carburetor, the distributor, and the timing. Those are things that can be inspected. As a matter of fact, any automobile owner who is really concerned about maximum efficiency of his car today would have those things inspected periodically to insure most efficient and economical fuel consumption and maximum performance. The Chrysler system is a refinement of those elements. So even though you can't actually test the emissions that are coming out of an exhaust, you can check these settings and these adjustments, or enough of them to make the inspection meaningful today.

Mr. FRIEDMAN. We do this, Senator. The only difference, I think, was, by specifically listing the air pollution control device as an item under our inspection, I think we intimated to the public we were checking it and we aren't. The test for the blowby is a simple procedure which takes a few seconds and we can say to the consumer in Colorado this has been checked. But I think it was a moral problem.

Senator MUSKIE. I realize it is an educational problem. I think we can find a little black box eventually that we can stick on the exhaust and determine whether the car is meeting its performance. We don't have it now, you are right.

Mr. FRIEDMAN. We are starting in a massive educational program with the automobile dealers, service station operators, to state that it is public policy that these devices be left on the car and be put in the best possible working order. We feel in this case this is probably better than legislation.

I will now conclude my prepared statement. As you know, the Colorado income tax represents a small percentage of the Federal tax liability for Colorado corporations, thank God. As a result, any tax incentive or tax credit systems which we might devise for the stimulation of control devices would have a very small impact on speeding up the

elimination of pollution. I earnestly beseech you to continue in your efforts to sponsor a Federal program in this area, and again, even though I greatly favor local government, I think this is an area which has to be led by the Federal Government.

I hope my remarks have helped to clear the air. Thank you again for letting me speak to you. If there is any way that I can be of further assistance to your committee, I would be glad to help.

Senator MUSKIE. Thank you very much. May I congratulate you and urge you to continue your efforts.

Senator DOMINICK. Mr. Chairman, I just want to say on that last point, I am completely in sympathy and agreement with Representative Friedman. All I want to add to that is, I don't see how we are going to provide the necessary impetus and incentive for automobile manufacturers, industries and everything else, to put on the necessary equipment, which are costs that are, relatively speaking, nonproductive from the point of view of salability of that particular product, unless we do have this credit. I have co-sponsored, I think two or three bills along this lineup to date, and I certainly hope we get it done. So I assure you that there are a number of us working on this particular phase of it and I hope to make some progress.

Senator MUSKIE. Thank you very much.

Our next legislative witness is State Senator John R. Bermingham. Senator, we are glad to have you with us this morning. We must be sure that both Houses are represented.

Senator DOMINICK. John, welcome.

Mr. Chairman, you should know that Senator Bermingham has not only been active in this field at the local level, but was also one of the ones that helped get some impetus and some real working order out of what you would call the population explosion law here and has come back and testified before our Senate on that point.

Senator MUSKIE. I note we have both a full statement and a summary statement.

Mr. BERMINGHAM. I had instructions from your office you would like to have both.

Senator MUSKIE. All right, you can use either one.

Mr. BERMINGTON. I will read the longer one, if I may.

Senator MUSKIE. All right.

STATEMENT OF JOHN R. BERMINGHAM, A SENATOR IN THE COLORADO LEGISLATURE

Mr. BERMINGHAM. Mr. Chairman, Senator Dominick.

I thank you for the opportunity to appear here today to discuss Colorado's air pollution control programs and progress. As a State senator and chairman of the Colorado Senate Health and Welfare Committee which deals with air pollution legislation, I am mainly concerned with the role which State government should play in the control of air pollution. I am also, of necessity, concerned with the complementary role which the Federal Government must play in controlling air pollution.

In the brief time which I have, I would like to address myself to the roles which I believe the State and Federal governments should play in air pollution control. It is essential, in my view, that there be

a cooperative partnership between State government and the Federal Government if we are to succeed in solving this problem.

Our air pollution stems from three sources—(1) the automobile, (2) backyard burning of residential refuse and (3) stationary sources such as factories, apartment buildings and other commercial structures. The automobile presents an engineering problem. Backyard burning has already been banned by several of the counties that have air pollution problems and a ban by Denver is expected within a year. A bill to outlaw any backyard burning in all air pollution basins is pending in the legislature. Stationary sources are tightly controlled by Colorado's Air Pollution Control Act of 1966, which I was pleased to co-author.

The theory of the 1966 law is that the moment the air in any area of the State fails to meet certain strict statutory standards the Department of Health is required to designate that area as an air pollution basin, using a legal land description to define its boundaries. At that moment, rigid statutory emission standards covering visible pollutants, sulfur dioxide, petroleum storage facilities, particulates, and other pollutants automatically come into effect. Let me emphasize that the statutory ambient air standards are very strict, having been designed as an early warning system so as to bring the emission standards into play before any appreciable pollution develops.

Senator MUSKIE. May I ask, is there air monitoring of the entire State underway?

Mr. BERMINGHAM. I don't believe the entire State, but the concentration is going on first in the populated areas.

Senator MUSKIE. The State must make a determination as to whether a particular area fails to meet those standards. What program does the State have underway to identify such areas?

Mr. BERMINGHAM. Well, I think they start watching, as I said, the populated areas. You can ask some of the later witnesses exactly how they do it. Briefly, there are four such basins now—Denver, Colorado Springs, Pueblo, and Grand Junction already are over the limits, and there may be others that are sort of creeping up, that they will be able to tell you about.

Anyone who violates any of the emission standards is guilty of a misdemeanor and subject to a fine of $100 per day. The Department of Health is charged with the duty to enforce compliance. Relief from compliance with the strict emission standards can be given only by a variance board composed of nine persons, including no more than three members representing industry. Variances may only be granted if strict compliance would result in an arbitrary or unreasonable closing of a lawful business activity without sufficient corresponding public benefit or if the variances would be consistent with the policy of the State as set forth in the act.

In addition, local units of government are authorized and encouraged to adopt their own local air pollution control laws, but these laws must be at least as strict as the State law. The State variance board has no power to relieve anyone from a duty to comply with a local law and a local variance board has no power to relieve anyone from a duty to comply with the State law, so that the stricter law is always applicable.

If I may, I would like to digress for a moment in view of your colloquy with Representative Friedman. I think possibly an impression was given that we hadn't solved this constitutional problem about the jurisdiction between the counties. I think we have solved that by giving the State health department complete authority within these multicounty basins, and secondly, we do have this provision in our Constitution that prevents a delegation of authority to write standards. That is not strictly true in that in our water pollution field we have delegated to a water pollution control commission the power to write standards. The major difference is that if we delegate the authority, we cannot put any criminal provision into our statutes. We kept the standards in the statute in the case of air pollution since air is pretty much uniform throughout the State, and by doing that we were able to put in a criminal provision. We have not been able to do that with the water pollution.

Senator DOMINICK. Could I interject here?

Senator MUSKIE. Yes.

Senator DOMINICK. Would you be able to tell me, John, whether or not these criminal penalties have in fact been exercised?

Mr. BERMINGHAM. I don't believe any have as far as the large industry is concerned. We had two types of problems. Colorado Fuel and Iron Co. or the Public Service Co. of Colorado, these tremendous concerns, that was one type of industry that probably at the beginning would not be able to meet these standards. Another type would be the automobile junk burner or the trash disposer, that type of operation, and it was felt that we should permit criminal sanctions as to these smaller concerns rather than the injunctive proceeding, which would be costly and by the time we get into court they have moved to some other location.

There was one apparent flaw in the bill we passed last winter, which would appear to have allowed one "free" burn. We have passed through the Senate, and expect it to pass through the House, a corrective statute so that loophole wouldn't be there any more. At the moment I don't believe anyone actually has been brought into court under the criminal provision.

Senator DOMINICK. We have the obvious problem, whenever you have a criminal statute, of trying to find the relative benefits to the public, either enforcing it or not enforcing it. It is always construed strictly so you have a tough problem in court. I imagine you have explored the proposed injunctive proceedings that we have used in other fields.

Mr. BERMINGHAM. These are definitely written into the act, that when a field man finds a violation occurring, his first duty will be—we are putting a slight amendment in the act this year—that his first duty will be to send a notice to the State board of health, then he will start his process of persuasion, conciliation, and so forth, and if he is unsuccessful then, then the division issues a cease and desist order and that's it, unless the polluter appears to the variance board for a variance. Injunctive proceedings are available to assure compliance with cease and desist orders.

Senator DOMINICK. That is the point I wanted to bring out, you are using all three of these and not just relying on the criminal provision.

Mr. BERMINGHAM. Oh, yes, very definitely. We have been told time and again that most of the industries are making an effort in the area to do something. Existence of this dual jurisdiction permits the State to concentrate its enforcement efforts on those areas where local authorities are not doing an adequate job.

Areas outside the boundaries of existing air pollution basins will automatically become designated as air pollution basins the moment our strict statutory ambient air standards are violated. In addition, Colorado has an extremely and unusually strict common law nuisance doctrine which our act specifically preserves and makes available to individuals, local governments, and the State.

Our State health department has the responsibility to conduct studies and to recommend standards for additional pollutants as the need arises to control them. It also reports to the State legislature on needed changes in the law. Overall, I feel that we have a good air pollution law, which deals with the problem in the fairest and most effective way; that is, by setting objective standards on the basis the best scientific evidence available. Individuals, industries, and communities can plan and meet, and government can more readily enforce objective, scientific standards.

What I am really referring to here is the standards that are written into the act. Everyone knows what the law is.

Air pollution is a vital concern to us here in Colorado. We pride ourselves on our clean air. Colorado has been in the vanguard of States in solving its air pollution problem, and the problem is being solved. The legislature continues to express a strong interest in the development of the air pollution control program, and will, I am sure, continue to meet air pollution problems which occur in the future with effective legislation.

Many of Colorado's air pollution problems are unique or unusual. The altitude, humidity, and climate here in Colorado present us with different problems than exist in other parts of the Nation, and the need for different standards to deal with and control them. It is my feeling that State government should continue to set the standards which are required to meet the particular problems of Colorado, and that the Federal Government should act in this area only when a State fails to act or a State law is inadequate. This is the pattern of Federal action in the field of water pollution control, and I believe it is working well there. The same pattern of Federal action seems appropriate in the control of air pollution.

At the same time, I believe with respect to one source of pollution there is a definite need for Federal action and assistance. The automobile which is the special concern of this committee today, probably produces more than 50 percent of Colorado's air pollution. Cars move across State lines. They are manufactured and assembled in many different States. The problem of controlling pollution from them is national in scope, and must be dealt with on the Federal level. Because of the conviction that control of automobile air pollution is a matter for Federal legislation, pending legislation in the Colorado Legislature has been postponed indefinitely.

There is also a need for Federal action in many areas of the country where metropolitan areas spread across State lines. We do not have that problem in Colorado. It seems to me, however, that a very wise

precedent has been set in dealing with the problem of interstate air pollution. The Clean Air Act, passed under the able leadership of the chairman of this subcommittee, first gives the group of States having an interstate air pollution problem the chance to act. Only if their action to control air pollution is insufficient will Federal action be taken. I believe that the same pattern of Federal action is appropriate in dealing with intrastate air pollution; that is to say that only when a State refuses to take sufficient action on its air pollution problems should Federal action be taken.

Putting aside the problems of automobile and interstate air pollution for the moment, it seems to me that air pollution is best dealt with on the State and local level. Indeed, the Federal Clean Air Act of 1963 and the 1965 and 1966 amendments thereto, seem to recognize the necessity of working through State and local agencies. Those acts, very wisely it seems to me, mainly provide much-needed financial and technical assistance to State and local air pollution control agencies. That financial assistance is vital and necessary to our air pollution control programs here in Colorado, and I hope it will be continued and expanded.

I might mention a few areas where we have found that Federal financial assistance is particularly needed. Training programs for air pollution control personnel must be provided. I do want to emphasize this, maybe some of the subsequent witnesses from the State health department will, too, because this a problem that is forced upon every State in the Nation. There is a great shortage of trained personnel and the cost of training them is high, and because of the shortage they bid each others' salaries up and it is a severe problem.

Senator MUSKIE. You might want to take a look at some legislation that has been introduced with respect to the general program of skills. Last year I introduced what was called the Intergovernmental Personnel Act. The President will shortly be submitting two bills which incorporate most of the principles of that Intergovernmental Personnel Act. Its objectives, among other things are: first, to make Federal training programs available to State and local personnel; secondly, to provide grants to State and local governments, to establish training programs of their own, especially those connected with grant-in-aid programs, of which air pollution control would be one. You might want to take a look at that legislation and then maybe advise Senator Dominick as to whether or not you think it is sound.

Mr. BERMINGHAM. Offhand, I think it is very sound.

Senator DOMINICK. I might also say we have public assistance for the training of Public Health personnel, which would come into this. We put that in to the Higher Education Act and I think it has been very helpful.

Senator MUSKIE. It goes without saying, as you have said, you can't make these programs work without trained people.

Mr. BERMINGHAM. Training programs for air pollution control personnel must be provided. A shortage of air pollution control personnel already exists, and it will grow worse as more States and cities enact air pollution legislation requiring administrative personnel. Research on inexpensive methods of testing air pollutants is also needed. One of the measures which the legislature recently considered would have made the testing of the automobile pollution control devices to

make sure they were in good working order, a part of our semiannual auto inspection. We were informed, however, that the exhaust analyzer required for this inspection presently costs in excess of $20,000, more than the hundreds of inspection stations which are necessary can afford. You commented on that earlier in connection with Representative Friedman's testimony.

In addition, there is a need for research on the effects of air contaminants on health, plants, materials, and our environment generally. This information is essential in setting control standards. Research on how to control several pollutants is also needed. Some work is presently being done in each of these areas, but much more is needed.

Finally, I believe that Federal tax incentives for the installation and maintenance of pollution control facilities and property are desirable and would speed the needed control of air pollution. Air pollution control facilities are often quite costly and nonproductive.

At this point I would like to mention the case of the Public Service Co. of Colorado, which has six plants in the State, I believe, and they have already spent (and they started before our act went into effect) something like $4½ million for electrostatic precipitators and other pollution control devices, and of these six plants, the devices on only one of them works. So, in effect, we hope it is not $4½ million down the drain but maybe it is. They have got some engineers from Colorado State University working, trying to figure out what the problems are and get the bugs out of them. It is just terribly expensive. A company like Public Service Co. can afford to go into this work, but the smaller companies have to struggle to go forward, unless there is going to be some sort of tax credit for these nonproductive devices. These devices benefit the public and their expense, it seems to me, should be borne at least in part by the public. Accelerated depreciation, tax credits, or other tax means seem to be the quickest, most efficient way for the public to bear a part of the cost and to provide the necessary incentive for air pollution control. The cost meaningful tax relief will be relief on the Federal level, since Federal taxes have by far the greatest impact.

In closing I would like to emphasize (1) that Colorado has a strong and adequate Air Pollution Control Act; (2) that Federal action is necessary to curb automobile air pollution; (3) that in other fields of air pollution control the Federal Government should not act unless State action is insufficient; (4) that Federal financial and technical assistance for State and local air pollution control programs is necessary and should be continued and expanded; and (5) that Federal tax incentives are desirable and would considerably speed our progress in air pollution control.

Again, may I thank you for the opportunity to discuss our air pollution problems here in Colorado with you. I would welcome the chance to answer any questions you might have concerning air pollution laws or any of the other matters I have discussed.

Senator MUSKIE. Thank you very much, Senator Bermingham. I think I have covered my questions as we went along. We do appreciate your interest.

Mr. BERMINGHAM. We appreciate yours.

Senator DOMINICK. I think this is a pretty good example of the fact our State legislature here is really moving forward in the fields

that are important. I am delighted Senator Bermingham was able to come and give us the benefits of his thoughts.

Senator MUSKIE. Now we will return to our regular witness list. Joseph Palomba, Jr., chief of the air pollution section of the Colorado State Department of Health. We are glad to welcome you this morning.

STATEMENT OF JOSEPH PALOMBA, JR., CHIEF, AIR POLLUTION SECTION, COLORADO STATE DEPARTMENT OF HEALTH

Mr. PALOMBA. Senator Muskie, Senator Dominick, it is my pleasure to be invited to appear before the subcommittee and present testimony on the State department of public health's program in air pollution control.

The present Air Pollution Control Act was enacted during the 1966 legislative session and was signed into law on March 11, 1966, by Gov. John A Love. This law gave the Colorado State Department of Public Health certain powers and duties which were heretofore not within the scope of our program. Among the more salient features was the authority given to the State department of public health to designate by legal description those areas of the State in which certain emission standards were to apply to stationary sources. The Colorado Air Pollution Control Act includes the enforceable emission standards directly in the statute rather than the utilization of rule and regulatory authority.

In effect, the act defines and establishes the limits of air contamination by particulates and certain gases above which the ambient air is deemed to be unacceptable.

In establishing the areas of the State in which the statutory emission standards are to apply, the State Department of public health measures the level of contamination of the ambient air. These areas, commonly referred to as air pollution basins, are considered polluted when the ambient air contains particulates or gases above certain prescribed limits. The pollutants for which ambient standards have been established are: particulates, coefficient of haze, total oxidants, oxides of nitrogen and sulfur dioxide. The operation of the Colorado air monitoring network thus continues to remain an important part of the department's program. The data from the network provides a factual basis for use in designating areas of the State which are to be considered as air pollution basins, in addition to determining trends in pollution levels and giving an indication of the effectiveness of enforcement programs.

Senator MUSKIE. Does your monitoring network now cover most of the areas?

Mr. PALOMBA. Yes. We have approximately 31 stations in about 16 or 17 areas of the State, and this comprises better than 75 percent of the State's population.

Senator MUSKIE. Incidentally, before I forget, I think we ought to include as an exhibit in this record the Colorado statute of 1966.

Mr. PALOMBA. I have a copy and we can so do.

Senator MUSKIE. Fine. We will place it in the record at this point.

(The Colorado statute referred to is as follows. Text resumes on p. 870.)

AIR POLLUTION CONTROL ACT

Section 1.—Short Title.—This act shall be known and may be cited as the "Air Pollution Control Act."

Section 2.—Legislative Declaration.—It is hereby declared to be the policy of the state of Colorado to maintain a reasonable degree of purity of the air resources of the state, which shall be consistent with the public health, welfare, and public enjoyment thereof, the industrial development of the state, the propagation and protection of human, plant, and animal life, and the protection of physical property and other resources. To that end, it is the purpose of this act to require the use of all available practical methods to reduce, prevent, and control air pollution in the state of Colorado and to maintain a cooperative program between the state and local units of government. It is further declared that the prevention, abatement, and control of air pollution in this state are affected with a public interest and that the provisions of this act are enacted in the exercise of the police powers of this state for the purposes of protecting the health, peace, safety, and general welfare of the people of this state.

Section 3.—Definitions.—(1) When used in this act, the following words and phrases shall have the meanings ascribed to them in this section:

(2) "Air pollution variance board" means the air pollution variance board created by section 7 of this act.

(3) "Division" means the division of administration of the state department of public health.

(4) "Person" means any individual, public or private corporation, partnership, association, firm, trust, estate, the state or any department, institution, or agency thereof, any municipal corporation, county, city and county, or other political subdivision of the state, or any other legal entity whatsoever which is recognized by law as the subject of rights and duties.

(5) "Air contaminant" means a dust, fume, gas, mist, smoke, vapor (other than water vapor alone), pollen, or any combination thereof.

(6) "Air pollution" means the presence in the atmosphere of one or more air contaminants in quantities, of characteristics, and of a duration throughout the state or throughout such areas of the state as shall be affected thereby, which are injurious to human, plant, or animal life or to property, or which unreasonably interfere with the comfortable enjoyment thereof.

(7) "Air contamination" or "emission" means the discharge into the atmosphere of one or more air contaminants which contribute to a condition of air pollution.

(8) "Air contamination source" means any source whatsoever at, from, or by reason of which there is emitted or discharged into the atmosphere any air contaminant.

(9) "Ambient air" is the surrounding or outside air.

(10) "Air cleaning device" means any method, process, or equipment which removes, reduces, or renders less noxious air contaminants discharged into the atmosphere.

(11) "Area of the state" means any geographical area of the state that may be so designated by the division, as provided in section 8(1)(c) of this act.

(12) "Gas" means a formless fluid which occupies space and which can be changed to a liquid or solid state only by increasing pressure with decreased or controlled temperature, or by decreased temperature with increased or controlled pressure.

(13) "Ringelmann" means the method of estimating smoke density described in U.S. bureau of mines information circular 7718, dated August 1955, by means of the Ringelmann chart.

(14) "Air pollution control authority" means any person or agency given authority by the division or by a local governmental unit with respect to air pollution control.

(15) "Local air pollution law" means any law, ordinance, resolution, code, rule, or regulation adopted by the governing body of any home rule city, city of the second class, town, county, or city and county pertaining to the prevention, control, and abatement of air pollution, including, but not limited to, the adoption of emission standards such as set forth in section 5 of this act.

Section 4.—Ambient Air Standards.—(1) The following standards of ambient air quality define the limits of air contamination by particulates and gases above which limits the ambient air is hereby declared to be unacceptable:

(2) (a) Kind of particulate: Measurable limits averaged for any 3-month period.

Suspended particulates: 120 micrograms per cubic meter.

Coefficient of haze: 0.5 Coh units.

(b) Sampling stations shall be so located and operated as to conform as nearly as possible to the following criteria:

(i) Located in the central business district of a city or community and at such other places as the division determines desirable, approximately twenty-five to fifty feet above ground level and where a single emission source is not the prime polluter of the air being sampled.

(ii) Samples to be collected on a regular three-day basis.

(3) (a) Gases: Measurable limits based on 1 percent of the time during any 3-month period.

Total oxidant: 0.1 part per million for 1 hour using a potassium iodide method of testing.

Oxides of nitrogen: 0.1 part per million for 1 hour.

Sulfur Dioxide: 0.5 part per million for 1 hour—or—0.1 part per million for 24 hours.

(b) Sites and conditions of gas sampling shall be so chosen as to realistically represent the exposures of persons and property which might be affected.

Section 5.—Emission Standards in Designated Areas of the State.—(1) Subject to such variances as may be granted pursuant to section 11 of this act, the emission standards set forth in subsections (2) through (6) of this section shall be in full force and effect in each area of the state designated by the division pursuant to section 8(1)(c) of this act, immediately upon such designation.

(2)(a) No person shall discharge, or cause or permit to be discharged, into the atmosphere, from any single source of emission, any air contaminant for a period aggregating more than three minutes during any hour which is:

(b) As dark or darker in shade as that designated as No. 2 on the Ringelmann chart, as defined in section 3 of this act; or

(c) Of opacity equal to or greater than smoke described in paragraph (b) of this subsection; or

(d) Of any shade or opacity greater than that specified in paragraphs (b) or (c) of this subsection and designated under any other nationally accepted measuring system which is comparable to the Ringelmann method.

(3) No person shall permit solid matter in combustion gas from any fuel-burning equipment in excess of 0.85 pounds per one thousand pounds of such gas, adjusted to twelve per cent carbon dioxide, or solid particulates in any other gas in excess of 0.85 pounds per one thousand pounds of undiluted gas, to escape into the atmosphere or to pass any convenient measuring point in a chimney, breeching system, or other discharge system.

(4)(a) No person shall burn or permit to be burned on any open premises owned or controlled by him, or on any public street, alley, or other land adjacent to such premises, any rubbish, waste paper, wood, or other flammable material, unless a permit therefor shall first have been obtained from the appropriate authority enforcing air pollution control standards. In granting or denying the issuance of any such permit, said authority shall base its action on the location and proximity of such burning to any building or other structure, the potential contribution of such burning to air pollution in the area when the same may violate any standard in this section, climatic conditions on the day or days of such burning, and compliance by the applicant for the permit with applicable fire protection and safety requirements of the local authority or area.

(b) This subsection shall not apply to:

(i) Burning in the course of any agricultural operation in the growing of crops;

(ii) Fires used for noncommercial cooking of food for human beings or for instructional or recreational purposes;

(iii) Incineration of paper and other trash on residential premises by the owner or occupant thereof;

(iv) Smokeless flares or safety flares for the combustion of waste gases; or

(v) Flares used to indicate some danger to the public.

(5)(a)(i) Any storage, holding, stationary tank, reservoir, or other container having a capacity of forty thousand or more gallons, constructed on or after the effective date of this act and used for gasoline or any petroleum distillate having a vapor pressure of one and one-half pounds per square inch absolute, or greater, under actual storage conditions, shall be designed and equipped with one of the following vapor loss control devices, properly installed, in good working order, and in operation.

(ii) A floating roof consisting of a pontoon type or double-deck type roof, resting on the surface of the liquid contents and equipped with a closure seal, or seals, to close the space between the roof edge and tank wall. The control equipment provided for in this paragraph shall not be used if the gasoline or petroleum distillate has a vapor pressure of eleven pounds per square inch absolute, or greater, under actual storage conditions. All tank gauging and sampling devices shall be gas-tight except when gauging or sampling is taking place.

(iii) A vapor balloon, or vapor dome, designed in accordance with accepted standards of the petroleum industry.

(iv) Other equipment of equal efficiency; provided, that plans therefor are submitted to and approved by the appropriate air pollution control authority.

(b) Propane or butane, and similar products, shall be stored in pressure tanks maintaining working pressures sufficient at all times to prevent hydrocarbon vapors or gas loss to the atmosphere, or at refrigerated low temperature, or in low pressure storage equipped with vapor collection and compression equipment designed to prevent loss of hydrocarbon vapor or gas to the atmosphere.

(c) Any petroleum storage tank, other than those covered by paragraph (b) of this subsection, which is constructed or extensively remodeled on or after the effective date of this act shall be equipped with a submerged filling device.

(d) All facilities for dock loading of petroleum products, other than those pertaining to products covered by paragraph (b) of this subsection, which are in existence or constructed on or after the effective date of this act, having a vapor pressure of one and one-half pounds per square inch absolute, or greater, at loading temperature shall provide for submerged filling.

(6) (a) No person shall cause or permit any emission of sulphur dioxide which results in average ground-level concentrations of sulphur dioxide at any given point in excess of one part per million, based on volume, of sulphur dioxide in a twenty-minute period of any hour and average exposure shall not exceed three-tenths part per million, based on volume, in any eight-hour period. Such limitations shall not apply to ground-level concentrations occurring on the property from which emission occurs; provided, that such property, from the point of emission to the point of any concentration, is controlled by the person responsible for such emission.

(b) Except as provided in subsection (6) (a) of this section, no person shall cause or permit the emission of gas containing sulphur dioxide in excess of two thousand parts per million, based on volume. All sampling of exhaust gases shall be conducted following techniques designated by the appropriate air pollution control authority. For the purposes of this paragraph, all sulphur present in gaseous compounds containing oxygen shall be deemed to be present as sulphur dioxide, and analyses of samples taken to determine the amount of sulphur dioxide in exhaust gases shall be made as specified by the air pollution control authority. Tests for determining compliance with this paragraph shall be for at least fifteen consecutive minutes or ninety per cent of the time of actual source operation, whichever is less.

(c) (i) Emissions in excess of the limits specified in paragraph (b) of this subsection shall not constitute a violation of this subsection so long as the requirements of paragraph (a) of this subsection and the following conditions are met:

(ii) Any person intending to operate under the provisions of this paragraph (c) shall so notify the air pollution control authority in writing prior to such emission.

(iii) Any person operating pursuant to this paragraph (c) shall provide for at least three recording sulphur dioxide monitoring stations, properly located, as well as a recording meterological station equipped to record wind speed and direction.

(iv) All reports of data obtained from such instruments shall be furnished to the air pollution control authority at the end of each month. Whenever such data indicate any emission in excess of the limits specified in paragraph (a) of this subsection, said person shall furnish the air pollution control authority evidence that proper action has been taken to reduce or prevent further such excess emissions.

Section 6.—LOCAL GOVERNMENT—AUTHORITY.—(1) Home rule cities, cities of the second class, towns, counties, and cities and counties are hereby authorized to enact local air pollution laws. Every such law shall provide for variances, hearings, judicial review and injunctions consistent with sections 11, 12, 13 and 14 of this act and may include standards which are the same as or

more restrictive than the standards set forth in this act; provided, nothing herein contained shall prohibit any such local law from controlling any air contamination or air contamination source which is not subject to control under the provisions of this act.

(2) All local air pollution laws and orders issued pursuant thereto in existence at the time this act takes effect are hereby validated as though adopted pursuant to the authority of section 6(1); provided, if any such local law or order fails to meet the requirements of this act, the governing body under whose authority such law or order was promulgated shall have until July 1, 1966, to amend, modify, or repeal the same so that it will meet the requirements of this act, but if not so amended, modified, or repealed, the same shall be superseded by this act.

(3) To the extent a local air pollution law adopted by a county is more restrictive than such a law adopted by any city or town within such county, the county law shall apply in lieu of the city or town law to the extent of the inconsistency.

(4) Application, operation, and enforcement of valid local air pollution laws shall be completely independent of but may be concurrent with the application, operation, and enforcement of this act. The appointment of an air pollution control authority by the division shall in no way affect the duties and responsibilities given the same person or agency under a local air pollution law, and the appointment of an air pollution control authority by a local governmental unit shall in no way affect the duties and responsibilities given the same person or agency by the division.

(5) Any local governmental authority enforcing air pollution control standards which shall issue any enforcement order or grant any variance shall, at the time of such issuance or granting, transmit to the division a copy of such order or variance. Within one hundred twenty days after the effective date of this act, any local governmental authority having adopted a local air pollution law prior to such date, shall transmit to the division a report setting forth sufficient information concerning any and all enforcement orders or variances, or both, issued or granted prior to the effective date of this act.

Section 7.—Air Pollution Variance Board.—(1) (a) There is hereby created, as a division of the state department of public health, an air pollution variance board which shall consist of nine members appointed by the governor, except as provided in paragraph (b) (i) of this subsection:

(b) The nine members of said air pollution variance board shall be:

(i) One member designated by the state board of health, to represent said board in matters of air pollution in the interests of the public health of the people of the state.

(ii) One member shall be a registered professional engineer with at least five years' experience in the actual practice of his profession and who is not from industry.

(iii) One member, who is not from industry, shall be either a physician licensed to practice in this state or a toxicologist.

(iv) Three members from industry in this state.

(v) Three members, as representatives of the public at large, not from industry.

(c) Members of such variance board appointed by the governor shall hold office for terms of four years and until their successors are selected and qualified, except that of the appointments first made by the governor, four shall be for terms of two years each, as designated by the governor at the time of appointment. The member designated by the state board of health shall serve at the discretion of the state board of health. There shall be no limitation on the number of terms any appointed member may serve. The members of the air pollution variance board shall be appointed within thirty days after the date of the approval of this act. If any member of the air pollution variance board appointed by the governor shall resign or be removed from the air pollution variance board, the governor shall promptly appoint a new member subject to the provisions of this act, to fill the vacancy for the remainder of the term of the member of the air pollution variance board who has ceased to be a member thereof. The governor may remove for cause any member of the air pollution variance board appointed by him.

(2) (a) The member of the air pollution variance board designated by the state board of health shall be the chairman of such variance board for the first year after the creation thereof, and thereafter the said variance board shall elect its chairman annually from its members for a term of one year or to fill a vacancy.

(b) The air pollution variance board shall meet at least quarterly, keep a record of its proceedings, and determine the rules of its own procedures.

(c) Special meetings of the air pollution variance board may be called by its chairman upon his own initiative and shall be called by him upon the receipt by

him of a written request therefor signed by two or more members of said variance board or by the division.

(d) Five members of the air pollution variance board shall constitute a quorum, and the concurrence of at least a majority of all members of the air pollution variance board in any matter within its powers and duties shall be required for any determination made by the said variance board.

(e) At least three days prior to each meeting, written notice shall be given to each member of the air pollution variance board of the time, place, and purpose of such meeting.

(3) Each member of the air pollution variance board shall receive a per diem of twenty dollars for each day actually spent in the discharge of official duties, not to exceed twelve hundred dollars in any one year; and shall be reimbursed for necessary and actual expenses which he shall incur in the performance of his duties under this act.

(4) (a) The air pollution variance board shall have the duty to:

(b) Grant variances as provided in section 11 of this act.

(c) On or before December 1 of each year, report to the members of the general assembly on the effectiveness of the provisions of this act in carrying out the legislative intent as declared in section 2 of this act, and include in such report such recommendations as it may have with respect to any legislative changes that may be needed or desirable.

(d) Promptly after every designation of an area of the state by the division pursuant to section 8 (1) (c) of this act, hold a public hearing in such area at which hearing the air pollution variance board shall not take any action but shall hear public comments on air pollution problems in such area, alleged sources of air pollution in such area, and the availability of practical remedies therefor.

(5) (a) The air pollution variance board shall have the power to:

(b) Hold public hearings, conduct investigations, compel the attendance of witnesses, receive such pertinent and relevant proof and other things as it may deem to be necessary, proper, or desirable in order that it may effectively discharge its duties and responsibilties under this act.

(c) Designate a hearing officer to conduct hearings only concerning violations of this act, which officer shall have power to issue notices of hearings, issue subpoenas requiring the attendance of witnesses and the production of such evidence, administer oaths, and take such testimony as may be necessary or in conformity with article 16 of chapter 3, C.R.S. 1963, and section 12 of this act; and such hearing officer shall certify and file with the air pollution variance board for adoption or modification by said variance board such hearing officer's recommended findings, conclusion, and proposed orders.

Section 8.—Powers and Duties of the Division.—(1) (a) In addition to duties specified elsewhere in this act, the division shall have the duty to:

(b) Determine, by means of field studies and air monitoring and sampling, if the ambient air standards are being violated in any area of the state.

(c) Designate by legal description the area or areas of the state in which the emission standards set forth in section 5 of this act shall be in effect. Each area so designated shall consist of an area in which air pollution results in the ambient air standards set forth in section 4 of this act not being met and also areas adjacent thereto from which air contamination does or is likely to contribute to such air pollution. The determinations as to such adjacent areas shall be based upon meteorological and topographical considerations.

(d) On or before December 1 of each year report to the members of the general assembly on the effectiveness of the provisions of this act in carrying out the legislative intent as declared in section 2 of this act, and include in such report such recommendations as it may have with respect to any legislative changes that may be needed or desirable, including changes in standards.

(2) (a) In addition to authority specified elsewhere in this act, the division shall have the power to:

(b) Conduct or cause to be conducted studies and research with respect to air pollution and the control, abatement, or prevention thereof.

(c) Designate one or more persons or agencies in any area of the state as an air pollution control authority and as agent of the division to exercise and perform such powers and duties of the division as may be specified in such designation.

(d) Enter and inspect any property, premise, or place for the purpose of investigating either an actual or a suspected source of air pollution or air contamination or ascertaining compliance or noncompliance with any emission stand-

ard or any order under this act. Any information relating to secret process, or methods of manufacture, or production obtained in the course of the inspection or investigation shall be kept confidential. If samples of air or air contaminants are taken for analysis, a duplicate of the analytical report shall be furnished promptly to the person who is suspected of causing such air pollution or air contamination.

(e) Provide advisory technical consultation services to local communities.

(f) Inform the appropriate governmental agency of the results of atmospheric tests conducted in its jurisdiction and notify the city, town, county, or city and county affected whenever tests establish that the ambient air or a source or sources of emission of smoke or air contaminant fail to meet the standards established by this act. From time to time after the local agency has been so notified, the division shall report and make available to the public such results, notices to local agencies, and any progress made by the local agency following such notices.

(g) Furnish such personnel to the air pollution variance board as the air pollution variance board may reasonably require to carry out its duties and responsibilities under this act.

(h) Serve as the state agency for the receipt of moneys from the federal government or other public or private agencies with respect to air pollution control activities.

(i) Certify, qualify, or otherwise designate to any other agency or department of the government of this state or of any other state or of the federal government that any facility, land, building, machinery or equipment, or any part thereof, has been constructed, erected, installed, or acquired in conformity with the requirements of this state or of this act for control of air pollution or in conformity with the requirements for control of air pollution of any other state or the federal government.

(3) In the performance of its duties and in the exercise of its powers as set forth in this act the division shall be subject to the supervision of the state board of health.

Section 9.—Temporary Orders Prohibiting Air Pollution of Immediate Danger to Public Health.—Whenever the division shall determine, after investigation, that any person is discharging or causing to be discharged into the atmosphere directly or indirectly any air contaminant which constitutes a clear, present, and immediate danger to the health of the public, the division shall issue its written order to said person that he must discontinue immediately the discharge of such contaminant into the atmosphere and whereupon such person shall immediately discontinue such discharge. If such person, notwithstanding such order, continues the discharge of such contaminants into the atmosphere, the division is authorized to apply to any district court of this state for the district in which the said discharge is occurring for a temporary restraining order, temporary injunction, or permanent injunction as provided for in the Colorado rule of civil procedure. Such action in such district court shall be given precendence over all other matters pending in such district court. The institution of such injunction proceedings by the division shall confer upon said district court exclusive jurisdiction to determine finally the subject matter of the proceeding.

Section 10.—Enforcement.—(1) The division shall enforce compliance with the provisions of section 5 of this act.

(2) In case any written and verified complaint shall be filed with the division alleging that, or in case the division itself shall have cause to believe that any person is violating any emission standard under this act, the division shall cause a prompt investigation thereof to be made and if the division shall find after such investigation that a violation of any such standard exists, it shall by conference, conciliation, and persuasion, endeavor to eliminate the source or cause of the air pollution or air contamination which resulted in such violation.

(3) In case of failure by conference, conciliation, or persuasion, to correct or remedy such violation, the division shall cause to be issued and served upon the person allegedly violating any such standard a written order which shall specify the provision of the emission standards of which such person is said to be in violation and a statement of the manner in which such person is said to violate it and such order shall require the person so complained against to cease and desist from such violation within such reasonable time as the division may determine.

(4) Within ten days after receipt of such order the recipient thereof may file with the air pollution variance board a written request for a hearing as to whether or not such violation exists or for a variance, or both. Upon the filing of

such a request the order complained of shall be stayed pending the air pollution variance board's final determination thereon. In the event the determination pertains solely to the question of whether or not a violation exists, the order shall be stayed an additional thirty days within which the recipient may file a written request for a variance.

Section 11.—Variances.—(1) The air pollution variance board may grant a variance, suspending or modifying the enforcement of any emission standard, or any rule, regulation, or enforcement order issued pursuant to this act against any person, whenever the said variance board shall determine that such variance would be consistent with and aid in implementing the legislative policy as set forth in section 2 of this act.

(2) The air pollution variance board shall grant a variance suspending or modifying the enforcement of an emission standard, or any rule, regulation, or enforcement order issued pursuant to this act against any person, whenever the said variance board shall determine that strict compliance with any provision of, or order issued pursuant to, this act would result in an arbitrary and unreasonable taking of property or in the practical closing of any lawful business or activity and such would be without sufficient corresponding public benefit.

(3) The variance shall be granted, terminated, or modified only after a hearing before the air pollution variance board held pursuant to the provisions of this act. A variance may be granted with respect to any existing or proposed facility, process, or activity, regardless of whether the same is located within or outside of any designated area of the state. Hearings may be requested either by the air pollution variance board, the division, or by any person applying for or having received such a variance.

(4) Any variance granted pursuant to the provisions of this act shall be granted for such period of time and under such conditions as shall be specified by the air pollution variance board. The failure to meet any condition of the variance without prior written premission of the said variance board shall render such variance null and void. The air pollution variance board shall review, at least annually, any variance that hs been grnted to determine whether the terms and conditions of said variance have been complied with, and whether the continuance of the variance is justified.

Section 12.—Hearings—General Provisions.—(1) Not less than fifteen days after a hearing has been requested pursuant to section 11 (3) of this act, the air pollution variance board shall grant such request and set a time and place therefor. Every such hearing shall be conducted pursuant to the provisions of this act and the provisions of article 16 of chapter 3, C.R.S. 1963.

(2) The division may appear as a party in any hearing before the air pollution variance board and shall have the same rights to judicial review as any other party.

(3) All testimony taken at any such hearing before the air pollution variance board shall be under oath or affirmation. A full and complete record of all proceedings and testimony presented shall be taken and filed. The stenographer shall furnish, upon payment and receipt of any fees allowed therefor, a certified transcript of the whole or any part of his record to any party in such hearing requesting the same.

(4) Any information relating to secret processes, methods of manufacture, or production, which may be required, ascertained, or discovered shall not be publicly disclosed in public hearings or otherwise, and shall be kept confidential by any member, officer, or employee of the air pollution variance board or the division.

(5) At any hearing, opportunity to be heard with respect to the subject thereof shall be given to the public to the extent deemed reasonable and proper by the air pollution variance board.

(6) After due consideration of the written and oral statements, the testimony, and the arguments presented at any such hearing, the air pollution variance board shall enter its findings and final order, or make such final determination of the matter as it shall deem appropriate.

(7) In all proceedings before the air pollution variance board with respect to any alleged violation of any emission standard or order, the burden of proof shall be upon the division.

Section 13.—Judicial Review.—(1) Any final order or determination by the air pollution variance board (including any final action taken with respect to an application for a variance as provided in this act) shall be subject to judicial review in accordance with the provisions of this act and the provisions of article 16 of chapter 3, C.R.S. 1963.

(2) Any party may move the court to remand the cease to the air pollution variance board, in the interests of justice, for the purpose of adducing additional specified and material evidence, and findings thereon; provided, that such party shall show reasonable grounds for the failure to adduce such evidence previously before the said variance board.

(3) Any proceeding for judicial review of any final order or determination of the air pollution variance board shall be filed in the district court for the district in which is located the air contamination source affected and shall be filed within twenty days after the date of said final order or determination.

Section 14.—Injuctions.—In the event any person fails to comply with a cease and desist order that is not subject to a stay pending administrative review, the division may request the district attorney for the district in which the alleged violation exists or the attorney general to bring, and if so requested it shall be his duty to bring, a suit for an injunction to prevent any further or continued violation of such order. In any such suit any finding of the air pollution variance board shall be prima facie evidence of the fact or facts found therein. An injunction proceeding may be consolidated with judicial review of any final order or determination of the air pollution variance board.

Section 15.—Penalties.—(1) Subject to such variances as may be issued pursuant to this act, any person who in any designated area of the state shall violate any of the emission standards specified in this act and effective in such area, shall be guilty of a misdemeanor and, upon conviction thereof, shall be punished by a fine of not more than one hundred dollars. Each day during which such a violation occurs shall constitute a separate offense.

(2) Subject to such variances as may be issued pursuant to a local air pollution law, any person who shall violate any emission standard specified in any local air pollution law, within the jurisdiction of the local governmental unit, enacting the same, shall be guilty of a misdemeanor and, upon conviction thereof, shall be punished by a fine of not more than one hundred dollars. Each day during which such a violation occurs shall constitute a separate offense.

(3) No person shall be prosecuted pursuant to both subsections (1) and (2) of this section for the same activity.

(4) For all purposes of either subsection (1) or (2) of this section, each facility, process, and activity that is a source of air contamination shall be deemed to be in full compliance with the emission standards specified either in this act or in any local air pollution law unless and until a cease and desist order, issued with respect to such facility, process, or activity pursuant to this act or such local air pollution law, has become final by exhaustion of all rights to administrative and judicial review, including any variance proceedings. Thereafter, the provisions of this subsection shall not be applicable to such facility, process, or activity.

Section 16.—Application of Act.—(1) The basis for proceedings or other actions that shall result from violations of any standard inure solely to and shall be for the benefit of the people of the state generally and it is not intended to create in any way new or enlarged private rights or to enlarge existing private rights, or to diminish private rights.

(2) A determination that air pollution or air contamination exists or that any standard has been disregarded or violated, whether or not a proceeding or action may be brought by the state, shall not create by reason thereof any presumption of law or finding of fact which shall inure to or be for the benefit of any person other than the state.

(3) The provisions of this act shall not apply to air pollution insofar as such pollution exists within the confines of particular commercial or industrial plant, or shop which is the source of such pollution and also shall not apply or affect the relations between employers and employees with respect to or arising out of any condition of air pollution.

(4) It is the purpose of this act to provide additional and cumulative remedies to prevent and abate air pollution and air contamination. Nothing in this act contained shall abridge or alter rights of action or remedies now or hereafter existing, nor shall any provision of this act or anything done by virtue of this act be construed as estopping individuals, cities, towns, counties, cities and counties, or the state or duly constituted political subdivisions thereof from the exercise of their respective rights to suppress nuisances.

Section 17. 66–2–6 (2) and (12), Colorado Revised Statutes 1963, as amended by senate bill No. 2 enacted by the forty-fifth general assembly and approved by the governor, is hereby amended to read:

66-2-6.—Powers and Duties of Health Departments.—(2) To administer and enforce the laws pertaining to public health and vital statistics, and water pollution control, and the orders, rules, regulations, and standards of the state board of health and the state water pollution control commission, and to enforce the orders of the division of administration of the state department of public health with respect to air pollution control.

(12) To cooperate with the state department of public health and the state board of health in all matters pertaining to the public health, with the state water pollution control commission in all matters pertaining to water pollution control, and with the air pollution variance board and the division of administration of the state department of public health in all matters pertaining to air pollution.

Section 18.—Severability Clause.—If any provision of this act or the application thereof to any person or circumstances, is held invalid, such invalidity shall not affect other provisions or applications of the act which can be given effect without the invalid provision or application, and to this end the provisions of this act are declared severable.

Section 19.—Repeal.—Article 24 of chapter 66, Colorado Revised Statutes 1963, and chapter 58, Session Laws of Colorado 1964, are hereby repealed.

Section 20.—Appropriation.—There is hereby appropriated, out of any moneys in the state treasury not otherwise appropriated, to the state department of public health, the sum of fifty thousand dollars ($50,000) or so much thereof as may be necessary, for the administration and enforcement of this act. Said appropriation shall be in addition to any other appripriation made to the department for such purpose, and shall become available on the effective date of this act and remain available until June 30, 1967.

Section 21.—Safety Clause.—The general assembly hereby finds, determines, and declares that this act is necessary for the immediate preservation of the public, peace, health, and safety.

Mr. PALOMBA. When a specific area of the State fails the ambient air standards, the State department of public health designates the air pollution basin and sets the geographic boundaries based on topographical and meteorological factors. Within these basins so designated, emission standards which include the No. 2 Ringelmann, a particulate load not in excess of 0.85 pounds per 1,000 pounds of gas, prohibition of open burning except by permit, requirements for petroleum storage and handling, and limitations on sulfur dioxide emission are applicable.

Enforcement actions by air pollution control agencies shall initially be attempted by conference, conciliation, and persuasion. In case this fails, the agency shall issue a written order for compliance. The violator may appeal such an order to an air pollution variance board, established by statute to hear appeals as to whether or not such violation exists or for a variance, or both. Mr. Clair Iverson, who is vice chairman of the air pollution variance board, will discuss some of the board's activities later on this morning.

Colorado now has four such air pollution basins in existence within the State. These basins are comprised of the Denver metropolitan area and portions of the surrounding counties; the city of Colorado Springs and surrounding portions of El Paso County; the city of Pueblo and surrounding portions of Pueblo County; and the city of Grand Junction and surrounding portions of Mesa County.

Senator MUSKIE. What percentage of the State's population is in these four basins?

Mr. PALOMBA. About 60 percent, I would say.

There are indications that the number of these basins and their areas will increase, and preventive action and correction is indicated. Boulder County, a neighboring county to the northwest of the Denver

metropolitan area, is a good example of an area which sought to take preventive-prophylactic action prior to becoming an air pollution basin through failure to meet the ambient air standards. The Boulder County Commissioners adopted an air pollution control resolution on January 19, 1967 which contains provisions similar to the State statute.

A further provision of the Colorado Air Pollution Control Act gave the State department of public health the power and duty to designate one or more agencies in any area of the State as an air pollution control authority and as an agent of the department for the purposes of the act. The Colorado State Department of Public Health, recognizing the adverse effects on health and because of its commitment and dedication to the principles and concepts of public health did designate, by letter signed by Roy L. Cleere, M.D., M.P.H., executive director, the local health departments in those basin areas where an organized local health department existed. In the case of the city and County of Denver, both the health department and the building department were designated as joint agents of the State. In addition to the State and the designated air pollution control agencies, local health departments are empowered by the present State statute to administer and enforce the orders of the State department of public health with respect to air pollution control.

Illustrative of a peculiar situation and one which I am sure is of immediate interest to this committee, is the kind of situation which currently is in existence in the Denver metropolitan area. Officials at both the local and State level have expressed concern over the difficult task of achieving uniform enforcement in view of the existence of five separate enforcement agencies and six air pollution variance boards in the same air pollution basin, each operating within its own political jurisdiction. However, progress has been made in at least one area of this dilemma, in that efforts have been successfully directed toward the adoption of uniform air pollution ordinances and resolutions which are quite similar to the State statute within these jurisdictions. Also demonstrated during the past year of program activities is the need for increased efforts on the part of all concerned for stepped-up coordination and cooperation among the existing agencies, and the State department of public health will continue to work with local air pollution control agencies toward this end.

The experience to date has indicated that substantial progress has been made. Assistance has been given by personnel of the State health department to local air pollution control agencies and health departments in establishing actual control utilizing the enforcement provisions established in State statute. This included joint inspections by State and local staff in a combined effort of reducing or eliminating air pollution. In addition, the State health department assisted in providing training sessions, and in providing laboratory service and other service where needed or requested. Further, the State health department plans to construct in the immediate future a smoke observers training school for training and qualifying air pollution control personnel. As a result, new programs have emerged and older programs have grown stronger, even though budget problems and lack of trained staff continue to plague attempts at more energetic control measures.

To divert a moment, Senator Bermingham did point out the problem of trained personnel and our inability to attract these people to our programs.

While there will be increased enforcement procedures in the future along with tighter controls, an even greater expansion into control of all sources will be necessary. In this regard, the Colorado State Department of Public Health takes note of the need for continued efforts and research into the problem of methods and devices, including instrumentation which are low in cost and capable of being operated by technicians with a minimum of training, to be used for testing the performance of automotive exhaust systems which will appear on 1968 autos, and we endorse this necessary action by the Federal Government.

The air pollution control activities to date have not shown any great reduction in the visible haze over many of our afflicted communities. However, progress has been made. Some of the major sources of pollution have already been controlled or eliminated, others will soon be, and still others will require more time and greater knowledge and understanding. Reasonableness and the complexity of the problem dictate that complete control will not occur overnight, but occur it must. Pollution reduction will not be a visible thing to the general public until a major portion of all sources, mobile and stationary, are successfully controlled. To this end, the State department of public health is dedicated.

Senator MUSKIE. Now, as I understand the operation of the Colorado system, in the Denver area the State standards are already being violated or not being met?

Mr. PALOMBA. Yes.

Senator MUSKIE. When was the Denver basin established?

Mr. PALOMBA. All of these basins were established subsequent to the passage of the State act, which was about April or May of 1966.

Senator MUSKIE. Now, under the operation of the statute, within this basin, is the timetable for achieving the State standards established?

Mr. PALOMBA. Senator Muskie, they are not. The main reason for this is that the standards are merely indicators for us to determine when an area has the beginnings of an air pollution problem, and really, they indicate to us, anyway, when we think local communities ought to begin getting busy on the job of preventing the air from getting worse. So they really are not goals, as such, to be reached, but they are more or less warnings and they are in that respect much tighter than some goals might be.

Senator MUSKIE. I would think the first task would be to identify the pollution sources within a river basin area. Is this undertaken?

Mr. PALOMBA. Yes, this is being undertaken by many of the control agencies through the use of emission inventory procedures.

Senator MUSKIE. What authority do the agencies have to identify pollution sources? Do you have the right of entry upon premises? To what extent can you inquire into performance of particular pollutants?

Mr. PALOMBA. The right of entry is provided in the statute on suspected violators. There is no explicit authority in the State statute for conducting an emission inventory. However, this has not been a problem to us. We have been successful in cooperating with most of the

industrial sources and have been able to get the information without the need for legislation.

Senator MUSKIE. What, if any, steps have you taken to control industrial sources of pollution?

Mr. PALOMBA. As was pointed out, the emission standards are established in the State statute, and these emission standards are being enforced in these present four basin areas. Progress is not an overnight occurrence, nor can it be expected. We do attempt by conference and conciliation and persuasion to get compliance before we have to take legal or court action. We have been doing this. A number of industries have complied voluntarily with the provisions of the statute. Others are still in the negotiation procedure, and still others have not been contacted, again because of the inability to distribute our personnel to all of the existing sources.

Senator MUSKIE. So that control devices have actually been installed on industrial polluters as a result of the operations of this act?

Mr. PALOMBA. Yes, I would say definitely so.

Senator MUSKIE. Has this involved major industries?

Mr. PALOMBA. Yes, it has. It has involved quite a number of larger industries in the State as well as many smaller ones and substantial outlays of equipment in terms of dollars.

Senator MUSKIE. Is there a record of the actions that have been taken that might be made a part of the record of these hearings?

Mr. PALOMBA. There isn't any formally compiled record that we have at present. This is something we intend to do as an activity of the department in the future. We intend to have a monthly reporting system from the local control agencies reporting what enforcement actions they have taken and what degree of compliance they have achieved.

Senator MUSKIE. At some point do you envision establishing a timetable for meeting some goals of air quality?

Mr. PALOMBA. I would think so; yes.

Senator MUSKIE. Now, there is not, as I understand your testimony, in the Denver area a single agency with jurisdiction over the Denver basin?

Mr. PALOMBA. That is correct.

Senator MUSKIE. Do you think there ought to be?

Mr. PALOMBA. Well, the State department of public health did recommend back in 1962, with a group of local officials, that a district approach would be the advisable way to approach the air pollution problem in this area. At that time special purpose districts were, and still are, I think, in Colorado, a bad word, in that there are a number of these around and it doesn't really answer the question of urban government or metropolitan government, as Representative Friedman pointed out. So this did not meet with favorable legislative action and has not come about. My personal opinion is that ultimately we are going to have to arrive at a single enforcement agency in the area.

Senator MUSKIE. So that the designation of a basin does not result in the establishment of a basin commission?

Mr. PALOMBA. That is correct.

Senator MUSKIE. All it amounts to is a designation?

Mr. PALOMBA. It is a designation of an area for which the statutory emission standards then become applicable.

Senator MUSKIE. Are enforcement agencies then established by the local jurisdiction?

Mr. PALOMBA. They can be established by the local governing officials, or if they are enforcing the State act they are designated by the State department of public health.

Senator MUSKIE. So the State department does take an affirmative action to insure there is an agency or agencies in the basin to enforce the State standards?

Mr. PALOMBA. That is correct.

Senator MUSKIE. But the State department does not have authority to designate a single agency to cover the whole basin area?

Mr. PALOMBA. Not when we cross jurisdictional boundaries.

Senator DOMINICK. I gather, Mr. Chairman, from what Senator Bermingham was saying, anyhow, that if you designate this as a control basin, then the stricter of the two laws applies, either the State law which is being enforced by you, or the local law, which would be enforced by the local enforcement people, is that correct?

Mr. PALOMBA. Yes.

Senator DOMINICK. So you do get into effect at that point one of the stricter of the two laws, the stricter of the two laws as it may happen to be?

Mr. PALOMBA. Yes, that is correct.

Senator MUSKIE. As you stated, this institutional problem is the concept of the Air Quality Act of 1967. I was interested in exploring rather thoroughly just how you actually apply the law once you designate an area as an area that needs its assistance. So you do have a problem for proliferation of agencies.

Mr. PALOMBA. Yes. Actually, by way of explanation, the present State statute not only allows the State department of public health to appoint its agent for purposes of the State act but it also allows for a local area to provide its own statutory provisions, by ordinance or resolution, and there is no guarantee that if the county commissioners of a particular county wanted to pass an air pollution law, that they would designate the same agencies that were designated by the State department of public health to enforce the State provisions. So there is a possibility this could happen. However, in all the areas where basins have been established, the local agencies are the ones that were designated by the State department of public health.

Senator MUSKIE. You say the State cannot designate one agency with areawide jurisdiction?

Mr. PALOMBA. Well, we could if there were such an agency in existence, but there is no agency in existence that has areawide jurisdiction at this time.

Senator MUSKIE. Do you mean that an areawide agency itself could not act as an enforcing agency in a given basin?

Mr. PALOMBA. Yes. We now have concurrent and independent jurisdiction in all of these basins, but we could do the enforcement program at the State level. However, our program (in air pollution) has been much as it has been with other public health programs, in that where a local agency is in existence we allow the local agency to conduct a

program with assistance and backup from the State department of public health.

Senator MUSKIE. If this proves inadequate, then you do have ample authority under the present Colorado law to move in and develop a larger program of your own in a given basin?

Mr. PALOMBA. I would think so, yes.

Senator MUSKIE. Do you have this same proliferation in the other three basins?

Mr. PALOMBA. Not exactly. Most of the other basins are city and county health departments which occur in a single county. For instance, the city of Pueblo is in Pueblo County and there is a city and county health department in existence. The same is true of our other two basins.

Senator MUSKIE. None of the basins involve other States.

Mr. PALOMBA. No, sir.

Senator MUSKIE. Do you have adequate personnel and funding to carry on the program in the various basins?

Mr. PALOMBA. As a State department we do have adequate funding now for the program we are conducting. We are receiving a Federal grant from the Public Health Service. Personnel has been a problem. It took us many months to recruit an engineer and a health educator to our program. One of our positions for an air pollution specialist is still vacant. We have hopes of filling it very soon. But recruiting has been a problem primarily because there isn't a great surplus of trained people around, to begin with, then as Senator Bermingham has pointed out, we become competitive with other areas in terms of salary and other benefits, which puts us at a little bit of a disadvantage in recruiting people, especially where the competition is with much larger programs that have been in existence for a long time.

Senator MUSKIE. What is your present annual budget?

Mr. PALOMBA. Our present budget is around $120,000 a year. We just received a notification of a Federal grant for another $82,000, which took effect April 1.

Senator MUSKIE. You said, I think, that you have 31 monitoring stations. What was the cost of establishing those?

Mr. PALOMBA. I don't have those figures in mind. The actual cost of equipment was minimal for these 31 stations because they are basically for suspended particulate. We spent in excess of $40,000 for a mobile air sampling laboratory, which we presently use in the entire State, moving it from area to area.

Senator MUSKIE. Do you have the technical staff necessary to establish air quality standards?

Mr. PALOMBA. To establish standards? Well, we have standards. We have utilized much of the resource personnel in the community, such as the National Center for Atmospheric Sciences. We have used professorial staff members at the University of Colorado and others nationwide who have had knowledge in setting standards, in establishing our original ambient air standards. We didn't feel we had the people ourselves at the time, so we did rely on outside consultation to a large degree.

Senator MUSKIE. Thank you very much. I am delighted to have this testimony. It will be very helpful.

Our next witness is Mr. John E. O'Fallon, director, building department, city and county of Denver.

STATEMENT OF JOHN E. O'FALLON, DIRECTOR, BUILDING DEPARTMENT, CITY AND COUNTY OF DENVER

Mr. O'FALLON. Senator Muskie, Senator Dominick, members of the committee; I am delighted to appear. I must admit I have a rather lengthy statement to make here, I will try to delete some of the statements I make here, but on the whole I would like to read the full statement rather than the summary.

Senator MUSKIE. That is what we are here for.

Mr. O'FALLON. I am John E. O'Fallon, director of the Denver Building Department which has jurisdiction over air pollution control for the city and county of Denver.

As all of us here are aware, air pollution is a threat to health and a problem politically, esthetically, socially and economically. The problem is a serious one—and fortunately, we in Denver recognized it early and have had a chance to take measures to stem the poisoning of our air before the situation got out of hand. Early action gave us an advantage over many other cities, but because of the vital importance of clean air to the "image" of our city, we still have a long way to go. We will probably have to achieve a quality of air far cleaner than that tolerated by other communities. We expect the standards that will finally be set for the quality of air here in Denver will be considerably higher than the maximum ambient air standards consistent with public health, safety, and welfare. Our efforts are geared to this anticipated high standard.

The Denver building department has exercised some degree of control over air pollution since 1917, when the enforcement of a smoke abatement ordinance was vested in the department. Ordinance No. 29, series of 1961, prohibited open burning and smoldering and restricted hours of burning in approved incinerators; enforcement was delegated to the building department and the provisions of this ordinance were incorporated into chapter 44 of the building code entitled "Air Pollution Control" in September 1964. Prior to the enactment of this ordinance, we lacked the necessary legislation to conduct a really effective control program and prior to the award of a Federal grant under the "Clean Air Act" effective April 1, 1965, we also lacked adequate qualified personnel and funds. In April of 1965, however, we began a systematic buildup in our staff and program. We now have 19 members in our air pollution control division. And if I may deviate at this point, we did have the same problem getting qualified personnel, but, fortunately, our salaries are high enough that we think we did come up with five very well qualified engineers that we hired from industry.

Denver began a comprehensive 5 year air pollution control program April 1, 1965, aimed at accomplishing the following objectives:

(1) Complete an emissions inventory of all air pollution sources no later than April 1, 1967.

(2) Eliminate 70 to 80 percent of all air pollution due to incineration by April 1, 1967.

(3) Set a schedule for compliance of the major industrial violators by April 1, 1967.

(4) Maintain a continuous emissions inventory showing the progress toward compliance of all violators after April 1, 1967.

(5) Maintain an estimated total of daily emissions by industrial classification after April 1, 1968.

(6) Eliminate the backyard incinerators by April 1, 1968, and cut the total incineration contribution of air pollution by 95 percent.

(7) Eliminate 25 percent or more of the total pollution from stationary sources by April 1, 1967. The projected reduction was 180 tons per day.

(8) Eliminate 40 percent or more of the total pollution from stationary sources by April 1, 1968. The projected reduction was 290 tons per day.

(9) Eliminate 50 percent or more of the total pollution from stationary sources by April 1, 1969. The projected reduction was 385 tons per day.

(10) Eliminate 60 percent (the estimated maximum controllable under existing controls) of the total pollution from stationary sources by April 1, 1970. The projected reduction was 480 tons per day.

(11) Effect a gradual transition into a complete basin air resources management program with 1, 3, 5, 10 and 15 year planned programs beginning April 1968. (These programs will be subject to continuous analysis and revision.)

Senator MUSKIE. Have you completed those portions of your program which were scheduled to be completed by April 1, 1967?

Mr. O'FALLON. Yes, we have.

Senator MUSKIE. What is the significance of the asterisk on item 7?

Mr. O'FALLON. This will be explained later on. The tonnages listed after each of those years' objectives actually was estimated prior to April 1, 1965, and because of a more complete emissions analysis that we have made, we know that these figures are incorrect.

Senator MUSKIE. With respect to the continuous emissions inventory, which is item 4 on the list that you read, do you have instrumentation necessary to maintain that?

Mr. O'FALLON. We do not have the instrumentation, no, but we do have the figures, as far as the total emissions from each particular type of industry, and by applying a factor we can come up with a fairly accurate emissions tonnage from each one of these industries, of each particular type of pollution.

Senator MUSKIE. Do you contemplate acquiring the instrumentation necessary to do a more effective and precise job?

Mr. O'FALLON. Yes, we do in the future.

Senator DOMINICK. This continuous emissions inventory is based on what type of schedule, a monthly one, weekly one, yearly one, or daily one, or what?

Mr. O'FALLON. This in most instances would be a yearly emissions inventory. In other words, once we determine that any industrial or commercial establishment is in violation, we will determine the amount of emissions coming from that particular source. Then if there are any expansions in the activities of that particular source, of course we will get it through a building permit and determine it.

Senator MUSKIE. Is this a regularly scheduled annual evaluation that you make, or are you in a position to make unscheduled evaluations?

Mr. O'FALLON. We are in a position to make unscheduled evaluations. We are taking industry by industry, each established potential source of emission.

Senator MUSKIE. Do you have an inventory of every industrial polluter or potential industrial polluter?

Mr. O'FALLON. No, but I will get into that later on in this discourse.

Senator MUSKIE. All right.

Mr. O'FALLON. Our approach to air pollution control has been a direct one. After determining the objectives outlined above, we staffed our department with personnel well qualified to establish and enforce air pollution controls.

Senator MUSKIE. May I interrupt to ask a question I don't want to overlook? What program do you have to deal with apartment house incineration and other nonindustrial installations that could contribute to the air pollution problem?

Mr. O'FALLON. We have chapter 48 of the Denver Building Code, which sets definite standards for commercial and industrial incinerators. We have made a block-by-block, apartment-by-apartment survey of all existing buildings in the city and county of Denver.

Senator MUSKIE. Do you have an inspection system to insure maintenance of a high order of efficiency?

Mr. O'FALLON. Yes, we have issued orders that those incinerators that do not comply, we have given them anywhere from 30 to 90 days to come into compliance or to arrange for private trash hauling.

Senator MUSKIE. Must they get regular approval of the performance of the incinerators?

Mr. O'FALLON. Yes. We have annual inspection on incinerators, commercial and industrial incinerators in the city and county of Denver. This is conducted along with our boiler inspection program. The cards are set up on IBM and a certain number of cards will come out each week and will be handed to the inspector and he will inspect to see if they are still in compliance or not. If not, they will be issued an order to comply.

We carefully recruited and assembled a staff of five professional engineers with broad design and construction experience in the steam powerplant, smelting and refining, metal processing, chemical and general industrial fields. Their specialties are chemical, mechanical, electrical, industrial, and structural engineering. Because these men know intimately the problems that confront industry and are able to work with industry's consultants at their own level, they can recommend controls and/or evaluate the probable result of installation of various controls proposed by industry, so that emissions can be reduced to acceptable levels at their source. This is possible only because our staff and the members of industry they work with speak the same language. Industry's engineers and technologists created the problem of air pollution—these same engineers and technologists have the knowledge and ability, and are the best equipped, to control air pollution if provided with the incentive and legislative power.

The 10 field inspectors who make up our enforcement team, have wide experience in the mechanical and combustion construction fields and are classified as either boiler or air pollution control inspectors. They patrol their districts and investigate all complaints called into the air pollution control section.

This knowledgeable group of engineers and inspectors analyzed our situation and used existing technology, backed up by strict enforcement policies, to launch an attack on the most tractable aspects of Denver's air pollution problem.

Space heating units in Denver utilize natural gas for fuel almost exclusively, therefore Denver did not have the air pollution problem that plagues many cities resulting from the use of oil or coal. The pollution resulting from gas-fired heating installation is less than 1 percent of the total air pollutants and is held to this low level by strict enforcement of the mechanical sections of the building code dealing with fuel combustion. It was determined that major contributors to Denver's air pollution problem were automobiles, open burning, and emissions from five industries: stone and clay products, grain processing, public service company (coal combustion), oil refineries and chemical, and metal processing (gray iron foundries.)

I would like to point out here that our attack on air pollution has been confined to stationary sources—automobiles do not fall under our jurisdiction. While automobiles contribute substantially to Denver's air pollution problem—we estimate automobiles are currently responsible for almost 60 percent of Denver's air pollution—we have not taken initiative in this matter because we feel that the ultimate solution to the mobile air pollution problem lies in effective control devices and regulation of such devices must come from the State and Federal Government. We feel it would be our responsibility, as a function of local government, to limit construction of freeways through the heart of the city and to promote mass transportation to reduce mobile sources of pollutants in the downtown Denver area, however, and are prepared to act in these areas when the need arises.

Senator MUSKIE. May I ask you this, whether or not you give or have given any attention to such things as the location of highways, the centralization of traffic lights, and other means of insuring the free flow of traffic and the avoidance of heavy concentrated areas?

Mr. O'FALLON. Yes, we have. However, this, of course, is going to have to be worked out with the Denver master transportation study, with the various planning departments in this area, and specifically with the intercounty regional planning commission. This will all be part of a master air pollution control program which we are aiming at in the future.

Senator MUSKIE. In Washington you are lucky if you can make one block on a traffic light, and it is this start-and-stop driving that contributes most to the automotive pollution in heavily concentrated areas. It seems to me if we could synchronize the green lights a little so an automobile might make five or six blocks at a time, we might reduce air pollution quite a bit.

Senator DOMINICK. We have done that quite a bit in the Denver area whereby the lights are synchronized at a certain speed and you can go right through.

Senator MUSKIE. Of course, your traffic pattern might be such that it would limit your capacity to do that, but I think it ought to be explored like it is here.

Mr. O'FALLON. In April of 1965, open burning became the immediate target of the bolstered abatement program. By August 1, 1965, Denver's burning dump located near Stapleton Field, which contrib-

uted an estimated one-fourth of all pollution attributable to open burning in the Denver air basin was closed. Between April 1, 1965, and March 31, 1966, we investigated 24,125 complaints of backyard incineration and open burning; 1,266 orders to cease burning or to observe hours were issued to repeat violators. And I admit at this point that this ordinance which was in effect at that time was extremely unpopular and very hard to enforce prior to the time we closed the Denver burning dump, because you can imagine the feeling of a householder, especially if he is hit with a $5 summons, who is contributing a few pounds of pollution to the air when the city had an authorized burning dump which was contributing 50 or 60 tons per day to the air.

Senator MUSKIE. How about that great American sport, leaf burning in the fall?

Mr. O'FALLON. We do not permit leaf burning in the city and county of Denver.

Senator MUSKIE. We discontinued it in Washington. I was heartbroken.

Mr. O'FALLON. In December 1966, the Union Pacific cooperated by closing down a railroad car burning operation. The gray iron foundry industry was chosen as the first of the offending industries to be brought into compliance and by January 18, 1966, they had been ordered to submit a detailed proposal for air pollution controls.

Concurrent with our efforts to bring obvious offenders into compliance as quickly as possible, we began longer term projects. In July 1965 a block by block emissions sources survey was begun on industrial and commercial concerns.

Senator MUSKIE. May I ask a question? You say, "Four orders to industrial concerns to comply with the provisions of chapter 44 were issued. Total compliance was obtained in one instance and partial compliance in the other three." Was the partial compliance agreed to by you people?

Mr. O'FALLON. No, the partial compliance was not agreed to and that particular industry is now in complete compliance. This relates to the period between April 1, 1965, and March 31, 1966, and I deliberately skipped that because I don't think it is very impressive to say that you issued four orders to industrial concerns in a period of a year. I am sorry you mentioned it, Senator. In fact, if I had paid more attention to it, I probably would have striken it before I submitted it.

We have made substantial progress toward our air pollution control goals over the past 2 years:

The industrial emission sources survey was completed in October 1966. The commercial emission sources survey was completed in January 1967.

Senator MUSKIE. May I interrupt? You issued four orders to industrial concerns to comply. Now, were you able to get compliance without the issuance of orders in other instances? In other words, did the four orders represent the sum total of your activity with industrial concerns?

Mr. O'FALLON. No; not the sum total, but in most instances, I mean especially in the case of small violators, where the cost of an installation of controls was minimal, this was accomplished by conference and conciliation rather than by the issuance of orders.

Senator MUSKIE. I thought that part of the record ought to be clear.

Senator DOMINICK. The orders you refer to were only between April 1, 1965, and March 31, 1966?

Mr. O'FALLON. That is correct.

Senator DOMINICK. All those firms are in compliance now?

Mr. O'FALLON. Those firms are, yes.

Of 7,600 commercial and industrial businesses surveyed, all but 1,058 were eliminated as actual or possible air pollution violators. A resurvey of these 1,058 is now in progress and as of this date the number of actual or probable violators has been reduced to 470.

I might add here the reason for the large total of 1,058 was that this first survey was rather a cursory survey and in many instances we listed an establishment as a probable or a possible violator strictly because of the type of industry it represented. In other words, a machine shop, a metal plating industry or any of that type, before we went into complete details to see whether or not there was an actual violation, was listed as a probable or potential violator because we wanted to narrow the list down so that we could really concentrate and establish the total number that were actually in violation.

Senator MUSKIE. What does your survey consist of? That is an impressive total figure. It seems to me with your small staff it would be a difficult one to make with any thoroughness.

Mr. O'FALLON. Well, we have five engineers. We had as many as three or four engineers and in some instances we had an inspector or two well qualified. These people were going block by block. This was an emissions survey in all of the zoned industrial or commercial areas of the city.

Senator MUSKIE. Is this a visual inspection, or did it go beyond that?

Mr. O'FALLON. This at first was only a visual inspection. In other words, the engineer walked through the plant, saw what type of controls, if any, were in existence, the type of manufacturing or processes that were involved, and of course, in the case of a commercial installation, an apartment house or a warehouse or something of this nature. What he was after was to see whether or not there was a complying or noncomplying incinerator. In the case of a manufacturing process, of course, many of these were very obvious. Of course, the Public Service Co., gray iron foundaries or something like that, we have to make a thorough survey. But in some of the other ones like a small metal plating industry, in the case of, say, a furniture manufacturer, or a machine shop or something of this nature which had a potential for pollution, this plant was listed as a potential polluter until we could go back and make a more thorough analysis with the authorities and the owners of the plant or commercial establishment.

Senator MUSKIE. Do you use any instrumentation in that more thorough survey?

Mr. O'FALLON. Yes; in the more thorough survey we have taken stack samples in some instances. This is especially true as far as chemical plants, and so forth.

By July 1, 1967, when the resurvey has been completed, we expect the list of known violators to stand at about 350. Confirmed violators are

being given a cutoff date for compliance or are being given orders to submit a timetable for compliance.

No permits for burning were issued to junk car yards after September 1965 and all burning of junk cars was effectively controlled by January 1966.

A strict clampdown on illegal incineration was begun in April 1965, and intensified in May 1966. That intensification, incidentally, was carried out by handing out summonses rather than orders. We estimate there were over 100,000 domestic incinerators, about half of which were the approved type, in service in February 1965. A minimum of 40,000 of the worst offenders have been eliminated and many of the owners of approved incinerators are now doing little or no burning. The open burning ban put an increased demand upon the Sanitary Services Department, but with their cooperation and our "get tough" policy adopted in May of 1966, 60 to 80 percent of pollution from backyard incineration has been eliminated.

The emissions survey of commercial and industrial incinerators begun in May 1966 has resulted in the elimination of over 2,000 noncomplying devices. To date, 112 approved commercial or industrial incinerators have been cleared for annual inspection.

Since September 1964 Denver has reduced total air pollution from all sources of incineration by approximately 65 percent or an estimated 200 tons per day. The closing of the Denver burning dump plus the closing of the Union Pacific car burning pit alone eliminated a total of at least 60 tons of pollution a day formerly thrown into the atmosphere.

Senator MUSKIE. What have you adopted as a substitute for the Denver dump to dispose of materials disposed of, then?

Mr. O'FALLON. Sanitary services is picking up all of this and it is being transported and disposed of in sanitary land fills.

Senator MUSKIE. What about the car burning problem?

Mr. O'FALLON. They are also hauling. They investigated the possibility of the installation of an approved incinerator. If I remember the figures correctly, it came somewhere between $60,000 and $75,000 because of the tremendous volume of wood they were burning. They were sawing out the bottom of obsolete freight cars and just burning this in a pit and it really gave up a tremendous amount of black smoke.

I will now continue my prepared statement. Of the five industries that were pinpointed as major contributors to Denver's air pollution problem: Stone and clay products industry—35 firms have been found to be violators. All have been contacted and ordered to submit a timetable for compliance: no compliance date beyond September 30, 1967, is being accepted.

All three asphalt plants are in compliance or are under orders to comply before the 1967 paving season starts.

Grain processing industry—The resurvey of the grain and feed industries is complete and conferences have been held with each organization's management. A timetable for compliance has been requested from seven of ten firms in the industry: the remaining three were found to be nonviolators. And this is going to be a fairly protracted but certainly a logical method of bringing these firms into compliance.

Oil refining and chemical industries—31 firms in the chemical and related industries have been listed as actual or possible violators in Denver and contact has been made. There are no oil refineries in Den-

ver: the two that lie outside our jurisdiction will be handled as a joint venture with the Tri-County District Health Department. This, incidentally, is probably the largest single source of pollution in the Denver metropolitan area. The last figures I saw on it was around 300 tons of pollution a day from these two refineries.

Public Service Co.—The Public Service Co. has been most cooperative and has gone to great lengths to take measures to control their emissions. Five out of nine generating units have been equipped with electrostatic precipitators; however, this equipment has not satisfactorily resolved the problem to date.

Toward this end, Public Service Co. has signed a contract with Colorado State University for research to improve collection efficiency of their precipitators. Public Service is also continuing independent studies.

Gray iron foundry industry—Negotiations with the gray iron foundries were begun in July 1965. Two have since shut down. Two have converted to induction melting. Two are in the process of installing control equipment and we anticipate compliance by September 1967. One is under orders to comply by October 1967. As I previously stated, we have developed equipment and are currently making stack analyses on suspected violators.

Since October 1963 we have maintained five air sampling stations in Denver for the State health department. The samples collected are analyzed by the State for suspended particulates and other contaminants.

We have operated the Continuous Air Monitoring program for the Taft Center since August 1966. Automatic continuous measurement of nitrous oxide, nitrogen dioxide, sulfur dioxide, carbon monoxide, hydrocarbons, and oxidants is made; particulate samples are collected; and equipment is now being installed to measure methane. The C.A.M.P. station requires a full-time operator. One of our inspectors operates the station.

From December 1965 through March 1966 in cooperation with the Taft Center at Cincinnati, we sampled air on major traffic arteries. Samples were analyzed at the C.A.M.P. station for carbon monoxide and hydrocarbons.

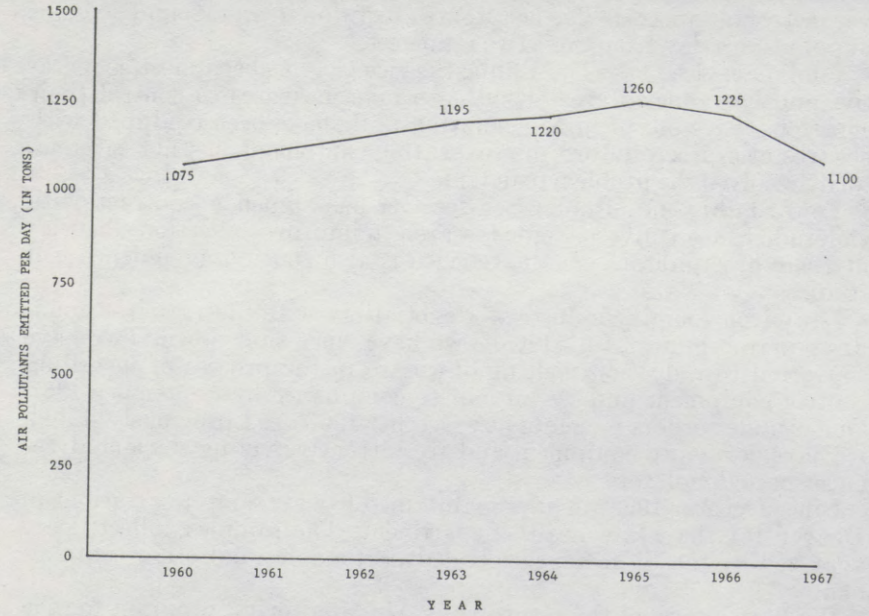
In the year 1966 the Denver Air Pollution Control section made 45,194 inspections. This is inserted solely to give an indication of the scope of our activities.

Attached is a graph (figure 1) showing the progress we have made to date in the reduction of air pollution in Denver. You will note that there is a discrepancy between the tonnages of pollutants shown on this graph and those listed in our comprehensive 5-year air pollution control program. When we set up our 5-year program in 1965, we overestimated the industrial contribution and underestimated the total from incineration. We calculated the total tonnage in 1965 to be 1,405 tons per day. This is for the City and County of Denver alone. That figure should have been 1,260.

Figure 2 shows our projections, up to the year 1970, for air pollution tonnage from transportation and stationary sources, with and without controls. Even with the stablishment of controls in 1963, the current emission level of pollutants (1,100 tons per day) is 25 tons higher than in 1960. By 1970, with further reduction of stationary

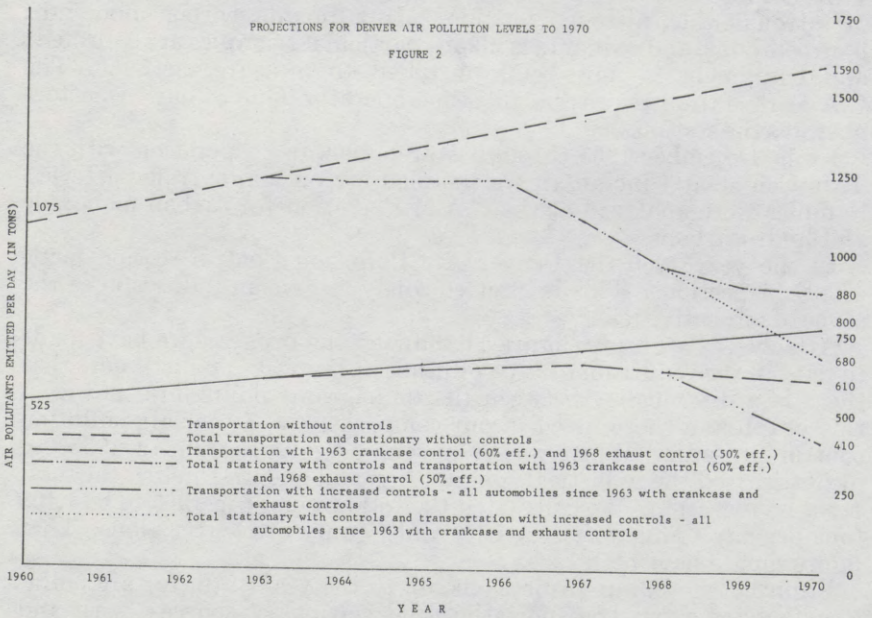
DENVER AIR POLLUTION LEVELS 1960-1967

FIGURE 1



PROJECTIONS FOR DENVER AIR POLLUTION LEVELS TO 1970

FIGURE 2



source emissions and the installation of the automobile control device now available on all new models beginning in 1968, we expect the daily tonnage to be 880. Although this represents a 20-percent reduction in total pollution from the 1960 figure, I doubt that this will be acceptable to the citizens of Denver for the reasons stated earlier. We project that controls installed on stationary sources will produce a significant reduction of Denver's total air pollution only until 1968 and it is our conclusion that unless more effective controls are installed on automobiles prior to 1970, we will be fighting to retain the status quo after 1969 when almost 70 percent of Denver's total air pollution will be charged to the automobile. Denver Air Pollution Control can and will reduce pollution from stationary sources by as much as 60 percent, but the key to acceptable air quality lies with the automotive industry and the refineries that produce the fuel for the automobile. It is essential that more effective controls be developed and installed on internal combustion engines if we expect to have acceptable ambient air here in Denver by 1970 without enforcing drastic curbs on freeways.

We have made substantial progress toward the control of air pollution in Denver in the last 2 years. A major factor in our success has been the excellent legislative support we have received. Denver had effective control standards 18 months prior to the adoption of statewide legislation. In fact, the RAPCA standards, adopted by Denver in September of 1964, are almost identical to those adopted in State legislation in April 1966. In addition, we have control over backyard incinerators and strict controls over commercial and industrial incinerators not contained in the State statute. Chapter 44 of the Denver Code defines a nuisance giving us the authority to abate the nuisance in a civil suit. Section 4406 calls for the registration along with all pertinent data of any article, machine, equipment or contrivance, the use of which may either contribute to air pollution or remove contaminants from the air. Section 4410(a) vests the authority in the department to set a reasonable date for compliance with the ordinance in the case of an existing facility that is in violation. Both the general scope of the code and section 4407 which calls for the submission of plans and specifications and inspections by the department have given us control over all new construction since the enactment of the ordinance in 1964.

Another factor that contributed greatly to our progress in air-pollution control was the manner in which our air-pollution control group was set up. We feel there has been a definite advantage in delegating air-pollution control to an existing department that already had the professional and technical personel necessary for plan examination, field inspection of all construction, including control devices and licensing control over the contractors and tradesmen who construct the controls and emission sources. We feel that emphasis should be placed on the use of existing technology and a tough enforcement attitude in utilizing the available technology, rather than on the accumulation of information. The solution to the air-pollution problem cannot wait until all the facts are in—action must be taken now.

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Here in Denver we have the legislative controls and the staff necessary to enforce the ordinances under which we operate and we are confident that we will reduce the pollution emissions from controllable sources to the near minimum standards existing under current legislation within a relatively short period of time. During the course of our control program, it should become apparent whether or not existing controls are restrictive enough and if not, we will seek additional legislation to correct the suspected deficiencies.

So much for our program—our progress—and our projections for the future. Now I would like to discuss a problem confronting us that is a cause of much concern. And here I would like to delete some of the remainder of this discussion because I learned just this morning that senate bill 380, which was passed by the State senate, I understand by a vote of 35 to 0, authorized by Senator Bermingham, probably takes away the threat of State interference as far as we are concerned. In short, this bill sets up a requirement that the State health department and all local control agencies meet at least semiannually to discuss their control programs and their progress to date. So a portion of this remaining discourse I would like to have stricken from the record.

Senator MUSKIE. Would you indicate what portions?

Mr. O'FALLON. Well, I will read the portion I want retained in the record and skip that I think should be deleted.

Senator MUSKIE. All right.

Mr. O'FALLON. We have always felt that in order for air-pollution control to be really effective, there must be coordination of regional programs and cooperation between the acting local agencies. Thus, we encouraged the formation of a regional air-pollution control agency in the Denver area. It was incorporated by five elected mayors and four elected county commissioners for the purpose of abating air pollution in the Denever area. This has been an "action group" from its inception in May of 1964. RAPCA successfully fought for and succeeded in having the RAPCA standards incorporated into the 1966 Colorado Air-Pollution Control Act. The board of directors of RAPCA was set up to coordinate the enforcement of uniform local ordinances and regulations within the local enforcement agency. A second objective was to sponsor legislation to enable the State to enter the enforcement field only when the local agency was incapable of action or refused to do so.

Unfortunately, section 6(4) of the Colorado Air Pollution Control Act permits dual jurisdiction of the local authority and the division of administration of the State health department. The existence of dual jurisdiction presents problems in enforcement.

Starting in 1968, we hope that the Department of Health, Education, and Welfare will recognize RAPCA as the only body qualified to effectively coordinate a maintenance program in air-pollution control in the Denver region and recognize the individual entities that comprise RAPCA as the proper enforcement agencies under the Federal grant program. As has been previously mentioned, RAPCA as an organization or an agency was turned down for a Federal grant in 1964; therefore, each of the political entities involved in RAPCA went for individual grants under the Clean Air Act. And I think, also, the legal ramifications and the constitutional requirements that made

this necessary have already been touched on by previous speakers. Denver's air-pollution control program now listed as an improvement program under the Federal grant classification is today an effectively enforced air-pollution control program. Other members of RAPCA have similar programs.

RAPCA has earned the respect of the populace, the press, and the elected public officials in this area and is known as a group that accomplishes its goals through positive action. The elected administrators of over a million people in this area who comprise the commissioners of the Inter-County Regional Planning Commission have delegated the responsibility for the solution of the solid wastes disposal problem to RAPCA. It is obvious that local government officials believe that RAPCA is the one and the only organization that is competent to deal with the air pollution and related problems in this region, and if we could get the Department of Health, Education, and Welfare to go along with a 60-percent maintenance grant for all of these agencies, certainly it not only would give us more additional funds, put us in a better monetary position to actually enforce this action program, but it would also, I think, consolidate all of the political entities in RAPCA toward a complete, inclusive, and fully cooperative enforcement program.

This concludes my presentation.

Senator MUSKIE. Thank you very much, Mr. O'Fallon, for a very thorough and complete discussion of your program here in Denver. I found it of real interest and I am sure that its inclusion in the record of these hearings will be useful to other cities and metropolitan areas across the country.

Mr. O'FALLON. Thank you, Senator.

Senator DOMINICK. Could I ask just one or two questions?

Senator MUSKIE. Yes.

Senator DOMINICK. What towns and areas are now in RAPCA?

Mr. O'FALLON. Tri-County Health Department has jurisdiction over all of Adams and Arapahoe Counties, plus a small portion of Douglas County, Jefferson County, and Boulder County are also included; in each case the designated agency, designated by the State health department to enforce, in this case the RAPCA standards rather than the State legislation, is the health department of that particular county.

Senator DOMINICK. So, in fact, you have control over the Denver metropolitan area through RAPCA by virtue of your organization and the Tri-County Health Department?

Mr. O'FALLON. And the Jefferson County Health Department and the Boulder County Health Department.

Senator DOMINICK. Thank you. That's all I have.

Senator MUSKIE. Thank you very much, Mr. O'Fallon.

Our next witness is really three, dealing with the problem of oxides of nitrogen and particulate matter associated with auto exhaust. May I welcome Dr. Walter Orr Roberts, Director of the National Center for Atmospheric Research, who is accompanied by Dr. Richard D. Cadle and Dr. James P. Lodge, and I understand each of them have statements.

STATEMENT OF DR. WALTER ORR ROBERTS, DIRECTOR, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Dr. ROBERTS. Senator Muskie, Senator Dominick, members of the staff of the subcommittee; first of all, we want to express our appreciation to you for the excellent work that the subcommittee is doing to help bring about better legislation and through legislation to protect this Nation's rapidly vanishing resource of pure air. It is a vitally important task that you confront. I sincerely hope that the present Congress will pass the strengthened measures you have proposed to protect the public from the further despoiling of our atmosphere.

Senator DOMINICK. Mr. Chairman, I just want to say Dr. Roberts, together with a good friend of mine by the name of Harry Combs, put together a TV film to show what the problems were in Colorado, which I had the pleasure of seeing a couple of times, which I think will have a great deal of benefit in educating the majority of the people in our State to the dangers which exist from air pollution. It was really a fine job.

Dr. ROBERTS. Thank you. Dr. Lodge, Dr. Cadle, and I are honored to be invited to testify before your subcommittee. We are all members of the staff of the National Center for Atmospheric Research, which is dedicated to the goal of achieving the knowledge underlying the mastery of our atmospheric environment for the good of all mankind. And mastery includes control of the pollutants that threaten to degrade the purity of the air we must breathe to live.

Fortunately the general public has become aware of the tragic consequences of the indiscriminate use of the atmosphere as a free, public sewer. An aroused public, supported by wise legislation, can perhaps reverse our present disaster course. But we must not expect the desired results to come easily. As with so many of the controls needed in an accelerating economy based on even more rapid technological advancement, the measures required will be costly, and in some instances unpopular. We can see clearly, for example, that an entirely different course is going to be required for the automobile. The car of the future is likely going to be electric, be slower to accelerate, limited in top speed, and possibly also in range, and considerably lower-powered—if we are going to achieve our goals for restoration of atmospheric purity. On the other hand, I am a great believer in the power of innovation in American industry, and I am not at all sure that the car of the future won't, in the end, turn out to be safer, more convenient, quieter, and just as much pleasure to drive.

There is a very interesting new concept evolving in the environmental sciences today—I have heard it from two sources, and don't know with whom it's original, but Dr. Kenneth Boulding and Dr. Athelstan Spilhaus have both enunciated it. It is simply that the products of a mature technological society, which we rapidly approach, must all be designed, in their every element, with the sum of their total end products in mind. That nothing, from a beer can to an automobile, should be designed without also engineering its ultimate disposal process in terms of the environment—because a mature technologically based society is like a space capsule, which our earth really is. Such a society no longer has any "away" into which to "throw things away." This concept certainly hits with force when we consider that

the atmosphere must be constantly regenerated by the cleansing of the rains and the curative breathing of the plants, and that we've begun to push the limits to which we can safely throw away waste gases and solids into it.

Let me say a word now about the organization of our testimony this morning. As I have mentioned, Dr. Lodge, Dr. Cadle and I are all members of the staff of the National Center for Atmospheric Research. Dr. Lodge is one of the members of the Air Conservation Commission of the American Association for the Advancement of Science, which recently produced a highly significant volume on preservation of clean air. Our laboratory is dedicated to basic research on the atmospheres of the earth and other astronomical bodies. A very large part of our scientific effort is dedicated to achieving a fundamental understanding of the processes of the earth's lower atmosphere—the part where men live and airplanes fly, the part of the atmosphere where weather is generated, the part where the air is cleansed and restored so that all living things can continue in equilibrium with their environment.

Though our work is entirely in the realm of basic scientific research, we are all very strongly motivated to see prompt and effective use of the product of our research for the welfare of the public that supports our effort. We are therefore deeply interested in assuring that the knowledge we gain finds application through new technology to just the kinds of questions your committee is pursuing. Air conservation, therefore, concerns us very intimately.

The quality of the air depends on many things. The contribution of internal combustion engines is only one factor, but it grows rapidly in relative importance in an advanced nation like ours, with its expending urban focus and growing populace. At your suggestion we are confining our testimony today to questions of the automobile and other vehicles driven by gasoline or diesel motors. But I want, in passing, to emphasize that the problem of air purity involves the whole of the meteorological environment; it depends on the wind strength, the vertical mixing of the air, the rainfall, the temperature, the strength of the incoming sunlight, and many other factors. Consequently, almost all of NCAR's meteorological work is relevant directly or indirectly to the overall system problem of man and his bounty of pure air to breathe.

Two of NCAR's atmospheric chemists will testify this morning. Cadle will speak about gaseous air pollution and Lodge about solid-particle air pollution from internal combustion engines. And we will all be happy to respond to your questions. I shall make a few further introductory comments about air pollution in general, and introduce a suggestion regarding automobile and truck inspection that I hope you will find worthy of consideration.

Everyone knows the breadth of the problem of air pollution. It is a worldwide problem and affects not only urban centers, but it is even serious in some rural areas, as in India where the great Rajputana Desert is a source of blowing dust. In the Dust Bowl years here in the West, as well as in the mid-fifties again, we had days when it rained mud in Kansas City from the blowing soil of the prairies.

Not all of the air's degradation is due to man's actions. Pine forests produce terpenes, natural hydrocarbons, that under strong sunlight produce blue haze, Dr. Frits Went has pointed out. Dr. Lodge is also

an expert on these hazes or natural smogs. But clearly in today's crisis spots of Chicago, New York, Los Angeles, as well as in hundreds of other cities, the principal culprit is the effluent from man's machines.

There is some evidence that not only is this pollution making the air unsafe to health, but that it is doing subtler things to our environment. For example, it is a striking fact of the cloud cover of the United States today that a very large amount of the thin cirrus cloud formation over the country is triggered off by the contrails of the jet airplanes that busily lace the sky, venting ther tons of waste solids and gases to the air, even though, I might say, this jet airplane contribution does not contribute significantly even in the most concentrated centers to the local air pollution. Atmospheric science cannot tell us today whether or not these cirrus clouds would have formed from natural causes, without the planes. That will take further research. But it seems indisputable that the existence of such cirrus clouds, if they are more abundant now than in past times, will have a significant and perhaps long-term influence on the climate, and in fact, the world.

There has almost certainly been a local climatic change resulting from the paving of previously green fields in the vast super cities like Bosnywash—the name I've given to the megalopolis that spreads almost unbroken from Boston to Washington. Heavy pollution, like that almost always seen over Chicago or New York in all seasons, very probably so alters the radiation processes over the region as to change the weather significantly for some distance from the city. Though it is a very speculative suggestion, some scientists have hazarded the guess that solid particles in manmade pollution may change the cloud droplet structure in potential rainclouds—thereby decreasing the probability of rain, and increasing the probability of drought. It is my own thought, still more speculative, that perhaps this same process will not only make things generally drier in some regions, but will cause the rains when they do come to be more severe, thus increasing the hazard of urban flash floods. So, you see, there are several possibilities that we may already be engaged in large-scale weather modification—but inadvertently and probably undesirably.

These are all questions that will be answered in coming years by the collective efforts of the atmospheric scientists of the world. Happily the ranks of such scientists are growing, and the quality of their efforts improving as the public recognition of the usefulness of their work grows. But this will not be enough. There are also hard political questions ahead. I name only three:

(1) How long is it before we must ban all internal-combustion-engine-driven cars from urban centers like New York or Los Angeles? Is it 1975 or 1985?

(2) What levels of pollution of urban centers will we tolerate in the year 2000 A.D. when our cities have over 50 percent higher poplation? Without drastic controls of almost heroic proportions, the cities will be vastly more populated than now, and severe urban health problems will be regular features of our society.

(3) What are we willing to pay to bring about a truly hospitable urban environment, with clean air, and a system-solution designed to optimize the human dimensions of urban life?

Senator MUSKIE. May I ask you to react to this, which I think is the present attitude of the automobile industry. Your first question

assumes there will be a time when we must ban all internal-combustion-engine-driven cars from urban centers. Did you intend to imply that?

Dr. ROBERTS. Yes, sir. I feel this is almost inevitable unless very, very major technological development that I don't now foresee comes about to make it possible to design an internal combustion engine differently from the way it is designed today.

Senator MUSKIE. Then the attitude of the automobile manufacturers, and I think at least it is my intent to state it accurately, is this: that there is a point beyond which you cannot concentrate any more automobiles in these metropolitan areas and we have reached or passed that point now. In other words, physically you just can't squeeze any more automobiles into them. So that the car population explosion of the future should not significantly add to the pollution problem in the concentrated areas of metropolitan areas.

Secondly, assuming this to be factual and sound, that reduction of the hydrocarbon emissions from the automobile to something in the order of 180 parts per million will, by 1980 to 1985, reduce the total contribution of the automobile to the air pollution of the metropolitan areas to that of 1940, which in their judgment was acceptable. The automobile manufacturers, therefore, reach the conclusion that the internal combustion engine does have a future in metropolitan areas. Now, would you want to respond to the validity of those assumptions?

Dr. ROBERTS. Well, first of all, I think it is likely that the internal combustion engine can be improved in its pollution to the place where it gives off something like one-third of its present level of pollution, at least when it is new. If you were to reduce by two-thirds, let's say for Los Angeles, the pollution produced by cars now, you would be back to something like the circumstances in 1940, but the air in which the city is imbedded is already polluted, as it comes to the city now, in a way it never was in the past. I suspect—although I don't know that there are figures to back this up—I suspect if you were to look at rural air pollution levels, particularly on the eastern coast, the eastern seaboard, you would find that the rate of increase of pollution in rural areas goes up faster than it has in urban areas. I am not sure about that, it is a guess. But you can't fly over the eastern seaboard today without seeing, even in the rural areas, the cast pall of atmospheric pollution. So that reducing the urban source may not be sufficient to improve the urban air by the amount you suspect if you were to calculate it directly. So I am inclined to believe that the only solution that will really prove effective in the end is to ban the internal combustion engine in the greatest concentration of automobile traffic and develop alternate means of transportation. This is why I say the important thing is the systems solution to the whole urban problem, not just going at it piecemeal and deciding to ban the internal combustion engine in the city, but looking at this question in the context of the whole world system problem, the whole national system problem, anywhere the polluted air may come from.

Senator MUSKIE. That is an approach to which I subscribe. It is going to take some time to get there.

Dr. ROBERTS. It is going to take time.

Senator DOMINICK. Dr. Roberts, in your second question, I would assume that what you have premised this on is that automobiles will

have been eliminated from the major urban areas. Now, under those circumstances are you still implying that the cities will be vastly more polluted than now?

Dr. ROBERTS. I am implying they will be vastly more polluted than now unless rather extraordinary measures are taken. I feel that these measures must be taken. But even banning internal combustion engine automobiles from the center of the city will not reduce, in my view, the level of urban pollution to the place where we are likely to demand it to be in the year 2000. I think since most of the people of the Nation are going to be living in cities, that we have a national obligation to make the city beautiful rather than just a place where you can tolerate life, and I think perhaps an entire new level of technological development, of economic growth, and so on, can be built about making the city a beautiful place socially, air pollution wise, in terms of the distribution of recreation and so on. This is the kind of system approach to the city that I think we are going to demand by the year 2000.

Senator MUSKIE. I call your attention to another series of hearings that another subcommittee of which I am chairman is conducting. I think at some point you might like to testify before that one because you certainly have evoked many of the considerations that we have had. I refer to hearings on a proposal to establish a Select Committee on Technology in the Environment. If we don't get the select committee established, then my subcommittee will continue hearings along that line just to get the concepts before the Congress.

Senator DOMINICK. In your systems approach I would presume you are talking not only about what we do here on the ground but also the possibility of weather modifications, I mean artificial weather modifications that we do deliberately, not the involuntary type which you referred to before, and possibly something with the upper air; is that also true?

Dr. ROBERTS. Yes, sir; I am talking about that, and I think that is perhaps going to be significantly involved by the year 2000, if not before.

Senator DOMINICK. I hope some of it will be well before that.

Dr. ROBERTS. I wish we had time to talk about that because there are some fascinating aspects, as you well know.

I have long been impressed with the need to approach the problem of automobile-produced pollution within the framework of the initiative of free enterprise, and with a minimum of necessary Federal regulation. As a consequence, I have been attracted to an idea suggested to me by an analogous problem in water pollution discussed in a Fortune article a couple of years ago.

My notion is to institute systematic pollution inspection of motor vehicles, along with brakes and light inspections, coupled with a graded series of taxes ranging from nil for cars that fall within very desirable pollution standards to rather stiff taxes for cars that pollute excessively. Nothing that I can imagine would be a greater incentive to the automotive industry than the pressure of the public purchasing power to produce a car that involved lower pollution tax costs. If Fords turned out to have systematically more pollution than Chevrolets (or vice versa), it would be a substantial advertising and sales advantage for the cleaner car. Moreover, such an inspection system would get at the vital question of whether a car's afterburner

or catalytic nitrogen oxide unit was not only installed but functioning—since keeping these devices in effective working order takes good maintenance.

My colleagues tell me that the technology to make measuring devices is either at hand, or nearly so, though cost of the machinery is perhaps yet a problem. There is some doubt in my mind whether the present methods of motor vehicle inspection in many States are adequately staffed to operate the rather specialized chemical analyzers to do the pollution inspection, particularly where the amount of tax would be determined by the finding. But I am of a mind that the mounting problems of automotive safety are going to require State operation of the motor vehicle inspection system anyway; and the inclusion of a car-pollution factor would make State-operated inspections more desirable.

My colleague, Dr. Lodge, has suggested that as a perhaps less expensive but still effective alternative there could be "blue book figures" for pollution taxes on given models of cars. Coupled with this could be means for specific inspection, at personal expense, if an owner felt that his car fell below the "blue book" pollution level because of various corrective devices. Similarly, inspection could be required, at State expense, if his car appeared to be a more-severe-than-average polluter.

Senator MUSKIE. There is one other consideration that I am sure would be advanced by the automobile manufacturer. That is, there is no way, even with modern mass production techniques, to insure that each unit meets a given standard, whether it is an air pollution standard or safety standard. So the present method of testing the compliance with the manufacturers, with the automobile exhaust standards, is an averaging concept. You have to evaluate a lot of units and average their performance. An interesting demonstration of this variation was the fact that when we were in Los Angeles we were at the State dynanometer. There they tested several automobiles, including an old clunker, I think a Chevrolet of 1950 or 1951 model that tested almost as well as the new controlled automobile. The reason is that it was a unit. When you have been buying automobiles as long as I have, sometimes you get a good one and sometimes you get a lemon. In that case the old Chevrolet was one of the especially good ones that was produced, from the air pollution standpoint.

Dr. ROBERTS. In a minute, if we can find out how to turn the lights off here when I finish speaking I would like to show you just a 2-minute color movie. This is a movie of air pollution taken by Doyne Sartor of our research staff over at NCAR. The film shows graphically why the concept of an airshed makes sense. Airsheds are natural air drainage basins in which, under prevailing weather conditions, polluted air tends to form growing stagnant pools, and these pools grow. A change of wind or weather can completely change the conditions in a given airshed, and the film that I will show was taken not as a part of an air pollution research effort but as part of an effort to study air motion over the Boulder Valley, and there are occasionally very, very severe winds that come with the chinook, very severe, we had 125 miles an hour over there one time this winter, and we are attempting to study the cause of these severe winds. But the film shows the airshed, the Boulder Valley, with air pollution sitting in it in spite of a quite

strong wind overhead, sitting in it like water in a lake and just sloshing around from edge to edge in this drainage basin.

It shows pollution from several different sources. The most obvious will be the stack of a factory, but there is also a large amount of contribution from automobiles or at least from some distributed source in Boulder, which you can see the general background rising, and apparently this background rise is not associated with the stack.

The film was taken by timelapse photography, so you will see about 3 hours of the morning condensed in about 2 minutes of projection time.

Then finally, I will mention I would like to give you a copy of an article in which I talked about this problem about a year and a half ago down in Miami; the problem of the city and atmospheric pollution problems. It seems clear to me, referring to that article where I spoke of two possible routes facing the country in solving the question of air pollution, it seems to me we are going to have to take the harder route that I described there rather than the easier route and that this will mean making major commitments of economic, scientific, and technological resources to the problem of atmospheric conservation. The blueprint for the steps that need be taken in research, engineering, and application are not difficult to formulate. But for these steps to have real prospect of success they must be rather heroic in their proportions. These are not minor advances in control and technology that we are talking about; these are almost in the nature of scientific, technologic revolutions that we are going to have to sponsor if we are to have pure, clean air, as I think we can and must, and the longer we delay taking these first realistically hard steps, the more difficult and the more heroic the problem will ultimately become.

Senator MUSKIE. Thank you very much, Dr. Roberts. Your paper will be included in the record at this point.

(The exhibit referred to is as follows:)

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TO MASTER OUR ATMOSPHERIC ENVIRONMENT—WALTER ORR ROBERTS, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, BOULDER, COLO.

Something more than a decade ago, a new view of the atmospheric sciences arose. It was a visionary image—part hopes and dreams. It expressed the intangible new sense of optimism and of determination that was pervading the science of meteorology—soon to stretch its compass to the depths of space. It was a glimpse of the goal of the mastery of our atmospheric environment, for the benefit of all mankind.

It is interesting today to try to trace some of the origins of this new aim and new resolve. Certainly an important part was played by the National Academy of Sciences, through is Committee on Meteorology, that included such men as the late John von Neumann, the late Carl Gustaf-Rossby, Edward Teller, and Lloyd Berkner. Von Neumann, among others, saw vistas opening before theoretical geophysics—and in particular atmospheric physics—if new and potent tools were applied to the complex and challenging problems of geophysics. For him, the most fascinating of these tools was the highspeed digital computer, which offered ultimate prospect of solving, as he put it in 1956, "the most complicated series of interrelated problems not only that we know of, but that we can imagine."

But toward what specific ends were these visions pointed? What was to be the payoff? Certainly it was the challenge of discovering new basic knowledge. We must not sell that goal short under any circumstances. But beyond that was, and is, the opportunity to understand and perhaps to influence the atmosphere, man's prime resorce as well as, at times of disastrous storms and droughts, one of his chief scourges.

It is not my purpose to discuss here the work of my own organization—the National Center for Atmospheric Research. But I do want to cite a sentence that the architects of NCAR put into its blueprint. The architects were a broad representation of the national atmospheric sciences community, and among their principal spokesmen were Tom Malone, Roscoe Braham, and Bill von Arx. These men staffed a joint university effort to design a National Institute for Atmospheric Research—which has now taken shape as NCAR. They produced the so-called "Blue Book" in 1959. Here is one of the salient specifications they stated: "The Institute is then to be thought of as a center at which high scientific competence and consummate technical skill can be combined in a free and natural alliance to *master our atmospheric environment.*"

The words are at the very heart of the challenge not just to NCAR, but to all of us in atmospheric sciences. The key words, as I see it, are "free and natural alliance" and "to master our atmospheric environment."

The "free and natural alliance" of which they spoke must involve all relevant research institutions of our nation, and also of all the world, for the problems we must ally to conquer are national and world problems. The atmosphere we ally to understand, to conserve, and hopefully to control is the common resource of all inhabitants of the planet— is shared by all, and the consequences of its alteration are the common concern of all. The problems of atmospheric science, moreover, are so formidable as to make demands larger than the capabilities of any given university, of NCAR, of ESSA, of the Bureau of Reclamation, greater even than the current capabilities of all together. There is, therefore, little justification for us to spend time or energy in jurisdictional disputes. We have far too much challenging work ahead; the benefits to be gained from alliances are to all far greater than any jurisdictional victory can bring to any one group or institution.

To return to the second key phrase, our goal before us is nothing less than the *mastery* of our atmospheric environment, for the good of all. But by stating this goal in 1959, or by accepting it today, we do not underrate the difficulty, perhaps even impossibility, of achieving full and beneficial mastery of all aspects of our atmospheric environment. It is important not to confuse the statement of major goals for the promise of specific returns, though it is also important to do both.

Where do we start? On anything so diffuse as this it is difficult to be sure. Obviously, we have to start from where we are now, but there is very much to do to get from here to where we want to be.

Even though various goals of atmospheric mastery admittedly seem far off, we should not underestimate how far we have come. In some areas, we are close to engineering applications of knowledge produced over the past 20 years. In others, the problems are larger and more complex, but the payoff is of far greater potential benefit. In the tougher problems we can see the path with less than perfect clarity. But our chances of success also now seem less slim than they did 20 years ago, and our need for success has vastly multiplied. The time is at hand, I believe, when we must take a new and even daring look at what is our proper role as atmospheric scientists.

But let me not speak quite so abstractly, and instead turn to a couple of concrete questions that I think deserve high priority in our commitment of intellectual resources for the future.

THE CITY AND THE SKY

Yesterday, I was in Boulder and went over to my office for a couple of hours before catching the plane to come down here to Miami. It was an extraordinarily clear sparkling morning, with fresh snow on the mountains in the distance. Every tree and rock and snowfield was etched in magnificent clarity on Boulder's skyline. I had some business with Bill Jones, and as we looked out the window of his office, we both felt a sense of elation and of well-being at the beauty of nature and the magnificence of the scene.

Then I got in the car and started for the Denver airport. As I arrived at the edge of Denver I was shocked and affronted by the sight of the city covered over by a dense layer of gray-white smog, so dense as to obscure any view of the mountains to the south, and so overpowering as to make it almost impossible even to see buildings in the center of the city. And as I drove into the smog, it was as offensive to the sense of smell as to the eye. This was the effect of the city on the sky. This was man in mastery of the atmospheric environment—but for the benefit of no one. And here is a problem of vast world concern

where the knowledge for mastery of atmospheric pollution is within clear sight, though the social and political factors are somewhat forbidding.

The devastating effects of air pollution have been well documented, not merely by scientists studying it as an interesting phenomenon, but by millions of people, each of them filling his lungs with his needed 15,000 quarts of air a day. Thousands live with air pollution so extreme that plants cannot grow in their yards, and their skies are never really blue. What has not been discussed so widely is the fact that pollution produces atmospheric sewers whose fouling effects can sometimes be seen for hundreds of miles.

Last July, I took a Friday afternoon flight to the John F. Kennedy Airport, arriving about 5 o'clock. As we neared the airport the pilot advised us that despite the complete absence of cloudiness, we would have to make a delayed instrument approach. He pointed out the extremely dense haze below. As we finally entered the haze, I realized that it was purely and simply a man-made smog of extraordinary proportions. When the plane finally reached the runway, I could look at the full disc of the sun, a dull orange orb. And over the airport and, I presume, over the whole city, was the hot offensive pall and smell of man-made smog.

The source was probably not only New York City, but also the effluent of the many upwind sewers gathering richness as they proceeded eastward.

Just last Friday, flying from Washington to Chicago, I noted that some time not too long after leaving Washington I could see a very marked streak of gray-blue haze below us, on the left side of the plane. It was like a river of smoke. Since its course paralleled the route of our plane, I decided to see how far I could trace it. Eventually I saw its source at the south end of Lake Michigan—a giant streak of atmospheric contamination spreading like a plume downwind from Gary, Indiana, and Chicago.

It is a big problem, and a complex one. Few more powerful statements of the problem have been made than the article by Edith Iglauer in the March 7, 1964, *New Yorker*. In this piece she pointed out many oddities of air pollution related to the organization of the city of New York—but her words have far greater generality than New York. For example, New York's smog is worse now in summer than in winter, primarily because of the necessity to generate huge quantities of power for air conditioners. This results in increased use of coal to produce electricity, with attendant dumping of solid and gaseous wastes into the atmosphere, and it comes in the season when the dilution by winds is generally less strong.

Think about the situation with respect to passenger cars. They are made ever more powerful, for ever higher speeds. But they are insanely designed, when one considers their use in cities already choking with traffic. They are recklessly engineered from the air conservation standpoint. And as our colleague Morry Neiburger, past president of the American Meteorological Society, has pointed out, the automobile population will probably rise so fast as to cancel out the gains achieved by blow-by devices even before the devices come into full usage.

Look at our laws on trash disposal in many cities, or on the control of industrial gaseous wastes and smoke disposal. Many communities are operating under archaic regulations. And these archaic regulations are based on the naive assumption that air is a free, public sewer and that sewer pots can freely be emptied in this public thoroughfare.

TWO POSSIBLE ROUTES

What does the future bring? A higher and higher proportion of our population will live in the city. Before too long most everybody will live in a city. What will this city be like?

As I see it, there at least two possible routes. One is the route we are on. It involves progressive inadvertent, almost unconscious degradation of the ocean of air in which we live. We are accelerating on this route day by day. Even to slow down this rate of degeneration will take major steps. Moreover, we are only dimly and inexactly aware of how great the change in our atmospheric environment may be. We do not even have good quantitative data on the growth of turbidity in rural or urban areas. And we have little or no understanding of the impact of the beauty of a city on its soul or even on its economic well-being.

The other route involves a task of heroic proportions, but will involve, if we succeed in doing it well, new dimensions of beauty, comfort and efficiency of urban life. It will take a major commitment of resources even to understand

quantitatively a system like the city and the sky—with the interacting elements involving meteorology, medicine and public health, aesthetics, socio-economic elements, engineering—just to name a few of the key features. Moreover, these elements are interacting in a highly non-linear fashion. Still further, each element is competing, and each is sometimes dominant in the scene—as is so true of the very dynamics of the atmospheric system itself.

Tough corrective steps are needed to reverse the present drift. And this is true if we look even at the isolated instances of specific cities like, for example, the megalopolis of Bosnywash. It will make major call on our total intellectual resources to understand and to reverse the elements aggressively destroying the atmospheric purity of this rapidly merging urban center that begins north of Boston and ends south of Washington. And it will also make major call on our pocketbooks if we decide to do anything but simply talk about it.

The fiendish complexity of the problem can be seen in only a few of the kinds of questions that must be answered, such as:

How long can we afford internal combustion engines in private cars in Bosnywash?

What must be done to halt the increasing pollution from Northern New Jersey's industrial concentration?

Must we switch heating and power-generating fuels for New York City, Philadelphia, Baltimore?

In the year 2000 A.D., with over fifty percent higher population in American urban areas, what levels of pollution will be tolerable? What levels will optimize public benefit in the light of the interactions among people, cars, public transportation, urban dwelling density, house heating, outdoor recreation, etc.?

As if this were not sufficient challenge, let me turn to another, clearly more speculative, aspect of the goal of mastery of our atmospheric environment for the benefit of all.

CAN WE INFLUENCE CLIMATE?

What about climate control? What are the causes of climatic change? We know, of course, that spectacular changes of climate have occurred—like the change in 550 B.C. when the growing season appears to have shortened drastically, giving rise, perhaps, to the legend of the *Twilight of the Gods*. And we know that around the time of Shakespeare's birth the climate of northern Europe, particularly England and Scandinavia, worsened markedly. And we know that between 1900 and 1950 in the northeast portion of the United States average temperature rose, perhaps by as much as two and one-half degrees Fahrenheit. Why? And are these changes controllable? One would tend, and probably be right, to say *no*, they are not controllable. Surely the forces are too great! But can we be sure?

For about a week at least, this month, I am convinced that there was, over a substantial part of the United States from the Rocky Mountains east, a persistent high cirrus cloud cover. And I am also convinced from watching the sky over Boulder, and from observations during a couple of trips I had to take to the East during this time, that a major fraction, perhaps all, of this cirrus cloud found its immediate origin in airplane jet vapor trails. I have a couple of quite striking photographs showing these as they appeared in Boulder. What degree of radiative influence did these cirrus clouds have on the thermal balance of the atmosphere? Were the temperature changes sufficient to have subsequent influences of major proportions on the weather? If the airplanes had not been flying through the region, would the cirrus clouds have formed anyway? These are questions to which we do not know the answers. But the cirrus blanket was probably a significant modifier of the heat sources and sinks of this period, and thus of the weather.

Perhaps, through this mechanism, we are already modifying the atmosphere, unknowingly and on a large scale, as we clearly are doing already on the city scale. Indeed, can we be sure that city-scale modification is simply city-scale? Or are the atmospheric solids and gases put in over the city bringing changes on a larger scale? The relative abundance of carbon dioxide is clearly rising in the atmosphere, almost certainly through man's intervention. But no one seems at all secure what this is doing to the climate.

Or to turn to another question. Are man's inadvertent weather modification activities all detrimental, as they seem to be on the city scale? Or have we possibly improved the available rainfall in some water-poor regions (or just the opposite)? Or have we done nothing? These are all questions where the stakes of being right are large, and the scientific basis for giving authoriative answers is today small—distressingly small!

ABANDON THE IVORY TOWER

What does all this mean? To me it means, quite clearly, that the atmospheric sciences must, first and foremost, grow in the scale and, even more importantly, in the quality of work carried on. The problems that we are attacking are among the most challenging facing physical science. They make nuclear physics look easy. The best of modern physical science may not even be good enough.

We must recruit students who are the best, and are trained to a sufficiently skilled level in mathematics and fundamental physics so that they can appreciate the full challenge of the underlying scientific problems, and contribute forcefully to their solution.

Moreover, we must devote ourselves more effectively to socio-economic analyses and to consideration of engineering aspects. And above all, to return to that key phrase, "to master our environment," the atmospheric sciences must emerge from the ivory tower. I applaud the way ESSA and the Bureau of Reclamation have chosen to undertake their responsibilities in application. NCAR has a responsibility in this field, too, and will take it. Coming down from the ivory tower means helping to develop practicable techniques arising from current knowledge; and it means teaming up to search out missing bits of knowledge whose absence stands in the way of solving large and important problems. Moreover, it means lending our support and encouragement to public officials, agencies, and legislative bodies who see the need to act to conserve and to use our atmospheric resources. There are, it seems to me, a number of problems—some of them connected to the air pollution dangers I have mentioned—where we already have the knowledge to start actually to alleviate the menace. In some communities, Los Angeles, for example, citizen groups have been trying to mount an effective attack on smog for more than a decade. It is time for all of us in the atmospheric sciences to join our colleagues who are already in the thick of these and other efforts. There is no reason why our efforts to arm the public with useful information should fail, if the effort is vigorous and constant.

NEED FOR LARGER CONCEPTS

Our concept of the proper scale of activity in the atmospheric sciences must also enlarge. We must face up, for example, to the need for creating a system for world weather observations, first experimentally and probably ultimately as an operating system. Ninety per cent of the surface of the earth now gets inadequate or negligible meteorological coverage. But we *must* observe these regions if we are to realize the fullest possible gains in weather forecasting or if we are to experiment realistically, but safely, by means of computer-simulated global weather modification. And we must insist that experiments in nature be deferred until we can assure that their consequences are known, and beneficial. There is much homework to be done before we are at this stage of progress. A first step, however, is for us to respond affirmatively to the recommendations of the National Academy of Science's report that Jule Charney of MIT has so ably offered. We must, indeed, be ready for a whole range of large, logistically complex research and development efforts of global scale and global importance.

The time has come for us to move vigorously to the exploitation of the kinds of advanced technologies that have been discussed in the symposium here—including the use of lasers, the use of airborne and satellite-borne radars, and the use of advanced satellite measuring techniques. We of the university community must more effectively join forces with ESSA and with NASA in using these new tools to wrest from nature the secrets that underlie the more effective exploitation of atmospheric science.

A sense of mission is, above all, the matter we must give attention to. We must join in that "free and natural alliance" without which we cannot solve problems of such complexity as those we are facing. These problems require a level of effort that will not be easily achieved, and we must sustain this effort not for just a few years, but at least a few decades. But we must find the way to do it. And, if we perserve, perhaps in 10 or 20 or 30 years, we will see the realization of at least a part of the goal we now visualize: mastery of our atmospheric environment for the benefit of all mankind.

Dr. ROBERTS. Now, if we can turn out the lights I hope will be able to see this.

(Showing of the film.)

You can see the pollution blowing to the left with the clouds up above blowing in a rather strong wind, and you can now see the pollution coming toward the camera, which is moving upstream against the wind. The very clear part down to the university dormitory, which is the central feature in the center picture, the very clear part is still swept out by the strong air, but the pollution behind is gradually moving forward against the wind and slowing a little bit to the left and a little bit to the right.

Now you can see the pollution level rather generally growing in the foreground and beginning to overflow those dormitories even though the wind is probably 25 or 30 miles per hour, just a little bit above the level of the top of that building.

This is not an unusual case. Boulder is not a city with unusually heavy pollution, but it does have it and it will persist, in an isolated drainage basin like this, even in the face of fairly strong winds aloft.

Thank you. (End of film.)

I am sorry the light wasn't better because under good light conditions you see many striking details.

Senator MUSKIE. This is one aspect of the problem that we haven't had at all documented in our hearings. I wish there were some way of putting that motion picture in the hearing record, but I guess we can't.

Let's hear our other witnesses.

Dr. ROBERTS. Our second one is going to be Dr. Richard Cadle, who is head of our Department of Chemistry and Microphysics.

STATEMENT OF DR. RICHARD D. CADLE, HEAD, CHEMISTRY AND MICROPHYSICS DEPARTMENT, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH, BOULDER, COLO.

Dr. CADLE. First, I would like to join Dr. Roberts in expressing my pleasure at having this opportunity to testify concerning air pollution before this Senate subcommittee.

In order to appreciate the role of nitrogen oxides in smog, which is what I am going to discuss primarily, it is important to differentiate between at least two types of smog. One type is little more than smoke mixed with air and is especially severe when the smoke particles serve as nuclei on which fog droplets condense. In fact, the word "smog" is a combination of the words "smoke" and "fog."

The other type, photochemical smog, is characterized by the presence of undesirable materials formed by the action of sunlight on a mixture of organic compounds, oxides of nitrogen and air. These materials are largely responsible for the eye irritation, visibility decrease, and plant damage produced by such smog. Actually, the smog in most cities is a combination of these two types. In Los Angeles it may be as much as 90 percent photochemical while in Denver it may consist of about 50 percent of each type. I notice that 60 percent photochemical was the figure for Denver mentioned earlier this morning.

Considerable evidence exists that smog of the type that is primarily smoke is decreasing in importance compared with photochemical smog. Perhaps part of this decrease is not real but only apparent, resulting from the development of more sensitive methods of rec-

ognizing photochemical smog. However, much of it is real and is the result of several trends. One of these, of course, is the increasing use of automobiles. Another is the trend in heating equipment away from coal, which is a smoke producer, generally, and toward oil-fired and gas-fired furnaces, which are cleaner, so far as smoke is concerned.

I have a slide (table I) that is an example of this. It is a little small to see it from this distance, but this has to do with the sale of central heating equipment, actually automatic equipment, during the decade of the 1950's. The first row shows the increase in the use of gas-fired warm-air furnaces—excuse me, this is in the back of the testimony, and so is the figure that I will refer to in just a moment. The sale of oil-fired furnaces first increased during this decade, than there was possibly a slight decrease. On the other hand, the sale of coal stokers, which constitute the automatic way of utilizing coal for home heaters, decreased very markedly during this period. As I say, this is just an example.

TABLE I.—*Sales of central heating equipment (units)*[1]

	1950	1955	1959
Gas-fired warm air furnaces	600,000	870,000	1,000,000
Oil-fired furnaces	160,000	370,000	340,000
Coal stokers	20,000	13,000	12,000

[1] Gas Appliance Manufacturers Association, Inc., "GAMA Statistical Highlights, 10 Year Summary, 1950–59." New York, 1960.

A third trend in the increasing control of effluents from various industrial operations.

Nitrogen oxides probably contribute much more to the unpleasant properties of photochemical smog than to those of the smoke type. Two of the many oxides of nitrogen seem to be particularly important; namely, nitric oxide (NO) and nitrogen dioxide (NO_2). The oxides of nitrogen, when first emitted as pollutants to the air, consist largely of nitric oxide but in the presence of (1) air, (2) organic vapors, (3) a trace of nitrogen dioxide, and (4) sunlight, the nitric oxide is rapidly converted to nitrogen dioxide. The latter absorbs sunlight and triggers the chain of chemical reactions that produce the smog. These reactions are summarized in Figure I.

FIGURE I.—Summary of Photochemical Smog Reactions

Sunlight
+
Unburned gasoline vapor
+
Nitrogen oxides
+
Air
↓
Photochemical Smog

In addition to triggering the photochemical reactions, nitrogen dioxide apparently undergoes reactions with fragments of organic compounds to form the group of substances known as "PAN," probably peroxyacyl nitrates. Several substances in photochemical smog, acting together, are probably responsible for the eye irritation that is produced; PAN is one of these. PAN is also partially responsible for the plant damage produced.

Most of the decrease in visibility caused by photochemical smog results from the scattering of light by the myriads of particles it contains. The particles are sufficiently small that the scattered light often has a blue and the transmitted light a yellow-brown cast. Recent calculations suggest that the nitrogen dioxide, which is brown, may contribute to the color of the transmitted light.

Nitrogen dioxide itself is a poisonous gas, and while not acutely harmful at the concentrations existing in smog, its possible chronic effects are unknown. The smog reactions scavenge the oxides of nitrogen and decrease their concentration. It is conceivable that attempting to decrease smog by decreasing the emission of organic vapors, such as the hydrocarbons in automobile exhaust gases, without decreasing the emissions of nitric oxide, may actually be harmful. However, the importance of this effect can only be evaluated after comparisons are made of the relative undesirability of nitrogen oxides and organic nitrogen compounds such as PAN in the air we breathe. A good deal of further research is needed at this very point in the matter.

Although automobiles emit most of the hydrocarbons polluting the air of a city such as Los Angeles, less than half of the nitric oxide is emitted from this source. The larger fraction of the nitric oxide comes from various combustion processes such as backyard incinerators, home furnaces, power plants, and blast furnaces.

Almost all of this nitric oxide is produced by "fixation" of the nitrogen of the air rather than from organic nitrogen compounds in the fuels. Nitrogen fixation is the result of a chemical reaction between the nitrogen and oxygen of the air to form nitric oxide. This reaction can only occur to an appreciable extent at relatively high temperatures; the higher the temperature the greater the conversion. For example, at 2,400° C (4,352° F) (and, incidentally, this is about the maximum temperature in the combustion zone of an automobile) the equilibrium concentration of nitric oxide is 2.33 percent by volume, while at 3,200° C (5,780° F) it is 4.4 percent by volume. Thus the percentage conversion to nitric oxide in a flame, which often has a temperature of about 1,000° C (1,832° F), is quite small but very important.

The rate at which the equilibrium is achieved is also temperature dependent. It is very rapid in a flame but is so slow at room temperature that nitric oxide stored in sealed tubes for tens of years was found to have undergone no measurable decomposition. When air containing nitric oxide leaves a flame, including the explosion flame of an automobile cylinder, it is cooled sufficiently rapidly that the nitric oxide does not have time to decompose completely before reaching its usual metastable state at or near room temperature. One method which has been proposed for ridding automobile exhaust gases of nitric oxide is to pass them while still warm over a suitable catalyst. Since all catalysts, for all chemical reactions, act by increasing the rate at which

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chemical equilibrium is achieved, such a catalyst hastens the decomposition of the nitric oxide during the cooling. I understand that appropriate catalytic devices for this purpose are now under development. They would, of course, have to be used in addition to the afterburners for removing hydrocarbons.

A technique which has been tested in the laboratory for greatly decreasing the formation of nitric oxide in the cylinders of automobiles involves water injection. This lowers the combustion temperature in the cylinder and thus the amount of nitric oxide formed. Unfortunately, it also decreases the engine efficiency. A 90 percent decrease in nitric oxide production has been achieved with a 10 percent reduction in efficiency. Of course, there is also the problem of including a water supply in the automobile, although the water can be added as an emulsion in the gasoline.

Even if nitric oxide is removed from automobile exhaust gases, the additional sources still need to be considered. Backyard incineration and other trash burning can be eliminated by cut-and-fill and composting techniques. However, other combustion processes, such as home heating and industrial power sources, are more difficult to control. Use of atomic energy and water power to produce electricity, combined with the use of the latter for home heating, would go a long way toward preventing the discharge of nitric oxide into our city air.

It is important, also, to consider the ultimate fate of the nitric oxide if it does not become part of organic compounds during the photochemical smog reactions. The nitric oxide (NO), as mentioned earlier, is rapidly converted to nitrogen dioxide (NO_2) and unless removed in other ways this is slowly oxidized by ozone to nitrogen pentoxide (N_2O_5). The latter reacts very rapidly with water vapor of the air to form nitric acid in vapor form. Ultimately, of course, the nitric acid is washed out of the air by rain or is removed by absorption on surfaces. Its lifetime in the atmosphere before this happens is probably a few days to several weeks. Nitric acid, like nitrogen dioxide, is very toxic though not acutely so at the concentrations considered here. Also, it is highly corrosive, and can probably cause damage over a long time period even at the concentrations that might occur in smoggy air.

An extremely important question is the extent to which pollution must be reduced in a given region so that it will not be apparent in any of its manifestations, even under the most unfavorable meteorological conditions, except possibly to an expert. Obviously such a question cannot be answered precisely, and the answer will vary with the region. Based on my own experience in Los Angeles, it is my opinion that it would be necessary to decrease the emission of all major pollutants by at least 85 percent in that city.

Very drastic measures would have to be taken in most metropolitan areas to achieve such a goal. Control devices currently used on or planned for automobiles are entirely inadequate and in fact, if private vehicles were to be retained it might be necessary to use electric motors. Public transportation might completely replace private transportation. I seriously doubt whether either of the above approaches could be achieved without extremely restrictive legislation concerning the use of automobiles. Conceivably, nonpolluting vehicles could be issued special license plates and only vehicles carrying such plates

would be admitted into certain metropolitan areas. In this connection it is important to realize that the exhaust gases of automobiles contain very large concentrations of particles, as Dr. Lodge will discuss in more detail, and that even if automobiles emitted no carbon monoxide, hydrocarbons, or oxides of nitrogen they would still produce some smog.

As indicated above, control of autombile emissions alone will not achieve the degree of cleanliness I have described. Even gas-fired furnaces produce oxides of nitrogen and huge numbers of sub-microscopic particles. An essentially combustion-free economy (using, for example, atomic energy for power) might be required.

Such drastic cleaning up of our cities should probably only be attempted in conjunction with broad urban planning. For example, places of work and shopping might be located as close as reasonable to homes so as to decrease transportation requirements. Many downtown streets might be converted into traffic-free plazas.

This goal is obviously an ideal, and various degrees of approach to this ideal can be achieved. Quite possibly the sacrifice of money and freedom to go all the way will not be considered desirable, and most persons will want to tolerate some smog in order to have greater freedom. Some difficult choices and compromises must be made.

Senator MUSKIE. Might I ask one or two questions? First of all, it had been suggested, although not urged, that because of the topographical conditions and sunshine conditions in the Los Angeles area, that conceivably automobile exhaust controls might be justified for that area that you couldn't justify in other parts of the country. Would you want to react to that?

Dr. CADLE. Well, in the first place, photochemical smog is being observed, is being detected, in most parts of the United States. It has even been detected in small towns along highways where there is a large amount of traffic. I think, therefore, that if we want to clean up smog to a major extent, that this type of smog will have to be reduced all over the country, not just in Los Angeles.

Senator MUSKIE. As I read your paper, you feel there is now demonstrable damage from the oxides of nitrogen to plant life, but that the concentrations are not such as to have a direct impact on health, that is, a toxic effect on health.

Dr. CADLE. This just isn't known. What I mean or intended to state is that the oxides of nitrogen are not toxic in the sense that they poison people over a very short period of time in the same sense that a very heavy dose of some poisonous gas would do. On the other hand, over a long period of time there may very well be serious toxic effects, chronic effects.

In addition to this, and I didn't mention it in here, there have been a number of instances where a combination of oxides of nitrogen, sulfur dioxide and other substances have produced acute effects on people who were particularly susceptible. The Donora, Pa., episode and the Meuse Valley in Belgium episode are examples of this.

Senator MUSKIE. There have been comments in connection with control of emission of hydrocarbons from automobiles that the high temperatures involved have increased the production of oxides of nitrogen from automobiles. Do you think that the dangers involved in that increased production of oxides of nitrogen is such we ought

to discontinue the controls on hydrocarbons until we have found some means of controlling both?

Dr. CADLE. I don't know and I don't think anyone really knows. Most of the comments that have been made with regard to oxides of nitrogen versus hydrocarbons and the dangers in removing one without the other are really little more than speculation. They are what may be the situation but the research to see whether there are really dangers inherent in this approach hasn't been undertaken.

Senator MUSKIE. I guess we have got to take the gavel, then, on whether we ought to retain the controls on hydrocarbons.

Did you want to ask some questions?

Senator DOMINICK. No; that was the point I wanted to get to.

Senator MUSKIE. There is a divergence on this point?

Dr. CADLE. Oh, yes; very definitely.

Senator MUSKIE. The automobile manufacturers feel there is no demonstrable proof that oxides of nitrogen are harmful. I don't know that they would accept what you say.

Dr. CADLE. There certainly is extremely strong evidence, if not proof, that the oxides of nitrogen trigger the photochemical smog reaction. So, in a sense, they are responsible or largely responsible for all of the products that one winds up with in photochemical smog.

Senator MUSKIE. The question is whether you ought to take a little eye irritation in order to keep the automobile. I am putting this in the context of what I think the manufacturers would tell us.

Can we have our next witness, and then maybe we will have the subject opened up for questions thoroughly.

Dr. ROBERTS. Our next person to speak is James P. Lodge, staff chemist at NCAR.

STATEMENT OF DR. JAMES P. LODGE, JR., STAFF CHEMIST, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Dr. LODGE. Senator Muskie, Senator Dominick, it is a great pleasure for me, also, to be here. It was a great pleasure to meet Senator Muskie and hear his speech at the National Conference on Air Pollution in December, and I am very glad to have the opportunity to make some remarks here at this time.

It is scarcely news to anyone today that photochemical "smog" has the automobile as its largest single cause, and that its symptoms include damage to plants, eye irritation in humans, and haze which restricts visibility.

Unfortunately, data are not available in a form which permits easy evaluation of the effect of exhaust particles. However, it is possible to get a feeling for the importance of the particles by some computations based on available published statistics.

Measurements made in Los Angeles in the early 1950's showed that nearly 15 percent of the gasoline put into automobile tanks escaped through the exhause pipe as unburned hydrocarbon. Successive studies have shown progressively lower levels of hydrocarbon emissions, until now two recent sets of data show between 2 and 3 percent of the fuel escaping unburned by this route. This change is probably real, and results from improvements in the automobile engine. Over the

same period, particulate emissions seem to have decreased by no more than a factor of 3, and are about 0.2 percent of the weight of the fuel. Of this, about 10 percent is lead.

However, the point to note here is that the weight of emitted particulate matter is nearly one-tenth of the weight of the unburned hydrocarbons. Of these hydrocarbons, about half are reactive in the formation of photochemical "smog," while the other half are inert and have little importance in photochemical air pollution. Hydrocarbons which do react do so in a number of ways, only one of which is the formation of the aerosols which make the pollution visible. The precise proportion of hydrocarbon entering into aerosol formation is apparently not known and is probably variable with conditions.

However, it seems evident from the above figures that the mass of aerosol formed in the "smog" reaction is not very different from the mass of aerosol emitted by cars directly. To put it another way: if we could stop photochemical pollution completely, we should have solved only half of the problem, so far as visible pollution, and the decrease of visibilty by pollution, are concerned.

Diesel smoke has been mentioned previously. A diesel engine is inherently smokier than a gasoline engine, emitting nearly ten times as much particulate matter per unit weight of fuel, together with half as much hydrocarbon and twice as much nitrogen oxides. However, the total consumption of diesel fuel is only about one-sixtieth of that of gasoline, so that, however, annoying the diesel may be locally, its overall contribution is fairly small.

Fuel additives for the reduction of pollution have been little used—and apparently little studied—in the United States, although they are required by law in several European countries. Little information on them is available in the open literature. They are primarily intended to suppress diesel smoke, and the only American study in print claims to see little effect. This may be caused by the American practice of rating diesel engines as more powerful than the same engines would be rated in Europe; we load the engines more heavily. Incidentally, a simple derating of our diesels would substantially decrease their smokiness.

Another class of additives, which improve gasoline quality, actually contribute to pollution—an example is tetraethyl lead. Lead emissions from cars have been accused of many crimes. Those accusations which have any basis in fact fall into three categories: direct toxicity, ecologic upset, and weather modification.

Direct toxicity is a proven fact for a few highly exposed people, but proof is lacking with regard to the general populace. It is probably inconsequential now, but will almost certainly be a problem in the future if the auto population and the lead content of gasoline both increase substantially. Ecologic upset refers to the possibility that some organism—plant or animal, land or aquatic—may concentrate lead, poisoning other organisms that feed on it, and that as a result some sizable segment of the balance of nature may be upset. This is certainly possible, but quite unproven.

Since iodine is known to exist in the atmosphere, and lead iodide is known to be a good laboratory cloud-seeding agent, it has recently been suggested that lead emissions may modify our weather. The unresolved

point is not whether lead and iodine exist in the atmosphere, nor whether they react together at the concentrations used in the laboratory, but whether they can react rapidly enough at the very low concentrations found in air for lead iodide to form before the lead is washed out. Lead in air occurs at concentrations of parts per billion, iodine at parts per trillion.

While urban atmospheres sometimes are found to contain cloud-seeding agents, these are generally traceable to specific metallurgical industries. The suggestion that lead may modify weather cannot be dismissed totally, but it does not appear to be a pressing problem compared with possible ecologic disturbance.

Other substances than lead are now being considered as additives. Before they are introduced widely, their pollution consequences need to be thought out, and their natural occurrence determined so that adverse effects can be detected with more ease than is now true of lead.

The question of whether lead and iodine react rapidly enough for significant amounts of lead iodide to accumulate in air brings up the whole problem of atmospheric reactions, a key question in air pollution. One frequently hears of the concept of "airshed management," without evidence that this has been thought through to its conclusion. One authority has phrased the idea as the creation of "giant smoking rooms for industry."

Airsheds—contiguous areas sharing a common body of air—do exist. These are far less well defined than watersheds. After all, "The wind bloweth where it listeth," and an arrangement of pollutant sources which practically never causes trouble is still unacceptable if once a century it fails and kills the total population of a city. This is an extreme case, but it makes the point that the idea of airsheds is a probabilistic one, not an absolute geographical separation.

Even allowing for the fact that airsheds are not always the same, people have to exist in all of them. While it is possible, at least in theory, to abandon some rivers to pollution, no part of the air can be rendered uninhabitable by man. Yet the air is a legitimate medium for the disposal and dispersal of wastes, so long as the self-purification powers of the atmosphere are not overtaxed.

We need to be able to design our use of the air to make optimum use of its ability to assimilate wastes, without putting the atmosphere of any particular airshed up to a dangerous pollution level. Obviously, we need better knowledge of (1) what constitutes a dangerous level—research around the world is attacking this problem—and (2) the rates at which different pollutants are removed from the atmosphere, in order to plan where and when more material can be safely added. Without research along both these lines, there is a real danger in continuing to increase our discharges into the atmosphere.

One major obstacle to expanding research in both areas is lack of analytical methods to measure pollutants at the concentrations at which they occur in the atmosphere. Development of such methods is one of the research activities at the National Center for Atmospheric Research which is most directly applicable to air pollution problems.

We have discovered, adapted, modified, and/or validated a number of techniques for collecting and measuring trace gases of such sensitivity that we have used them to measure, for the first time, the nitrogen oxides in the atmosphere of tropical jungles, and the formaldehyde

content of the air of Antarctica. Although the choice of these locations is clearly not motivated by considerations of air pollution, such methods are more than sensitive enough for studies of the lifetimes of these same substances in the airsheds of the United States. Furthermore, the fact that we have been able to use these methods under primitive conditions in such remote places indicates that they are relatively simple to perform.

We have also concerned ourselves with the nature of the fine particles present in air. These are as diverse as the gases, and at least as important. Many pollutant gases are removed from the air by reactions which first transform them into particles which are then washed out by rain or trapped out by trees.

We have shown that, after suitable treatment, sulfuric acid droplets weighing as little as 10^{-15} gram may be identified by their characteristic appearance in the electron microscope. Phosphoric acid and phosphates can also be recognized on sight.

Formaldehyde which is held on particles may be distinguished from gaseous formaldehyde. Chloride and sulfate can also be measured in individual particles.

Another activity directly related to the problem of smog is an investigation of chemical reactions occurring in the photochemical variety. As Dr. Cadle indicated, the reactions that trigger such smog are well known and the end products are fairly well known, but the nature of the intermediate reactions producing these end products is little more than educated guesses. We are now investigating these intermediate reactions in the hope that by understanding them we will be in a better position to suggest measures which might diminish or interrupt these reactions.

Thank you.

Senator MUSKIE. I take it that your common attitude is that we cannot assume that the discharge of any pollutant in the atmosphere is safe. Our objective ought to be to reduce these emissions as rapidly as technology makes possible or as rapidly as we are assured that a particular pollutant isn't harmful. Is there any evidence of the accumulation in the atmosphere of residual bodies or pollutants?

Dr. ROBERTS. You are talking about long term, like years, so on?

Senator MUSKIE. Yes.

Dr. ROBERTS. There is evidence that the total amount of carbon dioxide in the atmosphere is rising by something like one-half of 1 percent per year, and this is very significant for the temperature balance of the earth, the amount of heat radiated in space is affected by the total carbon dioxide concept which changes the amount of blanketing in the atmosphere. But there is no evidence, that I know of, at least, that there is any health hazard involved in any pollutant that remains in the atmosphere a long time. Maybe my colleagues would have additional comment to make on that.

Dr. CADLE. Radioactive fallout, which is a form of air pollution, certainly remains for a long time and can't be dismissed as being harmless.

Dr. ROBERTS. Yes; radioactivity, to be sure. I think one of Dr. Lodge's important points is that in order to know how safe a particular pollutant is and how much the atmosphere could be used as a dispersal means for these pollutants, we must know more about the life cycle of

each of these pollutants in the atmosphere. We must know more about the extremes that will occasionally occur in the concentration of these pollutants, and while, to be sure, we are faced with the immediate engineering decisions now as to what things to control, there is a great deal more research that needs to be done so that the control measures of 1980 and 1990 will be soundly based and they will have to be more stringent at these later times.

Dr. LODGE. I think I might add one comment. There are several other substances that one can convince himself might well be accumulating. Carbon monoxide would be one example here. The trouble is that we do not have a long enough run of historical data to know, and one of the things I have been quite strongly speaking in favor of is the establishment of some atmosphere chemical observatories, worldwide, to determine some of these substances on a continuing basis so that we can be certain whether or not they are accumulating.

Senator MUSKIE. We have had some testimony, I think last year, in hearings on lead, that the snows of the Arctic and the Antarctic show an accumulation of lead in the atmosphere. So this may be taking place without our knowledge because of lack of research. That is one question, whether or not if you were to shut off all sources of pollution we would have built up an accumulation of pollutants in the atmosphere that it would be difficult or impossible to eliminate. But then there is this other question, which is a different one; that is, whether or not the concentrations of pollutants in particular areas tend to build up in a way that does not decrease. In other words, is there this kind of an accumulation, assuming the on-going character of pollution discharges in a particular area?

Dr. ROBERTS. It is important to remember that it takes a parcel of air only a week or some weeks to travel completely around the world in the intermediate levels like at the bottom of the stratosphere or the top of the cloud and rainfall region of the atmosphere. So that the mixing is reasonably rapid compared to the lifetimes of some of the things that are put into the atmosphere, and one would expect, for example, that the carbon dioxide is almost completely mixed. The things that would rain out or react out of the atmosphere in a matter of 3 or 4 days will come in gobs and bunches as the eddies begin to swirl over different regions. If you have ever been recently to the city of Geneva in Switzerland (and I mention it only as one for there are many such instances), you see, on occasion, very severe pollution in winter, in January and February, over that beautiful lake, and a good deal of that pollution has drifted in from very considerably further west. At other times there is no trace of it.

Senator MUSKIE. Over how much of a distance can pollutants be discharged from one area into another?

Dr. ROBERTS. It depends a little bit on what the pollutant is, but in instances, thousands of miles. I traced on one particular occasion a plume of smoke with cloud particles forming on it that went to Chicago, almost to Washington, D.C., for example, and that is mentioned in the paper that I gave you. It is possible to have some substances also concentrated by the temperature structure of the atmosphere so that they sit in a little pocket under a certain wind condition and concentrate very, very significantly. That is what the dormitory incident was.

Senator MUSKIE. Or in the case of the motion picture here.

Dr. CADLE. May I comment on that just a moment?

Senator MUSKIE. Yes.

Dr. CADLE. Many people who are concerned with such questions like to speak in terms of half lives, and the half lives for most substances that are emitted from the atmosphere are of the order of days or weeks at the most. So that while one cannot quite properly speak of an overall lifetime, because one, in effect, is continuing to cut the concentrations in half, in a matter of a few weeks or, at most, a few months, even on a worldwide basis, most substances will have been to all practical purposes completely removed.

Now, in the case of carbon dioxide or sulfur dioxide, concentrations are probably building up in the atmosphere because there are more or less continuous sources of these things, but from the standpoint of a particular basin, such as Los Angeles, which may have a smog incidence, meteorological conditions conducive to smog, for a few days, after these conditions disappear, then the lifetime or, let's say half life of what it accumulated is probably just a few hours, or at the very most a couple of days.

Senator DOMINICK. One thing I want to make sure for the record because it concerns me a little. First of all, Dr. Cadle said perhaps it is not a good idea to take hydrocarbons out of the automobile exhaust, and then Dr. Lodge indicated that perhaps we ought to find out more about the makeup of the air and the reaction of any kind of pollutant emitted into the air. I gather, however, that you don't feel that even though these things should be done, that we ought to stop control methods now, you still think we ought to go forward?

Dr. ROBERTS. Yes, we think control measures must be taken now, and that, in addition, we must determine how these things interact together, because even subtler means of control may be required. But I don't think a single one of us would feel that we should relax the control measures on either the one or the other component at the present time.

Senator DOMINICK. Do you also agree at this point that the major source of pollution which we call smog in popular terms, lay terms, is from internal combustion engines?

Dr. ROBERTS. I think we agree this is the case in certain regions like Los Angeles and perhaps at certain times in New York. Maybe, Jim, you would like to say a word about that.

Dr. LODGE. This is certainly the largest single category of trouble, there is no question about that, especially if you take a rather broad view of the question. If you will remember, the article on air pollution in Fortune lumped all transportation together and attributed about three-quarters of all pollution to it. So in this sort of terms I think there is no question. On the other hand, certainly there are individual areas in which a lone industry or something of this kind may quite swamp the automobile in effect. Obviously, what has happened in Los Angeles, what is happening in Denver and elsewhere as well, is that local effort is controlling the stationary sources so that the mobile sources become increasingly more important.

Dr. ROBERTS. It is interesting in cities where the stationary sources have not been adequately controlled, how serious the trouble can be.

I visited one foreign country recently where, interestingly enough, there were no controls of the stationary sources of smoke in its major city. The level of pollution produced there at certain times by the industry sources was, I was told, higher than anything I have ever seen here in this country. The automobile there, of course, is contributing nothing, practically, so it is clear that stationary sources can be very serious.

Senator DOMINICK. One other question and comment on one of the things that you said, Dr. Roberts, and that is, as most of you know, I have done a lot of private flying. It has become apparent at this point, at least in the eastern portion of the country, you are going to have to have an instrument license if you are going to fly, even on a good day, because the haze is so bad you can't see anything. I am concerned as to whether this is because this is the rear end of the sewer that you referred to, or as to whether this is being produced by the industries and the concentration of traffic and people right there. In other words, could you cut out all the industrial pollution, could you cut out all the automobiles, and still find this condition existing?

Dr. ROBERTS. That is a difficult question, but certainly the local contribution is substantial; the air to which the contribution is being made is already reasonably heavily polluted. Maybe Cadle or Lodge would have more quantitative data. I suspect that if you cleaned up New York, well, my city, Bosnywash, if you cleaned that up completely, you would still have a substantial haze from the contributions from the rest of the country over these cities on many occasions.

Senator DOMINICK. Could you give me any kind of guesstimate at all? Let's suppose an instance that the sun stops, or in a different type of way let's say the sun doesn't stop but everything stops in this country, all industrial activities, all automobiles, all internal combustion engines, so on, nothing is being emitted at all except people's breath, how long would it take to clear up the atmosphere in that kind of a situation?

Dr. ROBERTS. This is an interesting question we have discussed a good deal. Probably it would be a relatively short time after all activity is cut off until the air is very clean of objectionable pollutants. Some things, like carbon dioxide, have a very long residence time, would not wash out but are not objectionable, the air would be clean, and would become so very quickly, like a few weeks or 10 days maybe. There are, of course, as I have mentioned, natural sources of pollution. Plant terpenes produce, for example, a blue haze in the Great Smokies. These occurred long before man was modifying the continent at all, they are known in the legends of the Indians, the earliest explorers here saw these hazes, and as we know, of course, there are occasions when tremendous amounts of pollution are produced by desert dust blowing in the air or by a change of climate which causes soil to blow in the air. So the air would never be completely free of pollution even if we shut off all of man's activities on earth. The planet Mars, which probably has no life at all, has an enormous amount of atmospheric pollution.

Senator MUSKIE. I guess we better cancel that target.

Dr. ROBERTS. I should say you can see quite often 300 miles downwind of New York. As you come in in an airplane from Europe in the

late afternoon you can see the definite evidence that the pollution is almost entirely manmade, and from the United States.

Senator MUSKIE. Really, to cap Senator Dominick's question, which I think is an excellent way to pinpoint the problem, what we are really struggling with is the price of our past technological advance. You just can't turn off all these pollutant sources. We have built our society and we have built our way of life and our standard of living, into them, and we did it rather carelessly, without thinking of the consequences. We thought we had plenty of places to throw things away, as you put it in the early paragraphs of your statement. But now we can't turn these things off, we can't accept the consequences of turning them off. So now we have to try to build into our economy and our technology the controlling mechanisms which will correct our past mistakes. We ought also, at the very minimum, begin to avoid contributing additional pollutant sources without effective control. I think that is the sum and substance of the problem.

Senator DOMINICK. There is one more question I would like to add on to what I have just posed. That is, let's suppose we did declare an armistice worldwide on anything going into the air except breath.

Senator MUSKIE. There is some breath that would pollute.

Senator DOMINICK. You see it in our TV ads all the time. Let's suppose we cleaned it out, the way we were referring to before, and then we started up again. Would we have less pollution as a result of that one major cleaning out period then we now have, after we started up?

Dr. ROBERTS. No; I think probably not. If we were to shut it off, let's say for a month, at the end of the month we would be back to conditions very much like those that existed long before there was any development of industry, major development of industry, in the world, we would be back to the level where natural forest fires and dust blowing from deserts, and so on, that would be very much less polluted than now; if we then turned it on, in something like 10 days we would be right back where we were. Would my colleagues agree with that?

Dr. CADLE. Absolutely. The lifetime of most pollutants of the air is very short, a matter of days or weeks.

Senator MUSKIE. Gentlemen, thank you very much for a very useful chapter in our hearing.

Our next witness is Mr. Clair H. Iverson, vice chairman, Air Pollution Variance Board, Colorado Department of Health.

STATEMENT OF CLAIR H. IVERSON, COLORADO DEPARTMENT OF HEALTH

Mr. IVERSON. Senator Muskie, Senator Dominick, what I have to say here in the beginning is largely to place into context the function of the State air pollution variance board.

It is hereby declared to be the policy of the State of Colorado to maintain a reasonable degree of purity of the air resources of the State, which shall be consistent with the public health, welfare, and public enjoyment thereof, the industrial development of the State, the propagation and protection of human, plant, and animal life, and the protection of physical property and other resources. To that end, it is the purpose of this act to require the use of all available practical methods to reduce, prevent, and control air pollution in the State of

Colorado, and to maintain a cooperative program between the State and local units of government. It is further declared that the prevention, abatement, and control of air pollution in this State are affected with a public interest and that the provisions of this act are enacted in the exercise of the police powers of this State for the purpose of protecting the health, peace, safety, and general welfare of the people of this State.

I have just quoted section 2 of the Colorado "Air Pollution Control Act."

I further quote from section 7 (1a and 1b):

There is hereby created, as a division of the State Department of Public Health, an Air Pollution Variance Board which shall consist of nine members appointed by the Governor, except as provided in paragraph (b)(i) of this subsection:

(b) The nine members of said Air Pollution Variance Board shall be:

(i) One member designated by the State Board of Health, to represent said Board in matters of air pollution in the interests of the public health of the people of the State.

(ii) One member shall be a registered professional engineer with at least five years' experience in the actual practice of his profession and who is not from industry.

(iii) One member, who is not from industry, shall be either a physician licensed to practice in this State or a toxicologist.

(iv) Three members from industry in this State.

(v) Three members, as representatives of the public at large, not from industry.

The charge to the variance board is contained in section 11(1) and (2), which I quote:

(1) The air pollution variance board may grant a variance, suspending or modifying the enforcement of any emission standard, or any rule, regulation, or enforcement order issued pursuant to this act against any person, whenever the said variance board shall determine that such variance would be consistent with, and aid in, implementing the legislative policy as set forth in section 2 of this act.

(2) The air pollution variance board shall grant a variance suspending or modifying the enforcement of any emission standard, or any rule, regulation, or enforcement order issued pursuant to this act against any persons, whenever the said variance board shall determine that strict compliance with any provision of, or order issued pursuant to, this act would result in an arbitrary and unreasonable taking of property or in the practical closing of any lawful business or activity, and such would be without sufficient corresponding public health.

This is the framework within which the variance board functions.

Since our appointment this board has accomplished the following:

A. Held public hearings in each of the four areas designated by the State board of health as not meeting the minimum air quality standards set forth in the law.

B. Held a public hearing to examine the opinions of members of the automobile salvage industry. A staff member from the Technical Assistance Branch, Division of Air Pollution (now the National Center for Air Pollution Control), appeared at the request of the board.

C. Held 32 variance hearings to date. Of these, one was with a steel producer, one institutional open burning operation, two with scrap electrical wire salvage firms, and 28 with firms in the automobile salvage industry. Nine variances were granted. Only one remains in effect today, and this firm is actively constructing facilities to bring its operations into compliance.

Senator MUSKIE. Twenty-three variances were not approved?

Mr. IVERSON. Correct.

Senator MUSKIE. Have those industries found it possible to continue operations?

Mr. IVERSON. They have not continued along the vein they did before the enactment of this law.

Senator MUSKIE. Have they found it possible to live with the requirements of both?

Mr. IVERSON. For a limited time; yes, sir.

D. Submitted to members of the State legislature a report listing suggested changes in the law. Of these, I would like to quote those which are significant to this hearing.

1. The Air Pollution Variance Board recommends that the legislature make no distinction between tax relief given for the construction and/or installation of air pollution and water pollution control systems.

We believe that capital expenditure by industry for the purpose of reducing air pollution is in the public interest. Therefore, we wish to place in the record that this board endorses the principle of tax relief for such expenditures, at not only State, but Federal and local levels as well.

2. (a) All new automobiles sold after January 1, 1968, in the State of Colorado should be equipped with air pollution exhaust control systems conforming to Federal law.

(b) A study should be made relative to inspecting techniques to insure proper operation of air pollution exhaust control systems on automobiles, and such inspections should be made a part of the State semi-annual automobile inspections now in effect.

(c) Any intentional effort to render an air pollution exhaust control system inoperative should be considered a misdemeanor.

In making this recommendation, the board recognized the following fundamental facts:

(I) Automotive emission sources constitute a major portion of air pollution and must be controlled.

(II) Any air pollution limiting control system required to be installed on an automotive vehicle would be of questionable value unless some means of insuring the continuity of its effectiveness is developed.

(III) The average automotive vehicle, because of its very nature, is continually involved in interstate transportation, and therefore is subject to multistate jurisdictions.

In view of the above, the board recommends the following:

(i) Universal emission standards for automotive pollution limiting systems should be established by the Federal Government.

(ii) Uniform inspection techniques and measuring devices should be prescribed by the Federal Government.

(iii) Inspection and enforcement of these standards should be the responsibility of the State in which the vehicle is licensed.

(iv) Adoption and enforcement of Federal automotive emissions standards, or more restrictive standards, should be required of all States.

Now I return to our recommendation to the legislature, the last one I will quote here.

3. Legislature should hold public hearings to determine if private industry will install acceptable means of disposing of junk automobile bodies. If this appears unlikely, the Legislature should consider a method by which the disposal could be implemented.

All interested parties should be aware that the Colorado law has created a dilemma insofar as the disposal of junk automobile bodies is concerned. At this time in Colorado, the only economical means of preparing junk automobile bodies for usable scrap iron is to burn all the combustible material out of the shell. This, however, is prohibited by the "open burning" provision, section 5(4)a of the Colorado law. Equipment for satisfactorily conducting this task is available, but in the present state of the art, is beyond the financial capability of individual enterprise. Although the board has granted six variances to auto salvage operators, all have expired. In an effort to encourage this industry to solve its own problems, the board has recently gone on record that it will grant no further variances to auto body burners unless unusual circumstances are presented. Yet the prospect of junk automobiles accumulating without disposal is frightening.

The Colorado Air Pollution Variance Board recognizes the gravity of the air-pollution problem. We have been charged with a part in the administration of a new, and relatively untried law. Our Air Pollution Control Act has been in effect since March 11, 1966. We have lived with it for 13 months and have found it, with a few minor exceptions, to be a good law, reflecting patient and careful consideration by those who drafted it. As experience and technology improve, our law will grow to encompass more types and number of pollutants, and the elimination of the few shortcomings.

While all air-pollution problems have certain factors in common, all differ by dimension and need. For this reason, we feel that just and effective administration of air-pollution statutes should be handled by that segment of government best able to assess local conditions and requirements. Therefore, this board subscribes to the principle that the lowest level of government capable of handling a given problem, be charged with that responsibility. State and local government should retain the right and responsibility to implement its air-pollution control program to achieve the air quality in keeping with its needs. Only when a jurisdiction cannot, or will not, meet its responsibilities should the next higher level of government assume control.

In keeping with these principles, this air pollution variance board pledges its efforts toward prudent administration of our law, to the end that the cleanest air practical will be realized with a minimum of economic dislocation.

I thank you.

Senator MUSKIE. Is any air-pollution situation in the State a source of care or likely to become a source of care as to require substantial

economic dislocation? In your judgment, is there any actual closing of industries?

Mr. IVERSON. Although not a major industry, the auto wrecking industry in the State of Colorado is a source of care and may suffer substantial economic dislocation, and actual closing of individual enterprises, before this problem is solved. The Colorado Association of Commerce and Industry is currently making a survey of those auto wrecking enterprises who have been issued cease-and-desist orders for the open burning of junk auto bodies to see how many of these have actually gone out of business. This information you will receive in due course. In my opinion, there are no other industries in this State which would be forced to close so long as the existing law is prudently administered.

Senator MUSKIE. So that in your judgment that provision of the law is not likely to be implemented in the foreseeable future?

Mr. IVERSON. Perhaps not.

Senator MUSKIE. I am not suggesting that as a goal, I am just trying to get an evaluation of the situation. Has there been any legislation in the State, either in terms of State and local taxation, to provide tax incentives to industry?

Mr. IVERSON. There is a bill before the legislature at the present time which would allow a State income tax credit in the amount of its general property taxes paid on pollution control property.

There are two bills before the senate. One would assess pollution control property at 5 percent of its actual value for purposes of local property taxes. The other would allow the amount of general property taxes paid on pollution control property as a credit against the State income tax.

Senator MUSKIE. Does Colorado have a sales and use tax?

Mr. IVERSON. Yes.

Senator MUSKIE. Are there any exceptions to that for equipment purchased for this purpose?

Mr. IVERSON. Not to my knowledge.

Senator MUSKIE. It would seem that would be another area of relief.

Mr. IVERSON. Could be.

Senator MUSKIE. When any new industry comes into my State it complains about the use tax, anyway, because this is a tax imposed before industries have made a dollar of profit and they would rather pay a corporate income tax than a use tax. So I think the use tax would be a good place, and I am speaking of my State now, possibly also Colorado, to provide some exceptions for industry.

Thank you very much, Mr. Iverson. We are glad to have this aspect of Colorado's program before us.

(In response to a request from Senator Muskie, the Ethyl Corp. submitted the following technical paper. Text resumes on p. 937.)

POTENTIALITIES OF EMISSION REDUCTION BY DESIGN OF INDUCTION SYSTEMS

By
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ABSTRACT

As an alternative to oxidation of hydrocarbons and carbon monoxide in the exhaust system, a research program conducted by Ethyl indicates that the volume of the combustibles discharged from the cylinders can be minimized by redesign of fuel-induction systems. The objective is achievable without lowering of the level of acceleration performance or increase of fuel consumption.

A two-stage carburetion system is employed in combination with a dual or single manifold. The single-barrel primary stage of the carburetor, which is used alone in cruising up to about 70 miles per hour, provides good mixture preparation and close to uniform fuel distribution to the cylinders. The one or two barrels of the second stage are brought into operation when maximum performance is desired. Other features of carburetors and manifolds are described that contribute to emission reduction.

POTENTIALITIES OF EMISSION REDUCTION BY DESIGN OF INDUCTION SYSTEMS

by Earl Bartholomew*

The air-pollution problem is of importance and concern to all segments of the automotive-transportation industry—particularly to those that manufacture vehicles and the petroleum products for their propulsion. Ethyl Corporation, conscious of its background in the mutual adaptation of engines and fuels and mindful of its responsibilities as a supplier of materials involved in the operation of automobiles, is engaged in research and development which it is hoped will make a contribution to the collective effort aimed at a solution of the problem. Most emissions control effort has been aimed at reducing the amount of hydrocarbons and carbon monoxide exhausted to the atmosphere.

Two broad approaches are possible to reduction of exhausted combustibles:

1. Oxidation of carbon monoxide and unburned hydrocarbons to harmless carbon dioxide and water in the exhaust system;
2. Reduction of the volume of the combustibles discharged from the cylinders.

There is some benefit to combining the two approaches but it is limited because, when the second approach has been pursued with reasonable success, some systems for oxidation in the exhaust system are less effective,

The extent to which emission from the cylinders can be reduced depends on:

1. The amount of fuel metered by the carburetor in relation to the air flow, together with the pattern of distribution of the fuel to the individual cylinders and within the cylinders; and on
2. Combustion conditions within the cylinders.

In view of extensive research on fuel-induction systems of automobile engines done in our Laboratories over a period of three decades for other purposes, and in the light of more recent data obtained on single-cylinder engines, we concluded in 1961 that:

1. As an alternative to oxidation in the exhaust system, redesign of engines probably could be made to yield quite large reduction of combustible emission.
2. The potentialities for improvement would be far greater if the redesign were made upstream from rather than within the cylinders.
3. The benefits would be achievable without lowering of the level of acceleration performance to which American motorists have become accustomed.
4. The task would be a most formidable one, would continue over a period of years, and would require enlistment of the most competent technical talent in the automotive and related industries.

Consequently work was undertaken

a. To establish basic information about engine, and particularly induction-system, factors that would permit design of low-emitting vehicles and
b. To modify production automobiles for demonstration of the practical applicability of the basic findings.

This work has yielded some worthwhile benefits and has indicated the potential for further progress.

BASIC FINDINGS

The rate at which the automotive industry will be able to develop engines having low levels of emission will depend in large measure on the speed at which fundamental knowledge is created. As in the case of other new technologies, the foundation will be constructed from the contributions of many research groups. Accordingly much of Ethyl's work relating to air pollution has been designed to augment the fund of basic information concerning the separate and interrelated effects of the variables of vehicle and engine design and operation on the levels of exhausted combustibles. Such information has value that is timeless and will be applicable generally.

This paper is concerned primarily with design of induction systems as a means of emission reduction. Such design involves numerous variables that directly affect the emissions of interest. Numerous other parameters cannot be ignored, however, inasmuch as they interact with the variables of manifold and carburetor design by affecting emissions, fuel economy, power, temperatures, reliability, cost, etc. In some cases, as discussed hereinafter, other engine components can be designed in combination with induction systems for attainment of lower emission levels than

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are achievable from efforts devoted exclusively to the latter. It is in order, therefore, to report briefly on the findings in these less directly related areas prior to the more comprehensive discussion of induction-system design, even though the information in some measure may be in confirmation of results reported by others.

General Background

Among the factors that have been studied for their contribution to the environment in which improved mixture-induction systems must operate are:

1. Spark advance
2. Engine speed
3. Air-fuel ratio
4. Manifold vacuum
5. Transmission type
6. Displacement
7. Combustion-chamber design and deposits
8. Valve timing
9. Exhaust back pressure
10. Maintenance

Retard of spark timing decreases hydrocarbon concentration but has little effect on carbon monoxide (CO). The effects on power and fuel economy limit the benefits attainable by this means. Penalty-free gain from this adjustment is realizable where advance previously has been greater than the minimum for best torque (MBT) or the loss of fuel economy from the use of less than MBT timing can be offset by gain in economy from improvement of the mixture-induction system.

Increasing engine speed decreases concentration of hydrocarbon in the exhaust and has little effect on CO if air-fuel ratio and spark advance are unchanged. The relationship with respect to hydrocarbon emission is so pronounced that it is present when the pattern of spark advance is MBT instead of constant timing. At full throttle, even the retarded timing at low engine speed that is normally given by production distributors usually fails to bring hydrocarbon emission down to the level observed at high speed with spark timing advanced relatively closer to that for best torque.

Leaning the air-fuel ratio from 12:1 or 13:1 to 14:1 or 15:1 reduces both hydrocarbon emission and CO. Increases from 15:1 to 17:1 reduce CO to a minimum of about 0.1% and provide some further reduction in hydrocarbon concentration, if they do not induce incipient misfire.

Manifold vacuum at constant engine speed, over the range from full throttle to about 20 in. Hg, has little effect on concentration of hydrocarbon in the exhaust when air-fuel ratio and spark advance are constant. On the other hand, when air-fuel ratio is constant and spark advance is that required to produce a constant percentage of the maximum obtainable torque, concentration of hydrocarbon rises with increase of manifold vacuum. As vacuum is increased beyond approximately 15 in. Hg, the rate of emission rise becomes much more rapid. When the pattern of spark advance is that furnished by a normal distributor, which includes retard in the lower range of manifold vacuum, emission rises quite sharply with increase of manifold vacuum. If power enrichment is provided, the rate of rise is less marked.

Like other investigators, we have found that the problem of obtaining low emissions is much more difficult when the engine is connected to a manual instead of an automatic transmission. In considerable measure the unfavorable effect of the manual transmission is attributable to its tendency to maintain high engine speed, and consequently high manifold vacuum which increases the likelihood of misfire, for a longer period when the throttle is closed. Accordingly, cars with automatic transmissions have less, if any, need for devices intended to reduce combustible emission during deceleration. In general, cars having automatic transmissions require less complex carburetors for achievement of low levels of combustible emission.

A simple relationship between engine displacement and emission level does not exist because of the complicating effects of associated variables. A particular displacement volume may be accounted for by four relatively large cylinders or by six or eight smaller ones. At constant bore-stroke ratio, smaller cylinders have the disadvantage of greater surface-to-volume ratio in the combustion chamber. Large engines have benefit from less use of the power-enrichment system and more frequent coupling to automatic transmissions. On the other hand, the larger engines have the disadvantage of usually lower rotational speed at any specific vehicular speed. An additional unfavorable factor is the more advanced ignition timing associated with the lower absolute manifold pressure during cruise operation. At Ethyl we have been able to develop mixture-induction systems for both large and small engines that have resulted in hydrocarbon emission of about 140 parts per million as measured by the California procedure.

In the research program on multicylinder engines having constant displacement of individual cylinders, no important effect of combustion-chamber design has been observed when combustion chambers are clean. As shown hereinafter, our experience has been that

little or no change of emission levels occurs in service when engines are equipped with mixture-induction systems that produce low combustible emissions in the absence of deposits.

Within the limits of camshaft variations available for passenger cars, we have not found valve timing to be an important variable in the emission problem. The same is true of an increase in exhaust back pressure.

Hydrocarbon emissions are very sensitive to such engine malfunctions as incipient valve leakage, incipient spark-plug misfire, excessive oil consumption past the intake valve guides, and air leaks into the manifold. Thus good maintenance, as well as proper design, is necessary for low emissions.

Induction-System Features

Based on the conclusion that "the potentialities for improvement would be far greater if the redesign were made upstream from rather than within the cylinders," effects of induction-system parameters on fuel distribution and combustible emissions have been studied and applied. The program has been concerned with such items as:

1. Dual mixture-induction systems
2. Manifold heating
3. Mixture velocity in manifolds
4. Fuel volatility

As noted hereinbefore, leaning of the fuel-air mixture markedly reduces emission of both hydrocarbons and CO but often the use of substantially leaner mixtures is not practically feasible in present mixture-induction systems of engines. In consequence of earlier Ethyl work conducted for other purposes, it was concluded that a large opportunity for improvement resided in the use of a dual mixture-induction system. A primary carburetor and manifold, having relatively small cross-sectional areas and high velocities would provide good fuel metering and uniform distribution of fuel to the cylinders, thus permitting the use of leaner mixtures during perhaps 95% of normal car operation. A secondary carburetor and manifold, having much larger cross-sectional area, would be brought into use when maximum performance was needed. Induction systems of this type have been built for both 4- and 8-cylinder engines.

Manifold heating has been found to be one of the most important determinants of emission levels and operability with lean mixtures. Mixture velocity in the carburetor and manifold and mixture temperature in the manifold, together with mixture ratio and fuel volatility, are dependent variables in the determination of warmup performance, particularly at low atmospheric temperature. A deficiency in one of the variables may be compensated for by an increase in one or more of the others. For equal warmup performance when fuel volatility remains fixed and mixture ratio is made leaner in the interest of reducing emissions, compensation must be provided through increase in manifold heating, mixture velocity, or both.

As shown later herein, large reduction of combustible emission and substantial improvement of fuel economy are obtainable by the use of a single quite small venturi in the primary carburetor. The higher velocities in such a venturi and in a primary manifold of small cross-sectional area are advantageous, however, the velocity cannot be made high enough practically to obviate the need for manifold heating.

Our experience has been that, when a dual-induction system is employed, attainment of satisfactory mixture temperature requires jacketing of almost all the necessarily small available surface of the primary manifold. Smooth engine performance during warmup when the throttle or throttles of a secondary carburetor are opened also necessitates substantial heating of the secondary manifold. During constant low-speed cruising with only the primary system in operation, a hot spot of small area in the secondary intake manifold can advantageously reach stabilized temperature of 375-400°F. When metal temperature is at this level, the augmented quantity of fuel metered momentarily after the throttle of the secondary carburetor is opened is vaporized completely and distributed uniformly. If operation of the secondary system is continued, the temperature of the hot spot decreases quickly. Thereafter less heat is applied to the normal smaller volume of fuel that is metered.

Heating the mixture reduces air-flow and power, but not as a linear function of the absolute temperature. The SAE Engine Test Code provides for correction of indicated power to a standard inlet-air temperature on the assumption that air consumption (and hence indicated power) is proportional to the square root of the inverse of the absolute temperature of the *inlet* air. Our experience has been that, when the mixture is heated in the manifold, the air consumption (and hence indicated power of the engine) is roughly proportional to the square root of the inverse of the absolute temperature of the *mixture* as it flows from the manifold. For example, if the temperature of the mixture is boosted from 120° to 140°F, the loss of air consumption is about 1.8%; if temperature is boosted to 160°F the loss is 3.4%.

Even in single-cylinder engines, where fuel vaporization and distribution are not a problem, moderate mixture heating has been observed to have surprisingly small effect on fuel octane requirement at full throttle as measured with blends of the primary reference

fuels, isooctane and normal heptane. For example, at both 900 and 2400 rpm, an increase in requirement of 0.8 octane unit was measured when mixture temperature was increased from 120 to 160°F.

Likewise, additional manifold heat has been found to have a relatively small effect on antiknock requirement when highly sensitive fuels are used. A gasoline having Research and Motor octane numbers of 95.0 and 83.9 respectively (11.1 sensitivity) was observed to rate 0.7 octane unit higher at 900 rpm when mixture temperature was increased from 120 to 160°F. At 2400 rpm, it rated 2.5 octane units lower at the higher mixture temperature.

Carburetor air-fuel ratio at full throttle is substantially richer than that for maximum knock but, if maldistribution of fuel to the cylinders occurs, one or more cylinders may receive mixture whose air-fuel ratio is close to that for maximum knock. The heavier portion of commercial gasolines has less volatility than that of the primary reference fuels hence fuel distribution to the cylinders tends to deviate considerably more from uniformity. Additional manifold heat may improve the vaporization and distribution of commercial gasolines and reduce fuel retardation in the manifold, during the short knocking period after the throttle is opened, and thus reduce the octane requirement. It is our belief that, in general, the increase in octane requirement ascribable to the malfunctioning of the manifold is larger than would result from a reasonable increase in manifold heating.

Carburetor Design

As a means for reducing the volume of combustibles discharged from the cylinders without impairment of car performance, nothing offers potentialities comparable to design of carburetors, even when design of intake manifolds remains fixed. Accordingly the practical applications growing out of Ethyl's basic research program have been largely in the area of carburetor development. Major attention has been given to:

1. Mixture preparation
2. Improved carburetor idle systems
3. Carburetors without separate idle systems
4. Three-barrel carburetors

Collateral investigations and developments have been concerned with details of design intended to minimize combustible emissions during acceleration and deceleration, and to insure maintenance of metering patterns in service.

Lag of fuel in the manifold, which may have such a large effect on antiknock performance immediately after the throttle is opened, also may prevent rapid take-off. Since the phenomenon is of short duration, only momentary compensation may be sufficient. Accordingly, increase in the volume of supplementary fuel, along with decrease in the diameter of the power jet, often can be employed to reduce emissions and to improve fuel economy.

The idle system of the conventional carburetor has a large effect on over-all emission, since it is involved in fuel metering over a wide range of engine operation, especially deceleration. The usual idle-mixture adjusting screw has threads that are too coarse and with too much clearance to permit easy adjustment and maintenance of the setting. We have found that 80 threads per inch, with minimum practical clearance between the male and female threads, are beneficial.

Two- and four-barrel carburetors have two idle-mixture adjusting screws, usually with coarse threads. The adjusting screws on one 4-barrel carburetor have threads such that less than one-quarter turn causes change of CO concentration from 1.5 to 6.0%. Our experience has been that the adjustment of two screws for minimum practical emission is difficult and time consuming, even when an emission-measuring instrument is available. The problem led to redesign of the idle system of a 4-barrel carburetor to provide only a single adjusting screw, with 80 threads per inch, as shown in Fig. 1. Rich idle mixture was delivered to the two primary barrels through a T-shaped passage located close to the tip of the mixture-adjusting screw. The standard by-pass arrangement for idle air was retained without change.

The single screw enabled the engine to idle at substantially leaner mixture ratio with resulting lower emission of hydrocarbons and carbon monoxide, as indicated in Fig. 2. With two adjusting screws, minimum hydrocarbon emission of 176 parts per million was at 12.7 air-fuel ratio where CO was 2.4%. With the single screw, minimum hydrocarbon emission of

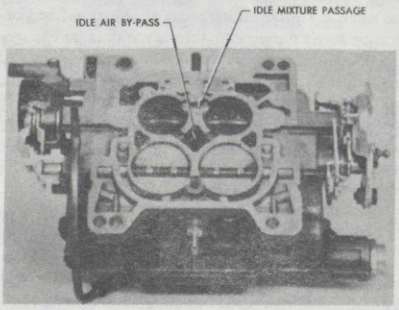

Figure 1. Four-Barrel Carburetor with Single Idle-Mixture Adjusting Screw

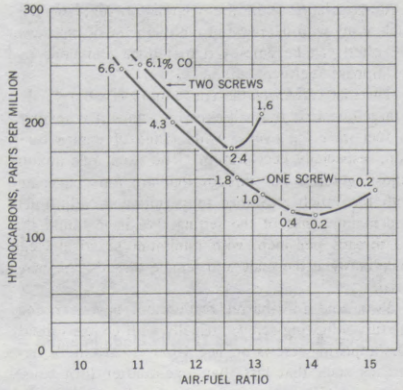

Figure 2. Effect of One Versus Two Idle-Mixture Adjusting Screws on Hydrocarbon Emission
Engine: Large V-8
Carburetor: 4-Barrel
Idle Speed: 575 RPM, Free Engine
Ignition Advance: —6°

118 parts per million occurred at 14.1 air-fuel ratio where CO was 0.2%.

Subsequent to the experiment on which Fig. 2 is based, a different pair of operators, working a full day on another engine with sophisticated instrumentation, was able to obtain an emission curve for the carburetor with two adjusting screws that was much closer to the curve for the carburetor with the single screw. Both pairs of operators were able to develop the curve for one screw in a few minutes.

Our experience has been largely unsatisfactory with production idle systems whose adjustment of air flow is obtained by positioning of the throttle. Consistent return of the throttle to the desired position often cannot be relied on, even over a period of a few hours. The result is significant variation of idle speed and of emission levels during idle, together with large change of emission levels during decelerations. Superimposed on this problem is the reduction of idle speed, and enrichment of idle and deceleration mixture, caused by the accumulation of gum and dust in the narrow crescent-shaped openings between the throttle and the throttle body. A system that by-passes idle air around the throttle blade, or partially around the blade and partially through one or more openings in the blade, obviates this trouble inasmuch as the blade closes tightly against the bore.

An idle system would not be included in carburetors except for the fact that pressure drop in the venturi during idle is insufficient to produce fuel flow through the main discharge nozzle. Furthermore, our experience has been that, when the main metering system does start to deliver fuel, the flow is irregular and emissions are high. As the throttle is opened from the idle position to the point required for low-speed cruising, manifold vacuum falls if timing has not been retarded during idle. In consequence fuel flow through the idle system decreases and the deficiency must be compensated for by transfer porting.

If ignition timing *is* retarded during idle, the volume of idle mixture is larger than conventional and manifold vacuum is relatively low. As the throttle is opened and ignition timing is advanced for cruising at low car speeds, manifold vacuum rises and flow through the idle system becomes even greater. With simultaneous activation of the main metering system, the mixture tends to become too rich.

Whether or not ignition timing is retarded during idle, fuel flow through the idle system continues over much of the range of normal car operation and makes difficult, or impossible, realization of the ideal pattern of carburetor metering which is conducive to low emissions and good fuel economy.

In connection with development of carburetors intended to reduce combustible emissions, the aforediscussed shortcomings of conventional idle systems can be obviated by design features that have been included in all induction systems for V-8 engines built by Ethyl in the current program. The primary stage of the carburetor is a single barrel whose venturi is sufficiently small for significant pressure drop to be produced by a rate of air flow equal to that during idle. As a consequence the mixture required during idle can be supplied by the main metering system with excellent engine operation and low levels of combustible emission. With this arrangement, the conventional idle and transfer systems are not needed. The essentials of such a simplified carburetor are shown in Fig. 3.

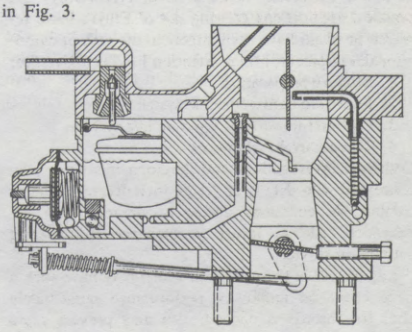

Figure 3. Carburetor for Reduction of Combustible Emission

A throttle blade of conventional design may be positioned in such a carburetor to provide the desired idle speed. This arrangement, of course, is subject to change in rate of mixture flow arising from the conditions discussed above. There is, however, this important difference: the only effect of the malfunction is change of idle speed. Accordingly, air-fuel ratio and levels of combustible emission are not affected significantly.

A preferable design of blade has notches cut into the periphery so that the blade can seat against the carburetor barrel during idle (Fig. 4). The total area of the notches is somewhat less than that required to provide the flow of mixture needed during idle. A sizable screw in a threaded boss adjacent to the throttle blade, as shown in Fig. 3, can be employed as a trimmer to increase or decrease the volume of mixture flow past the throttle blade and thus to establish the desired idle speed. The screw also can be used for maintenance of constant idle speed when power-absorbing accessories are added to or removed from the engine or the car is operated at altitude different from that at which the original setting was made.

An alternative (and the best) design of the throttle blade, shown in Fig. 5, has a multiplicity of relatively small holes distributed over the face. The total area of the holes is less than required for proper idle speed, the additional area being provided by an adjustable mixture by-pass screw of the type just described. This design has the advantage of permitting any fuel that may fall on the throttle blade to escape into the manifold without having to drain to the lower edge of the blade. Mixture flow is distributed evenly over the cross-section of the throttle bore. Apparently flow through the holes resembles that into a vacuum cleaner, aspirating into each opening any fuel that is nearby.

Experience has shown that the primary stage of a carburetion system having a venturi and idle system of the type just described is capable of good idle at mixture ratios considerably leaner than the leanest shown in Fig. 2, however, such range of air-fuel ratio is not required for low combustible emissions during idle and deceleration.

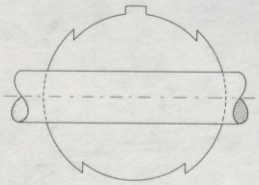

Figure 4. Notched Throttle Blade for Small Carburetor

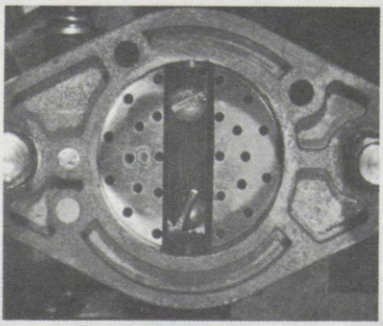

Figure 5. Perforated Throttle Blade in Small Carburetor

Except for the power jet (if one is used), the primary carburetor or primary barrel of a 3-barrel carburetor, such as illustrated in Fig. 3, has only one fuel jet and one air bleed. A power jet normally would not be used in combination with an automatic transmission. The diameters of these two orifices can be chosen to provide desirable air-fuel ratio close to stoichiometric over the whole of the operating range served by the primary carburetor. This includes idle and cruising up to perhaps 70 miles per hour, as well as acceleration and hill climbing within the breathing capacity of the primary venturi.

If for any reason a slightly richer idle is desired, a small port can be drilled in the throttle body just under the lower edge of the throttle to supply a small amount of rich mixture. Approximately one-quarter pound of additional fuel per hour is sufficient to enrich the idle mixture of a large engine by 0.6 air-fuel ratio without loss of the above-discussed advantages of the simple carburetor. Flow through the supplementary port ceases when the throttle is moved from the closed idle position. When the floatbowl is internally vented, idle enrichment also may be obtained by external venting during idle.

That a primary induction system of small cross-sectional area provides better metering and distribution of fuel is indicated by Fig. 6 which shows for a large V-8 engine, when warm and operating under conditions similar to cruising at 35 miles per hour, the variation of hydrocarbon emission with change in mixture ratio as measured on a test stand for two different induction systems. The combination of standard manifold and 4-barrel carburetor gives minimum emission at substantially richer mixture than

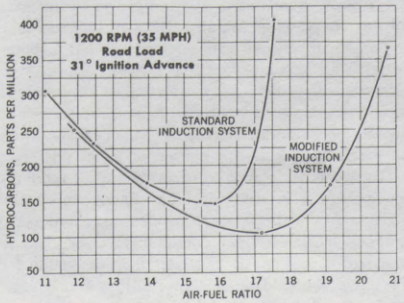

Figure 6. Effect of Design of Mixture-Induction System on Hydrocarbon Emission
Large V-8 Engine

the combination of small manifold and small carburetor. Moreover, the minimum emission of the standard combination is 40 parts per million higher.

When the mixture is made still leaner, emission with the standard system rises to 300 parts per million at 17.4 air-fuel ratio. Low emission is maintained over a considerably wider range by the small system, with the result that the level of 300 parts per million is reached at 20.4 air-fuel ratio — three ratios leaner.

Fig. 6 shows that the V-8 engine, when using the primary induction system of small cross-sectional area, can operate at 20.8 air-fuel ratio without misfiring. Thus additional evidence is provided that the primary system gives excellent fuel distribution.

Even after warmup, the mixture ratios provided by conventional induction systems may differ widely from cylinder to cylinder but, in any engine, the variation is much greater during warmup. Since the leanest cylinder must receive an ignitable mixture during warmup, the mixture metered by the carburetor must be richer by several ratios than the leanest mixture usable in the engine when hot. Fig. 6 indicates that, with a dual-induction system, the factor of safety is as high at 17.0 carburetor air-fuel ratio as with the standard system at 13.5 ratio. Thus, when the dual system is employed, appreciably leaner carburetor mixtures are practical for idle, cruising, and acceleration at less than full power. Accordingly emission of combustibles is lower in these operating modes.

Design of carburetors is important even when design of intake manifolds remains fixed. A primary carburetor having small cross-sectional area was found to be beneficial even when it discharged into a conventional V-8 manifold of large cross-sectional area from which the partition under the carburetor had been removed. This suggested the feasibility of a 3-barrel carburetor mounted on a single manifold. The design and performance of one such unit are discussed hereinafter.

The improved carburetors that have been mentioned are effective in reducing the volume of exhausted combustibles because of steadier metering and better charge preparation. In turn, these result in:

1. Closer approach to uniform distribution of fuel to the cylinders;
2. Less variation of air-fuel ratio from cycle to cycle; and
3. Delivery of more nearly homogeneous mixture to the cylinders.

Two observations made during the carburetor development illustrate the subtle changes of design that can markedly affect the induction process. First, the nozzle with a stepped skirt shown in Fig. 7 gave better distribution and lower emissions than one identical except for having a smooth cone-shaped skirt. The ridges provide for higher shear of the fuel by the air and lead to better atomization. Second, tests in which analyses of the exhaust products from individual cylinders were used as guides for modifications to minimize variation in air-fuel ratio from the average

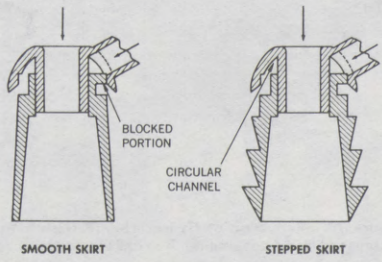

Figure 7. Experimental Fuel Nozzles

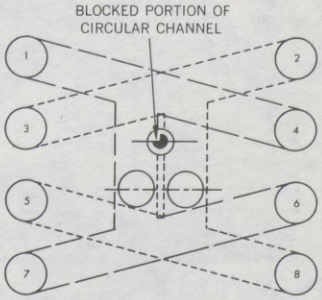

Figure 8. Nozzle Modification and Orientation for More Uniform Mixture Distribution

showed that proper orientation of partial blocking of the circular channel of the fuel nozzle, as shown in Fig. 8, gave a closer approach to uniform distribution.

Combinations for Increased Emissions Control

When the value of any one of the aforediscussed variables is changed for the purpose of reducing the volume of one of the exhaust combustibles, it usually causes a simultaneous change in one or more of the other variables. As a consequence the power or fuel economy of the engine may be affected and the emission level of the other combustible may be altered. In some cases it may be desirable to change the values of two or more variables at the same time for reduction of emissions below levels not achievable otherwise. Among such combinations that have been studied, one is especially interesting.

Primary carburetors of small cross-sectional area have potential advantage that is beyond the emission reduction resulting from the leaner mixtures which they make feasible. In combination with modified distributors, they may be made to yield further emission reductions without increase of fuel consumption beyond that of conventional induction systems. As is well known, ignition timing has a marked effect on hydrocarbon emission. Fig. 9 illustrates the relationship for one large V-8 engine equipped with a dual-induction system and operating under conditions corresponding to constant-speed cruise at 35 miles per hour. Unfortunately the decrease of emission resulting from ignition retard is accompanied by increase of fuel consumption, as also indicated in Fig. 9.

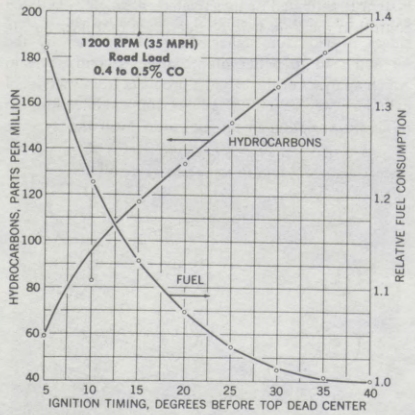

Figure 9. Effect of Ignition Timing on Hydrocarbon Emission and Fuel Economy
Large V-8 Engine

Some experimental cars equipped in our Laboratories with mixture-induction systems of the type described hereinbefore and operated at conventional ignition timing have consumed from 12 to 15% less fuel in the California emission test than standard cars of the same makes. If a portion or all of such gain of fuel economy is used to offset the loss of economy ascribable to retarded ignition timing, substantial reduction of hydrocarbon emission becomes possible without increasing fuel consumption over that of standard cars. Fig. 10 illustrates the potentiality for the engine whose data are shown in Fig. 9. If ignition timing is retarded to 17.5 degrees from 40 degrees to produce 10% increase of fuel consumption, hydrocarbon emission is reduced 69 parts per million from 195 parts, or 35%. Similar modification of design also is feasible for acceleration at part throttle, under which conditions most accelerations of modern automobiles are made. Reduction of combustible emission obtained in this manner could be very important since it is realizable after the potentialities of other means have been exhausted.

AUTOMOBILE ENGINES HAVING LOW EXHAUST EMISSIONS

The results from fundamental research on exhaust emissions have practical value only to the extent that they can be applied successfully in the design of automobile engines. Data obtained in laboratory experiments with a carefully controlled artificial environment may have large technical importance. On the other

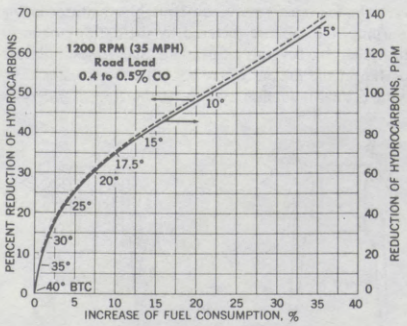

Figure 10. Reduction of Hydrocarbon Emission Vs. Increase of Fuel Consumption Due to Retarded Ignition Timing
Large V-8 Engine

hand, automobiles must operate over an extremely wide range of frequently changing conditions, hence innovations must be proved on cars in service. Acceptable levels of power and fuel economy alone are not sufficient. Driving and operational problems must not be present. Moreover, initially satisfactory emission performance must not be impaired in service because of instability of engine adjustments or significant deterioration of combustion conditions within the cylinders.

Because of these practical requirements, Ethyl has constructed and obtained experience with a variety of mixture-induction systems for cars that reflect the basic findings discussed hereinbefore. To some extent the engine design has been carried on simultaneously with the fundamental research. As a consequence, development of the modified induction systems has been evolutionary. The more recently designed systems are better than the earlier forms and, in general, are simpler.

The assemblies that have been made represent only one means of implementing each of the basic findings involved. As is traditional in the automotive industry, others would be able to achieve the same results by a variety of other approaches.

Cars with 4-Cylinder Engines

A 1962 4-cylinder engine of 8.2 compression ratio incorporating a dual mixture-induction system and manual choke, together with automatic controls and supplementary carburetor devices intended to reduce emission during deceleration, was developed on a test stand and later installed in a car having a manual transmission. Fig. 11 shows a cross-section of the engine.

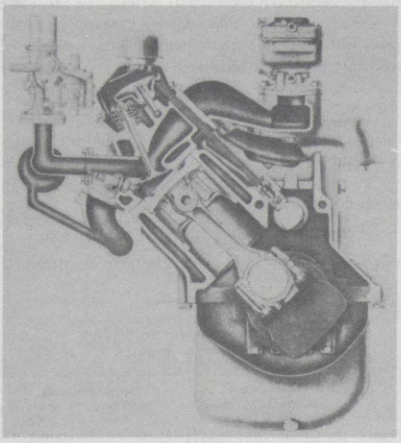

Figure 11. Cross-Section of Dual Mixture-Induction System for a 4-Cylinder Engine

The mixture-induction system of the modified engine was initially designed to shift automatically from the primary to the secondary system, and back again, in accordance with torque requirements. Thus only one system was in use during any particular moment. Transfer of operation from the primary to the secondary system was perceptible to the driver, and transfer from the secondary to the primary system was more noticeable. The automatic controls for effecting such a transfer were complicated and, of course, would have been expensive.

In the subsequent work it has been found that, if the levels of manifold heat are adjusted properly, the throttles of both carburetors of a dual-induction system may be opened simultaneously at any speed when maximum torque is required. In consequence, drastic simplification of the control equipment has become possible.

The vacuum cylinder originally installed on each carburetor for throttle operation was discarded, along with the units in the "black box" which controlled the shifting from one carburetor to the other. As a substitute for these, a simple mechanical progressive linkage was installed which first opens the throttle of the primary carburetor and then, without closing this throttle, opens the throttle of the secondary carburetor. Operation is smooth when the secondary induction system is activated or deactivated. A single remaining control in the "black box" interrupts fuel flow during

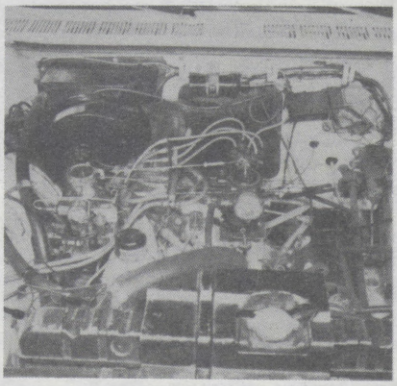

Figure 12. Four-Cylinder Engine with Dual Mixture Induction System Installed in Car

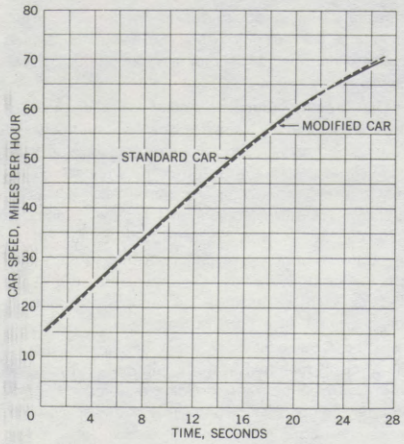

Figure 13. Acceleration Performance of 1961 Car with 1961 Engine and Modified 1962 Engine
Full Throttle, High Gear
Vehicle Test Weight = 3350 lb.

deceleration from high speeds and signals an enrichment shot when fuel flow is restored, either by deceleration of the car to about 20 miles per hour or by opening of the throttle during deceleration. A throttle-closing check controls emission during deceleration from the lower speeds but is operative only when the car is in motion. Fig. 12 shows the engine in its present form.

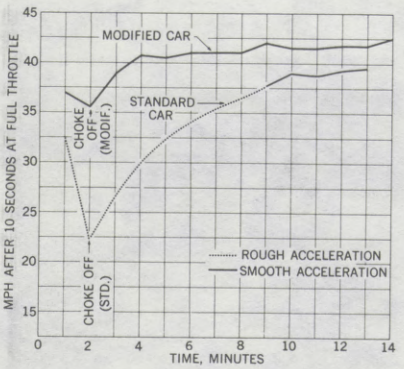

Figure 14. Warmup Performance at 0°F
Chassis Dynamometer
Modified Car: 1961 Car with Modified 1962 Engine
Standard Car: Standard 1963 Car and Engine
Fuel: Full-Boiling, 11.7 lb. Reid Vapor Pressure
232° F ASTM 50% Point

Fig. 13 shows accelerative ability on the road in high gear from 15 miles per hour at constant vehicle weight for the car with a standard engine and with the modified engine. Over the whole of the speed range the performance of the two engines is equal within the limits of reproducibility from day to day.

Fig. 14 indicates the accelerative performance from cold start at low atmospheric temperature, on a fuel having 232°F 50% point. The test was conducted on a chassis dynamometer at 0°F ambient air temperature. After starting, operation was at 20 miles per hour, road load, for 50 seconds, followed by full-throttle acceleration for 10 seconds. Car speed at the end of the acceleration was noted and the cycle of operation repeated until speed at the end of acceleration reached equilibrium. Acceleration at the end of 3 minutes with the choke off was almost as good as after full warmup. Performance was better than that of the car with standard engine.

In standard California-type tests carried out in our own and two other laboratories (Table 1), hydrocarbon emission ranged between 126 and 144 parts per million and CO between 0.94% and 1.15%. Hydrocarbon emission for similar unmodified engines ranged from 475 to 550 parts per million and CO from 2.70 to 3.80%.

A similar engine installed in a car with automatic transmission was equipped with a less sophisticated experimental mixture-induction system, not including devices intended to limit emissions during decelerations. Emission of carbon monoxide and unburned hydrocarbons was a little less than for the car with manual transmission, illustrating the less formidable problem presented by automatic transmissions.

Our experience with these two 4-cylinder cars has shown an added advantage for improved induction systems. If low levels of emission are achieved by engine design which

1. Permits the use of lean mixture and also
2. Insures the stability of carburetor adjustments,

TABLE 1

Combustible Emissions from Cars with 4-Cylinder Engines

Laboratory	Hydrocarbons, ppm		Carbon Monoxide, %	
	Standard Car	Modified Car	Standard Car	Modified Car
A	—	126	—	1.15
B	475	129	3.8	1.05
Ethyl	550	144	2.7	0.94

little or no change of emission levels occurs in service. Thus the advantage of reducing the volume of combustibles discharged from the cylinders is compounded.

The 4-cylinder car with manual transmission, having a dual mixture-induction system built by Ethyl, has been driven for distances up to 8600 miles without removal of combustion-chamber deposits. In no case has a significant change been observed in hydrocarbon emission from the originally measured level. Neither has a change occurred in octane requirement.

Further confirmation is provided by the performance of the 4-cylinder car with automatic transmission whose engine was modified by Ethyl (Fig. 15). This car, driven intermittently for 15,000 miles in average service, showed only a small change in emission levels. The car not only met California's current standards, but also the more rigid standards set for 1970, which are 180 parts per million for unburned hydrocarbons and 1.0% CO.

Cars Having Large V-8 Engines

After the performance of the 4-cylinder cars with modified induction systems had been observed, it was logical for the following questions to be raised:

1. Would a dual mixture-induction system of the general type developed for the 4-cylinder cars be feasible for cars having large V-8 engines that provide much higher power-to-weight ratios?
2. Would smooth activation of the secondary induction system be achievable when such cars are equipped with automatic transmissions that permit considerably more rapid engine acceleration?

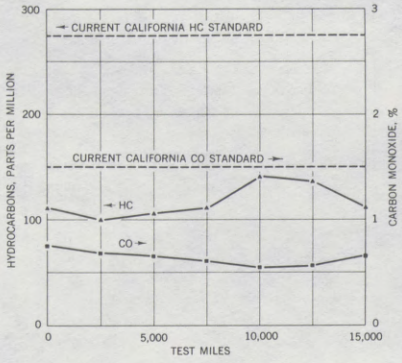

Figure 15. Combustible Emissions from Car with Modified 4-Cylinder Engine
Automatic Transmission

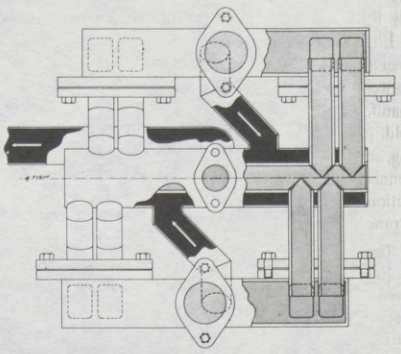

Figure 16. Dual Mixture-Induction System for Large V-8 Engine

With the objective of furnishing answers for these questions, a dual mixture-induction system was made for a 1965 large V-8 engine of 10.3 compression ratio. Fig. 16 is a partially cut-away drawing of the intake-manifold assembly. The primary manifold is of the rake type. The central runner has internal diameter of 1.03 in. while the branches have I.D. of 0.84 in. A rake-type secondary manifold, having cross-sectional area of 2.5 square inches, is provided for each bank of cylinders.

Mixture heating is by exhaust gas supplied from the two exhaust manifolds in a symmetrical arrangement. Gas first flows past a hot spot in the floor of a secondary manifold, thence into the jacket surrounding the primary manifold and from the rear of the jacket. The primary manifold is jacketed for its entire length.

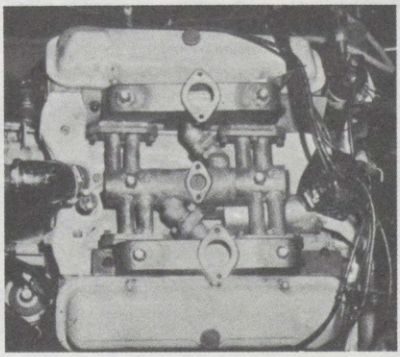

Figure 17. Dual Mixture-Induction System for Large V-8 Engine

Fig. 17 is a photograph of the intake-manifold assembly installed on an engine.

Engine designers immediately will observe that both systems violate the principle of uniform time interval between suction impulses in each main branch of a manifold runner. High velocity in the primary manifold, good vaporization from adequate manifold heating, and the pressure equalization provided by interconnection of the two systems prevent the maldistribution of fuel that might be expected in such a simple arrangement.

The primary carburetor is much like that shown in Fig. 3. Except for an idle-fuel trimming arrangement of the type described in connection with the discussion of Fig. 3, a single jet supplies all fuel used during idle, as well as in cruising below 70 miles per hour and during acceleration within the air capacity of the small venturi. The throttle blade is completely closed during idle. Idle mixture flows through perforations in the throttle blade and a trimmer by-pass at the edge of the throttle blade. In all of the modes of operation served by the primary carburetor, the metered mixture is close to stoichiometric. Leaner mixture ratios are not needed for low emission of carbon monoxide and unburned hydrocarbons.

Each of the two single-barrel secondary carburetors has a perforated air-bled emulsion tube in the main fuel well. For starting fuel flow during fast opening of the throttle and preventing otherwise unsatisfactory lean mixture during the first portion of throttle opening, a vertical transfer "idle"-mixture slot is milled in the throttle body adjacent to and above the upper edge of the throttle as shown in Fig. 18. Fuel for the slot is fed from the main well through a tube that is bled to both the float chamber and the main discharge nozzle. At high-speed cruise and part-throttle acceleration, the secondary carburetors continue the near-stoichiometric pattern of metering provided by the primary carburetor at lower cruise speeds. Mixture for best power is provided at and near full throttle. Response of the engine is smooth when the secondary carburetors are bought into operation at any throttle opening at any car speed.

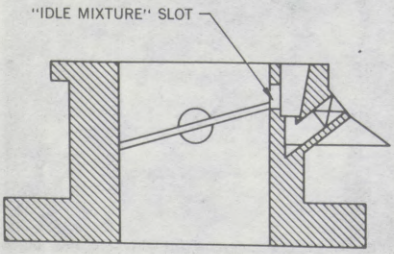

Figure 18. Throttle Body with "Idle"-Mixture Slot
Secondary Carburetors for Large V-8 Engine

TABLE 2

Fuel Metering Pattern of V-8 Engine with Dual-Induction System

Part-Throttle
Clayton Dynamometer

Car Speed, MPH	Engine RPM	Man. Vac., in. Hg	CO, %	CO_2, %	O_2, %	A/F (Calc.)	HC, ppm
Idle	600	13.0	1.0	14.0	0.6	14.6	107
15*	860	15.5	0.4	13.9	0.9	14.7	110
20	890	16.0	0.3	13.6	0.9	15.0	142
30	1120	16.7	0.15	13.45	1.6	15.3	142
40	1440	16.6	0.15	13.5	1.65	15.3	114
50	1750	16.0	0.15	13.45	1.65	15.3	82
60	2040	15.0	0.17	13.45	1.6	15.3	68

*2nd Gear

The patterns of fuel metering from the primary carburetor and levels of combustible emission of the engine are indicated in Table 2. Mixture ratios were calculated from observations of exhaust-gas composition made during operation in a car on a Clayton chassis dynamometer.

The total net venturi area of the three carburetor barrels is a little less than that of the standard 4-barrel carburetor for the engine and more than that of the standard 2-barrel carburetor.

The data herein, on the first large V-8 engine modified by Ethyl, that resulted from its operation in a car were obtained with a pattern of ignition timing shown in Fig. 19, along with the timing for the stand-

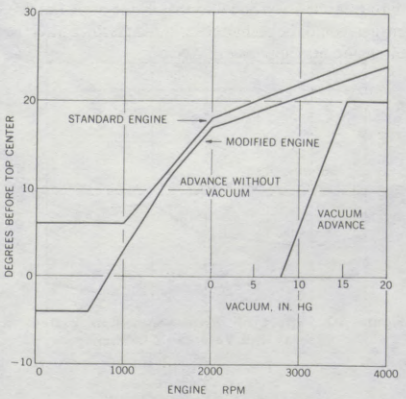

Figure 19. Ignition Timing for Large V-8 Engine with Dual-Induction System

ard engine. The timing for the modified engine represents one of the possible compromises between the sometimes differing requirements for power and fuel economy, as well as control of fuel knocking and emission of exhaust combustibles. In contrast to the distributor on the standard engine, the vacuum advance unit is inoperative at idle on the modified engine. Hence the idle advance for the modified engine is $-4°$ compared to $+26°$ for the standard engine.

The retarded timing at idle is beneficial by providing low concentrations of exhausted hydrocarbons in that mode of operation, along with drastic reduction of these combustibles during deceleration. It does have the disadvantage of raising under-hood temperature during idle and of limiting the amount of spark retard that is tolerable for reduction of knocking when fuel antiknock quality is inadequate. It also increases fuel consumption and causes rougher idle. It is believed that most of the benefit of retarded idle timing could be retained and the disadvantages substantially reduced by an alternative arrangement that would be less simple. More advanced idle timing would be used than in the engine under discussion. Provision would be made for effecting in the deceleration mode only:

1. Ignition timing less advanced than at idle; and
2. Increase in area of the mixture by-pass at the throttle of the primary carburetor.

The greater spark advance at idle would increase hydrocarbon emission in that mode but the percentage effect on average over-all emission would be small. On the other hand, a level of hydrocarbon emission during deceleration equal to that of the aforedescribed engine could be achieved without further decrease of engine braking.

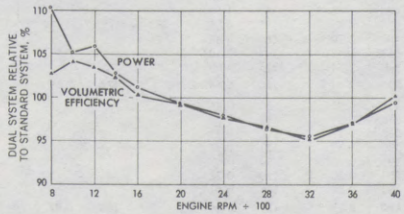

Figure 20. Effect of Mixture-Induction System on Power and Volumetric Efficiency
Engine: Large V-8
Induction Systems:
Standard: 4-Bbl. Carburetor
Dual: *Primary* 1 Single-Bbl. Carburetor
***Secondary* 2 Single-Bbl. Carburetors**
Operating Conditions: Full Throttle
Max. Power Air-Fuel Ratio

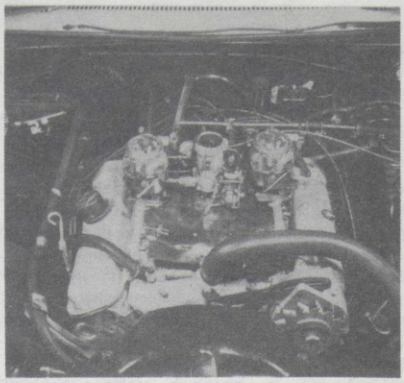

Figure 21. V-8 Engine with Dual-Induction System Installed in Car

Fig. 20 indicates the variation of full-throttle power and volumetric efficiency with speed for the engine equipped with the dual mixture-induction system relative to that developed by the standard engine with 4-barrel carburetor. At 2000 rpm the power of the modified engine is down 0.6%; at 3200 rpm, 4.4%; and at 4000 rpm, 1.0%. As an average between 2000 and 4000 rpm the deficiency is 2.4%. Above 2000 rpm, relative power is substantially identical to relative volumetric efficiency. Below 2000 rpm, relative power is somewhat higher than relative volumetric efficiency.

The greater power of the modified engine below 2000 rpm is probably due to the throttles in all three carburetor barrels being open whereas the auxiliary valves of the standard carburetor restrict air flow

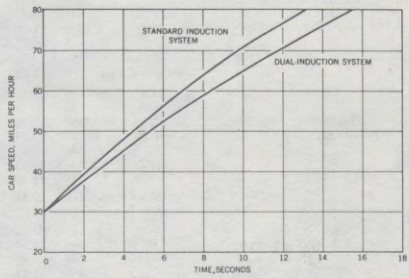

Figure 22. Acceleration of Car with Large V-8 Engine Having Standard 4-Barrel and Dual-Induction Systems
Full Throttle, Second Gear
Vehicle Test Weight = 4430 lb.

through the secondary barrels in this speed range. When an automatic transmission is installed, this difference has no practical significance.

Fig. 21 shows the V-8 engine with dual manifold but without air cleaner, after installation in a car.

Fig. 22 indicates the acceleration of this car and of a car with the standard 4-barrel induction system. The modified induction system has less total effective venturi area; hence it has somewhat slower acceleration. Computation indicates that the relative accelerative abilities of the two cars are in line with what would be expected from their relative power outputs over the speed range. The secondary carburetors were developed from the largest suitable single barrel units that could be obtained commercially. For production, larger ones might be used for elimination of the difference in acceleration.

Combustible emissions in the operating modes included in the standard California test are shown in Table 3 for a car having the standard 4-barrel induction system, for a second car of the same model equipped with the dual-induction system, and for a third car with an Ethyl experimental 3-barrel carburetor to be described later. The weighted average hydrocarbon concentration for the whole test is 145 parts per million for the car whose engine is equipped with the dual-induction system, and the CO percentage is 0.27. These figures are below the current California limits as well as those established for 1970. The emissions are about one-third those for the standard 1965 car without any emission-control equipment.

As an average between 30 and 70 miles per hour in cruising, the miles per gallon of fuel are 9% greater for the car with the dual-induction system than for the standard car. On the other hand, the former consumes about 5.5 pounds of fuel per hour during idle compared to 4.1 pounds by the latter. As a consequence, the relative fuel economy of the cars in service will depend in considerable measure on the ratio of cruising time to idle time.

The unfavorable fuel consumption during idle of the car having the engine with dual-induction system provides an incentive for idle at earlier ignition timing without loss of the previously discussed advantages of the unconventional idle system. Since earlier timing would reduce the volume of mixture consumed at idle, restoration of the pressure drop at the discharge nozzle required for stable fuel flow would necessitate some reduction of the clear area in the throat of the primary venturi. This should be feasible inasmuch as activation of the secondary carburetor is quite smooth and hence could be accomplished as satisfactorily at say 60 mph as at 72.

Maximum fuel antiknock requirement at full throttle for the car with dual-induction system is 94 octane number with primary reference fuels and 97

TABLE 3

Exhaust Emissions of Cars with V-8 Engines in California Test

Induction System	Mode	Cycle 1 HC, ppm*	Cycle 1 CO, %*	Cycles 1-4 HC, ppm*	Cycles 1-4 CO, %*	Cycles 6-7 HC, ppm*	Cycles 6-7 CO, %*	Test Result HC, ppm*	Test Result CO, %*
Standard 4-Bbl. Carburetor and Manifold 767 Deposit Miles	Idle	655	4.00	681	5.33	588	5.88		
	0-25	582	4.12	523	2.81	436	3.00		
	30	506	3.21	405	1.85	347	1.84		
	30-15	672	3.98	675	4.45	598	4.55		
	15	544	1.86	502	3.70	465	4.48		
	15-30	475	0.81	437	1.48	397	2.19		
	50-20	2242	5.42	1920	5.34	1273	4.93		
	Weighted Avg.	**579**	**2.42**	**526**	**2.42**	**450**	**2.84**	**476**	**2.69**
Dual-Induction System 6200 Deposit Miles	Idle	456	1.27	201	0.51	88	0.44		
	0-25	330	0.58	216	0.33	117	0.23		
	30	260	0.49	182	0.27	146	0.17		
	30-15	277	0.71	180	0.37	122	0.41		
	15	292	0.40	193	0.26	89	0.30		
	15-30	230	0.27	168	0.20	119	0.22		
	50-20	282	1.49	350	0.84	165	0.61		
	Weighted Avg.	**276**	**0.47**	**190**	**0.27**	**121**	**0.26**	**145**	**0.27**
3-Barrel Carburetor on Single Manifold 4600 Deposit Miles	Idle	366	3.02	181	1.15	66	0.56		
	0-25	331	2.46	208	1.01	138	0.40		
	30	288	2.10	214	0.76	156	0.30		
	30-15	244	2.49	182	1.03	113	0.48		
	15	254	1.11	145	0.58	58	0.40		
	15-30	248	0.50	188	0.38	144	0.25		
	50-20	531	1.23	302	1.42	289	0.81		
	Weighted Avg.	**285**	**1.78**	**197**	**0.69**	**139**	**0.34**	**160**	**0.43**

*Beckman Nondispersive Infrared Analyzer

octane number with 1965 CRC full-boiling reference fuels of average sensitivity.

In production it is essential that engine modifications for the purpose of emission reduction cost as little as possible. Automotive history is replete with examples of engineering developments whose practical application required less complexity of design as experience was gained. Events in connection with development of the previously described emission-reducing modifications for 4-cylinder cars conformed to this pattern. It was inevitable therefore that, even before completion of the first modification of the V-8 engine, consideration would be given to simplified designs that would accomplish the same objectives.

When the aforediscussed relation of manifold heating to carburetion, acceleration, emission and fuel knocking was learned, it was natural to speculate on the possibility of applying to a single manifold the carburetion principles developed for dual-induction systems, the most important of which was the use of one primary barrel and two secondary barrels. Two approaches were tried. In one the hot spots under each of the secondary carburetor barrels, which attain high temperature during operation on the primary barrel alone, were retained. In the other, significant changes were confined to the carburetor.

For the first approach, the 4-barrel manifold of the standard V-8 engine proved to be more suitable than the 2-barrel one for modification to receive three carburetors similar to those previously used in conjunction with the dual manifold. Fig. 23 shows the new manifold at the stage of the modification where lateral branches had been added for reception of the large-bore secondary carburetors but before installation of the manifold cover which includes flanges for the three carburetors.

The roof of the heat crossover of the standard manifold was used to provide a floor for the lateral branches and thus a heated surface under each of the secondary carburetors.

The partition between the two manifold runners was milled out for a depth of one inch to receive a disc equal in diameter to the throttle bore of the primary carburetor, as shown in the photograph. The disc was welded securely to the manifold to facilitate heat conduction and thus to provide a heated surface for impingement of unvaporized fuel from the primary carburetor.

Fig. 24 shows the test-stand setup of a second V-8 engine incorporating the modified single manifold with its primary and secondary carburetors. The carburetors are essentially similar to those used on the first V-8 engine. Operation of this engine on the test stand is proving to be quite satisfactory. The levels of hydrocarbon emission with this induction system, as presented in Fig. 25 for a range of simulated cruise operation on the test stand, are about the same as those obtained with the dual-induction system at a comparable period in its development. Idle is smooth on the primary carburetor which has a single fuel jet and a perforated throttle blade. Like the first engine, the second has demonstrated its ability to operate well at extremely lean mixture ratios. Evaluation of rapidity of warmup relative to that of the first modified V-8 engine cannot be made until the second engine has been installed in a car, however, the performance on the test stand justifies expectation that operation at low atmospheric temperature will be satisfactory when cruise air-fuel ratio is near stoichiometric.

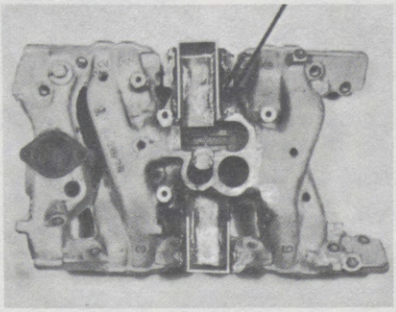

Figure 23. Four-Barrel Manifold During Modification to Receive Three Carburetors

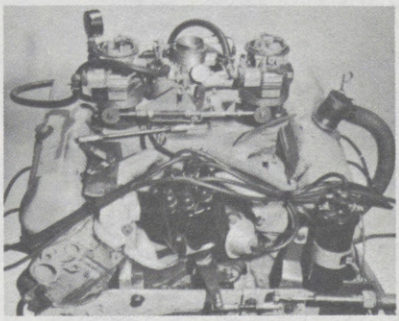

Figure 24. Modified Four-Barrel Manifold and Three Carburetors Installed on V-8 Engine

16 *Ethyl Corporation*

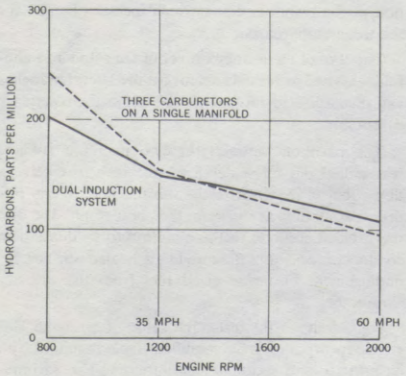

Figure 25. Hydrocarbon Emissions for Large V-8 Engines Having Dual-Induction System and Three Carburetors on a Single Manifold
Simulated Cruise Operation

The least expensive embodiment of the basic principles of induction-system modification for V-8 engines probably would be a single 3-barrel carburetor mounted on an essentially standard manifold. Although lesser improvements were expected because such restrictions compromised some of the principles, such a carburetor was constructed and applied to a 1965 automobile with a large V-8 engine and automatic transmission.

Fig. 26 shows the carburetor. The basic unit has been constructed by combining a production single-barrel model with a production two-barrel model in an arrangement that retains the two float bowls. A production three-barrel model employing the same important principles should be simpler since, as a fully integrated unit, it would have a single float bowl.

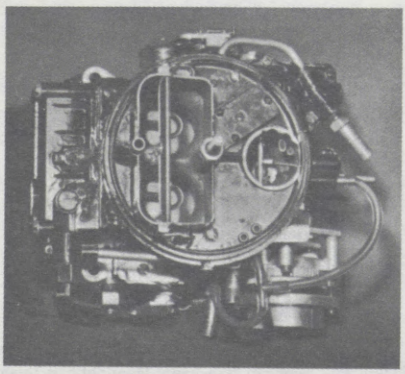

Figure 26. Three-Barrel Carburetor

The three barrels are closely grouped in a symmetrical arrangement. The primary barrel has a small venturi but is capable of providing enough air flow for cruise at speeds up to about 70 miles per hour. The standard 4-barrel manifold is fitted with an adapter plate. Part of the partition between the two manifold runners is removed to provide passage for flow from the single primary carburetor barrel. Each of the larger secondary barrels is located over one of the parallel manifold runners. Almost all of the idle fuel flows through the main jet of the primary barrel. An auxiliary idle system is capable of supplying a quite small amount of fuel for trim adjustment of idle mixture ratio. The secondary throttles start to open when the primary throttle is about 20 degrees from its fully open position. A transfer port in each secondary barrel maintains air-fuel ratio when the secondary throttles are just cracked. Throttle response is good and the transition is smooth when the secondary throttles are opened or closed.

Fig. 27 indicates the characteristics of the distributor used.

Fig. 28 shows the acceleration of the car with the experimental and standard carburetion systems. The acceleration time from 30 to 80 miles per hour measured for the two induction systems is approximately equal.

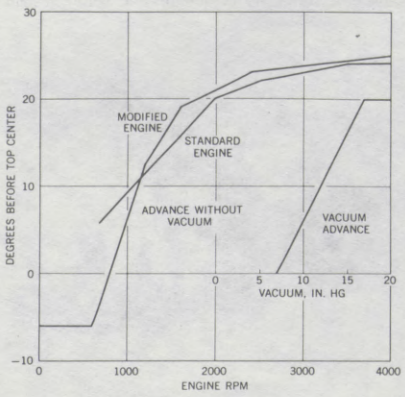

Figure 27. Distributor Characteristics
Large V-8 Engine with 3-Barrel Carburetor

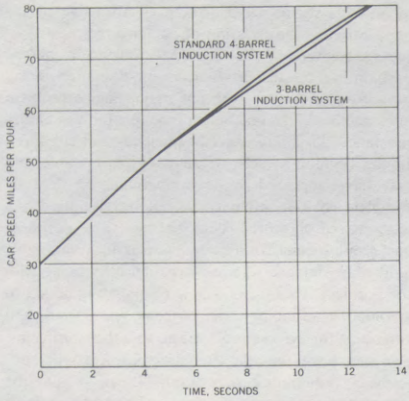

Figure 28. Acceleration of Car with Large V-8 Engine Having Standard 4-Barrel and 3-Barrel Induction Systems
Full Throttle, Second Gear
Vehicle Test Weight = 4430 lb.

Emissions in the standard California test are 160 parts per million hydrocarbons and 0.43% CO, as shown in Table 3. These levels are well below the current California limits and the 476 parts per million hydrocarbons and 2.69% CO measured with the standard 4-barrel induction system.

Due to the design of the small carburetor selected for the primary barrel of the 3-barrel carburetor, full vacuum advance begins at a higher cruise speed than for the car with dual-induction system. As a consequence the environment with respect to hydrocarbon emission at low cruise speed is not exactly comparable for the two cars.

As an average between 30 and 70 miles per hour in cruising, the miles per gallon are 5% greater for the car with the 3-barrel carburetor than for the standard car. The car with the experimental carburetor uses 5.1 pounds of fuel per hour during idle compared to 4.1 pounds by the standard car. The earlier discussion concerning the improvement of fuel economy that would result from more advanced ignition timing at idle, in combination with the simple idle system, also applies to the car equipped with the 3-barrel carburetor.

The fuel antiknock requirement of the car with 3-barrel carburetor at full throttle is 96 octane number with primary reference fuels and 98 octane number with 1965 CRC full-boiling reference fuels of average sensitivity.

A hybrid of the two aforedescribed single-manifold systems can be visualized that would retain the advantage of a single casting but also provide a hot spot under each secondary barrel. An in-line arrangement of the three barrels transverse to the axis of the crankshaft would be employed, with the primary barrel in the middle. The distance between the axis of the primary barrel and the axis of each of the secondary barrels would be sufficient to locate the secondary barrels over hot spots adjacent to the manifold runners. Thus the arrangement of the barrels would resemble that in Fig. 24 except that the separation distance would be less. The float bowl might be concentric with the primary barrel and fill the space between the primary and secondary barrels. In view of the relative simplicity of the fuel metering systems, the cost of such a design should be of the order of that of conventional 4-barrel carburetors.

From the foregoing data it is obvious that the emission levels obtainable by redesign of the fuel-induction systems of large V-8 engines are of the order of those previously measured on modified smaller 4-cylinder engines. In some respects the problem presented by a car powered with a large engine is considerably easier, particularly when an automatic transmission is used. The power required to drive a heavy car with large engine at 70 miles per hour is not greatly different from that needed by a lighter car with a small engine. When it is desired to have cruising up to this level of speed handled by the primary barrel of the carburetor, it is feasible to employ about the same diameter of primary venturi for each size of engine. The resulting pressure drop in the primary venturi of the large engine at idle is sufficient to permit elimination of the conventional idle system whereas it must be retained for the small engine. Thus the desired pattern of carburetor metering over the range of car speed and engine torque is readily obtainable in the large engine, even though ignition timing may be retarded at idle. In turn, the relatively greater air flow at idle (when ignition timing is retarded) provides an advantage for the large engine from the standpoint of hydrocarbon emission during deceleration. When the usual idle system is present in the small engine, ignition retard at idle introduces some metering problems, as discussed earlier.

Experience has shown that the aforedescribed experimental induction systems for large V-8 engines do not result in driveability problems, notwithstanding the high power-to-weight ratio of the cars. Neither does such a problem arise when the induction systems are used in combination with automatic transmissions. Thus it is believed that answers have been given to the

logical questions raised after development of the modified induction system for the smaller 4-cylinder engine coupled to a manual transmission.

CONCLUSION

All who are familiar with the problems of engine design will understand that the mixture-induction systems we have developed are not proposed as production prototypes; instead they are intended to be demonstrations of what can be achieved by application of a foundation of basic principles which can serve as guides in the development of commercially producible automobiles.

The foundation of basic principles will grow steadily in the years ahead as many investigators make additions of new knowledge. Application of the principles must be complemented by extensive testing, development and field experience:

1. To ensure that the cars delivered to customers will perform safely, reliably and acceptably with minimum attention and maintenance; and
2. To indicate the details of design that would best accommodate the effects of production variations and the requirements of mass production.

As with any new development, the engineering work required is tremendous and must not be underestimated. Adding emissions control to the present important functions of induction systems would place further large demands on the designer's skill. However, it need not result in serious compromising of the other design requirements. The results reported herein indicate that, after extensive development and proving of components and production methods, modification of intake systems can constitute an attractive means for controlling the emission of combustibles.

As the automobile has moved forward to its present position in the transportation system, design engineers have been confronted with one major engine problem after another. To name only a few: reliability, weather resistance, durability, thermal efficiency and vibration. In the beginning each problem was formidable and may have appeared to be insuperable. At least its complete solution often could not be visualized. As time passed, however, contributions to a pertinent background came from many sources in a variety of industries. Engineers gained experience by living with the problem. Eventually a new chapter was added to automotive technology, the problem was solved, and engineers turned their attention to other problems. One can hope that the emission problem will conform to this traditional pattern. If so, it may be expected that successive years will see progressive decrease of emission levels to eventual irreducible minima and, in consequence, lifting of the present burden from the automotive-transportation industry. Ethyl stands ready to work with others to that end.

ACKNOWLEDGMENT

The efforts of Edward F. Fort, Sue A. Gendernalik, Rollin E. Gish and others at Ethyl's Detroit Research Laboratories over the whole course of this four-year program contributed significantly to its success. Frederick J. Marsee made the more recent application of the available basic findings in the development of the 3-barrel carburetor. Lamont Eltinge made large contributions to the program, particularly in connection with writing of the paper.

Senator MUSKIE. Our final witness of the day, Mr. T. C. Reseigh, planning and research engineer, Colorado Department of Highways. You ought to be able to give us the road to a solution.

STATEMENT OF THURLOW C. RESEIGH, PLANNING AND RESEARCH ENGINEER, COLORADO DEPARTMENT OF HIGHWAYS

Mr. RESEIGH. Senator Muskie and Senator Dominick, it is a pleasure to appear before this committee. I might start by saying that if some of the things that Dr. Roberts proposed happened, for instance, not having any more traffic in urban areas, I wouldn't have any reason to be here.

Coordinated transportation planning in the Denver metropolitan area started about 1959 with the organization of the "Denver Metropolitan Area Transportation Study," commonly known or referred to as DMATS.

In January 1965 DMATS made their first evaluation of a future road and street system for the Denver area. This system was predicated on projected land use for the year 1980 and considered the anticipated motor vehicle trips for that year. This 1980 road and street network contained about 120 miles of new freeways, proposed the changing of a number of miles of collector streets to major arterial highways, and the development of new collector streets. When a map of this proposed future road and street system was published in the local newspapers, Denver, like most other cities in the United States—developed a number of citizens groups who were violently opposed to freeways in their entirety, or at least to freeways that were proposed near their homes or neighborhood. There appeared to be little or no opposition to the major arterial highways or the new collector streets. With this in mind, the DMATS organization felt that the next evaluation should be of a system for 1980 that contained no new freeways, but had considerably more major arterial highways and collector streets.

In late 1965 this proposed system was coded and sent to the computer. The evaluation showed that you cannot provide for uncongested movement of the anticipated 1980 motor vehicle trips on a street system that does not contain new freeways.

At this point it appeared that the problem which confronted the DMATS group was to come up with some information which would show that new freeways might be desirable and necessary in the Denver area for reasons other than moving traffic. Also by this time the DMATS study group had begun to consider such things as air pollution, esthetic beauty, mass transit, and other items which affected the community as a whole.

The following is a summary of the work that has been performed by the engineers working on DMATS with regard to the air pollution problem.

Air Pollution

AREA WITH FREEWAYS VERSUS AREA WITHOUT FREEWAYS

One of the criticism which is commonly leveled at freeways is the accusation that they produce smog. On first thought this criticism appears reasonable because more vehicles are present on the one facility and the resultant smog would concentrate over that facility. However, the question that should be answered is: How does the total smog in an area produced by motor vehicles on a street system without freeways compare with a system that contains sufficient freeways? To show the total effect the DMATS engineers used research data that had been developed by the California Health Department.

The area bounded between Quebec Street to the east and Washington Street to the west and between Evans Avenue on the south and Colfax Avenue on the north was considered. First, computations were made using existing surface street system within this area and the traffic anticipated in 1980. Present surface street system has one freeway (the Valley Highway), which traverses the southerly portion of the area. Second, computations were made using existing surface street system augmented by sufficient freeways to handle anticipated 1980 traffic volumes without congestion. The results of this analysis showed that the smog producing hydrocarbons would be reduced by about 13 percent and the emission of carbon monoxide would be reduced by almost 6 percent by having the present surface street system augmented with freeways.

Similar computations could be made for the entire Denver metropolitan area. This has not yet been done, but we would estimate that the results would be approximately the same because proposed freeways and major arterial highways are fairly well distributed throughout the area.

FREEWAYS VERSUS MAJOR ARTERIALS

To supplement the above information an evaluation of two individual existing traffic carriers was made using present-day traffic volumes.

1. On Colorado Boulevard, which is a six-lane major arterial highway, there was an average of 285,000 vehicle miles of travel per day during 1965 between Hampden Avenue and Vasquez Boulevard. It was found that this traffic emitted 1,750 pounds of hydrocarbons and 31,000 pounds of carbon monoxide per day on this 8.2-mile section. This amounts to 615 pounds of hydrocarbons and 10,900 pounds of carbon monoxide per 100,000 vehicle miles of travel.

2. On Valley Highway, which is a six-lane freeway between Santa Fe Drive and the 46th Avenue interchange, there was an average of 420,000 vehicle miles of travel per day during 1965. It was found that this travel resulted in emission of 1,260 pounds of hydrocarbons and 31,500 pounds of carbon monoxide on this 6.2-mile section. This amounts to only 300 pounds of hydrocarbons and 7,500 pounds of carbon monoxide per 100,000 vehicle miles of travel.

The above analysis shows that a six-lane major arterial facility, because of its slower speed of travel and numerous locations where starting and stopping for traffic lights is necessary, produces about twice

the amount of hydrocarbons and about 1½ times the amount of carbon monoxide per 100,000 vehicle miles of travel as does a six-lane freeway type facility.

ONE-WAY PAIRS VERSUS TWO-WAY OPERATION

Although we have not yet computed actual data, it is probable that it can be shown that a one-way pair of streets will produce slightly less smog than having two-way traffic on two major streets. With a one-way pair the traffic signals can be timed and synchronized to provide faster and smoother operation with much less starting and stopping. Denver has a number of excellent examples of one-way pairs where this belief will probably be investigated in the near future. However, in the DMATS organization at this time we believe that one-way pairs is another method to reduce the total smog in an area as well as move traffic in a more efficient manner.

MASS TRANSIT OR RAPID TRANSIT

The use of mass or rapid transit has long been advocated as a solution to the transportation problem in an area, and in doing so, would aid in the solution of the air pollution problem.

At the present time intercounty regional planning commission is in process of hiring a consultant to make a study to determine the feasibility of a mass transit and/or a rapid transit system for the Denver metropolitan area. We do not yet have any ideas on what recommendations will result from this study. However, at the present time we do know that the present mass transit system operating in the Denver area handles less than 3 percent of the total trips. We also know that the Denver area has a low population density. Also, we can see no reason for this to change as the Denver metropolitan area can expand in any direction—north, south, east, or west.

It is undoubtedly a recognized fact that one mass transit bus hauling 50 people will produce less smog-producing hydrocarbons and emit less carbon monoxide than would 30 to 40 automobiles which otherwise would be used. However, in a low population density area, it is difficult for many of those working on DMATS to conceive of how you would get people to use mass transit even if an excellent system was available. One of the many advantages of living in a low population density area is that there is freedom for the use of a personally owned vehicle and the people in the Denver metropolitan area appear to enjoy this freedom.

Based on the above, the majority of planners and engineers working on DMATS at this time are not looking for any major solution to the transportation or air pollution problem to result from increased use of mass transit.

CONCLUSIONS

Those involved in the DMATS study do recognize the fact that air pollution must be considered in the overall transportation planning of the area. Every effort is being made to keep abreast of the latest developments in working with both the transportation and the air pollution problem.

This report contains two specific approaches which we believe should be considered in the interest of reducing air pollution in the Denver area:

1. Transportation planning should include an adequate number of freeways. Freeways appear to be necessary to move traffic and therefore lessen traffic congestion in an area. Also, the use of a street system which contains sufficient freeways will lessen the overall resulting air pollution as compared with a street system without freeways.

2. The use of one-way pairs is another excellent method of moving traffic with less starting and stopping, and we believe will also reduce the overall resulting air pollution as compared with two-way traffic on two major streets.

In a lighter vein, it could be mentioned that problems which confront the engineers and planners in the field of transportation are often very perplexing. Several years ago at the annual highway conference held at Boulder, Colo., there was a very interesting afternoon session. The first paper presented called our attention to the fact that esthetics of the community should be considered in freeway planning and design. The specific recommendations were: That the depressed freeway is much more pleasing to the eye than the viaduct type freeway, as was used on East 46th Avenue in Denver.

Later that same afternoon a paper was given to call our attention to the air pollution problem in connection with freeway planning and design. In this discussion the theme was that depressed freeways provided a place for carbon monoxide and other air pollutants to concentrate in and that freeways up in the air, such as the East 46th Avenue viaduct, were a better answer. Also suggestions were made that you should build freeways in the direction of the prevailing wind so that air pollutants would be cleared out faster. This would be difficult to accomplish because you generally have to plan for freeways where there is traffic demand for such a facility regardless of the prevailing winds.

Senator MUSKIE. Then there was a suggestion in New York that all New York streets ought to be one-way pointing west.

Senator DOMINICK. That is the best one they have had yet.

Mr. RESEIGH. I thought it was interesting, some of the things we have been studying are the very things you mentioned a little while ago.

Senator MUSKIE. Yes; I think this is the first testimony we have had that has covered these approaches to the air pollution problem. I think it is very useful. It tends to confirm the assumptions we would all tend to make, but that confirmation is an important part of the record. Of course, if you have got an already established street system, it is a little difficult to arrange these one-way pairs you are talking about, isn't it?

Mr. RESEIGH. I think that Denver has been very successful in doing that. They recently opened Broadway and Lincoln as an alternate one-way pair, which are two heavily traveled streets, and they are working toward that end all the time.

Senator MUSKIE. I think this is a very constructive approach.

Senator DOMINICK. I think it is a constructive bit of testimony. I don't know whether you built into your study the question of what freeways do to the pattern of living within a city, so that by construct-

ing a freeway in many cases you create a block and therefore you create another suburb moving somewhere else and you find yourself with the other sources of air pollution problems when the new place is developed right off the freeway. So you do get into that kind of a complex situation. I know I have had a lot of talks with architects on this, who are very skeptical about whether in fact a freeway does do anything on air pollution because of its effect on the makeup of the city from then on. I don't suppose you have had any chance, have you, to go into that phase of it?

Mr. RESEIGH. No. The phase that we are in at the present time is, of course, I think like most other cities in the country. We have got an elaborate freeway system which would handle traffic in 1980 planned, but we haven't explored what changes would happen if we go away from the concept that everything had to be in downtown Denver. If you could change your land use planning and provide for more business and industrial use out in the environs, the entire picture might change. As to whether it would be better or not we don't know as yet.

Senator MUSKIE. Then there is the problem of getting from one side of a freeway to another. I remember trying to cross a busy street once, I saw a fellow on the other side and I said, "How did you get over there?" He said, "I was born here."

Well, I think this has been a good morning of testimony here in Denver.

Senator DOMINICK. Mr. Chairman, excuse me, just before you close the hearing, I have been presented a release from Weather Engineering who did hope they were going to be able to testify and were not able to do so because of the time limitation, and I would just like to offer this release for the record.

Senator MUSKIE. Fine. I may say we have indicated our desire to have statements presented by anyone who has a point of view, who has not had a chance to express it in oral testimony, and we would accept any statements and include them in the record as though they had been read.

May I express my appreciation to the law school for making these facilities available to us once more. They are very comfortable. I wish we could transfer them to Washington, especially with the other facilities that are available in this area for pleasant living.

Senator DOMINICK. There are some of us who would prefer to transfer a part of Washington out here.

Senator MUSKIE. I welcome the testimony. It has been a good morning. Thank you very much.

(Whereupon the hearing was adjourned at 12:45 p.m.)

(Subsequently, the following statements were submitted and were ordered printed:)

STATEMENT BY WEATHER ENGINEERING, INC., DENVER, COLO.

Weather Engineering is proud to have assisted legislation now taking shape. Their research director became aware of air pollution effects observing X-ray and physical cross-section of human chests at the Chicago World's Fair in 1933. The unmistakable black lung conditions were appalling.

Will a method be acceptable which will reduce most cost? This method will (1) merely require clean combustion from automobiles, (2) permit back yard incinerators, and (3) eliminate most costs of industrial installations. This will favor a control basis as against fragmented area solutions to the problem.

This method will eliminate most smog and pollutants by impressing an 8 mile an hour breeze across any smog basin as atmospheric conditions require. This method converts latent heat in water vapor into sensible heat, raises smog over any geographic barrier, is available today on a 30 day or longer demonstration for as low as $10,000 per month field expedient test.

WESTERN ELECTRIC COMPANY, INC., PUBLIC RELATIONS DIVISION NO. 1

". . . THE SUNBEAMS THAT SHINE, THEY'RE YOURS, THEY'RE MINE . . ."

. . . And the reason for this optimistic attitude is in the song's title: "The Best Things in Life Are Free." But for growing numbers of Americans, this prospect is becoming dimmer. The clear, clean air, so long taken for granted as a birthright, is clear or clean no longer and will take many millions of dollars to restore.

Ironically, it was just about the time that this song was on the Hit Parade that Los Angeles was contributing a new word—smog—to our language. From that one city twenty years ago, the number of communities that now have air pollution problems has risen, according to the U.S. Public Health Service, to 7300. Experts in the field believe that it has reached crisis proportions.

With a few exceptions, Washington has generally left the responsibility for clean air to the states. But last month, a new and more radical approach by the federal government was heralded by a conference in the Capital attended by 3,000 scientists, physicians, industrial leaders and government administrators called by the Department of Health, Education and Welfare. In a swing away from reliance on research and aid to the states, speaker after speaker (including VP Hubert Humphrey and HEW Secretary John Gardner) called for federal standards for clean air. The theme of this conference—"Action Now!"—is a straw in the wind, and the ramifications of a major change will be felt by the man in the street for many years to come.

WHAT DOES AIR POLLUTION DO?

The list of effects is long, and since pollution is a by-product of an urban, technological civilization, the list is growing longer. The man in the street is most aware of an ochre-colored sky, smarting eyes or a burning sensation in the throat. But air pollution need not be this obvious to cause damage. HEW Secretary Gardner told a Senate subcommittee: "There is no doubt that air pollution is a contributing factor to the rising incidence of chronic respiratory diseases—lung cancer, emphysema, bronchitis and asthma. There is evidence to suggest that certain types of air pollution may even contribute to the common cold." A year ago, a bout of smog in Denver (once proud of its crystal-clear air) doubled the normal absentee rate in schools, factories and the city government. Carbon monoxide in auto exhausts has been found to slow reaction time. And it is becoming common knowledge that extended periods of high pollution increase the number of deaths among people suffering from bronchial disorders: one prolonged seige in New York in 1963 is blamed for 240 deaths, another in London for 4,000.

Measurable pollution-caused property damage totals $11 billion *a year*. Stunted plants, slow-maturing crops, injured cattle, corroded metals, scarred buildings, discolored houses, higher cleaning bills, embrittled rubber, and even dissolved nylon stockings are some of the results. Smog and weather have joined to weaken the marble ornamentation on St. Luke's Hospital in New York so that it crumbles between the fingers like a cube of sugar. Trees grown in normal city air are 10% smaller and bear 10% less fruit than their country cousins. Unmeasurable costs include lower property values, inconvenience when roads are closed due to bad visibility (smog shut sections of the N.J. Turnpike 23 times last year), and delays and danger of landing through haze at airports.

WHERE DO THE POLLUTANTS COME FROM?

Just about everywhere. Virtually everything that is burned throws off gases or soot (or both). In the past, clean-air proponents attacked smoke from coal-fed fires, and this battle has been virtually won. Turning from coal to fuel oil, however, released different and less visible by-products.

According to the U.S. Public Health Service, the largest source is transportation—largely passenger cars—with 64% of the total. Second is industry (16%) and the other major contributors are electric power generating stations (11%), heating (6%), and refuse burning (3%). New pollutants are frequently uncovered; some plastics, when burned, liberate phosgene, a poison gas used in World War I. Even rockets are implicated. *Fortune* magazine summed up the current situation this way: "The air above us is not a boundless ocean. Much of the time it is a shallow, stagnant pond, and we are the fish at the bottom."

CHANGING POICY

In addition to the Washington conference last month, the trend points toward changes in the federal government's approach to the problem. Though it has traditionally left policing the air to the states, it has grown steadily more active. From a modest $5 million-per-year beginning (for research) in 1955, Congress in October budgeted some $185 million for the next three years to speed research and provide grants to local, state and regional agencies. Of greater significance: in 1965, Congress set federal standards for auto exhausts.

Implicit in these mushrooming allocations and calls for nation-wide controls is the admission that existing laws have not worked. Why this change in attitude? Of the 7300 communities that now have pollution problems, only 130 have control programs of any consequence. In the conference's keynote speech, VP Humphrey noted that he knew of not "a single effective interstate regional air pollution control program anywhere in this nation." Last summer, Senator Lee Metcalf (D. Mont.) told a Senate subcommittee that his state didn't have a control program. This, he continued, "must raise questions regarding the validity of the states assuming primary responsibility . . . "To which Senator Muskie (D.-Me.) replied, "If the states do not respond, the Congress will face an increasing responsibility to act . . ." Of the fifty states, 18 allotted less than $5000 for air pollution control in 1966 and several of these, including Maryland, Nebraska, North Carolina, Ohio and Wisconsin, have large urban centers.

THE COST OF CONTROL

Forecasts of the price of a clean-up vary widely. President M. A. Wright of the U.S. Chamber of Commerce stated last month: "It appears from some estimates that the price will be at least $275 billion over the next 34 years . . . for a relatively pollution-free environment." A corporate witness at a Senate hearing in 1964 spoke of $50–75 billion a year. Probably the most widely quoted figure was made a year ago by business-oriented *Fortune* magazine: "It is difficult to see how the total could greatly exceed $3 billion a year," which would "reduce total pollution by at least two-thirds . . . For $1.30 a month each, we could all breathe easier." By this estimate, families would feel the cost only in the price of electricity and cars. "These two items are so universal that price increases, rather than subsidies, would be a perfectly equitable way to distribute the burden."

Right now, one cost is certain. The Congressional action setting auto exhaust standards requires control equipment that will raise the price of the 1968's by about $50. But this may be only a down payment. The combination of pre-standard cars, the growing numbers of cars and higher average mileage will probably mean that auto-created pollution will continue to rise. Complicating the situation are two factors: early (and inconclusive) tests hint that the new control devices deteriorate in effectiveness as the car accumulates mileage. Second, auto makers require lead time, sometimes measured in months, to make changes. Failure to meet standards means a fine of up to $1000 for each car.

Cleaning up the second and third largest pollution source—industry and power utilities—offers radically different cost problems. Industry, which has already spent millions, generally favors some form of aid—investment credit, faster tax write-off, or tax exemption have been suggested—to install what is essentially non-productive equipment. (When the 7% investment tax credit was suspended last fall, Congress specifically exempted air and water pollution equipment.) Critics of these plans claim that such concessions amount to a bribe to stop poisoning everyone's air, and advocates of national standards point out that such standards will treat all localities the same.

But simply cleaning up the air is not an end to this complex problem. Even with effective control, the soot, dust, gases, refuse and chemicals must be disposed of, and costs can crop up elsewhere. Soot or chemicals washed from chim-

ney smoke becomes water pollution. Banning backyard incinerators (25% of Denver's air pollution comes from this source, for example) means more costly municipal refuse collection; installing better cleaners on municipal incinerators could also raise taxes. Controlled apartment house incinerators, mandatory in 1968 in New York City, may drive rents up. Refuse can be used for land reclamation (Los Angeles has built a botanical garden on a soil-and-garbage landfill project), but some cities (among them New York City) are running out of dumping space.

On the other hand, reclamation can counterbalance some costs. Trapped fly ash is sold as a strengthener for concrete. Sulfuric acid and sulfur can be saved from burning coal and fuel oil. ($300,000,000 worth of sulfur—equal to about one-third of the world's production, which is now in short supply—is now lost out U.S. smokestacks each year.) One California refinery, for instance, paid for its hydrogen sulfide and carbon monoxide controls by selling the recaptured chemicals and using the heat generated by the process to make steam for the entire installation.

THE FUTURE

Many corporations are working on long-term solutions that may mean basic changes. General Motors has designed a battery-driven van; Ford, an experimental battery said to double the power output of present types; and Union Carbide, a battery-powered motorcycle. U.S. Interior Secretary Stewart Udall predicted in October that by 1985 half the cars will be electrically powered, and he expects the first commercial models on the market within five years. This would be a boon to the electric power utilities, since recharging cars at night would put spare capacity to work. In other areas, atomic power exclusively may generate electricity (in some instances, it is already competitive with coal or oil); pipelines to eliminate private incinerators and costly collection by truck may carry refuse directly to tightly regulated municipal processors.

For the next few years, though, the outlook is decidedly less optimistic. HEW Secretary Gardner said at the Washington conference last month, "We are actually losing ground in the fight against air pollution—the smog continues to grow more dense even as we talk about it." The new Congress will almost certainly take further action this year, probably with the big step toward setting nationwide standards. Though many Congressmen have advocated cuts or slowdowns in many Great Society programs because of the costs of the war in Vietnam, they are unlikely to wield a budgetary knife here.

Experts generally agree that current technology can cope with most air pollution sources, and there is little question that controlling pollutants will affect many facets of everyday life. The problem has moved into the political arena—to decide how fast, how far, and at what cost. Though there is disagreement, it may seem that now isn't too soon for some areas. The air pollution emergency for a large portion of the Northeast last Thanksgiving is a recent example, as is this ironic incident in Cincinnati reported on October 25 by United Press International: "Cincinnati celebrated the opening of 'clean air week' yesterday with a day and night of smog, the worst in its history. A choking, acrid vapor swept south into the city from adjoining counties."

WEATHER ENGINEERING, INC.,
Denver, Colo., February 16, 1967.

Hon. ED MUSKIE,
U.S. Senator,
Senate Office Building, Washington, D.C.

ESTEEMED SIR: Your Denver hearing was looked forward to, by many, as an opportunity to "air" some clean air ideas, which must now be offered by mail.

It appears that present considerations of air pollution are looking at the wrong end of the horse.

The movement of still air, via eight mile per hour breezes impressed on any wind system of any city or smog basin, has been demonstrated by our computerized, competent, advanced scientific procedures.

Less than one percent of the U.S. area makes all the smog, and by diluting this, and bringing the lofted, elevated, breezes and smog, down in areas where its light rain-out will make welcome fertilizer, smog will have been eliminated from the current costly problems of the U.S.

These methods have been proven by tests across Denver August–September 1963 (Denver General Hospital, pollen count reduced from usual +50 to never over 3), Los Angeles southeast portion (August 20–23, 1965); New York and Jersey area September 1965 twice; etc.

It is simpler to stage a new test, than to waste time on "paper proofs", and we welcome adequate tests, since seeing is believing.

Method developed causes rising air currents off the edge of the city, hence moving the smog (if it has developed) off the city (or preventing its build-up, if the System is installed) and is a 24-hour daily, year-round Operation. Requires scientifically determined spacing and operation of units, from central consol, coordinated with total weather regionally and up to the Jet stream (35,000 feet). This is based on 25 year's study, building on Dr. Irving Langmuir's library of weather modification from GE.

We welcome inquiry and arrangements for adequate tests to confirm for the public the availability of this health giving, clean air program, overnight from now on.

NEAL BOSCO.

WEATHER ENGINEERING, INC.,
Denver, Colo., February 20, 1967.

Removal of smog, overnight, and permanently, across entire cities, or smog basins, is available, today. All present methods of smog control are looking at the wrong end of the horse. The application of our known, tested, computerized, low cost systems for smog removal appears inevitable. The delay in adoption of this clean air program, since now presented, is difficult to excuse, especially since an adequate test will be made free, for responsible authorities who will authorize its adoption upon reasonable proof.

Method which we have perfected, impresses an eight-mile-per-hour breeze across any wind system of any city, raising the smog up and over mountain barriers into the downwind area, where it may be rained out in controlled light showers, where and as desired. Maintained 24 hours, annually.

The method is a research development based upon 25 years study, including the ten years research program of "Project Cirrus" of Dr. Irving Langmuir, Nobel Prize Winning Scientists, whose library was made available to us 15 years ago, patent pending and copyrighted.

Under our competent control, the method has been tested at Denver, Colorado for sixty days (August–September 1963), across S.E. Los Angeles (August 20–23, 1965), New York City and smog laden South Jersey (September 1965, two times), etc.

New Air Pollution legislation should include funds for testing and adoption of this, at a cost to you of $1.00 per person per year. This permits keeping back yard and industrial incinerators, allows forgetting the "junk" on car exhaust, saves dollars, and lives.

R. R. DEEM, CONSULTING ENGINEERS,
Indian Hills, Colo., February 10, 1967.

Hon. EDMUND S. MUSKIE,
Chairman, Subcommitee on Air and Water Pollution,
New Senate Office Building, Washington, D.C.

DEAR SENATOR MUSKIE: In compliance with your letter of the 2d February relative to the Subcommittee hearing to be held at Denver, Colorado on the 16th February, the following is offered in evidence to be made a part of the record of the hearing in question:

Attached, please find information covering some of the equipment that has been developed over the years with the expenditures of some few millions of dollars, and, which is being added to, and, further refined by the firms of Fried, Krupp Industriebau, and Lurgi AG, of West Germany, (the said firms being in continuous operations jointly in excess of 200-years), that has proven in years of service that it will meet the requirements and specifications necessary for good control, at the source, of those man-made actions responsible for the build-up of the whole Air and Water Pollution enigma.

Among other things, you will note in the attached data that we already have equipment that will, among other things, control the deadly exhaust gases emitted by the diesel locomotive, and diesel-powered, highway vehicles, con-

struction equipment, and, coastal, river and sea-going vessels of every class and description.

Further, in the realm of rail transportation, we wish to inject at this point, that as far back as 1944 we, in cooperation with the late John W. Burnett, Chief Mechanical Officer, Union Pacific System, and the late Frank P. Roesch, Vice President, Standard Stoker Co., had developed a sound design of steam turbo-electric locomotive with such a far advanced boiler design, coupled with the burning of Solvent Refined Coal with the end result of practically no contamination of the Air, and, in the field of economics, would have been much better for the Railroads than the diesel locomotive which has been proven to be operating on lies in most areas.

In the final analysis, in support of our contentions and factual statements, the writer for his part, wishes to state, that as an individual, he has to date, in excess of 40-years experience in many facets of engineering and the sciences. And, that so far as the firms with whom he is associated are concerned, namely, Fried, Krupp, and Lurgi AG., their experience is far in excess of that that can be claimed by any Bureau, and/or, Department of the Federal or State Governments, without proof of fact, set themselves up as Experts? in the Control of Air and Water Pollution.

And, as a taxpayer, and, on the part of Krupp and Lurig whom pay a fair share of taxes into the irresponsible spending grab-bag, it is felt that the major portion of our tax-dollars being spent for the so-called research on the questions of Air and Water Pollution are being wasted, as the people within Government have not proven their competence outside of living on the tax-rolls as being capable of handling this, and/or, any other kind of problem as they relate to any phase of Private Business.

Sincerely,

R. RILEY DEEM, P.E.

PROVEN EQUIPMENT AVAILABLE FOR THE CONTROL OF AIR AND WATER POLLUTION

ELECTRICAL GAS CLEANING

Wire & tube type—Wire & plate type Dry or Wet Gases (Dry Electro-Precipitator, Wet Electro-Precipitator).

MECHANICAL DUST COLLECTION

Cyclone Separators.—Large-Capacity Cyclones, Multiclone Separator.

Wet Separator.—Collection of carbon black, pigments and other dust occurring in chemical processing plants.

Venturi Scrubber (Imatra System).—(1) Cooling, scrubbing and dedusting of blast furnace gases and waste gases from chemical and related plants, and (2) Reactions *between* gases and fluids.

ELECTRICAL DEDUSTING OF FLUE GASES FROM POWER STATIONS

Vertical Electro-Precipitators, Horizontal Electro-Precipitators.

STRÖDER GAS SCRUBBER

(1) Removal of undesirable (e.g. corrosive) solid, misty or gaseous substances from gases. (2) Reaction between gases and liquids; and (3) Cooling of gases.

EXHAUST PURIFICATION BY CATALYTIC OXIDATION

Elimination of noxious odours, purification, deodorization of industrial exhaust (for instance in spray-painting shops as in automobile factories) and motor exhaust (for instance from motor vehicles, diesel locomotives and boats); combustion gases of a low calorific value and poor ignition characteristic such as mine gas; aftercombustion of carbon-monoxide-containing flue gases from regenerators of cracking plants.

ELECTRICAL DEMISTING OF PROCESS AND WASTE GASES IN THE CHEMICAL INDUSTRY

Precipitation of H_2SO_4 mist from the tail gas of tower systems, contact and wet catalytic reactors; removal of HCl mist from exhaust air from the production and processing of chlorosulphonic acid; removal of mists containing acids, lyes, and salts, from the exhaust of reaction vessels and filling stations, and from the waste gases from calciners; precipitation of oil and tar mist from the waste gases from electrode burning furnaces, linseed oil boilers, etc.

ELECTRICAL GAS CLEANING IN THE CEMENT INDUSTRY

Precipitation of dust from raw material drying, crushing and grinding plants, from rotary kilns, shaft kilns, and cement mills; dedusting of the coal preparation plant.

EVAPORATION AND BURNING OF SULPHITE AND SULPHATE WASTE LIQUOR

During the production of sulphite or sulphate pulp, approximately half of the solids content of the wood is dissolved by the decomposing agents. Hence, the sulphite or sulphate waste liquors carry a large quantity of organic compounds causing pollution of rivers and lakes. This equipment prevents pollution and, at the same time recovers valuable by-products.

WATER POLLUTION CONTROL

Chemical Treatment of Water and Waste Water

Treatment and purification of surface water, ground water, sewage and waste water; softening; removal of iron, manganese, carbon dioxide and other organic and inorganic impurities.

Biological Treatment of Industrial Wastes and Domestic Sewage

Treatment and purification of industrial wastes and domestic sewage.

(Subsequently the following communication was received:)

COLORADO PETROLEUM COUNCIL,
Denver, Colo., May 10, 1967.

Hon. EDMUND S. MUSKIE,
Washington, D.C.

DEAR SENATOR MUSKIE: On April 3, 1967, Mr. John E. O'Fallon, Director of Air Pollution Control, Building Department, City and County of Denver, testified before your Subcommittee here in Denver. Mr. O'Fallon said, with respect to refining and chemical industries, as follows (such statement appearing at page 7 of his written statement):

"Oil refining and chemical industries—Thirty-one firms in the chemical and related industries have been listed as actual or possible violators in Denver and contact has been made. There are no oil refineries in Denver: the two that lie outside our jurisdiction will be handled as a joint venture with the Tri-County District Health Department."

At this point Mr. O'Fallon departed from his prepared statement and stated, in substance, that the Denver refineries were emitting approximately 300 tons of pollutants per day.

Mr. O'Fallon has authorized us to indicate to you that the figure of 300 tons per day was based on a refinery emissions survey conducted in 1962, which is now considered to be inaccurate. The Colorado Petroleum Council has updated the refinery emissions inventory and this inventory reflects that the Denver refineries are emitting approximately 100 tons of pollutants per day. Mr. O'Fallon agrees that this figure is very substantially correct.

In the interest of accuracy and fairness we respectfully request that the printed record regarding your Subcommittee's hearing in Denver on April 3rd be corrected to reflect the foregoing. We would appreciate your efforts on our behalf in this regard.

Very truly yours,

C. R. HAMPTON,
Chairman, Air and Water Conservation Committee.

AIR POLLUTION—1967

TUESDAY, APRIL 4, 1967

UNITED STATES SENATE,
SUBCOMMITTEE ON AIR AND WATER POLLUTION
OF THE COMMITTEE ON PUBLIC WORKS,
St. Louis, Mo.

The subcommittee met, pursuant to notice, at 9:30 a.m., in west meeting room, Soldiers Memorial Building, Senator Edmund S. Muskie (chairman) presiding.

Present: Senators Muskie (chairman) and Randolph.

Also present: Richard B. Royce, chief clerk and staff director; Leon G. Billings and Richard D. Grundy, professional staff members; and William Hildenbrand, legislative assistant to Senator Boggs.

Senator MUSKIE. The hearing will be in order.

I am delighted to present members of the subcommittee who are here this morning. Senator Jennings Randolph, of West Virginia, who is chairman of the full Senate Committee on Public Works is with us. I am delighted that he was able to get away from Washington yesterday to be with us this morning, giving the subcommittee invaluable support in connection with its work. We do need support from the chairman of the full committee, so it is a pleasure to have Senator Randolph here this morning.

Senator RANDOLPH. Senator Muskie, I am delighted to join you at this important hearing in St. Louis. We are pressed for time. I think that perhaps our best method of procedure will be to hear the people who are to testify. I want to simply underline what you have said, the job is highly important. There is an urgency about the pollution problem, and in this area there are perhaps peculiar problems which will be pointed out by the witnesses. I welcome the opportunity to share in the information they shall give to us for our legislative effort to do this job, not only for this area but for the people throughout the country. Thank you.

Senator MUSKIE. Thank you very much, Senator Randolph.

I will now place in the record the statements of the two Senators from the State of Missouri. Each regrets that he is unable to attend. I am sure that, when you read the statements, you will agree that they are both intensely interested in this problem.

(The statements are as follows:)

U.S. SENATE,
Washington, D.C., March 23, 1967.

HON. EDMUND S. MUSKIE,
Chairman, Subcommittee on Air and Water Pollution,
U.S. Senate,
Washington, D.C.

DEAR ED: Metropolitan St. Louis is a prime example of the interstate character of the air pollution menace. The question is raised whether, in a bi-state area such as metropolitan St. Louis, a workable interstate agreement can be achieved to forestall the ever-worsening condition of air pollution.

77-515 O—67—pt. 2——14

In his recent message to Congress, the President emphasized the urgency of solving this problem and recommended the establishment by federal law of regional commissioners where needed.

The hearing the Subcommittee on Air and Water Pollution opens April 4 in St. Louis will contribute significantly to the information on which the Congress will decide whether additional federal standards are required for the effective solution of this problem .

As you know, I am deeply interested in this matter and would very much like to be with you for the hearings in Missouri, but unfortunately other commitments will prevent.

Sincerely,

STUART SYMINGTON.

STATEMENT OF HON. EDWARD V. LONG, A U.S. SENATOR FROM THE STATE OF MISSOURI

Mr. Chairman, I appreciate the opportunity to express my views as your subcommittee meets today in St. Louis to continue its study of problems related to air pollution.

Although the hazards of pollution were recognized by St. Louis many years ago and although continuing efforts have been made to control the release of pollutants in the City and County, St. Louis is still faced with a very serious situation. Effective control of interstate pollution has been difficult to attain.

The President has recognized the problems States have encountered in resolving differences of opinion as to how interstate pollution should be restricted. In his air pollution message to the Congress, he noted that, although the Clean Air Act of 1963 encouraged the States to develop regional interstate control programs through generous financial aid, no effective programs have been established.

"The Air Quality Act of 1967" which was recently sent to the Congress offers a means through which the solution of regional pollution could be accelerated. I feel that the need for this or similar legislation has been clearly shown.

While independent regional efforts should be permitted to continue when they show promise of being effective, the Federal government should have the ability to move into and expedite efforts when no discernable progress is being achieved,

We cannot continue to ignore the hazardous conditions existing in many areas of this Nation where local governmental units have been unable to reach satisfactory agreements.

The hearing before your Subcommittee today should help provide an insight into the difficulties which have been encountered in the St. Louis area and perhaps suggest a solution which will be useful throughout the country.

Senator MUSKIE. We also have with us a good friend, the leader of this community, who has had an interest in the problems of air and water pollution, and who communicated that interest to us in Washington. We are delighted that he could take the time this morning to welcome us. Mayor Cervantes.

Mr. CERVANTES. Thank you, Senator Muskie.

I just want to take this opportunity to thank you and your subcommittee for coming to St. Louis to investigate the problems of air pollution. As you probably know, we have just passed one of the most stringent air pollution laws in the United States in the board of aldermen. Today we have just appointed our variance chairman, and throughout the years, St. Louis has been known for its aggressiveness in the field of air pollutants, commencing some years ago with the antismoke ordinance, but we have a deep problem here in that the city of St. Louis has moved forward with a stringent control and we have St. Louis County on one side who has not, and also the east side on the other side of the river who has not. We are hoping, of course, that in your programs and in your deliberations that you will consider strongly substantial tax credits for industries so that they may sched-

ule their programs, perhaps a little more rapidly than would ordinarily be done under their financial strains, and if this can be done, of course, I feel it would be better for the total area, but we hope that the Federal Government and your committee will find the air pollution laws enforceable and practical, and thanks so much for coming to St. Louis.

Senator MUSKIE. Thank you very much, Mr. Mayor.

I might say that Senator Randolph and I, and I think the full Committee on Public Works, support the idea of tax incentives for industry to do this job. Unfortunately, we are not in the tax writing committee of the Senate.

Mr. CERVANTES. You can recommend it, Senator, can't you?

Senator MUSKIE. We do recommend it. As a matter of fact, we recommended that local taxes take into consideration this problem and that local property tax relief to industry might be appropriate. In those States that have sales and use taxes, I think there is a place for abatement there on the cost necessary to do this job.

Senator RANDOLPH. Mr. Chairman, I want to compliment the mayor. I think he places us in a position to move into this hearing with an affirmative action already spelled out in this administrative effort. I do want to tell you that I am the author, with others, of several bills to bring tax credits to help industry to move forward affirmatively in this field. I am sure I share our distinguished chairman's view on this, that it can and should be done.

Mr. CERVANTES. Thank you, Senator.

Senator MUSKIE. I might say that we are under pressure of time. We did not realize we would be when we scheduled these hearings, but there are important votes coming up in the Senate this afternoon, so we are trying to catch a 1:05 plane back to Washington, which means we ought to leave city hall, I guess, about 12 o'clock, unless we want to break the speed limits, and we wouldn't want to do that.

Our first witness this morning is Mr. Jean J. Schueneman, chief of the control development program of the U.S. Public Health Service here in St. Louis.

STATEMENT OF JEAN J. SCHUENEMAN, CHIEF OF THE CONTROL DEVELOPMENT PROGRAM, NATIONAL CENTER FOR AIR POLLUTION CONTROL, PUBLIC HEALTH SERVICE, CINCINNATI, OHIO

Mr. SCHUENEMAN. I have with me this morning Mr. James Williams, who was in charge of the studies that were done in the St. Louis area with respect to the Public Health Service contribution. Mr. Williams will prompt me if I forget any details.

My mission on the program this morning is to describe the cooperative interstate air pollution study that was done in the St. Louis metropolitan area. To give you just a bit of background, the population of the metropolitan area is about 2 million people. It encompasses parts of the States of Missouri and Illinois. The metropolitan area includes the city of St. Louis and three counties in Missouri; namely, St. Louis, St. Charles, and Jefferson. In Illinois, there are three counties in the St. Louis metropolitan area with most of the people being in Madison and St. Clair Counties, with a few in Monroe County.

The city of St. Louis has a population of about 750,000, St. Louis County about 850,000 (excluding the city of St. Louis), and in the Illinois portion of the urbanized area there are about 450,000 people. There are some 100 incorporated communities in the metropolitan area.

The interstate air pollution study was a cooperative venture that was initiated in the fall of 1962. As you know, this was before enactment of the Federal Clean Air Act, so there was no Federal abatement authority in existence at that time. There was no air pollution program in the State of Missouri. There was only a very minimal air pollution program in St. Louis County. There was no air pollution activity in Illinois except for some nuisance abatement work done by the health departments. In the city of St. Louis there was and had long been a smoke abatement program, but activities of this program were largely limited to control of smoke and flyash. The study was a collaborative, educational program directed primarily toward the development of State and local capability to take care of air pollution problems.

The origin of the study came from two quarters. First, Mr. James Carter, then smoke commissioner for the city of St. Louis, requested the Public Health Service to assist him with an odor problem that pervaded south St. Louis. The suspected source of the odor was in Illinois. At the same time, the air pollution committee of the city of East St. Louis requested the Public Health Service to assist in the preparation of air pollution ordinance. It was obvious to us, at least, and many others, that to provide only these two limited bits of assistance would not result in the kind of viable air pollution program that was needed in the area, so we sponsored meetings of concerned local and State governments in the area to explore the possibility for broadening the base of the study.

Senator RANDOLPH. May I interrupt, Mr. Chairman?

Senator MUSKIE. Certainly.

Senator RANDOLPH. Does the community itself actively work in this area? Is there a desire to come to grips with the problem at the local level?

Mr. SCHUENEMAN. Yes, sir. We sponsored meetings that were attended by Missouri and Illinois State representatives, the St. Louis Department of Air Pollution Control, the city of East St. Louis, the East Side Health District, Bi-State Development Agency, and the Chamber of Commerce of Metropolitan St. Louis. At these meetings much local and State interest in attacking the air pollution problem was evidenced, and we felt it appropriate to expend some of our limited resources to work with the State and local governments in the area. An executive committee composed of concerned agencies was formed.

The study was set up in two phases. What was referred to as phase 1 was a cursory, preliminary examination of the problem to define what work might need to be done to find more complete answers to problems. At the end of phase 1 any agency that wasn't interested in proceeding or didn't want to contribute resources could withdraw, but no such lack of interest was evidenced.

Phase 2 of the study proceeded with more detailed technical investigations, planned and carried out through the executive committee made up of the various government agencies that I mentioned. In

phase 2, the principal objective was to design an air resource management program that would provide a factual, technical basis for solution of air pollution problems and to develop the programs of State and local governments so that they could manage the air pollution problems that confronted them. The air resource management program was to include recommended air quality goals or air quality standards and recommended emission limitations to apply to the various sources of air pollutants.

The work of the study was done collaboratively by State and local governments and the Public Health Service. The Public Health Service provided five full-time people to work in the area for about 3 years. Local and State governments matched this contribution by providing services of staff members, facilities, laboratory analyses, and so on. The study also provided a framework for a meteorological research study that was done by another group within the Public Health Service.

There were two principal results from this study. One was a technical plan designed to achieve clean air, including emission regulations and air quality goals. The other principal result was a recommended plan for governmental functions and organizations to take care of air pollution problems.

The technical plan is essentially scientific, in that it projected to the future what the air quality situation would be and what actions were needed to control air pollution problems. It was directed toward control of both localized and broad scale regional problems and toward elimination of both peak pollution situations and long-term average pollution problems.

With respect to administrative and organizational aspects, the interstate study group agreed that a coordinated regional approach was necessary. The group also recognized the merit of using existing units of general purpose government and the merit of using the largest units of government available to operate air pollution control programs. The use of existing governmental structure was considered best to get action going rapidly. It was recognized that a long time is necessary to consummate an interstate compact or other formal interstate agreement, but this was seen as a long range goal to be accomplished as soon as possible.

The final plan evolved by the Interstate Study Group for organization of governmental functions recommended that the State of Illinois create an air pollution control regional office to serve the largest part of Madison and St. Clair Counties, operating under provisions of the State law, and using State personnel stationed in the area. They would enforce State regulations and encourage local governments to control problems of minimum technical complexity to the maximum extent possible. Such problems as the open burning of rubbish, the burning of leaves, and smoke from small combustion units were considered to be within the capability of local governments, with the State acting when local government failed to do so. It was considered that in the long run the cities and counties might take over this program from the State and operate a regional program, at least to the extent that they would finance the operation of the State's programs. This would be a means of equalizing the tax-benefit questions raised when a State government uses a large share of its resources for a small part of the State,

while the taxpayers are located throughout the State. It was also recommended that there be an advisory committee made up of local governmental representatives—mayors and county commissioners—to advise the State air pollution control board on its operations in this local area. The State of Illinois was also viewed as the entity that would provide for interstate collaboration as might be appropriate.

During the course of the study, a basic enabling law was passed in Missouri which permitted the State to operate an air pollution program and to establish emission standards and air quality standards. The law requires that local air pollution control regulations be at least as stringent as those of the State. The Interstate Study Group recommended that the State of Missouri adopt regulations applicable in the St. Louis area and thus promote uniformity of regulations throughout the area. The State was also viewed as the agency to provide for interstate collaboration and regulation of pollution outside of the city of St. Louis and St. Louis County.

St. Louis County and the city of St. Louis were considered to have sufficient population base, public support, and political support to operate their own air pollution programs. Coordination could be provided by administrative agreements. It should be noted that the county health department has authority to enforce air pollution control regulations both within and outside of incorporated areas.

There was discussion of whether or not some sort of single, regional program could be generated to cover both the city of St. Louis and St. Louis County. This was considered unattainable in view of the past failures. Four proposals for some form of city-county collaborative activities (metropolitan service districts, borough plans, etc.), which had been proposed had been rejected by the voters by very substantial margins. It was felt that the most advantageous attainable organizational structure was to have two separate programs.

Senator MUSKIE. Two separate programs in the State of Missouri, the county and the city program?

Mr. SCHUENEMAN. Yes.

Senator MUSKIE. And in addition there was an interstate problem?

Mr. SCHUENEMAN. Yes, sir. I was about to get to that aspect.

Senator MUSKIE. All right.

Mr. SCHUENEMAN. All recognized the need for coordination between activities of the three principal agencies, the Illinois State agency, the city of St. Louis, and St. Louis County. It was proposed that this coordination be provided initially by continuation of the interstate study executive committee, made up of representatives of the local and State governments. This committee would lead to eventual formation of a formal interstate agreement.

There is in existence a Bi-State Development Agency that operates in the St. Louis area. Two of its principal activities presently are operation of wharfs along the river and operation of the metropolitan transit system. This agency was not considered adequate for air pollution control activities since its basic State laws do not give it any regulatory powers or police powers. It can only operate self-supporting revenue-producing operations.

There was formed at about the time our reports were drawing to a close, an organization known as the East-West Gateway Coordinating Council. It is made up of elected officials representing the several

governmental jurisdictions in the area. This group expressed interest in the air pollution problem and indicated that it might act as the coordinating group for the three pollution agencies and, in fact, did hold public hearings on the proposed regulations that resulted from the study. There would be a need for a working staff to be assigned to this organization if it were to function as a coordinating body. Until such time as a formal interstate compact agency can be developed, the role of the coordinating body was viewed as one of promoting uniform air quality standards and emission regulations; encouraging uniform enforcement programs; collection and interpretation of data from a regional point of view; and the provision of special technical services which couldn't reasonably be provided individually by the three groups.

At the present time, the State of Illinois is developing a regional air pollution control office in the East St. Louis metropolitan area. The State has adopted some regulations which are less restrictive than the ones recommended by the Interstate Study Group, and has proceeded with a program to eliminate the open burning of refuse in the whole State, including the Metropolitan East St. Louis area.

The city of St. Louis, as Mayor Cervantes mentioned, has recently adopted an ordinance which essentially incorporates the recommendations of the Interstate Study Group and a modernization of their abatement program is underway, with some assistance from Federal grants for program operation.

In St. Louis County an ordinance has been introduced in the council and is under consideration. The county air pollution program is developing and has come a long way in the past 3 years.

In Missouri, a basic law has been adopted, and regulations which are essentially in agreement with the recommendations of the interstate study have been adopted. These will be binding on all agencies within Missouri, and therefore, the city of St. Louis and St. Louis County will adopt regulations that are consistent with those.

The State of Missouri's air pollution program is developing, so we feel that substantial progress has been made in this area and hope that it will continue.

Senator MUSKIE. You have a prepared statement here which will be included in the record. This is more complete coverage of the points you raised, I take it?

Mr. SCHUENEMAN. Yes, sir.

Senator MUSKIE. Well, now, let me ask you this. You have three jurisdictions involved, the State of Illinois, and then in the State of Missouri, the city of St. Louis and the county?

Mr. SCHUENEMAN. Yes, sir.

Senator MUSKIE. There is an air pollution problem here which is traceable to sources in all three jurisdictions?

Mr. SCHUENEMAN. Yes.

Senator MUSKIE. So that the people in any one of these jurisdictions are affected by pollution sources in one or both of the other two jurisdictions, so there is, in fact, a regional air pollution problem?

Mr. SCHUENEMAN. Yes, sir.

Senator MUSKIE. Now, secondly, there is not an effective regional institution for dealing with it?

Mr. SCHUENEMAN. That's right.

Senator MUSKIE. What you have been developing here is effective policies or moving toward what you hope will be effective policies in each of the three jurisdictions, is that correct?

Mr. SCHUENEMAN. Yes.

Senator MUSKIE. Now, are the three programs in each of the three jurisdictions comparable in terms of adequate policy and means for implementing it?

Mr. SCHUENEMAN. Not entirely adequate or not entirely uniform, no, sir. The regulations in Illinois are somewhat different than the ones on the Missouri side of the river.

Senator MUSKIE. Are they less meaningful?

Mr. SCHUENEMAN. They are somewhat less restrictive, yes, sir.

Senator MUSKIE. Now, is there effective policy in all three jurisdictions to control stationary sources of pollution?

Mr. SCHUENEMAN. There is such policy. It is more vigorously prosecuted and moved forward on the Missouri side of the river than on the Illinois side at this time.

Senator MUSKIE. Do the State laws of the two States permit the development of comparable policy on both sides of the river?

Mr. SCHUENEMAN. I believe they do, yes.

Senator MUSKIE. So the question is how fast State law will be implemented on both sides?

Mr. SCHUENEMAN. Yes.

As you may know, there are negotiations proceeding at this time between the Governors of Missouri and Illinois to develop an interstate compact to formalize the collaboration and joint activity.

Senator MUSKIE. Would an interstate compact require additional legislation in both States?

Mr. SCHUENEMAN. Yes, and also, as you know, ratification by the U.S. Congress.

Senator MUSKIE. So this is the institutional means toward which both sides are moving, in your judgment?

Mr. SCHUENEMAN. Yes; they are.

Senator MUSKIE. Now, in terms of each of the three programs, I notice in your prepared statement you list, first what you describe as air resource management program elements, and, secondly, program needs for regional air pollution control programs.

In terms of the first, do each of the three jurisdictions conduct a continuing air quality monitoring program?

Mr. SCHUENEMAN. Do they or would they?

Senator MUSKIE. Do they?

Mr. SCHUENEMAN. At this time they are inadequate in that regard.

Senator MUSKIE. Do any one of the three do a better job than the others?

Mr. SCHUENEMAN. As of today I can't answer that.

Jim, do you know?

Mr. WILLIAMS. I don't believe I could answer it either because I haven't been close to their program development for the last few months.

Mr. SCHUENEMAN. Mr. Copley of St. Louis and Mr. Mitchell of St. Louis County are here. Perhaps they can answer that.

Senator MUSKIE. Is there underway in each of the three jurisdictions a current and continuing emission inventory?

Mr. SCHUENEMAN. Probably not, in that the emission inventory that was conducted during the interstate study has been adequate for the present time. They will need to update it continually as soon as they can develop the resources to do it. They have been more concerned with providing the basis and preparing testimony in connection with the preparation of ordinances and regulations and the initiation of abatement activities and have given second priority to the technical activities to provide continuing information which will be needed in the long run.

Senator MUSKIE. Do you mean that up to now what we have been concerned with is development of policy and program without much application of them?

Mr. SCHUENEMAN. To a large extent that's true.

Senator MUSKIE. So we have had talk and no action?

Mr. SCHUENEMAN. There has been some action.

Senator MUSKIE. Well, you have had action in the sense that you have developed legislation and policy but you haven't really applied it?

Mr. SCHUENEMAN. Well, the agencies have recruited additional staff and are training them, and they have initiated some abatement activities with respect to such laws as they did have before and are going ahead to some extent. The city of St. Louis, as you know, has long operated a program. They are continuing to enforce the law that was on the books many years ago.

Senator MUSKIE. That's the smoke control law?

Mr. SCHUENEMAN. And fly ash and odor nuisances.

Senator MUSKIE. I am simply trying to pinpoint what it is that we want to dig into in the next two and a half hours.

Do you have any questions, Senator Randolph?

Senator RANDOLPH. Mr. Chairman, I would like to point out that the interstate air pollution study recommended, as I understand it, a goal of one-tenth part per million of sulfur dioxide or less for a 24-hour average 99 percent of the time.

Mr. Schueneman, is that correct?

Mr. SCHUENEMAN. Yes, sir.

Senator RANDOLPH. What reduction in percentage of the total sulfur dioxide emissions would be required if that goal were to be reached?

Mr. SCHUENEMAN. I forget the exact figure, but about 60 to 65 percent reduction of emissions would be needed to reach that goal.

Senator RANDOLPH. And therefore, there are recommended target dates to achieve that goal?

Mr. SCHUENEMAN. Yes, sir.

Senator RANDOLPH. Can you give use those dates?

Mr. SCHUENEMAN. I'm sorry to say I can't recite those from memory.

Senator RANDOLPH. Well, at this point I will follow through with the reason for asking you these preliminary questions.

Mr. SCHUENEMAN. They are in our supplementary statement here.

Senator RANDOLPH. It will be good for you to place it in the record at this point.

(The supplemental statement is as follows. Text resumes on p. 977.)

Implications of the Interstate Air Pollution Study, St. Louis Regional Area, for Regional Programs in Air Pollution Control

(By J. J. Schueneman and J. D. Williams)

The Interstate Air Pollution Study was a cooperative venture of two state and eight local agencies and the Public Health Service conducted in the St. Louis-East St. Louis Metropolitan Area. When the Study was organized in the fall of 1962 the State of Illinois was just starting to develop its air pollution control program under a law enacted in 1961. The State of Missouri did not have an air pollution control law and had essentially no air pollution control activities. At the Federal level, the then existing law did not provide for any regulatory activity in situations involving interstate transport of air pollutants; such authority was not given to the Federal program until the Clean Air Act was adopted on December 17, 1963. There has been no application of the Federal abatement authority in the St. Louis area. The Study and its resulting action therefore have come primarily from collaborative and educational approaches. The Study indicates the large number of independent resources available to assist with air pollution control activities in a metropolitan area. The Study has defined the air pollution program elements that are needed for a viable air resource management program, started the development and organization of these program elements on a regional basis, and, in this process, has uncovered most of the needs for a successful regional program. This report will list those needs as well as describe some of the highlights of the Study.

THE INTERSTATE AIR POLLUTION STUDY—A SUCCESSFUL COOPERATIVE EFFORT

The Interstate Air Pollution Study originated with two independent requests from the St. Louis Metropolitan Area for assistance from the Public Health Service, Division of Air Pollution. In February, 1962, the St. Louis Commissioner of Air Pollution requested help in resolving an odor problem believed to be caused by pollution sources in Illinois and the Chairman of the Mayor's Air Pollution Committee in East St. Louis, Illinois, requested assistance in formulating an air pollution ordinance. Preliminary investigation indicated that there was a substantial regional air pollution problem involving many jurisdictions and of such magnitude that assistance on the limited requests alone would be ineffectual in coping with the overall problem. Interested parties met with representatives of the (then) Technical Assistance Branch of the Division of Air Pollution. This and subsequent meetings revealed that there was enough local interest and concern to warrant an extensive cooperative study.

At a meeting held in the fall of 1962, representatives from the State of Missouri and Illinois and from local metropolitan agencies drafted the Interstate Air Pollution Study Project Agreement. The agreement was signed on January 17, 1963, by representatives from the St. Louis Division of Air Pollution Control, the City of East St. Louis, St. Louis County Health Department, East Side (Illinois) Health District, Missouri Division of Health, Illinois Department of Public Health, Bi-State Development Agency, Chamber of Commerce of Metropolitan St. Louis, and the U.S. Health Public Health Service. An executive committee, composed of representatives of the participating agencies, was formed to serve as a policy-making body.

This project was divided into two phases. Phase I was performed to make a preliminary evaluation of air pollution in Greater St. Louis and to recommend what should be studied in greater detail. Phase II consisted of gathering the additional detailed information. The combined information was used to form the basis for an air resource management plan recommended for the Study area.

On May 14, 1964, when the Phase II Project Agreement was signed, the St. Louis Health Division and the Illinois Air Pollution Control Board joined forces with the Phase I participants.

The Interstate Study Executive Committee gave priority in Phase II of the Study to those items that were essential in reaching project goals. These first-priority activities were to:

1. Develop an air resource management plan.
2. Continue the air-quality measurement program and turn it over to local agencies after termination of the Study.
3. Make a detailed emission inventory to determine the kinds and amounts of pollutants present and their geographical distribution.
4. Institute a complaint-recording system for use with modern data-processing techniques.

5. Establish a subcommittee to select air-quality goals.
6. Establish a subcommittee within the Executive Committee to review ordinances, rules and regulations and prepare ordinance provisions for area-wide application.
7. Prepare a detailed report on the entire project.

To gather the mass of information required, forces were mobilized and networks of sampling stations were installed. The Public Health Service, Division of Air Pollution, Technical Assistance Branch, provided a full-time technical staff, offices and equipment. Local agencies furnished personnel and a variety of services.

An extensive odor survey was conducted with the help of local firemen and other participants to determine the types and extent of odors in the area. The damaging effects of air pollution on vegetation and materials were studied. Meteorological research activities included the development of a mathematical diffusion model for predicting pollutant concentrations and a fluorescent particle dispersion study for a better understanding of local air movements. Work is also in progress for developing an air pollution forecasting system.

The Study area consisted of 3,567 square miles, encompassing the City of St. Louis and the six surrounding counties—St. Charles, St. Louis and Jefferson in Missouri and Madison, St. Clair and Monroe in Illinois. The 1960 census reported 2,062,711 people in the area.

Local communities provided services and facilities valued at half of the $500,000 required to complete the Interstate Air Pollution Study. The Federal Government contributed the other half and also an additional $250,000 for the meteorological research activities. In all, over 400 individuals, other than federal, participated in making the Study.

The findings of the Interstate Air Pollution Study are reported in detail in an eight volume report containing over 700 pages. It is further reported in numerous technical papers and is summarized in two publications, a brochure entitled, "The View From the arch," and a paper entitled, "Statement of Governmental Agencies Concerned with Air Pollution Control in the St. Louis Area, September, 1966." Copies of these reports are being furnished for the files of your committee.

THE AIR RESOURCE MANAGEMENT PLAN PROPOSED FOR THE ST. LOUIS-EAST ST. LOUIS METROPOLITAN AREA

The proposed air resource management plan prepared by the project participants is based on mathematical relationships of physical phenomena over the air pollution basin. The physical phenomena are air pollutant emissions, transport conditions (meteorology), and effects on receptors. The relationships are developed and explained in detail in the reports. Without consideration of the mathematics involved these relationships may be explained by comparing the air pollution basin to a large box, a box that exerts its restraining influence on the air pollutants because of distance and variability of transport conditions rather than because of any actual walled barriers. These conditions, however, exert a very genuine restraint. Under these restraining influences it is evident that for a certain air pollution concentration (air quality) only a certain quantity of pollutants (emissions) can be put into the air. There are, however, two major considerations regarding the amounts of pollutants that may be emitted.

First, a high air pollutant emission rate will overload the air in a limited area of the box (air pollution basin) for a limited time. Any air pollutant receptor exposed to such air pollutant levels could find this exposure undesirable even though conditions in the rest of the box area would be perfectly satisfactory. The Interstate Air Pollution Study measured this condition by the 99 percentile on a frequency distribution diagram of air pollutants and treats it in the program proposal by goals not to be exceeded over 1 percent of the time.

Second, after air pollutants have been discharged into the air pollution basin for a considerable period of time at a fairly constant rate, the air quality will be the same over large areas. This condition was measured by the Interstate Air Pollution Study by long-term or average air pollution levels. Effects are associated with each of the described conditions.

In view of these facts, each air pollutant source must be controlled for two reasons. The first, to prevent short term effects, and the second, to prevent chronic effects. The prevention of short term effects applies to any source regardless of its location, and the second applies to all sources when they are within range of

each other's pollutants. The latter would ordinarily require more restrictive regulations than those involving only control of short term effects.

The Study group recognized that air pollution control programs need to be directed toward goals and these goals should be related to the effects that air pollution may cause. These air quality goals being community goals are positive statements of objectives not necessarily capable of immediate accomplishment. In order to reach these goals there must be implementation of both air use plans and program plans. The air use plans are based on the diffusion capacity of the air and the configuration of air pollutant sources and land uses in the air pollution basis. The program plans define the organizational elements required to implement the air use plans and thus reach the air quality goals.

STRONG GOVERNMENTAL AGENCIES ARE ESSENTIAL

The Interstate Air Pollution Study recognized the fact that strong governmental agencies are essential for both air use planning and program plan implementation and that air use planning requires air quality information, air pollutant emission data, meteorological data, and computer services to prepare the engineering plans and develop the necessary ordinance provisions or rules and regulations. Program plan implementation was approached on the basis of categories of pollutant sources. Since some air pollutant sources are relatively simple in a technical sense, though often numerous, the group concluded that they could be controlled effectively and efficiently by several kinds of local governmental agencies. Other pollutant sources may be extremely complex in a technical sense but few in number. The Study group felt that their control could be most effectively and efficiently carried out by regional, major city or county, or state agencies. The total governmental organization proposed for implementation of an effective air resource management program reflected, to a degree, the division of control activities by source categories, current capabilities of existing agencies, the time required to bring about changes, and proposed a means for the several levels of government to coordinate activities while maintaining all or part of their respective authority, responsbility and capability. Detailed recommendations were made in the Interstate Air Pollution Study reports. They are summarized and brought up to date in the following sections.

PROGRAM IN ST. CLAIR AND MADISON COUNTIES, ILL.

To implement air pollution control in St. Clair and Madison Counties, the Interstate Air Pollution Study group proposed that the Illinois Air Pollution Control Board assume primary responsibility and meet it by organizing a regional office in that area and assigning to it an adequate and competent staff. Work in this regard has already been initiated. An office has been established. Staffing has begun. It was further proposed that the Illinois Board meet frequently in the metropolitan East St. Louis area to consider the problems of that area. It was suggested that the Board be guided by an advisory committee representing county and municipal governments of that area.

It was recommended that the regional office of the Illinois Air Pollution Control Board, while carrying out program responsibilities in the area, be continually alert to the interest of local groups in establishing a control effort which might eventually assume responsibility for air pollution control in the area pursuant to a certificate of exemption issued by the Illinois Board. As a step toward qualifying for exemption, the local control effort might take the form of a locally financed district operation administered by the Board (similar in organization to those in the State of Massachusetts). It was suggested that the eastern parts of the two counties (Madison and St. Clair) be excluded from such a district operation because of their physical separation from the main air pollution basin. (The line of separation is the bluff line bordering the American Bottoms.) It was suggested, however, that the Board consider appropriate recommendations for State legislation to permit local governments to join together legally for the control of air pollution on a regional basis.

The Study group recommended that initially activities of local agencies should include:

1. Solid waste collection and disposal problems including backyard burning on private premises but excluding those involving large incinerators or disposal of wastes from entire communities.

2. Smoke and flyash emission control involving units with input of less than one million Btu (British thermal units) per hour, including a program for finding and eliminating hand-fired coal-burning installations.
3. Weed control.
4. Wind-borne dust control from construction and other sites within the jurisdiction of the local agency.
5. Other problem areas or items that may be agreed to in writing between the State Air Pollution Control Board and the local agency.

MISSOURI STATE AIR POLLUTION PROGRAM

In accordance with provisions of the state law, the Missouri Air Conservation Commission would participate in any interstate compact preparation and in any governing board provided by such an agreement. The State agency would review air quality goals, rules and regulations in the Missouri part of the St. Louis area and take action to approve or disapprove them in accordance with state requirements. The State's approval authority would apply to interstate standards and rules and regulations and would, through them, apply to the State of Missouri's responsibility to the State of Illinois under the terms of an agreement. The Missouri state agency would also have the responsibility for controlling air pollution sources outside the jurisdiction of the City of St. Louis and St. Louis County (in which areas local programs exist) which have or might have a deleterious influence on the air quality. This would include St. Charles and Jefferson Counties in which an organizational arrangement between state and local agencies would be needed. These counties were not considered to be part of the St. Louis air pollution basin.

MISSOURI LOCAL AGENCIES

The Interstate Study group concluded that the City of St. Louis Division of Air Pollution Control and the St. Louis County Health Department (serving all of St. Louis County, including all incorporated areas) were the most appropriate agencies to provide air pollution control services in the Missouri portion of the air pollution basin, particularly in view of the growth plans of these agencies. A formalized single agency serving both jurisdictional areas was considered unattainable. It was recognized that both agencies need a means for coordination of their activities with other air pollution control agencies in the area.

INTERSTATE ORGANIZATION

The participating agencies of the Interstate Air Pollution Study recognized the need for an interstate organization even before the Phase II project agreement was made in 1964. In that agreement is a statement indicating that it was the intent of the project executive committee to continue to function until some other organizational means was found to assure joint action in the entire air pollution basin. The project reports suggest that an agreement be made between the states to establish an interstate control organization. This organization would initiate its own enforcement action only after it had provided opportunity through leadership and coordinating activities for the appropriate state and local agencies to manage their own air resources and resolve their own air pollution problems. Since there would be only three local agencies with major responsibilities, coordination was not considered to be difficult. Each of the three agencies, because of its size, would be viable in its own right.

The interstate organization visualized by the Study would consist of representatives from each state, the three local agencies, and other groups as appropriate. It would have authority to adopt rules and regulations. Each state would make equal appropriations to pay for the coordinating functions of the interstate organization. The reports of the Study conclude that an agreement or interstate compact is needed and that it should provide for a continuing day-to-day operation in the St. Louis region and that it should, from the state levels, contain elements that assure adequate action at any point needed along the boundary of the two states.

The interstate organization proposed by the Interstate Study would have a technical staff that would handle air quality and emission data supplied by the control agencies. It would collect meteorological data, prepare air use plans, and predict air pollution episodes. It would prepare emission standards, and air quality goals, and do other matters of a technical nature in order that the agency

representatives to the organization could make suitable, factually oriented decisions. The membership of the organization would include an adequate number of elected officials, properly selected from different geographic areas, to assure responsiveness to the electorate.

During 1966 as the Study reports were being written, consideration was given as to whether the Bi-State Development Agency was an appropriate organization to carry out the interstate air pollution control functions. Although it had been active in the Study in a very constructive way, it was concluded by the Study group that it did not qualify for the expanded function because it was not organized to be sufficiently responsive to the electorate. By that time (early 1966) the East-West Gateway Coordinating Council had been formed. Since it has 12 elected officials in its 13 member organization, it was considered sufficiently responsive to the electorate. The Project Executive Committee asked the East-West Gateway Coordinating Council to take over the coordinating functions that had developed under the Study project's operation until some formal interstate agreement could be consummated. After considerable deliberation it accepted this responsibility and during the Summer of 1966 volunteered to hold hearings on the Study reports. This was a major undertaking with all 13 of the Council's members forming the Hearing Board. The hearings lasted three days and took place in three different parts of the region. These hearings publicized the reports and the findings widely even though they concentrated on the controversial aspects of the reports and discussion was limited largely to suggested ordinance provisions. They uncovered considerable areas of truth that the technically oriented executive committee could not bring forth. The action of the Council following the hearings was interpreted to mean that the Council was limited in its ability to formulate or implement a clean air policy. It did, however, provide a valuable service.

The two states have now accelerated their action to prepare and enact an interstate compact covering air pollution control in the St. Louis region. With the guidelines from the Study reports and resulting from the action that has been going on in the area, they are in a position to prepare a compact that may well be a monument to progress in air resource management and intergovernmental cooperation.

AIR RESOURCE MANAGEMENT PROGRAM ELEMENTS

The following major elements indicate the enlarged scope of an air resource management program compared with control programs of the past:

1. A continuing air quality monitoring program.
2. A current and continuing emission inventory.
3. Air quality goals and standards based on air quality criteria.
4. Thorough knowledge and use of conditions influencing the transport of air pollutants.
5. Urban planning decisions based on air quality as well as other environmental factors.
6. Air pollution control decisions and resulting ordinances and enforcement programs based on air quality information and relationships between air quality and effects.

PROGRAM NEEDS FOR REGIONAL AIR POLLUTION CONTROL PROGRAMS

Air pollution control programs as they develop into air resource management programs will find that they are required to meet a number of new program necessities. These necessities, recognized in the St. Louis Interstate Air Pollution Study area, exist in many other regions as well. They are:

1. Strong air pollution control agencies with a regional decision making body and an adequate technical staff and facilities to organize facts and prepare air use plans, thus assuring adequate and correct input to this decision making body followed by adequate implementation.
2. Air quality criteria from which air quality goals can be selected.
3. Air quality measurements adequate to assure valid data on a geographical basis.
4. Air pollutant emission information both adequate and continuing and supported by automatic data processing to assure information in suitable form for program decision making and, if necessary, for air pollution alert warning systems.

5. Adequate economic resources for the total governmental organization. Funding from local, state, and federal sources is consistent with the categorical approach to the program. This approach would maintain both program growth characteristics and responsiveness to the electorate.
6. A personnel and education system that will assure adequately qualified personnel for the total organization, local, regional, and state.
7. Adequate enforcement powers through both administrative procedures and judicial action.
8. Responsiveness to the electorate.
9. Responsiveness to the air pollution basin's (region's) total needs and long term development plans.
10. Adequate technical resources to assure correct decisions.
11. Analysis of economic factors to assist with decision making.
12. Research and development to meet specific needs of the region in augmentation of the research programs of larger organizations.

Statement of Governmental Agencies Concerned With Air Pollution Control in the Metropolitan St. Louis Area

(Presented to the East-West Gateway Coordinating Council, hearings on air pollution control regulations, Sept. 27, 1966, Kiel Auditorium, St. Louis, Mo.)

I. INTRODUCTION

This statement is in behalf of the governmental agencies concerned with air pollution control in the Interstate Metropolitan St. Louis area. It is based largely on reports resulting from the Interstate Air Pollution Study conducted during the period from January 1, 1963 to July 1965. The following organizations were involved in these studies:

Bi-State Development Agency.
St. Louis Department of Health and Hospitals.
St. Louis Division of Air Pollution Control.
East St. Louis Air Pollution Control Commission.
St. Louis County Health Department.
East Side Health District.
Missouri Division of Health.
Illinois Department of Public Health.
Chamber of Commerce of Metropolitan St. Louis.
Illinois Air Pollution Control Board.
U.S. Dept. of Health, Education, and Welfare, Public Health Service, Division of Air Pollution.

The results of the studies conducted and other information are incorporated in eight reports totalling more than 700 pages. Copies of these reports have been made available to the East-West Gateway Coordinating Council. Some of these reports and other documents have been made widely available in the St. Louis area and throughout the Nation. All of them will be broadly distributed as soon as printing can be completed. The names of the basic reports are as follows:

Part I. Introduction.
Part II. Air Pollutant Emission Inventory.
Part III. Air Quality Measurements.
Part IV. Odors—Results of Surveys.
Part V. Meteorolgy and Topography.
Part VI. Effects of Air Pollution.
Part VII. Opinion Surveys and Air Quality Statistical Relationships.
Part VIII. Proposal for an Air Resource Management Program.

A summary report for information of the general public, entitled "The View from the Arch," has also been prepared and distributed, and has been made available to the East-West Gateway Coordinating Council.

Obviously, in the time available here, we cannot go into any detail concerning the great amount of work and study that has been done. The governmental agencies are, of course, willing and anxious to discuss with the Council aspects of the air pollution situation in this area and the reports that have been submitted.

II. GENERAL PHILOSOPHY

The frame of reference in which air pollution control has been considered by the Interstate Air Pollution Study Group recognizes that approaches of the past are not always valid now. For example, looking into the field of public health, one finds successes of the past stemming from control of epidemics. These successes have been based on single cause-effect relationships. Few, if any, of these simple relationships seem to exist in the complexities of community air pollution. It is also recognized that community capability has changed and that increased capability holds the promise of effective action toward improving air quality. Programs which might have been considered unfeasible years ago are now well within our reach.

Modern programs in public health are being oriented toward a relatively new priority need; the control of chronic diseases and conditions. In the air pollution control field these conditions are associated with multiple types, combinations, and levels of air pollutants, which combined with other stresses on individuals or groups, cause undesirable effects. These circumstances call for program needs only remotely resembling the old priority need, epidemic control.

It is recognized that metropolitan areas have decided to develop their areas for new purposes. By way of example, the old purpose might very well be compared to an extractive operation such as mining or lumbering. The new metropolitan area's purpose emphasizes people rather than production or even sales. In effect, metropolitan areas have, without consideration of air pollution and probably many other important factors, committed themselves to a mixed and varied land use, at least in their central areas. Major decisions left for the future pertain to how these many mixed and varied land uses can be made to function in a compatible manner to the best interests of all concerned.

Recognition has been given to the competition between major metropolitan areas for people, money, and talent; in effect, viability of the total metropolitan areas as contrasted with competition between the area's several parts, as has often been the case in the past.

Last but not least, recognition has been given to the beginnings of attempts to come to grips with the urban environment. These attempts are directed toward making the urban environment such that it develops the best in its citizens, while making living in this urban environment worthwhile, and imparting beauty and a sense of well-being to not only those people who live there, but also to those who visit and those who might choose to come to the area to live or conduct their business. Among the questions considered in reshaping the urban environment are: "Does the existing air quality in our city promote well-being?" and "Do community decisions made now adequately consider future air quality?"

The Interstate Air Pollution Study group has considered the total welfare of the total metropolitan area. A plan of action has been proposed. While the plan will cause inconvenience, change, and expenditure of money in some quarters, the benefits to be achieved, we believe, far outweigh the costs of obtaining them.

With this basic philosophy in mind, let us now review briefly the air source situation in the Interstate Metropolitan St. Louis Area, as revealed by work of the Interstate Air Pollution Study group, with some reference to the work of others in the air pollution field throughout the world.

III. AIR POLLUTION IN THE INTERSTATE ST. LOUIS METROPOLITAN AREA IS DETRIMENTAL IN MANY WAYS TO THE COMMUNITY AND TO ITS PEOPLE

Effects of air pollution on health

The connection between community air pollution and respiratory disease in the general population has been the subject of an appreciable degree of research for only 10 years—too short a period to permit detailed exploration of all aspects of this complex environmental health problem. In that time, however, there have been numerous epidemiological and statistical studies of illness and death from respiratory diseases and impairment of respiratory function in relation to air pollution as well as many laboratory and clinical studies of the effects of single pollutants or combinations of pollutants on man and animals.

This research has produced a substantial body of factual information concerning the ways in which exposure to community air pollution affects the human respiratory system. The main thrust of the evidence is clear and conclusive—the types and levels of air pollution which are now commonplace in American

communities are an important factor in the occurrence and worsening of chronic respiratory diseases and probably are a factor in producing heightened human susceptibility to upper respiratory infections, including the common cold.

In general, chronic diseases, including those associated with air pollution, develop slowly over long periods of time. In contrast to infectious diseases, they are more likely to result from a series of insults to the body rather than from a single event. In consequence, it may be difficult, perhaps impossible, to satisfy the traditional scientific preference for concrete evidence of a direct and easily demonstrable cause-and-effect relationship between such factors as air pollutants and such effects as the development of chronic respiratory disease.

This problem and its implications for public health were put into meaningful perspective by the Surgeon General of the Public Health Service in his opening address to the 1962 National Conference on Air Pollution: "I submit that much of the speculation and controversy about whether or not air pollution causes disease is irrelevant to the significance of air pollution as a public health hazard.

"That there is frequently a simple association between an infectious disease agent and the acute disease reaction which it provokes was once a startling revelation. And in public health it has served us well and continues to serve us well. But we have learned that it is not the master key that unlocks all the secrets of disease and health. The idea that one factor is wholly responsible for any one illness is patently too simple to provide all the answers we need to deal with the chronic diseases which are on the rise today.

"Chronic bronchitis, which in Great Britain is established as a specific disease entity, is a good example. It develops over a long period of time and can become crippling through a combination of many factors—air pollution, smoking, repeated and recurring bouts with infectious agents, occupational exposures—all affected, perhaps, by an hereditary predisposition. What then is the cause of chronic bronchitis? The answer is obvious. There is probably no single cause, but there is sufficient evidence that air pollution can and does contribute to its development. This is what really matters, whether we choose to consider it the cause, one of several causes, or simply a contributing factor."

There were in 1962 and there still are deficiencies in scientific knowledge of the relationship between air pollution and respiratory disease. A need exists for more quantitative information—for more precise data concerning the pollutants which affect human health and in what amounts and under what conditions they produce their effects. But the qualitative evidence is conclusive. There is no doubt that air pollution is a factor which contributes to illness, disability, and death from chronic respiratory diseases. In a report at the 1962 National Conference, a panel of health experts said: "The evidence that air pollution contributes to the pathogenesis of chronic respiratory diseases is overwhelming."

The evidence indicating that air pollution has a detrimental effect on the health of man, and in some cases may cause death, is so voluminous that time does not permit a review of it at this hearing. For convenience of the Council, we have submitted a recent review of the matter taken from the U.S. Congressional Record. It was prepared on request of the Senate, by the U.S. Department of Health, Education, and Welfare. We have also arranged for qualified experts to appear before the Council.

While no major studies of the health effects of air pollution have been done in recent years in the St. Louis area, there is no doubt that such effects exist. This conclusion is based on air pollution measurements in the St. Louis area as related to pollution levels both in the ambient air of other communities and in laboratory exposures which have been shown to cause adverse effects. For example, in New York City, in November of 1953, about 200 excess deaths occurred during a 10-day period of high air pollution levels. During that time, daily maximum 30-minute average sulfur dioxide concentrations ranged from 0.16 to 0.85 ppm. In St. Louis, maximum hourly concentrations of sulfur dioxide greater than 0.25 ppm occur at the Continuous Air Monitoring station during every month of the year and a peak hourly concentration of 0.79 ppm has been observed. In Nashville, Tennessee, air pollution has been shown to be directly correlated with total and cardiovascular disease morbidity and with mortality from certain diseases. The average winter season pollution levels in Nashville were as follows:

Sulfation—0.54 mg SO_3/100 cm^2/day
Total particulate—135 $\mu g/m^3$
Soiling Index—2.3 Cohs/1000 linear feet of air
Sulfur dioxide—0.031 ppm

Roughly comparable data for the St. Louis area were as follows:
Sulfation—1.33 mg SO_3/100 cm^2/day (Range 0.36 to 3.89)
Total particulate—105 $\mu g/m^3$ (Range 52 to 208)
Soiling index—0.60 Cohs/1000 linear ft. of air (Range 0.11 to 2.86)
Sulfur dioxide—0.035 ppm (Range 0.02 to 0.10)
(Ranges are for values observed at the several sampling stations.)

In other study of occurence of respiratory disease lasting more than seven days among women in five cities, there was a close correlation between atmospheric sulfates and incidence of rates of respiratory disease. Average sulfate concentrations in the seven cities ranged from 7.4 to 19.8 $\mu g/m^3$ while the number of cases of respiratory disease ranged from 18.5 to 85.7 cases per 1000 women per year. In St. Louis, annual average atmospheric concentration ranges from 17 to 22 $\mu g/m^3$.

Effects of air pollution on property value

In a general sense, most people would agree that a home or business located in an area of low air pollution is worth more than one located in an area of high air pollution. To quantitate this relationship into dollars and cents is indeed a difficult task. Dr. Ronald Ridker, formerly of Washington University, studied this matter. He concluded that air pollution (as indicated by sulfation rates) has a substantial effect on property values in the St. Louis metropolitan area. On the basis of certain assumptions, his data indicate that residential property values for the area might increase by something like $25 to $250 million dollars if air pollution were reduced to certain levels.

In another study of two similar areas in St. Louis, Dr. Ridker found that residential property in an area subjected to unpleasant odors sold for as much as $1,000 less per parcel than property in an unaffected area. The loss from polluted air in just this one neighborhood was estimated at $765,000.

Damage to materials caused by air pollution

Air pollution causes soiling of all sorts of surfaces and accelerated deterioration of such materials as iron, steel, fabrics, stone, paper and rubber. We have all seen the great change that occurs when buildings are cleaned. An outstanding recent example is the post office in downtown St. Louis.

Studies of corrosion of steel in the metropolitan St. Louis area demonstrated that sample specimens exposed for three months were corroded four times more in areas of high sulfur dioxide concentrations than in areas of low concentrations.

Studies of the effects of air pollution on nylon fabric in the metropolitan St. Louis area clearly showed more rapid deterioration and soiling in more polluted areas. In two areas near factories emitting sulfuric acid particles, especially rapid deterioration was noted. All exposed nylon fabrics lost strength to the point that they could be torn readily by hand. Unexposed nylon could not be torn by hand.

Studies of the effects of air pollution on cotton fabrics were made in the St. Louis metropolitan area. Loss of strength of the fabrics was used as an index of deterioration. The rate of loss of strength increased as air pollution levels increased, as measured by dustfall, total suspended particulate, and sulfation levels. Loss of strength of the cotton fabrics was as much as twice as great in areas of high pollution as compared to areas of low pollution.

Effect of air pollution on visibility

Visibility may be reduced appreciably by particulate matter in the air. The particulate matter may be dust, fumes or liquid aerosols emitted by industrial processes or fuel burning, sulfuric acid aerosols resulting from conversion in the air of sulfur dioxide to the acid, or result from photochemical reactions involving gaseous hydrocarbons, nitrogen oxides, and sulfur dioxide. Small particles (less than one micron) have the greatest ability to reduce visibility.

Severely decreased visibility is a common occurrence in the central part of the metropolitan St. Louis area, a fact well known to many local residents. Even at Lambert Airport, located outside the area of highest air pollution, visibility associated with air pollution is decreased to less than 7 miles during more than 100 hours per month in December, January, February and March. (Data from 1951 through 1960).

Obscured visibility hampers airplane traffic and contributes to automobile accidents. With a potentially desirable view impaired, an area or a location loses much of its value.

Air pollution damage to vegetation

Air pollution can cause extensive damage to vegetation of all kinds, including crops, trees, ornamentals and green house plants. Recently Dr. Edgar Anderson of Missouri Botanical Garden gave the opinion that air pollution prevents the survival of Korean lespedeza (a plant used for ground cover along roads) in the central-near central portions of the area. E. P. Hume, a horticulturist at Southern Illinois University at Edwardsville, reports damage to many plants because of air pollution in the East St. Louis area. He reports that only a few of the less desirable ornamentals will grow satisfactorily. Dr. R. J. Gillespie at Meramec Community College has observed repeated instances of orchid damage. Specific damage to vegetation by sulfur dioxide was observed by consultants to the Interstate Study staff.

Damage to special tobacco plants caused by photochemical-type air pollutants was shown to occur throughout the metropolitan area during the Interstate Air Pollution Study. Leaf damage was observed on 20 or more occasions at central locations during the period April 29 to October 15, 1965 and on two or more occasions at all locations. Oxidant-type damage to greenhouse crops was noted during the same time.

Public dissatisfaction caused by air pollution

In addition to all of the effects of air pollution on health, vegetation, and materials, we are concerned about how people believe themselves to be affected by air pollution. During the course of the Interstate Study, a public opinion survey was conducted by the National Opinion Research Center, Chicago, and the Public Administration and Metropolitan Affairs Program of Southern Illinois University. Results of the survey showed that almost 50 percent of the entire metropolitan St. Louis population was bothered by some effect of air pollution, and in the Illinois segment, two-thirds of the population so indicated. Air pollution was found to affect personal aspects of living and even in St. Louis County where air pollution is relatively low compared to other parts of the area, 20 percent of the residents stated that air pollution affected their choice of jobs and affected household maintenance activities. More than 50 percent of the persons interviewed listed odors in their definition of air pollution.

The people interviewed considered air pollution of such importance that they were willing to spend some money to improve air quality. Eighty-five percent of the people indicated a willingness to pay $1 per year in extra taxes to support governmental air pollution control activities and 66 percent were willing to pay $5 per year extra in the cost of living which hypothetically was to be brought on by price increases necessitated by the cost to companies for installing pollution control devices.

Public dissatisfaction with air pollution is also indicated by the number of complaints made by citizens of a jurisdiction. In the City of St. Louis, about 3700 citizen complaints about air pollution were lodged with the city government during the period 1958–1962. Records of complaints received by four agencies active in air pollution control in the St. Louis area indicate that odors account for more than half of all complaints.

Air pollution, urban decay, and urban renewal

Air pollution has a generally degrading effect on the community environment. Maintaining an attractive home or office and personal cleanliness is more laborious if the air is dirty. Beautiful landscaping becomes a chore if plants turn brown or their growth is stunted. Drab-colored dark paint is more practical than easily soiled white or pastels, and the neighborhood becomes as dull as the gray polluted sky. People react to their environment; and as time passes, they do less and less maintenance.

This lack of care is reflected in community activities. Community pride suffers, and the pollution-besieged neighborhood becomes an undesirable place to live. Many people find that the exodus to the clean air of the suburbs is the answer.

The rebirth of downtown St. Louis is a testimonial to the ability of people with a purpose to reverse the trend by changing their environment. The economic stimulus to the business community will be felt for many generations. If, however, air pollution in the center of the city is permitted to continue unabated, the success of the redevelopment is placed in jeopardy. Sports enthusiasts and tourists will find less enjoyment in the foul-smelling air, and luxury living in high-rise apartments will lose its appeal if the air is not fit to breathe.

IV. THE OBJECTIVES OF THE PROPOSED AIR RESOURCE MANAGEMENT PROGRAM

In brief, the objective of the air resource management program proposed by the Interstate Air Pollution Study group is to protect the air resource in such a manner as to promote the public health and welfare and the productive capacity of the people. The precise definition of the air quality appropriate for accomplishment of this objective is established in air quality goals. The goals are presented in terms of the concentrations of pollutants which may occur for certain periods of time with stated frequencies.

The air quality goals are based on the following guidelines:

1. The quality of the air should be such that the health of even the most sensitive or susceptible groups in the population will not be adversely affected.
2. Pollutants should not reach concentrations that cause a nuisance, such as the sensation of unpleasant tastes or odors.
3. Pollutant concentrations should not reach levels that would be damaging to animals, ornamental plants, or agricultural crops.
4. Pollutants should not reach levels that will significantly reduce visibility, especially visibility reductions that would, or could, be a hazard to transportation.
5. Soiling, corrosion, and damage to materials, as well as economic effects should not occur to any great extent. These effects have been considered in a way which points toward the economic savings that could result from improvement in air quality.

Air quality goals, of themselves, are not directly useful for general air pollution control work. It is necessary also to design requirements limiting the emission of air pollutants from all kinds of sources which, when met, will result in the desired air quality. The air quality goals, being based on the need to prevent undesirable effects, therefore, should not be subject to change from one place to another. However, since various means may be employed to achieve the desired goals, emission control regulations may change from one air pollution basin to another.

The air quality goals proposed by the Interstate Study groups are based on the best information available in the published literature and on the unpublished knowledge and opinions of various specialized professional people. They do not provide a great factor of safety in health matters.

The Interstate Study group has not recommended a time by which the air quality goals should be achieved. Some provisions of the proposed emission control regulations do so. The state and local governmental agencies responsible for air pollution control should establish target dates by which the air quality goals would be achieved.

The proposed air quality goals are presented in parts VI and VIII of the Interstate Study reports and in "The View From the Arch." The evidence which supports the selection of these air quality goals is presented in much summarized form in part VI of the Interstate Study report.

The proposed air quality goals are considered to be necessary to protect the health and welfare of the people of the metropolitan St. Louis area. They are not "idealistic" nor do they represent "pristine pure" air. However, when the goals are met, there will be reasonable assurance that adverse effects of air pollution have been minimized. The sooner these air quality goals can be met, the sooner many citizens of the St. Louis area will begin to enjoy the benefits of reasonably clean air already being experienced in parts of the St. Louis metropolitan area and in some other communities of the Nation.

V. THE AIR IN THE INTERSTATE METROPOLITAN AREA IS EXCESSIVELY POLLUTED

Extensive measurements of air pollutants were made in the metropolitan St. Louis area during the Interstate Air Pollution Study. The area now has more information about its air than all but a very few other cities of the country. The data provide a firm foundation for an appraisal of the adverse effects being caused by air pollution and a sound basis for design of an air resource management program, including proposals for emission control regulations.

Dustfall

Dustfall is a measure of the amount of dirt which settles on porches, automobiles, window sills, etc. It is made up primarily of rather large particles. Dustfall was measured at 42 sites. Annual average (geometric mean) values ranged from 9 to 92 tons per square mile per month. Among the dirtiest locations were values of 54, 38, 59, 66, 45 and 36 tons per square mile per month. Any value greater than 15 tons per square mile per month averaged over a three

month period is considered excessively dirty. In the spring season, this value was exceeded at 32 of the 42 sampling stations, with some values being over 100 tons per square mile per month. It is concluded that dustfall in many parts of the metropolitan area is far above satisfactory levels.

Total suspended particulate matter

Total suspended particulate matter is determined by pulling air through a filter in a sampling device that operates like a household vacuum cleaner. Particles accumulate on the filter and are measured by weighing the filter before and after use. Measurements of this class of pollutants were made at 17 locations. Annual averages (geometric means) ranged from 61 micrograms per cubic meter in Kirkwood to 222 in Granite City. Maximum 24-hour values at the several stations over a year of sampling ranged from 171 to 1337 micrograms per per cubic meter of air. Two general areas of extremely high concentrations were found. One is centered over East St. Louis and Granite City and the other in the vicinity of the mouth of the River Des Peres.

Air is considered excessively polluted with particulate matter if the annual average (geometric mean) exceeds 75 micrograms per cubic meter. This value was exceeded at 12 of the 17 sampling stations. Maximum daily values in excess of 200 micrograms per cubic meter which occur more than four times a year are also considered unsatisfactory. This value was exceeded at most of the sampling stations.

It is concluded that concentrations of suspended particulate matter in the air are in excess of satisfactory levels, and far in excess in some parts of the metropolitan area.

Total suspended particulate matter is measured at a central location in many large cities of the Nation in the National Air Sampling Network of the U.S. Public Health Service. The most recent available data from 381 cities indicate that suspended particulates average (geometric mean) more than 150 micrograms per cubic meter in 26 cities; from 126 to 150 in 31 cities; and from 101 to 125 in 61 cities. In this National Air Sampling Network, the concentration of suspended particulate matter for St. Louis is 140 and for East St. Louis, it is 186 micrograms per cubic meter. These data give a rough indication that East St. Louis is among those cities having the highest suspended particulate levels and St. Louis has roughly the same degree of particulate pollution as such cities as Cincinnati, Chicago, Los Angeles, Pittsburgh, and Philadelphia. These data, however, represent only one sampling station, making comparisons of limited significance.

Benzo(a)pyrene

One of the polynuclear hydrocarbons found in urban atmospheres is benzo(a)-pyrene, referred to as BaP. This material is known to be carcinogenic to experimental animals and is suspected of being so to man. BaP is collected along with particulate material from the air by filter sampling. Measurements made in 94 cities during the period January to March 1959 indicated concentrations of 10 micrograms or less of BaP per 1000 cubic meters of air in 60 of the cities and values ranging from 11 to 20 in 18 cities. In St. Louis, a value of 54 micrograms per 1000 cubic meters was reported. However, there is reason to believe that this St. Louis value was not representative because of temporary emission conditions (open burning of demolition waste) near the sampling station.

During the Interstate Air Pollution Study, samples were collected at 14 locations during the period January 6 to March 18, 1964. Three to seven samples were pooled for each station. The sampling days generally represented days of higher than average space heating requirements. Results varied from 1.4 micrograms of BaP per 1000 cubic meters of air in the outskirts of the study area to 28 just north of downtown St. Louis. Higher concentrations were noted in areas where coal is used for residential heating. The higher values noted, along with similar values observed in other cities are cause for concern, even though a quantitative appraisal of their public health significance cannot be made on the basis of available information.

Soiling index

The soiling potential of small sized suspended particulate matter is measured by drawing air through filter paper and measuring the change in light transmittance from unused filter paper to sample spots. Results are expressed as Cohs (coefficient of haze) per 1000 lineal feet of air drawn through the filter paper. Samplers were operated at 12 locations for one year.

Annual average (geometric mean) values ranged from 0.15 Cohs per 1000 lineal feet of air in a low density residential area to 1.62 in a heavy industrial area. Highest mean values occurred in the metropolitan East St. Louis area and along the river in the central part of the interstate metropolitan area. Annual average values in excess of 0.4 Cohs per 1000 lineal feet are considered unsatisfactory. This level was exceeded at seven of the twelve sampling stations, with annual mean values at some of the more polluted locations being 0.91; 1.38 and 1.62. It is concluded that concentrations of soiling particles are excessive in much of the metropolitan area.

Sulfur dioxide

Sulfur dioxide was measured by a volumetric wet chemical analytical method (West-Gaeke) at 20 locations from December 1963 through February 1964, and at 40 locations from December 1964 through February 1965. Samples were collected over a 24-hour period. Average values (geometric means) for 1963–64 during the 3-month period ranged from 0.01 to 0.04 parts of sulfur dioxide per million parts of air (ppm) and maximum daily values from 0.05 to 0.24 ppm for the 20 sampling stations. Average values (geometric means) for 1964–65 during the 3-month period ranged from 0.02 to 0.10 ppm and maximum daily values ranged from 0.05 to 0.26 ppm for the 40 sampling stations. Higher concentrations occurred in the central part of the interstate area. Areas subjected to maximum daily values in excess of 0.10 ppm, the level considered satisfactory, are on both sides of the river and cover an area about twice the size of the City of St. Louis.

Sulfur dioxide was also measured at the Continuous Air Monitoring Program station (USPHS) located at 12th and Clark in St. Louis. During 1965, the 24-hour average value exceeded 0.10 ppm in each of the seven colder months and reached 0.19 ppm in one month. Maximum hourly average values ranged from 0.26 to 0.79 ppm for the 12 months. Peak 5-minute values exceeded 0.50 ppm in all but two months and exceeded 1.0 ppm in two months.

It is concluded that sulfur dioxide levels are excessive in much of the interstate metropolitan area.

Sulfation

Another index of contamination of the atmosphere by sulfur compounds is referred to as "sulfation." To measure this air pollution parameter, a glass cylinder is wrapped with gauze which is painted with a paste containing lead dioxide. Sulfur dioxide, sulfuric acid droplets and certain other sulfur compounds react with the lead dioxide when the cylinder (called a lead peroxide candle) is exposed to the atmosphere. After a 30-day exposure, the material is removed from the cylinder and analyzed for sulfate. Results are expressed as milligrams of sulfur trioxide per 100 square centimeters (of lead dioxide coated gauze) per day (mg SO_3/100 sq. cm/day). Sampling stations were operated for a year at 42 locations for making this measurement.

Annual average (geometric mean) values for the 42 stations ranged from 0.22 to 5.26 mg SO_3/100 sq. cm/day. Higher values occurred along and east of the river around the central part of the interstate area and near the mouth of the River Des Peres. Winter season average (geometric mean) for the 42 stations was 1.33 mg/SO_3/100 sq. cm/day and for summer it was 0.66. Spring and fall were intermediate. This indicates the influence of sulfur dioxide emissions from space heating operations.

Results of measurements in the St. Louis area are about one-half of those reported for London. Values observed in the St. Louis area are generally much higher than the air quality goal set by the Interstate Study group (0.25 mg SO_3/100 sq. cm/day, annual average).

Oxidant

Oxidant measurements are an index of photochemical reaction products involving hydrocarbons and nitrogen oxides in the presence of sunlight. The compounds measured include ozone and other oxiding materials. Oxidants are measured by absorbing the pollutants in a solution in a bubbler and analyzing the resulting material. Two methods, referred to as the phenolphthalin and potassium iodide methods, were used. Since the phenolphthalin method measures a broader range of contaminants, it usually yields values about double those indicated by the potassium iodide method.

Measurements made at nine locations from May through October, 1964 using the phenolphthalin method indicated highest average (geometric mean) values in July. This is to be expected since photochemical reactions occur most readily

in bright sunshine and at high temperatures. The area of greatest oxidant concentrations was in parts of St. Louis and St. Louis County and coincided, in general, with areas of high automobile traffic density. Concentrations sufficient to cause the odor of photochemical smog occurred in about 4 percent of the measurements and sufficient to cause eye irritation, plant damage, and decreased visibility in about one percent of the measurements.

Oxidant is measured at the Continuous Air Monitoring Program station at 12th and Clark in St. Louis using the potassium iodide method. During 1965, hourly average values in excess of the air-quality goal recommended by the Interstate Study group (0.15 ppm) occurred from time to time. On about 1 percent of the days in 1964, an hourly value of 0.15 ppm or more was observed.

It is concluded that air pollution by photochemical reaction products is only slightly above the recommended goals. However, in view of anticipated growth in the area, appropriate measures to prevent worsening of the situation are warranted.

Odors

Odor observations were made by firemen at 79 firehouses during the period November 18 through December 1, 1963. The firemen, who had been tested for their olfactory acuity, simply stepped outside the firehouse and "sniffed." If an odor was noticed, the fireman classified it in his own words and indicated whether it was pleasant or unpleasant. Observations were made at 7 AM, 2 PM, 8 PM, 10PM and midnight.

For the whole metropolitan area, odors were noticed on about 30 percent of the observations. Greatest frequencies of odor were observed in the City of St. Louis (32 percent) and least in St. Louis County (25 percent). In some parts of St. Louis, odors were observed on more than 40 percent of the tests. Two-thirds of all odors observed were considered unpleasant. Animal, decomposition, and chemical odors were described as unpleasant most frequently, being 98, 93, and 80 percent respectively.

Chemical odors are most prevalent in the metropolitan East St. Louis area and along the river front and the Mill Creek Valley in the City of St. Louis. Another area of chemical odors is near the mouth of the River Des Peres. Chemical odors in the downtown part of the City of St. Louis are often associated with easterly winds which bring pollutants in from industrial areas in Illinois.

It is concluded that the frequency of occurrence of objectionable odors is excessive in many parts of the study area and far too high at some locations.

Other Air Pollutants

Measurements of one kind or another were made of a number of other air pollutants including hydrogen-sulfide, carbon monoxide, hydrocarbons, nitrogen oxides, and aeroallergens. Detailed analyses were made of some samples of total particulate matter. However, these are of lesser concern at the moment and, in the interest of brevity, the results of these studies are not discussed in this brief summary statement.

VI. THE SOURCES OF AIR POLLUTION

Knowledge about the sources of air pollution in a community and the amounts of the various pollutants emitted to the air provide basic information for decision-making in air pollution abatement program activities.

Such an inventory was conducted by the Interstate Air Pollution Study during 1963–64. Although the survey considered all of the Study area, consisting of 3,567 square miles, the major emphasis was centered on the central 400 square miles of the urbanized area where more than 95 percent of the population works and resides. Almost all of the emissions are attributed to this urbanized portion.

The emission inventory shows that particulate matter is primarily emitted from the combustion of coal, various industrial processes and the open burning of refuse. Industrial operations account for 65 percent of the particulate emissions, of which 34 percent is from the combustion of coal, 27 percent is from process operations, and 4 percent from refuse disposal. The combustion of coal by all sources throughout the area contributes 56 percent and the burning of refuse 10 percent of the particulate emissions to the atmosphere.

More than 90 percent of the sulfur oxides are emitted from the burning of fossil fuels, 87 percent of which are from the combustion of coal. Industrial consumption of fossil fuels and process operations account for approximately 83 percent of the sulfur oxide emissions, of which 54 percent is from steam-electric generating plants.

Benzo-a-pyrene (BaP), a large molecular structure hydrocarbon compound, exists in the air over our cities. The combustion of fossil fuels accounts for 41 percent of the BaP emissions, essentially all of which is from burning coal. The other sources of BaP are vehicles (32%) and refuse disposal (26%), essentially all of which is from open burning.

The oxides of nitrogen are discharged primarily from the burning of coal (51%), transportation sources (35%), and the burning of gas (7%).

Motor vehicles emit more than 63 percent and the open burning of refuse almost 23 percent of the total hydrocarbon released to the atmosphere.

Gasoline-powered vehicles are the major source of carbon monoxide (98%) in the Study area.

In summarizing these emissions it is evident that any decisions for improving local air quality must take into consideration such things as the fuel-use patterns of the community, refuse disposal practices, and vehicular traffic. Use of coal accounts for 56 percent of the particulates, 87 percent of the sulfur oxides, 51 percent of the nitrogen oxides, and 39 percent of benzo(a)pyrene emitted to the atmosphere. The prevalent practice or open burning of combustible refuse accounts for 10 percent of the particulate matter, 23 percent of the hydrocarbons, and almost 26 percent of benzo(a)pyrene in the atmosphere. Emissions from vehicular traffic amount to 35 percent of the nitrogen oxides, 63 percent of the hydrocarbons, and almost 98 percent of carbon monoxide. A summary of pollutant emissions in various political subdivisions, tabulated by source categories in the St. Louis metropolitan area is given on pages 20 and 21 in the publication, "A View From the Arch." This shows that St. Louis County is the largest source of sulfur oxides (38%), with Madison County, Illinois, (30%) running a close second. Particulate emissions are greatest in Madison County (34%), with St. Clair County and the City of St. Louis contributing about 21 percent each of the area's total particulate emissions. St. Louis County has the highest emission of nitrogen oxides (36%); Madison County follows at 25 percent, and the City of St. Louis at 22 percent. The high density of automobile traffic in the City of St. Louis and St. Louis County together account for 64 percent of the hydrocarbon emissions and 74 percent of carbon monoxide emitted to the atmosphere.

The impact on a relatively small area by localized sources account for the bulk of citizen complaints to the public agency. While the emissions from a single source may be relatively small when compared to the area's total emissions, the problem resulting from the source may be very troublesome to neighbors. For example, the particulate emissions from a manufacturer of cement may be only 1 to 2 percent of the area's total particulate emissions, but an acute problem develops when the area is subjected to short duration, high concentrations that occur when the receptor area is hit by a looping or meandering plume. Ordinance provisions must be able to provide relief for these types of situations.

It is interesting to compare one metropolitan area to another. There are many pitfalls to avoid in making such comparisons but these can be minimized by using a uniform time period (a year) and by calculating emissions in terms of tons of emission per 1,000 population. The nature of the air pollution problems in the metropolitan St. Louis area can be put in perspective by comparing air contaminant emissions in this area with those in Louisville, Detroit, Los Angeles County, the San Francisco Bay Area, Philadelphia, and New York City. The data are presented in the following table. On the basis of total tons of pollutants emitted per year, the St. Louis area ranks sixth on hydrocarbons, fifth on nitrogen oxides, second on sulfur oxides and third on particulate matter in comparison to the other areas. Sulfur oxides emissions are more than twice those in San Francisco and Los Angeles. Particulate emissions in the St. Louis area are more than three times those in Los Angeles. On the basis of tons of contaminant emissions per year per 1,000 population, the St. Louis area is highest in sulfur oxides and nitrogen oxides and ranks third in particulate emissions and fourth in hydrocarbon emissions.

Emission inventory data

Pollutant	City and population						
	St. Louis, 2,150,000	Louisville, 700,000	Detroit, 3,360,000	Los Angeles, 6,039,000	San Francisco, 3,300,000	Philadelphia, 2,003,000	New York City,[1] 7,800,000
Hydrocarbons	373,600	25,000	605,900	645,000	648,700	493,000	543,900
	(4) 174	36	(3) 180	107	(2) 196	(1) 246	70
NO_x	136,700	18,000	160,600	272,300	169,000	109,500	430,000
	(1) 64	26	48	45	51	(2) 55	(3) 55
SO_x	446,500	92,000	397,850	200,400	202,210	309,950	1,022,000
	(1) 208	131	118	33	61	(2) 155	(3) 131
Particulate matter	148,400	15,700	463,550	45,630	123,000	171,600	122,275
	(3) 69	22	(1) 138	8	37	(2) 86	16

[1] Counties of Bronx, New York, Kings, Queens, and Richmond.

NOTE.—Ton, year (upper figure). Tons, year, 1,000 people (lower figure). Figures in parentheses are rank.

VII. THE AIR RESOURCE MANAGEMENT PLAN PROPOSED FOR THE INTERSTATE METROPOLITAN AREA

General concept

The benefits to be gained by good management practices are well known, whether these practices are applied to the home, to business, or to government. The principles are basically the same in each case calling for a thorough knowledge of resources and plans for the application of these resources toward specific goals. The air, being a basic material for combustion, many manufacturing processes, and for the use of humans in supporting life, can hardly escape the attention due it by present day society. The air is a matter of public business calling for good management practices. Based on a thorough knowledge of all pertinent aspects of air pollution and related community characteristics and aspirations, public organizations must establish air quality goals and standards, and develop operating program goals and air-use plans and action programs to reach the goals. The program needs to be organized as a means of assuring sound community growth, optimizing the use of the air resources of the community, along with other resoures.

Strong governmental agencies are essential

The most critical requirement for a successful air resource management program is the establishment and operation of adequately funded and staffed governmental air pollution activities. The program must be based on sound legislation empowering the agency to carry out all necessary studies and preventive and corrective actions. An expeditious system of prosecution is needed to ensure that the few recalcitrants are required to fulfill their obligations. Without viable and aggressive governmental agencies, proper air resource management cannot develop. Without air resource management, one can only expect deterioration of air quality, public dissatisfaction, and perhaps unnecessary expense.

The Interstate Study group has recommended that certain governmental agencies bear responsibility for air pollution control. The recommendations were made in the light of the need for immediate action, the possibility of actually attaining various organizational structures, and the time required to do so. In brief, a three-level coordinated organization is proposed. In time, perhaps other organizational arrangements can be brought into being.

Illinois program in St. Clair and Madison Counties

To implement air pollution control in St. Clair and Madison Counties, it is proposed that the Illinois Air Pollution Control Board organize a regional office in that area and assign to it an adequate and competent staff. Work in this regard has already been initiated. An office has been established. Staffing has begun.

It is further proposed that the Board meet frequently in that area to consider the problems of that area. It is suggeste dthat the Board be guided by an advisory committee representing county and municipal governments of that area.

The regional office of the Illinois Air Pollution Control Board while carrying out program responsibilities in the area should be continually alert to the interest of local groups in establishing a local control effort which might eventually assume responsibility for air pollution control in the area pursuant to a certificate of exemption issued by the Illinois Board. As a step toward qualifying for exemption the local control effort might take the form of a locally financed district operation administered by the Board (similar in organization to those in the State of Massachusetts). The eastern parts of both counties should probably be excluded from such a district operation because of their physical separation from the main air pollution basin. The line of separation is the bluff line bordering the American Bottoms. It is suggested, however, that the Board consider appropriate recommendations for State legislation to permit local governments to join together legally for the control of air pollution.

Initially, activities of local agencies might include:

1. Solid waste collection and disposal problems including backyard burning on private premises but excluding those involving large incinerators or disposal of wastes from entire communities.
2. Smoke and flyash emission control involving units with input of less than one million Btu (British thermal units) per hour, including a program for finding and eliminating hand-fired coal-burning installations.
3. Weed control.
4. Wind-borne dust control from construction and other sites within the jurisdiction of the local agency.
5. Other problem areas or items that may be agreed to in writing between the State Air Pollution Control Board and the local agency.

Missouri State air pollution program

The Missouri Air Conservation Commission would participate in any interstate agreement preparation and in any governing board provided by such an agreement. The State agency would review air quality goals, rules and regulations in the Missouri part of the St. Louis area and take action to approve or disapprove them in accordance with state requirements. The State's approval authority would apply to interstate standards and rules and regulations and would through them apply to the State of Missouri's responsibility to the State of Illinois under the terms of an agreement. The Missouri state agency would have also the responsibility for controlling air pollution sources outside the jurisdiction of the agreement area which have or might have a deleterious influence on the air quality in the Missouri portion of the air pollution basin. These would include St. Charles and Jefferson Counties in which an organizational arrangement between state and local agencies would be needed.

Illinois local agencies

As a general policy there should be as few air pollution control agencies as possible at a local level in an air pollution basin, with each agency having jurisdiction over as much of the area as possible. Where local ordinances are enacted they should be reviewed and approved by the Illinois Air Pollution Control Board. In its considerations the Board should seek and be guided by comments of any interstate agency which might be created for the purpose of coordinating the efforts of all control groups. It is important that there be agreement among the control groups regarding which agency is responsible for specific activities to assure that there are no geographical areas missed or functional items overlooked. The general policy should be to have activities assigned to the agency which can best handle them. The air resource management plan and the air-quality goals should serve as the primary basis for decisions regarding activities to be conducted by local agencies. The local agency must have authority to enforce action as well as technical capability for handling the activity. In general, types of air-pollutant source categories will be the basis for establishing the division of responsibility.

Missouri local agencies

The St. Louis City Division of Air Pollution Control with modifications and growth envisioned in its development plan is satisfactory except that the agency needs a means for coordination of its activities with those of other air-pollution-control agencies in the area and planning agencies within their areas of jurisdiction.

St. Louis County is covered by a single air pollution control agency. It is part of the St. Louis County Health Department. This agency's immediate development plan is satisfactory. Like the rest of the metropolitan area, this agency's plan for the future needs to include a means for coordination of its activities with other agencies.

Interstate agreement

The Interstate Study participants recognize a need for an interstate agreement between the States of Illinois nad Missouri to provide for the control of air pollution originating in one state and affecting the other. It is suggested that such an agreement establish an interstate control organization which would initiate its own enforcement action only after it had provided opportunity through leadership and coordinating activities for the appropriate state and local agencies to manage their own air resources and resolve their own pollution problems. The interstate organization should consist of representatives of state and local control agencies and other appropriate groups from each state and should have authority to adopt standards and regulations. It is suggested that the operating organization provided for by agreement be supported by equal appropriations from the two states.

The States of Missouri and Illinois have not at this time fully considered the nature of any compact or agreement between the two states. It is agreed, however, that an agreement or compact is needed and that it should provide for a continuing day-to-day operation in the St. Louis area, and that it should, from the state levels, contain elements that assure adequate action at any point needed along the boundary of the two states.

Interstate coordinating organization

It is recommended that the activities of all control agencies throughout the area be coordinated through a central organization comprised of representatives of each agency. Such an interstate coordinating organization should have as its primary objective the provision of an orderly and scientifically correct approach toward the control of air pollution through an air resource management program and as its secondary objective the development of needed aspects of metropolitan area government. Such an organization might well be the successor agency to the Executive Committee of the Interstate Air Pollution Study.

The duties of an interstate coordinating organization should include a consideration of emission standards or other regulations which could be uniformly applied to meet air quality goals. The recommendations of the organization would be made available to the control agencies. The organization might provide meteorological service for the area including prediction of air pollution levels. It might provide data handling and reporting on an area-wide basis for the several control agencies. It is essential that the organization have its own technical staff and continuing financing adequate for the activities to be undertaken.

Development of air-use plan

The design of an air-use plan consists of two parts. The first part is the calculation of the quantity of pollutants that can be emitted and still meet air-quality goals. Second, it is necessary to provide guidelines for the achievement of these emission rates by prescribing allowable emission from specific source categories, in certain areas, or even from individual sources.

The pollutants considered include particulates, sulfur dioxide, hydrocarbons, carbon monoxide, oxides of nitrogen and odors. Comprehensive emission reduction plans have, however, been developed for only particulates and sulfur dioxide. Hydrocarbons, carbon monoxide, oxides of nitrogen and odors have been considered to a lesser degree. Hydrocarbons and carbon monoxide are emitted primarily by motor vehicles and are expected to be controlled primarily on a nationwide scale and secondarily by changes in transportation systems.

In the design of the air-use plan, the pollution sources were classified according to land-use categories. The land-use categories consist of residential, commercial, industrial, and open space (including roads). In this manner the variability in emission sources was considered and different area emission limitations dependent on land use were prescribed. This leads to a more equitable basis for reducing the emissions and permits cleaner air in the place where people live.

Utilization of air-use plans is not limited to setting emission control regulations, but is also applicable in the various aspects of urban planning activities. Future activities are therefore encouraged to utilize the information presented here by recognizing that some of the best and least expensive ways of combating

air pollution may come under the responsibilities of planning and not control agencies. Similarily, it is necessary that information needed to fill the gap in the presented air-use plan be collected, so that a continuous refinement becomes possible.

In developing the proposed emission control regulations, the Interstate Study group considered first the need for emission control required to achieve the air-quality goals. Next, the various ways in which the required emission levels could be accomplished were studied, giving consideration to technical feasibility, costs, inconvenience, public acceptance, enforcement problems, timing, etc. The group believes that the best possible program has been developed and that it will provide the desired air quality, when implemented. The plan allows for expansion of industrial, commercial, residential and transportation activities so that growth can continue and still achieve the necessary air quality.

VIII. THE PROPOSED AIR RESOURCE MANAGEMENT PLAN IS WORKABLE AND WILL SERVE THE BEST INTERESTS OF THE INTERSTATE METROPOLITAN AREA

Clean air is needed for community growth and renewal

The great majority of states and communities in the Nation are actively seeking new industrial facilities while retaining the industries they have. Air pollution is a factor in locating industrial plants. Two aspects are involved. First, industrialists like to locate their plants in desirable communities so that prospective employees will want to live there, and they want the environment of their factories to be commensurate with the prestige of their companies. Clean air is a desirable attribute in the area where factories will be located, especially in the electronic and outer space program industries which require clean air in which to carry on their operations. In all cases, clean air is desirable in nearby areas where employees will live. Secondly, industrialists want to know of the various requirements which will be placed upon them by state and local governments in building and operating their plants, including those concerned with air pollution control.

Generally speaking, we believe that most industrialists would rather locate in an area where air pollution control programs and requirements are well developed and based on long-range plans, rather than in an area where the matter is poorly handled or in a state of evolution. The uncertainty of the latter situation could result in deteriorated air quality and frequent, costly changes in emission control requirements.

Major efforts are being made to rehabilitate the central portions of the St. Louis metropolitan area on both sides of the river. It does not seem appropriate to improve the physical facilities on the ground in these areas and not take equally vigorous action to improve the air supply in the area. The success or failure of some renewal projects will be influenced greatly by the general impression that people have of air quality in the area.

Clean air encourages the development of cultural and recreational facilities, tourism, and generally improved living conditions. In effect, commitment to a clean air policy recognizes and assists with development of a new kind of metropolitan area; one which is broadly based functionally and one better designed to prosper under present day conditions and the desires of people.

Air pollution levels existing in many parts of the St. Louis metropolitan area are excessive and many industries are known to cause unsatisfactory conditions in their surrounding communities. This being the case, the public may well resist the construction of any new industries for fear of new air pollution nuisances and further deterioration of air quality. On the other hand, if emission control and land-use plans can be implemented which will provide assurance that new emissions will not cause air quality to deteriorate below acceptable levels and if industrial air-pollutant emission control is demonstrated, then the public will welcome new industry.

The costs of air pollution control are not excessive

Costs incurred by industry to control air pollution are no doubt a factor in its total economic position. In some kinds of industrial plants, air pollution control costs may be relatively high while in other kinds of plants it may be little or nothing. In general, on a national basis, at the present time, the total cost of air pollution control to industry is estimated to be as much as $850 million per year, including costs for installation and operation of pollution control equipment, disposal of collected pollutants, taxes, etc. Many estimates are much lower than this. Based on this estimate, however, the cost for air pollution control is only about 0.5 percent of the value added by manufacture; about 3 percent of the

annual investment in new plants and equipment; and 0.14 percent of the gross national product.

Vigorous air pollution control programs have been under way in several communities for some time. Los Angeles County, California, is known to have the most restrictive air pollution control requirements in the world. From February 1, 1948 through January 1965, the Los Angeles County Air Pollution Control District approved 35,491 units of basic production equipment valued at $748 million, and 11,873 units of air pollution control equipment valued at $115 million. Based on a population of six million, the cost of air pollution control equipment was $19 per capita for the 17-year period ($1.12 per capita per year). The severe air pollution control requirement have not deterred industrial development. In a recent year, Los Angeles County experienced the second largest dollar value of capital expenditures for new plants and equipment of all the Standard Metropolitan Statistical areas of the Nation.

While some industrialists may claim that imposiiton of restrictive air pollution control requirements will cause them to seek other locations for their factories, this is rarely, if ever, a major factor in choosing a plant location. Furthermore, it is becoming increasingly more difficult to find a location where there are no air pollution control requirements. Since 1951 the number of states with regulatory air pollution control laws has increased from one to nineteen. Most large cities now have air pollution control laws and these are gradually becoming more restrictive and more comprehensive in coverage. In the past five years, 45 communities have established new air pollution control programs. Thus, industry and all other segments of society are increasingly being called upon to meet their responsibilities to protect the air supplies of the Nation.

The public is spending many millions of dollars to provide refuse collection and disposal facilities so that open burning of refuse in dumps and in back yards can be eliminated so as to reduce air pollution. And, starting in late 1967, the citizens of the St. Louis area will be spending about $4 million per year to reduce pollutant emissions from their automobiles.

The costs of industrial air pollution control and all other air pollution control is borne, in the end, by the general public. While the cost is not negligible, it is not exorbitant, and certainly, beyond reasonable doubt, it is less than the cost of tolerating polluted air.

Senator RANDOLPH. Now, the important point that I want to raise with you: To what extent will these targets be achieved as a result of normal attrition in the use of coal in residential and commercial heating and for other purposes?

Mr. SCHUENEMAN. In developing the recommended air pollution control program, the interstate study committee gave consideration to the best information we had available on what was happening in terms of residential use of coal and in terms of industrial and utility use of coal and designed the abatement program recommendations on that basis.

Since that time there has been some supplementary information submitted by the utility company which indicates perhaps somewhat more rapid phaseout of powerplants within the central part of the metropolitan area than we had originally contemplated.

Senator RANDOLPH. Do you find industry cooperation?

Mr. SCHUENEMAN. Yes and no. Some industrial people are reasonably cooperative. Others are not.

Senator RANDOLPH. Some are spending funds of a private nature?

Mr. SCHUENEMAN. Yes, sir.

Senator RANDOLPH. And have really moved ahead not waiting for even the Clean Air Act; is this correct?

Mr. SCHUENEMAN. Yes, sir. Some industries voluntarily are doing things that no one is yet forcing them to do.

Senator MUSKIE. You have this statement to which you referred in response to Senator Randolph's question on details of the air pollution situation here in St. Louis and that will be included in the record.

I note in these conclusions, among others listed in it, in connection with dustfall, "It's concluded that dustfall in many parts of the metropolitan area is far above satisfactory levels." In that connection, with total suspended particulate matter, "It's concluded that concentrations of suspended particulate matter in the air are in excess of satisfactory levels, and far in excess in some parts of the metropolitan area."

Next, the soiling index, "It is concluded that concentrations of soiling particles are excessive in much of the metropolitan area."

Sulfur dioxide, "It is concluded that sulfur dioxide levels are excessive in much of the interstate metropolitan area," so that there is a metropolitan area air pollution problem of considerable significance and seriousness, is there?

Mr. SCHUENEMAN. Definitely so.

Senator MUSKIE. And despite the actions that have been taken to date, this problem hasn't really been brought in hand by any agency or combination of agencies in the St. Louis area?

Mr. SCHUENEMAN. Not as yet.

Senator MUSKIE. Thank you very much, Mr. Schueneman.

Our next witness is Dr. Barry Commoner, chairman, department of botany, and director, center for the biology of natural systems, Washington University.

STATEMENT OF DR. BARRY COMMONER, CHAIRMAN, DEPARTMENT OF BOTANY, AND DIRECTOR, CENTER FOR THE BIOLOGY OF NATURAL SYSTEMS, WASHINGTON UNIVERSITY

Dr. COMMONER. Thank you, Senator Muskie.

I would like to go through the main points made in my prepared testimony, and raise certain issues which I think you have begun to consider.

Great progress has been made in the last few years in recognizing that the air pollution problem is a serious one that must be corrected. We have learned more about air pollutants; we have learned more about the resultant medical hazards, the economic costs and the necessary technology of reducing air pollution. There have been, as we have heard, very important legislative measures to control air pollution introduced locally and, of course, nationally as well. Particularly in St. Louis, I think it is clear that the news media and civic organizations have done a great deal to inform the public about these problems; this is important.

While all this is encouraging, it remains true that despite specific programs to reduce emissions from automobiles and some industrial plants, and despite the legislative work, nowhere in this Nation, and certainly not in this airshed, has there been established a comprehensive program which we can reasonably expect to roll back the rising tide of noxious substances which contaminate the air.

Senator MUSKIE. I think there ought to be a qualification of that. I think that in the Los Angeles area there has been effective and meaningful control of stationary sources of air pollution.

Dr. COMMONER. I am making a statement here which I am going to support in the rest of my testimony, and that statement is: We can't deal with the problem piecemeal. If we want to solve the air pollution problem, we will have to do it on a much broader front than stationary sources.

Senator MUSKIE. I won't disagree with that, but you made a rather broad statement here that I thought ought to be qualified to that extent at least.

Dr. COMMONER. Now, the main concern I have here as a biologist is with that part of this rather complicated problem which relates to the nature of the environmental system affected by air pollution, and with the nature of the biological hazards associated with it. I believe that what I have to say in this limited area may tell us something about the action that needs to be taken.

Now, I can, if you like, review some of the physical attributes of this airshed. Would you find that useful? It is in the prepared testimony. Otherwise we can skip through that.

Senator MUSKIE. You use your testimony in any way that you want. I don't know your testimony so I can't prejudge it.

Dr. COMMONER. Let me just recall the basic environmental facts which infiuence the local situation. The East St. Louis-St. Louis airshed is a river valley with numerous industrial plants, considerable urban concentrations, and automotive transportation systems on both sides of the river.

We are unusually fortunate in that we are surrounded by relatively pollution-free areas, so that the air, so to speak, delivered to the airshed, is relatively free of pollutants, but for very well known meteorological reasons the air overlying this area often becomes trapped in the river valley. This is a situation which is not helped by the high bluffs along part of the riverbanks. As a result, the pollutants which we produce in the air remain to some degree stagnant over the area; in effect, we ourselves are making the pollutants that we are breathing. This is a situation which is not true in all urban areas, and in a way it is a favorable one, because we essentially have complete control over our own air and would reap the benefits, the main benefits, certainly, of our own efforts to clean up the air in this airshed.

It is known from the work that's been described that there is a wide range of pollutants in the air in this airshed, and I believe not all of them, have been identified. It has been pointed out by Dr. Gaspar at Washington University that we do not have a complete inventory of the sources of sulfur, of oxides of sulfur in the air. We all know that the power and heating plants in the area use fuels at the present time with a rather high sulfur content; this results in sulfur dioxide contamination. We also have the usual problems arising from gasoline driven engines because we lack a mass transportation system. The result is the typtical photochemical smog, a complete mixture of nitrogen oxides, ozone, and the noxious products of light-induced reaction between these substances and waste hydrocarbon fuel. We have carbon

monoxide, we have lead, and other substances that come out of gasoline additives.

In addition to these common sources of urban pollution, this airshed has a wide variety of industrial plants which produce dusts and fumes of various kinds. Although the actual data about these pollutants, I mean the identification of specific substances, are rather scarce, a chemist can tell from the odors alone in the St. Louis area that these plants must inject into the atmosphere a significant amount of complex synthetic substances and waste chemical reagents.

What we know, then, is that the air in this airshed is polluted by sulfur dioxide and other sulfur oxidation products, not all of which have been identified carbon monoxide, nitrogen oxide, ozone, the complex components of photochemical smog, various known organic compounds that are the products of incomplete fuel combustion and probably by a larger list of unkown synthetic chemical compounds.

The first point that I want to make is that this is not an inventory of the actual pollutants which we breathe, because these substances themselves are highly active chemicals and may react with each other.

In order to evaluate the biological hazard, we first need to know what substances are emitted into the air in the original effluents, the concentrations they reach, and the various weather conditions, the way in which they interact chemically to produce new pollutants, and, finally, the influence of the resultant chemical mixture on health.

It is evident there is very little detailed information of this sort in this area, or elsewhere in the country. I want to make the point that the accuracy of a prediction of the effect of attempting to control any single pollutant will depend entirely on whether we understand the entire complex picture, and I provide evidence in support of that contention now.

Let me take an example which I think has already been discussed by Professor Leighton of UCLA, the impact of reducing emission of waste fuel from automobiles. The situation is relatively simple.

Nitrogen oxide, after exposure to sunlight, reacts with waste fuel to form noxious oxidation materials. If we cut down only the emission waste of fuel by putting exhaust control devices on cars, we will also increase the level of nitrogen oxides (which have harmful effects on the respiratory system), no longer able to react with fuel, may accumulate in higher concentrations.

The sulfur dioxide problem which is very important in St. Louis, bears examination here. You can't evaluate the sulfur dioxide problem simply by looking at the amount of sulfur dioxide in the air. In the first place, there are other types of sulfur oxides, some of which we have not really identified, that may be important. Secondly, there are important kinds of chemical interactions that we must consider.

Think, for a moment, about nitrogen oxides. It is entirely possible that the kind of interaction carried out in waste fuels by nitrogen oxide may take place in connection with organic chemicals disseminated in the air. There are oxides (organic oxides of various kinds that are carcinogenic), and it is entirely possible, and I mention this simply as an indication of the complexities of the chemistry involved, that harmful substances may be actually synthesized in the air by interactions of original pollutants.

When we look at the way these substances affect the body, I think we can understand the complexity of the situation.

For example, the problem of evaluating the hazard of lung cancer that arises as a result of a substance such as benzpyrene in the air. Benzpyrene has been identified in the air in St. Louis, as it has been in many other cities. The general method of evaluating this hazard is to determine how much is in the air, and relate this to animal experiments. Well, it is really not that simple, because in order to do this we must know how much benzpyrene gets into the lungs and how long it stays there; this, in turn, is influenced by protective mechanisms in the lung. The air passages in the lungs are lined by cells which do a pretty good job of removing toxic substances; if these purification processes inside the lung are affected by air pollution, then the impact of benzpyrene will be considerably worsened. Sulfur dioxide is such a substance. Sulfur dioxide paralyzes the cells which act as protective mechanisms in the lungs. Therefore, an increase in the level of sulfur dioxide will make the benzpyrene lung cancer problem considerably worse.

This leads to an important conclusion: The medical impact of air pollution will go up faster than the level of pollution itself. The reason for this is (if you want to examine the impact of a carcinogen such as benzpyrene) you need to multiply it through by whatever effect there is of air pollution on the protective mechanism.

For a simple example, let's assume the benzpyrene level doubles, and the sulfur dioxide level doubles because air pollution as a whole, goes up. This will result in a benzpyrene effect which may be four times what it was originally rather than two times. The reason is that not only has the benzpyrene concentration increased, but the protective mechanism has been paralyzed by the sulfur dioxide.

The point I am making here is simply this: We have to take into account these complexities and know that if we allow the air pollution levels to go up gradually, we will run into drastic increases in the incidence of disease associated with pollution.

Adequate public health data are lacking to do a good job of generalizing about this. I notice that a figure, published in a report of this committee, a staff report, September 1963, on the relationship between lung cancer mortality rates and the concentration of certain organic pollutants, tends to support the idea I have just put forward; namely, that the medical effect rises faster than the level of pollution itself. In this figure there are data on the incidence of pollution and the incidence of lung cancer in cities of different sizes and the two curves suggest that the medical effect rises faster, more precipitously than the level of air pollution itself.

The point, then, is that the air-pollution problem involves a complex network of chemical and biological interactions. Like all other environmental systems, the air that we breathe, and we ourselves, make up such a system with tight interconnections, that any single change—for example, an increase or decrease in the amount of any given pollutant—is likely to set off a chain of side effects. For this reason it is extremely difficult to predict the result of controlling any single pollutant unless we understand the system as a whole.

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Those are the points which lead me to suggest that we need to develop a new kind of strategy in dealing with the air pollution problem. The problem is, I think, a lot more urgent than it has been, and nothing is gained by simply looking at the trends in air pollution levels. The medical problem will get worse faster than the air pollution problem itself, for the reasons I have already given; I believe there is a danger that even with the enactment of standards and enforcement procedures (the actual steps taken to "clear the air" points that you, Senator Muskie, made earlier this morning), the actual removal of pollutants is going to be so slow as to fall quickly behind the rapid increase in pollution-caused diseases.

What I think we have to do is this. Now that the first steps, the legislative steps to develop controls, have been taken, we should very quickly move to master the problem as a whole. Otherwise, we may find that in trying to control a single pollutant, we may simply exchange one air pollution problem for another. Without a broad intensive attack on the problem as a whole, there is a real danger that the urban air pollution problem may quickly outrun even our present efforts to control it, and erupt in a series of catastrophic episodes.

This points toward the urgency of finding the necessary technical, economic, and administrative solutions to the whole air pollution problem as quickly as possible, so as to guide the vast national program which is just now getting underway. In a problem which is so complex and so intimately connected with the intricacies of our entire urban life, industry, and so on, solutions can't be found in the laboratory alone. In addition to laboratory research, we need to set up, somewhere in the country, a pilot program, a pilot airshed, in which possible solutions are quickly put to the test of the practice, and perfected in use. Because all air pollution problems relate to the behavior of the total air mass involved, such a pilot program has to deal with an entire airshed where the real complexities of the problem can be encountered and solved.

Until such a pilot program is established to work out practical methods for rolling back the level of air pollution, there is grave danger that the worsening of the health hazards will outrun our present efforts to control air pollution.

Such a pilot program will need to work out quick ways of tying together the technical data with the practical actions to control pollution. The point I am making is that it won't do simply to set up standards and then say let's enforce them. While they are being enforced the air will have to be monitored so that the impact of the enforcement will be known. It may turn out that a new kind of pollutant becomes a problem just because one pollutant is being taken out by stringently enforced control measures. Therefore, a pilot program would have to have a closely integrated technical and operational program. We need to know what is in the air. We will have to follow the changes of the pollutants while controls are being imposed. Various ways of imposing controls, various technological means of controlling the pollutants will have to be tried.

The point that you, Senator Muskie, made about the lack of inventory is an extremely good one, because at this moment if the controls that have just been voted in this area were imposed, I don't think we have the technical means of knowing whether they are really working

or not. Nor, and this is more important, would we be able to detect the change in the pattern of air pollution, or the change in the structure of the entire pollution problem brought about by the control measures themselves. Therefore, it is essential, it seems, that a very active, technological, and analytical program be established along with the operational one.

Also, and this may sound a little pessimistic, with all the legislation in the world, we are not going to be able to get the air cleared in any reasonable time unless we work out a very intensive pilot program in one place. What I want to propose is that such a program be established for the purposes of the entire national program. I think a program of this sort needs to be a kind of community crash program.

I don't see any way of getting the necessary technical help in this area, let's say, without getting volunteer work from local scientists and engineers. I believe they would do it. Also, it would take a very long time to understand the air pollution problem if we did not get from industry sufficient cooperation; for example, information from them concerning the kind of pollutants their processes are contributing. You could, of course, at great expense, park an analytical truck outside a plant and learn what is going on inside, but the easy way is to ask. This kind of cooperation from scientists, from industry, and indeed, from citizens generally, will be needed if we are to solve this problem.

As it turns out, I think that the St. Louis-East St. Louis airshed is an ideal and perhaps unique place to set up the kind of pilot program that I am talking about. This airshed has most of the types of pollutants found in urban areas. We have therefore an opportunity to set up here a good testing ground for a wide variety of control measures. As I pointed out, because this airshed is relatively isolated, and nearly all pollutants are produced locally, what happens in our airshed would immediately reflect the impact of the control measures. This is an extremely important point. With all the legislation in the world, we can't tell what a control measure is going to do until we get measurements on what happens in the air after the control measure has been imposed.

In many places it would be almost impossible to figure out the actual effect of a control-measure setup by one area because it would be receiving pollutants from another area, where these controls were not underway. Here we could do it and we have an excellent, so to speak, field laboratory right in this airshed where we could determine the actual effects of various control measures.

The industrial and economic features of the St. Louis-East St. Louis airshed are very well suited to a pilot program. We have a good deal of flexibility. We have a good deal of variety in the industries so that various problems would arise. We also have a great technical competence among the industries which would be a major contribution.

Administrative problems, just because they exist, make this a good pilot program, too. One might say, if we can solve the interstate problem here, anybody can solve it. It would be a good idea to show how to solve it as a guide to the rest of the country.

I also think that the excellent work of our newspapers and civic groups in developing promotional efforts is important, because obviously citizen support is needed, and, finally, we are unique in having

a group, with which I am associated, the committee for nuclear information, which has a valuable capability for developing the kind of public information that is so important here.

For these reasons, both biological and because of the complexity of the situation, I believe the air pollution problem nationally requires for its solution the establishment of a pilot program intensively operated locally and nationally. Such a program would merit financial support federally because it would have an important impact on Federal programs. This would be the place to work out methods, for example, for subsidizing industrial control measures; this would be the place to try out the research results of a vast Federal research program on air pollution. St. Louis could do a great deal to help the Nation solve its critical air problem.

Thank you.

Senator MUSKIE. Thank you very much, Dr. Commoner, for your thoughtful statement. I think some of the considerations that you raise underlie the airshed concept of the President's proposed Air Quality Act of 1967. I think there is much to be said for stimulating the development of effective programs in airshed areas rather than to undertake a totally national approach to the problem, because there is diversity in conditions in these various areas.

I think that an area like this is a challenge to the development of cooperative arrangements among political institutions, in two different States, various local jurisdictions, and that an area like this can really pioneer policies which can be useful across the country. In the same way an airshed approach to the problems of New York, of Chicago, of even Los Angeles which is largely within one State, could accomplish the same thing. So I think you have highlighted some important considerations.

Senator Randolph.

Senator RANDOLPH. Dr. Commoner, I am intensely interested in what you are saying. There is somewhat an element of dreaming in it and that's not so bad.

Dr. COMMONER. That's my profession.

Senator RANDOLPH. Don't misunderstand me. It is only when we make dreams dynamic that we really reach helpful conclusions, but I do share the thinking of our chairman to some degree in reference to the so-called area approach or airshed pilot programing. It is aside from this subject matter, but I think it is important to say that for the first time in the enactment of the Appalachian Regional Development Act we have attempted to grapple with problems in an area that has similar conditions of terrain, and so forth. That program has, I think, been effective in "creative federalism," and now we are thinking in terms of the Ozarks region, which would encompass Missouri, Oklahoma, and Arkansas.

In these programs, perhaps the most realistic way would be by region or area rather than just broad national approach that you mentioned. The chamber of commerce, I'm sure, would not disagree with the fact that another program is needed here.

Dr. COMMONER. It wouldn't hurt for St. Louis to be the first city in the country to clean its air.

Senator RANDOLPH. It wouldn't hurt any city, of course.

Now, you have indicated, and with some clarity, the complexity and the interrelatedness of the air pollution problem to our health hazards.

When we think of all these factors, I wonder if you would comment on the potential effectiveness of establishing national emission standards.

Dr. COMMONER. I think national emission standards are useful as a backstop, but they will have to be translated into local situations by local analyses and, more important, by local followup of the impact of these standards on the air pollution problem as a whole. This is an extremely important point. It seems to me that simply blindly saying, let's say if we were to have national standards, that the application of these standards everywhere will result in the same kind of reduction in the problem, that is oversimplifying the situation. We need to translate those standards. The standards, after all, are designed to reduce the medical effect of the pollutant, and I think that if you were to translate the standards to the actual reduction in biological hazard in the local area, it would require careful analysis of the effects of imposing these standards; in many cases, it seems to me, it may turn out that the strategy would call for a shift in emphasis on another pollutant.

Senator RANDOLPH. Dr. Commoner, we have had chronic long-term problems of air pollution as related to health hazards. You recognize that. You have said very forthrightly from your standpoint that a crash program is needed. Would this crash program that you envision give the type of information that would help us to deal with this problem?

Dr. COMMONER. Yes. I am proposing the kind of crash program that would impose controls quickly, follow the impact of those controls on the actual pollutant content of the air and readjust the controls on the basis of that information, perhaps I didn't get my point across.

We are dealing with an escalating problem medically, and unless we match the speed and urgency of our interaction with it we may find that for years we nibble at the edges, and never solve the problem. In other words, we are going to have to determine the level of effort that is actually required to roll back the pollution problem as a whole. Until we do that, we may be fooled into thinking things are going to work out because we have established the best standards we now know.

The necessity for new standards will arise insofar as any standards have an effect. In other words, if you establish standards and change the situation you will need new standards; the new standards may emphasize hidden problems. The fallout problem is a very good example. In the early days, everybody worried about strontium 90 (it turned out it was an element that nobody worried about for a long time); iodine 131, was really the critical element. The only way we know about that is keeping watch on the impact of control measures; this is the point I am trying to emphasize. This should be done locally, and I think that community resources, scientists in and out of industry, for example, need to be mobilized in order to carry out such a program. Until there is an intense pilot program somewhere in the country, it is going to be very difficult to get good results anywhere.

Senator RANDOLPH. Doctor, I agree with you that the nibbling process will not suffice, but if the bites are helpful—and sometimes they are—it is preferable even to a gulping which you may choke on. There is a problem here, isn't there?

Dr. COMMONER. Right. What I am talking about is a continuous program, a process of attacking the problem as critically as you know how; this requires stringent action and quick analysis of the results of that action, followed by the development of new action.

What I am saying is, if you simply say, "here are emission standards, let's now wait and see what happens" we are going to get fooled. We will find that it does not solve the problem. This is the experience with every environmental situation that we have run into. In any complicated situation like that, the problem has a nasty way of changing itself as you deal with it. What I am emphasizing is the need to keep your eye on the problem continuously, particularly as you are trying to solve it.

Senator MUSKIE. Thank you very much, Dr. Commoner. We appreciate your testimony. Your prepared statement will be placed in the record at this point.

(The statement is as follows:)

PREPARED STATEMENT OF BARRY COMMONER, CHAIRMAN, DEPARTMENT OF BOTANY, AND DIRECTOR, CENTER FOR THE BIOLOGY OF NATURAL SYSTEMS, WASHINGTON UNIVERSITY, ST. LOUIS, MO.

Great progress has been made, in the last few years, in recognizing that air pollution is a serious problem that must be corrected. We have learned more about the nature of air pollutants, the resultant medical hazards, the economic costs and technology of reducing air pollution. Important legislative measures to control air pollution have been introduced on all levels of government from the municipal to the national. News media and civic organizations have begun to do a great deal to inform the public about the problems and possible solutions.

All this is encouraging, but it remains true that, despite specific programs to reduce emissions from automobiles and some industrial plants, nowhere in the nation has there yet been established a comprehensive program which we can reasonably expect to roll back the rising tide of noxious substances which contaminate the air.

As a biologist I shall concern myself with only that part of this vast problem which relates to the nature of the environmental system affected by air pollution, and the biological hazards associated with it. However, I believe that a consideration of even this limited aspect of the problem leads to certain new conclusions about the kind of action that will be needed, particularly in the St. Louis-East St. Louis airshed, if we ever hope to make the air reasonably clear of pollutants.

To begin with, let us recall the basic environmental facts, as they influence the local situation. The St. Louis-East St. Louis airshed is a river valley, with numerous industrial plants, considerable urban concentrations, and automotive transportation systems on both sides of the river. We are unusually fortunate in being surrounded by relatively pollution-free areas so that the air delivered to the airshed is itself fairly free of pollutants. But, for well-known meteorological reasons, the air overlying this area often becomes trapped in the river valley—a situation which is worsened by the high bluffs along part of the river banks. As a result, the pollutants which we produce become concentrated in the air which we ourselves must breathe; our air pollution problem is of our own making. In effect, we have essentially complete control over our own air and would ourselves reap the main benefit from our own efforts to clean the air.

We already know that our area produces a very wide range of pollutants, only a few of which have been identified. Power and heating plants in this area use fuels with a rather high average sulfur content and account for most of the sulfur dioxide contamination of the airshed. The remaining sulfur dioxide comes, apparently, from household and commercial heating and from sulfuric acid plants in the area. The airshed lacks a mass-transportation system so that we are afflicted with the pollutants emitted by numerous gasoline driven vehicles. These emissions produce photochemical smog—a complex mixture of nitrogen oxides, ozone, and the noxious products of the light-induced reaction of these agents with

waste hydrocarbon fuel. Automotive transport is also responsible for contamination from carbon monoxide, and from lead and other substances present in gasoline as additives.

In addition to these common sources of urban pollution, this airshed contains a wide variety of industrial plants which produce dusts and fumes of different kinds. Although actual data about these pollutants are scarce, it is evident from odors alone that these plants must inject into the atmosphere a significant amount of complex synthetic substances and waste chemical reagents.

We know, then that the air in the St. Louis-East St. Louis airshed is polluted by sulfur dioxide (and other sulfur oxidation products), carbon monoxide, nitrogen oxides, ozone, the complex components of photochemical smog, the various known organic compounds that are products of incomplete fuel combustion, and by a probably larger list of unknown synthetic chemical compounds. Many of these substances are highly active chemicals, and may react with each other to produce new substances, the nature of which will vary with weather conditions, temperature and sunlight. In order to evaluate the biological hazard from air pollution, we need to determine the following: (1) the harmful substances emitted into the air in the original effluents; (2) the concentrations they reach in the area under various weather conditions; (3) the way in which the pollutants interact chemically, and the concentrations of new pollutants which result; (4) the influence of the resultant chemical mixture on health.

Such detailed information, very little of which has yet been achieved, is essential if we are to translate the recently enacted control measures into the actuality of clean air. The accuracy of a prediction of the ultimate consequences of an effort to control any single pollutant depends strongly on how well we understand the entire set of complex interactions.

A good example is the complex of chemical reactions that occur when automotive emissions are exposed to sunlight and produce smog. One result is that nitrogen oxides, activated by sunlight, react with waste fuel to form noxious oxidation products. If exhaust devices are installed to cut down waste fuel emission, we would surely benefit from the reduced concentration of these oxidation products. But, nitrogen oxides are themselves medical hazards; they may damage the lungs and interfere with the capability of blood to carry oxygen to the tissues. As Professor Leighton of UCLA has pointed out, if only the emission of waste fuels is reduced, the nitrogen oxides, no longer able to react with the fuel, may accumulate in higher concentrations. Thus, by reducing the hazard from the fuel oxidation products, we may increase the hazard from nitrogen oxides.

In the same way the sulfur dioxide problem is not related solely to the concentration of this substance in the air. Under some atmospheric conditions, which are still poorly understood, sulfur dioxide may be converted to sulfur trioxide and sulfuric acid, considerably increasing the medical hazard. This process may take place on dust particles, such as those emitted by steel plants; such particles may become lodged in the lungs greatly increasing the local effect of these substances.

This type of atmospheric chemistry may be particularly important in our own airshed. As already indicated, our airshed contains chemical plants which appear to emit varying amounts of still unidentified organic compounds, which may, like waste fuel, also react with nitrogen oxides. It is possible that some of these reaction products might be potent carcinogens. If this were so, by controlling fuel emission, and elevating the levels of nitrogen oxides, we might simply exchange one medical hazard for another.

The impact of air pollution on the human body also involves a highly complex system, which must be understood as a whole. Consider, for example, the problem of lung cancer arising from chemicals such as benzpyrene which are found in the polluted air of our cities, and, in fact, in specially high concentrations in St. Louis. The general method of evaluating the hazard of benzpyrene is to determine its concentration in the air and to relate this to animal experiments in which a particular concentration of benzpyrene is observed to give rise to a measurable incidence of cancer. These relationships are, of course, not very exact and are subject to the difficulty of connecting results with animals to effects in humans. Nevertheless they provide some way of evaluating the meaning of measured concentrations of air pollutants.

However the matter is not at all this simple. The impact of benzpyrene on health may be greatly influenced by other effects, which are themselves due to other air pollutants. In animal experiments it has been found that while a low

concentration of benzpyrene may by itself fail to cause cancer in mice, it does cause cancer if the animals have been also subjected to pneumonia. In turn, the incidence of pneumonia might be increased by other air pollutants. Similiarly it has been observed that the concentration of sulfur dioxide required to cause measurable constriction of lung air passages is reduced when dust is also present in the air. Thus, the influence of air pollution as a whole may cause more serious medical effects than would be expected from the known effects of the separate pollutants.

The complexity of the problem is particularly evident from what is known about the biology of the lung. Although a good deal of research on this matter still needs to be done, it would appear that air-borne organic carcinogens such as benzpyrene are capable of inducing lung cancer because of their influence on certain cells which line the air passages of the lungs. Laboratory studies show that the degree of the carcinogenic hazard will rise with the concentration of carcinogens to which the cells are exposed and with the duration of the exposure, that is, the amount of time that the carcinogen spends in contact with the susceptible cells. There are certain protective mechanisms in the lung which tend to limit exposure to materials drawn in from the air. The air passages in the lungs are lined by cells which secrete mucous that can trap foreign materials contained in the air. Other cells are covered with small hair-like cilia which, beating continuously, move the mucous up out of the lungs, thereby limiting contact between foreign materials and the lung cells. This situation is typical of living things which are highly adaptive in the sense of having within them processes that can work against influences imposed on them from the outside.

When we consider the effect of a carcinogen such as benzpyrene on the lungs, we need to know how much of it is in the air because this in turn influences the concentration of the carcinogen to which the lung cells are exposed. We also need to know how long this concentration is maintained, for this affects the duration of the carcinogenic insult to susceptible cells. But we can estimate the hazard from a known carcinogen concentration maintained for a known period of time only if it is assumed that there are no changes in the efficiency of the self-protective mechanism of the lung. In a laboratory test with experimental animals matters can be controlled so that such changes in self-protective efficiency do not occur. But in a real-life situation—exposure of people to air polluted with numerous noxious agents—the situation is very different. Changes in the efficiency of self-protection do take place and have an important impact on the biological effects of air pollutants. For example, sulfur dioxide tends to paralyze the ciliated cells of the lung air passages and thereby cut down the self-protective cleansing process in the lung. For this reason sulfur dioxide will intensify the contact between a carcinogen such as benzpyrene and the lung and could thereby increase the risk of cancer from a particular concentration of the carcinogen.

If sulfur dioxide becomes sufficiently concentrated, it can not only paralyze the self-protective cells which line the air passages, but also hasten the death of these cells. Lying below these surface cells is another layer—the basal cells—which are believed to be the very cells which can be made cancerous by contact with agents such as benzpyrene. In a normal healthy lung, the contact between the carcinogen and the cancer-susceptible basal cells is limited not only by the protective action of the mucous and ciliated cells which lie above them, but also by the very presence of the overlying cell layer. If air pollution becomes bad enough, the death of the cells in the top layer may expose the basal cells to direct contact with an air-borne carcinogen, greatly increasing the probability of cancer.

Because of such interactions one would expect that the over-all hazard of air pollution as a cause of lung cancer would generally be related to the product of the sulfur dioxide concentration *multiplied* by the concentration of carcinogens in the air. Thus, as the total level of pollution increases, and the amounts of *both* sulfur dioxide and carcinogens increase, the medical hazard would be expected to go up not proportionally with the level of pollution, but rather with some *multiple* of the pollution level. For example, in this situation a doubling in the pollution level might be expected not merely to double the medical hazard but perhaps to quadruple it. Because there are dozens of different agents capable of such multiplicative interaction now present in polluted air, we must expect drastic increases in the incidence of diseases associated with pollution if we permit even a gradual increase in the overall level of air pollution to occur.

Unfortunately, we do not yet have sufficient public health data to generalize about the quantitative relationship between the level of air pollution and the

medical effects associated with it. However, the relatively sparse data that are available do show some signs that the health effects associated with pollution may be rising faster than the level of pollution itself. This is suggested, for example, by the data contained in the September 1963 staff report of this committee on lung cancer mortality rates and the concentrations of benzene-soluble organics (in suspended particulates) in cities of different sizes. This figure shows that the concentration of these pollutants increases more or less proportionally with city size. However, with increase in city size, the incidence of cancer seems to rise more rapidly than the pollution level. Obviously there may be other factors involved in this problem as well, but the present information should certainly warn us that the health effects from air pollution may worsen faster than the pollution level itself—a result expected from the multiple effects of pollutants.

It is evident, then, that the air pollution problem involves a complex network of chemical and biological interactions. Like all other environmental systems, the air that we breathe, and we ourselves, make up an inherently complex system which is so tightly interconnected that any single change—such as either an increase or decrease in the amount of any given pollutant—is likely to set off an intricate chain of side effects. For this reason it is extremely difficult to predict the result of controlling any single pollutant unless we have some understanding of the system as a whole.

I believe that these considerations have important implications for the strategy of air pollution control. If the present trend toward an increased incidence of pollution-related disease is to be reversed, an intensive national effort against air pollution is urgent. The standards being developed nationally, and in the St. Louis-East St. Louis airshed by muncipal and state actions, are an essential step in the right direction. But, in my opinion, there is a grave danger that, even with the enactment of standards and enforcement procedures, the steps taken against air pollution will be so slow as to fall quickly behind the geometrically increasing incidence of pollution-caused disease. Now that we have taken the first steps to control the most obvious and accessible pollutants we must move quickly to master the problem as a whole. Otherwise we may find that the effort to control a single pollutant only exchanges one air pollution problem for another. Without a broad intensive attack on the total problem there is a real danger, I believe, that urban air pollution may quickly outrun the present efforts to control it and erupt in a series of catastrophic episodes.

This points toward the urgency of finding the necessary technical, economic, and administrative solutions to the *whole* air pollution problem as quickly as possible, so as to guide the vast national program which is just now getting underway. In a problem which is so complex and intimately connected with the intricacies of our entire urban life, solutions cannot be found in the laboratory alone. What is required, in addition to laboratory research, is a pilot program in which possible solutions are quickly put to the test of practice, and perfected in use. Because all air pollution problems relate to the behavior of the total air mass involved, such a pilot program must encompass an entire airshed, where the real complexities of the problem can be encountered and solved.

I believe that until such a pilot program is established to work out practical methods for rapidly rolling back the level of air pollution, as a whole, there is a grave danger that the worsening of the health hazards will outrun the present efforts to control air pollution. The establishment of a pilot airshed program is, I believe, essential to the success of the national program to control air pollution.

How would such a pilot air pollution control program work? It should be designed to accomplish two main purposes: (a) The closest possible correlation between analysis of the problem and action to control air pollution; (b) Total mobilization of the airshed's resources for an all-out attack on the problem.

Of course we already have, locally as well as nationally, a well-developed program to study air pollution and to develop effective controls for specific pollutants. The recent development of sulfur dioxide standards is a good example of what has already been accomplished in this way. However, because of the enormous complexity of the air pollution problem, we also know that each local situation will have its own distinctive features, the recognition of which is crucial to an effective control program. In turn, because of the complexity of the industrial and economic system involved in air pollution, any remedial action will have a distinctive impact on a local airshed. What is essential therefore is a dynamic progression of events: (i) The air pollution problem as it exists, is described; (ii) Control measures based on this analysis are proposed; (iii) The effect of

the new controls on the air pollution situation is measured, and their impact on economic adjustments evaluated; (iv) New steps for further control are devised, which take into account the impact of the previous steps. A pilot program designed to carry out these steps would permit tests of different alternative control techniques and an evaluation of their effectiveness in an actual field situation in a real airshed. Such information would be of great value to many other airsheds and, by permitting rapid, realistic evaluation of control measures, considerably speed up the entire national program to control pollution.

For reasons already given, the program would also need to operate on the broadest possible base, making a comprehensive attack on all the major analytical, technological, economic and administrative barriers to overall improvement in air quality. Obviously this would require an unprecedented effort and a new level of cooperation among industry, government agencies, university scientists and citizens generally. For example, I believe that scientists and engineers would be prepared to volunteer their services to establish task forces, in collaboration with existing agencies, for the rapid collection and analysis of pollution data, for the solution of specific industral problems, and for the planning and development of new departures in industry and transportation. If local industries were assured of such extraordinary technical support, I believe they could more effectively meet their responsibilities toward the analysis and solution of their own specific pollution problems. And given this kind of encouragement citizens might be more ready to support the new expenditure that will be needed.

Such a pilot program would also need, and in view of its importance to the national air pollution program would certainly merit, extraordinary federal support. Here would be the place, for example, to try out on a small scale the efficacy of various kinds of financial incentives to industries which are engaged in extraordinary efforts to control pollution. Federal support could enable rapid field trials of control techniques developed by the national program of air pollution research. Federal support might provide valuable staff assistance to teams of volunteer scientists and engineers engaged in assistance to small industries, or in developing new methods of pollution control.

The St. Louis-East St. Louis airshed is an ideal and perhaps unique place to set up such a model program. This airshed has most of the types of pollutants found in urban areas—sulfur dioxide, smog, dust, and a good share of the special pollutants produced by cars and trucks, by steel plants and foundries and by chemical plants. It is therefore a good testing ground for a wide variety of control measures. Because this airshed is isolated and nearly all pollutants are produced locally, it would readily reflect, in its own air, the impact of new control measures, thus yielding information on their effectiveness. I believe that the industrial and economic features of the St. Louis-East St. Louis airshed are also well suited to its choice for a pilot program. The administrative problems in the two-state area, like the technical issues, are very complex and here too, a great deal could be learned of national significance, by mounting a special effort locally. The economic and industrial structure of the airshed is varied, thus providing opportunities for working out the different types of economic adjustment that may be needed to absorb the financial impact of pollution control. In the excellent work of our newspapers and civil groups such as the Health and Welfare Councils of St. Louis and East St. Louis, we have the promise of the kind of intense promotional effort that would be needed to enlist citizen support for the program. Finally, this area has a unique asset in the Committee for Nuclear Information which has a proven capability for developing the kind of public information that is essential to the development of the most fundamental ingredient in any such program—an informed electorate.

For these reasons I believe that we in the St. Louis-East St. Louis airshed ought to take the lead and establish here, as a combined local and national effort, a pilot program to serve as the testing ground for the new effort which the entire nation must make if we are to survive the growing menace of polluted air. I believe that we can, in this way, learn what it takes to clean the air.

Senator MUSKIE. Our next witness is Mr. Lewis C. Green, chairman of the Missouri Air Conservation Commission.

We welcome you this morning, Mr. Green.

STATEMENT OF LEWIS C. GREEN, CHAIRMAN OF THE MISSOURI AIR CONSERVATION COMMISSION

Mr. GREEN. Mr. Chairman, Senator Randolph, it is a pleasure to be here.

My name is Lewis C. Green. If I emphasized that middle initial, it is because I hope the committee's staff will take note and punch a different key on the typewriter next time.

I am the chairman of the Air Conservation Commission of the State of Missouri, which is the State's air pollution agency. I am grateful for the opportunity of appearing here today and offering whatever I can to illuminate the question of governmental organization to deal with air pollution in interstate metropolitan areas.

I should make it clear that I am a lawyer in private practice in St. Louis. I am chairman of this commission only as a part-time hobby. I am not an expert in the technology of air pollution. I am not a political scientist by profession, nor a scholar in the field of urban affairs, so it is with some diffidence that I tread upon the territories of these other disciplines.

However, for the past year and a half as chairman of this commission I have had an opportunity closely to observe the attempts to control air pollution in Missouri's two major metropolitan areas, that is, St. Louis and Kansas City, both of which overflow into neighboring States.

It might be helpful to this committee if I begin with a brief account of the recent history of governmental activity in the field in these two areas. After that I'd like to discuss some of the governmental problems which appear to have emerged from these activities, and to suggest a possible solution. Finally I would like to offer a few suggestions on the role which I think the Federal Government might play usefully in effectuating this solution.

In the St. Louis metropolitan area the contemporary era of air pollution control began early in 1963 with the undertaking of the interstate study which Mr. Schueneman described earlier today. The study continued for about 3 years, and its report was issued last May 31. I understand that from strictly a technical and scientific standpoint, it was the most comprehensive and thorough such project ever undertaken.

As to the subject of governmental institutions to deal with air pollution control in this area, the executive committee of the study suggested that responsibility for air pollution control should be vested in the counties and in the larger municipalities in the thickly settled portions of the metropolitan area and in the respective State governments for the less thickly settled portions, and that coordination between these authorities would be achieved through both a voluntary interstate council of governments, which Mr. Schueneman mentioned, I believe, the East-West Gateway Coordinating Council, and through an interstate compact organization. The relationship between the compact agency and the concil of governments was not explained.

The East-West Gateway Coordinating Council had been previously established chiefly in response to Federal requirements for regional planning, mainly with the highway program. It is composed of elected officials and planners from the two States, and its powers are largely advisory. It can take no action, as I understand it, without the concurrence of a majority of representatives from each State. It was to this group that the interstate study report was referred.

That Gateway Council held informal hearings late last year during the course of which the local industrial organization protested the standards recommended by the interstate study and offered an alternative set of regulations. In January of this year the council voted, with only the mayor of St. Louis dissenting, to reject the interstate study recommendations and to enforce what amounted to the industry package.

In the meantime, the Missouri Air Conservation Commission held hearings on a set of regulations and standards based on the interstate study recommendations, these regulations to apply to the city of St. Louis and the county of St. Louis, and two neighboring counties, St. Charles and Jefferson Counties. In February of this year, after some modifications, these standards were adopted for the Missouri portion of the metropolitan area. They became effective in March of this year.

It should be made clear that the commission, the Air Conservation Commission of Missouri, unlike its counterpart agency in Illinois, was not a party to the interstate study. Our commission was not established until the fall of 1965, after the study was almost completed.

The regulations adopted by the commission are, in effect, the minimum standards for the Missouri portion of the metropolitan area. Local political subdivisions may, under Missouri law, enforce their own regulations if they are as strict as our State standards, or more strict. The city of St. Louis has already approved standards as strict, or in some respects, even more strict than the ones we have adopted. The county of St. Louis has a bill pending before it which I would hope would be adopted next Thursday to adopt standards identical with those that the State commission has adopted for this area.

Parenthetically I might mention another activity that our commission has engaged in, in connection with comments of the Senators this morning about tax relief. Our commission has unanimously gone on record as supporting both Federal and State tax relief, and we have communicated our views to your colleagues, Senators Symington and Long, and to all 10 Representatives from Missouri, urging them to support whatever tax relief seems to be reasonable, either a rapid writeoff or tax credit or otherwise. We have also found in the Missouri General Assembly legislators to sponsor our proposals for property tax relief and sales and use tax relief. We feel strongly that this kind of tax relief will be a great aid to all of us in bringing about the cleaning of the air that we are all looking for.

Besides promulgating regulations for this part of the St. Louis area, the commission has been trying to reach agreement on an interstate compact with Illinois. Negotiations have bogged down over some rather fundamental points. Our Governor, Warren Hearnes, feels that the compact commission should have a free hand in establishing and enforcing air quality standards and emission regulations and should not be limited to those regulations which might be the least restrictive

in effect in either party State. He has expressed himself clearly on this point. I find it difficult to paraphrase the Illinois point of view. I can only say that those various emissaries with whom we have been dealing up to this point do not apparently concur in our proposal. There are some other rather fundamental differences of opinion which appear to crop out from time to time between the various persons with whom we are trying to negotiate this compact.

In the Kansas City area, developments have followed a different pattern. Acting on a complaint from the Federal Aviation Agency that reduced visibility resulting from air pollution constitutes a menace to air navigation, the Secretary of HEW last year instituted an abatement action. That action led to an abatement conference which was held on January 24 and 25 of this year in Kansas City. The conference not only determined that interstate air pollution existed, as it obviously does there, but resulted in adoption on January 25 of our proposal that a single regional interstate air pollution control authority be formed under the authority of a compact between Missouri and Kansas. This is to be a single authority with jurisdiction on both sides of the State line. As far as I have learned up until today, the Secretary of HEW has not acted on that recommendation made last January 25.

A compact to implement that recommendation has been drafted and is before the legislatures of the two States. It enjoys the support of both Governors, and as far as I know, it has aroused no opposition from any of the local governments that would fall within its jurisdiction. It even enjoys the qualified support of the Kansas City Chamber of Commerce.

Senator MUSKIE. May I ask a question to clarify a point?

Mr. GREEN. Yes, sir.

Senator MUSKIE. Earlier you said that negotiations for a compact with Illinois—oh, this is Missouri and Kansas. I'm sorry.

Mr. GREEN. Yes, sir.

Senator MUSKIE. In connection with the point made on the negotiations between Illinois and Missouri, has that same point been resolved in the Missouri-Kansas compact?

Mr. GREEN. Oh, yes. We aren't running into that difficulty at all in Kansas. There is clear agreement that the compact commission should have a free hand to establish the air quality standards and the emission standards that the compact commission determines necessary, whether or not they turn out to be more stringent than the standards in one State or the other, or even in both States.

Senator MUSKIE. But the compact would provide that kind of flexibility?

Mr. GREEN. Yes, sir; right.

It hardly needs to be reiterated that air pollution is a problem that rarely falls within ready-made political boundaries. In any metropolitan area both the social costs incurred in failing to control it and the benefits to be derived from regulation within a single political subdivision inevitably spill over into other jurisdictions, and in Missouri into neighboring States. The necessity for regional or air-shed-wide coordination and uniformity is rather generally agreed upon. The issue appears to be one of the degree of centralization of authority that is required and is acceptable.

It seems clear to me that independent air pollution control programs operated by the several political subdivisions in the area will never be effective, even if they are members of a voluntary federation or under the supervision of an agency with authority to adjudicate disputes between them or among them.

Now, I believe that the only practical answer to this is to replace the present fragmentary separate programs with a single agency with rulemaking and primary enforcement powers throughout the airshed. Experience, I believe, supports this view. The chairman suggested a little earlier this morning that Los Angeles has shown how at least stationary sources can be controlled, and I believe if the technology were available Los Angeles would also have shown us how the moving sources could be controlled. I think it is significant that Smith Griswold, the former director of the Los Angeles Air Pollution District, has stated flatly that the program there would never have succeeded had the task been left to the 71 separate incorporated municipalities of Los Angeles County. D. J. Callaghan, director of the San Francisco Bay Area Air Pollution Control District, and Benjamin Linsky, the former director, have made essentially the same statements with respect to the six-county bay area.

There is precedent for metropolitan air pollution control districts outside the Los Angeles and bay areas, furthermore. There are regional authorities in the Lehigh Valley in Pennsylvania and the Greater Boston area. The establishment of such authorities, I understand, is under consideration and study for the Cincinnati-Covington area, the Philadelphia-Camden area, as well as the New York-northeastern New Jersey standard consolidated area. I can foresee that similar proposals will not be long in coming in other interstate metropolitan areas of which, I believe, there are about 25.

Most of the advantages of placing all responsibility for air pollution control in the hands of a single regional agency are obvious, and I will only touch on them briefly here. There are a few which I believe have not been widely discussed and deserve mention.

Obvious is the advantage of uniformity of standards and regulations. Such uniformity is absolutely necessary, in my opinion, as a matter of equity to prevent one area within the region from enjoying an economic advantage over another, to give all the citizens of the area the same quality of air. The performance of the East-West Gateway Coordinating Council illustrates the futility of trying to achieve even this minimum uniformity on a voluntary basis. Voluntary federations of governments, as the performance of the East-West Gateway Council typifies, tend to adopt the least courageous course in the interest of compromise and unity in the same fashion that a camel train can proceed only as fast as the slowest camel.

Senator MUSKIE. May I ask a question for the record?

Mr. GREEN. Yes, sir.

Senator MUSKIE. I may be in error, but it seems to me there is no effective metropolitan air pollution district which is interstate in character yet established.

Mr. GREEN. I think that is correct.

Senator MUSKIE. And it is easier, of course, to establish such a district which is intrastate than one which is interstate?

Mr. GREEN. I'm sure it must be much easier.

Senator MUSKIE. Well, I think you are going through the labor pains here. It will be interesting to us to see how it develops.

I just wanted to make that point for the record, because I think that the interstate compact as a device has never been used in the history of the country to deal with this kind of a problem which would require, in a sense, the delegating of some of the sovereignty of each of the participating States to an interstate agency. I make that as a historical point and not as an argument one way or another, because I tend to agree that we do need an inerstate agency of some kind, but it would be plowing new ground. I think that point ought to be clear as you develop your thesis here.

Mr. GREEN. Yes, Senator, I think you are absolutely right, or at least almost absolutely right. I agree——

Senator MUSKIE (interrupting). No Senator is ever absolutely right.

Mr. GREEN. It really would require essentially some delegation of the powers. It would require the creation really of a third form of government, separate from the State government and the Federal Government, something different to deal with these problems, and it is this delegation which is so very, very hard for State officials to accept. I don't think it is perhaps in a broad sense absolutely without precedent. I think, for example, with respect to water pollution control, the Delaware River Valley compact provides for firm enforcement powers, as well as standards and rulemaking powers. It has five members, each of four States has one member and the Federal Government has one member, and these five members by majority vote can adopt standards and enforce them. Now, water pollution, I think, is a much——

Senator MUSKIE (interrupting). I think the authority is there, but I don't think it has yet been used to authorize an enforcement action in the State of a dissenting Governor, and this is an ultimate test.

Mr. GREEN. Right, this is.

Senator MUSKIE. It can act by majority vote, but whether or not it would use that authority to institute an enforcement action in the State of a dissenting Governor is yet to be tested.

Mr. GREEN. That is right, as I understand it, and I do think our experience of the last hundred years or so in the development of compacts—well, it gives cause for pessimism on that score.

Senator MUSKIE. I think we should press forward, because I think the air pollution problem in metropolitan areas is simply the first of a number of problems that may stimulate the development of metropolitan areawide government that spills over State lines. It is this kind of thinking that we have to begin doing, and this probably is a good place to start here in connection with the air pollution problem.

Mr. GREEN. We have been trying to start the haven't gotten very far, but I do hope that we will make some progress at the Kansas end of the State.

Senator MUSKIE. I hope my questions indicate my approval that you do it.

Senator RANDOLPH. Mr. Chairman, on this point that Mr. Green is discussing, I believe that what you have been attempting to do has been modeled somewhat after the proposed interstate compact between

West Virginia and Ohio. West Virginia has ratified the compact, and Ohio has it under active consideration in its legislature. So we can move in this area and I think we must move with the cooperation and certainly the prodding of the Federal Government and industry participation as well.

I don't think it is hopeless, Mr. Green. I think this can be done.

Mr. GREEN. I don't think it is hopeless, either. I think all we need is a little more agreement and we can move ahead and do it, and I am very eager to try.

Senator RANDOLPH. I don't want to be facetious and I will stop very quickly, but the chairman said that no Senator is completely or wholly right. I don't know whether he used the word "completely" or "wholly."

Senator MUSKIE. "Absolutely."

Senator RANDOLPH. At any rate, I have thought that an expert is seldom right, but never in doubt.

Mr. GREEN. I am in doubt frequently here, Senator. I'm not——

Senator MUSKIE (interrupting). You took yourself out of that category by disclaiming the role of an expert, so you are all right.

Mr. GREEN. Another advantage of this kind of proposal, perhaps a little less obvious, but I think just as important as uniformity of standards, is uniformity of enforcement. Clearly, uniformity of regulations and standards without uniformity of enforcement, and by that I would include uniformity in the policy of granting variances, is utterly meaningless. This has been illustrated here in the example of a municipality in Illinois which for a number of years has had a strict ordinance provision for the control of visible emissions, but as far as I can determine, the provision has never been enforced.

It is my feeling that uniformity of enforcement without which there could never be an effective areawide air pollution control program is impossible unless the enforcement is in the hands of a single agency.

The issue of enforcement relates to a rather distasteful subject which has not often been mentioned in the debate on this question, and this is the opportunity for iniquity that presents itself in any regulatory activity where administrative discretion plays so large a part and such high financial stakes are involved. In the St. Louis area, and I suspect this is true of many metropolitan areas, especially those of the interstate variety, profound social and economic disparities have developed over the years among the component political subdivisions. Some of the municipalities have, at various times in history, acquired a certain notoriety, not just as the preserves of unbridled capitalism, but also for easy civic virtue. I suggest that the temptation that presents itself to a public servant in a relatively inconspicuous community of a large metropolitan area is greater than presents itself to the employees of a single consolidated agency whose activities are subjected to the scrutiny of more than 2 million citizens, hundreds of ambitious politicians and four or more inquisitive, excitable, and highly competitive daily newspapers. A large measure of administrative discretion appears to be an evil—a necessary evil—in a field as new and complex as air pollution control. But as long as we have to put up with it, it would be wiser to keep it in one place where we can easily see how it is being handled.

It is interesting to me to observe that in the Kansas City area, which is smaller and more homogeneous than the St. Louis area, and where there are fewer of what might be called special purpose municipalities, the industrial community has supported the formation of a regional authority, whereas in the St. Louis area where little industrial villages abound, industry has maintained a silence on the subject, which one can only regard as hostile.

A single consolidated agency would also be able to realize economies to scale, to a degree not possible with smaller agencies. Some of the requisite facilities, such as a continuous air-monitoring station and laboratory, are extremely costly and may be beyond the means of small individual agencies. In any case, it is clearly extravagant to have more than one sophisticated air pollution laboratory in a metropolitan area. While it could be argued that one municipality could establish a laboratory and others could contract for its use, such arrangements are seldom entirely satisfactory to all the parties involved. Sooner or later quarrels develop.

A single agency, moreover, would be able to employ highly specialized personnel, such as meteorologists and electronic data processing experts which the several political subdivisions would not be able to make use of on a full-time basis. In the St. Louis area we have the temporary assignment of a Federal meteorologist and we are placed in the position of having periodically to plead with the Weather Bureau to extend his tour. We'd prefer to have one of our own, and I think the Weather Bureau would prefer it, too.

A large consolidated agency would be better able to attract and hold qualified personnel. This is one field in which, as chairman of a new agency which is trying to recruit help, I can speak with some authority. Air pollution control is an exploding field of endeavor and an agency must be able to offer excitement, prestige, and opportunity for advancement, as well as money, to get anybody aboard.

The report by the Advisory Commission on Intergovernmental Relations on Performance of Urban Functions, local and area wide, lists seven criteria for evaluating the optimum performance of governmental activities. Paraphrased they are:

(1) The area of jurisdiction should be as extensive as the area benefited by the activity.

(2) The unit should be large enough to realize economies to scale.

(3) The unit should cover an area large enough for effective performance.

(4) The unit should have legal and administrative capability to perform the task assigned to it.

(5) Every unit should be responsible for enough functions so that it can balance conflicting demands for governmental services.

(6) The performance of the unit should be politically accountable to the residents.

(7) A function should be carried out by that level of government which can maximize the opportunity for citizen participation.

I submit that in the case of air pollution control in a metropolitan area an areawide agency could satisfy four or five of these criteria. Nevertheless, there are some problems in the creation of such an authority which should not be overlooked.

One is the problem of political accountability. It has been suggested that the members of the authority might be elected, but this would be something of an imposition on the voter. We are undergoing considerable complaint here in the St. Louis County area about the long ballot. There is a great move afoot to achieve the short ballot here, and there is much to be said for that.

In the bay area, I understand that they tried to achieve political accountability by having the elected officials of the counties serve as directors on a rotating basis. This might work, though I question whether a mayor or alderman wouldn't typically regard the air pollution control district as just another meeting to attend. I wonder whether political accountability is all that important here. If the authority does not have the power of taxation and the power of eminent domain, it may be that we could dispense with political accountability in the creation of this kind of authority.

Another problem is financial support. We are going to have to get—according to the calculations that have been made for the St. Louis area, about $258,000 would have to be raised from non-Federal sources. Unless the district, the interstate district, were to get into the taxing business, which seems inadvisable, this would have to come from direct contributions from the taxing governments in the area, or from the States. If they came from the local authorities there might be a need for new legislation to raise the limitations on local and county taxing authority. Missouri, like many States, has kept a pretty heavy lid on the taxing authority of local government.

A fourth problem which arises in interstate metropolitan areas is Federal participation. I feel that the Federal interest in the quality of air that moves from State to State is clear and that the Federal Government ought to be more than a passive onlooker in such an agency. Precedent has been established in the Delaware Basin compact for Federal participation as a full fledged signatory party to the agreement. I have been told that similar participation is being considered for the proposed Susquehanna River compact and the proposed Middle Atlantic States Air Pollution Control Commission.

A fifth problem is supervision and review of the agency by some higher governmental authority. In the proposed Kansas City area compact, we have attempted to deal with this problem by providing that the compact can be dissolved by either State on 90 days' notice.

Finally, there is a relatively minor problem of establishing the geographical limits of jurisdiction. If one accepts the theory that emission standards should be uniform for the sake of economic equality throughout the region, then the boundary would be drawn according to economic criteria.

Despite the complexities of these questions, I believe the metropolitan air pollution control authority, with Federal participation, offers the best hope for control of air pollution in interstate metropolitan areas. I believe that regional air quality commissions of the sort specified in the administration's proposal, as I understand it, constitute an inadequate substitute, and should be considered only as a last resort. It is not at all clear to me that the commission proposed by the administration would undertake primary enforcement activity, which I think is the heart of the regional program. As I understand the statement of Dr. John Middleton, the Director of the National

Center for Air Pollution Control, quite the opposite would be true, for he said that the proposed legislation would not deprive the States or local governments of their control and enforcement responsibility. In other words, the legislation would not do precisely what I think needs to be done, which is to take air pollution out of the hands of balkanized local jurisdictions and to place it in the hands of the regional agency.

I respectfully suggest that the Department of Health, Education, and Welfare ought to take more seriously that provision in title I of the Clean Air Act which states that it is the purpose of the act to encourage and assist the development and operation of regional control programs.

The Department ought not to allow itself to be a party to subverting that provision which, I think, is in effect what it does when it comes out in support of the kind of balkanized control which was recommended in the interstate study.

To encourage local units of government to proceed with parochial programs is to pay a sort of seductive lipservice to the cause of grassroots government and home rule, but all that is really accomplished is furtherance of a situation into which the Federal Government will eventually be forced to intrude.

As Governor Hearnes noted recently, the Federal Government has moved into the vacuum created by the lack of local cooperative leadership. "The ultimate aim of regionalism," he said, "is to strengthen, not eliminate, the smallest unit of government so that it can operate at maximum efficiency and provide adequate services to its residents."

I suggest that to accomplish this purpose the Secretary of HEW might be empowered to call conferences of local and State officials in interstate metropolitan areas for the purpose of hammering out specific plans for regional authorities, under broad guidelines which should include such requirements as full Federal participation.

Finally I suggest that a great deal of the grant money now being spent by fragmented jurisdictions in metropolitan areas is being wasted, and that the Secretary already has the power and perhaps the duty to withhold grants from those areas which have failed to establish regional authorities.

Senator MUSKIE. Thank you, Mr. Green, for your thoughtful and constructive statement.

I think I ought to make two or three observations with respect to some points in your statement.

First of all, I doubt that we could do anything in Federal legislation to force two or more States to initiate the legislation necessary to establish interstate compacts. This would depend upon action on their part. So, short of that authority on the part of the Federal Government, the question is whether we should do as the President proposed, or something like it, to stimulate the development of regional commissions, failing the action of the States to establish interstate compact institutions.

The second point I'd make is that I don't think the legislation submitted by the President really spells out in sufficient detail the authority of the proposed airshed commissions for us to draw any final conclusions as to whether or not they would have regional enforcement responsibility. I think this is a question we will have to consider as we

consider the legislation, and the committee, I assume, will make a decision at some point as to whether or not there should be regional enforcement responsibility in such commissions. Even if there were regional enforcement responsibility, that might not necessarily deprive the States or local governments of their control and enforcement responsibility.

On the question of withholding grants from areas which have failed to establish regional authorities, this might in this area, for example, penalize Missouri, which wants to establish such a regional authority, but cannot do so without the cooperation of Illinois. I would not think it would be equitable to deprive Missouri jurisdiction of those Federal grants, because, willing as they are, their willingness is not matched by people in another State. That's why I think there might be some question as to the advisability of that proposal.

With those observations, I think this is a most constructive and useful contribution to this hearing this morning. I think it raises fundamental questions which the citizens of these States ought to consider. I think certainly the objective that you hold up, that of an effective regional agency to deal with air pollution problems in this airshed, is the objective toward which this area ought to be moving, not only this area, but other interstate metropolitan areas.

Mr. GREEN. Mr. Chairman, may I try to clarify two of those points you mentioned?

The latter point, I should say, and make it very clear, I am not speaking for the city of St. Louis or the county of St. Louis. I am only chairman of the State commission.

Senator MUSKIE. I understand that.

Mr. GREEN. I am not at all clear that the county or city would feel as I do.

As to the role of the Federal Government in this affair, it is quite clear, of course, the Federal Government cannot compel the States to pass legislation they don't want to pass. What I have tried to suggest here is that the Federal Government has been, in fact, perhaps encouraging, or shall I say it this way, has been discouraging the States from taking the action which I think is necessary, by recommending balkanized control in the interstate study and by developing the multitude of separate programs in the regional area.

Senator MUSKIE. That would not appear to be an accurate description of the role of the Federal Government in the New York-New Jersey situation, for example. Now what it is here I don't know, and I assume we will get further comment on it in this hearing. But it has been the effort of the Federal agencies, HEW particularly, to stimulate the development of the regional program in the New York metropolitan area. I am surprised if their objective is different here.

Mr. GREEN. That is true in New York and Kansas City, Mr. Chairman. I think it was not true of the interstate study here, and what I am suggesting is that, also, perhaps that policy is not fully reflected in the grant program today.

Senator MUSKIE. Well, that's the last point you made in your statement. I have already commented on that, and it seems to me it would be questionable wisdom to deprive metropolitan areas of Federal assistance in dealing with the air pollution problem because they have not been able to develop a metropolitan areawise agency to deal with

it. This would mean that we come to a standstill until showtime. It might be well to ask Mr. Schueneman if he would want to comment on the question of Federal policy with respect to development of a regional agency in this area.

Thank you very much, Mr. Green.

Senator Randolph.

Senator RANDOLPH. Senator Muskie, I have no further questions. I am very happy that Chairman Green and Mr. Schueneman seem to be such good friends.

Mr. SCHUENEMAN. We talk.

Senator MUSKIE. I don't want a long response here because we have three more witnesses and we have an hour left, but I think the record ought to be completed by a response on your part to this question.

Mr. SCHUENEMAN. We do advocate and do the best we can to encourage regional programs for air pollution control. In this particular circumstances, it was our feeling that to accomplish regional control in this area would take somewhere between 3 and 5 years for the necessary State legislation to be adopted and for congressional approval to be obtained and for a viable agency to be established, get the taxes raised and the commissions appointed and the rules adopted. This being the case, we felt it was appropriate to proceed with existing agencies that could move rapidly and get something done immediately rather than to wait for the longer range thing which we did recommend in our report, that a regional agency evolve as soon as it could be achieved.

Senator MUSKIE. As a matter of fact, as I recall your testimony this morning, you recognize the shortcomings of the Gateway Council approach.

Mr. SCHUENEMAN. Yes, sir.

Senator MUSKIE. And suggested the long-range answer is a compact, is that your belief?

Mr. SCHUENEMAN. Yes, sir.

Senator MUSKIE. Thank you, gentlemen.

Our next witness is listed as Mr. J. I. Bregman, chairman of the Illinois Air Pollution Control Board. He is not able to be with us, but we do have Mr. John G. Warren, who appears for him.

May I say to Mr. Warren and to the other two witnesses that we have an hour, and I think to be fair we ought to give each of you 20 minutes, covering both your statement-and-question time. I don't like to cut short time, but we are faced with a reality and I think we do have to be fair in dividing up the remaining time.

STATEMENT OF JOHN G. WARREN, VICE CHAIRMAN OF THE ILLINOIS AIR POLLUTION CONTROL BOARD

Mr. WARREN. Senator Muskie, members of the committee, my name is John G. Warren. I am vice chairman of the Illinois Air Pollution Control Board. I am making this testimony in the absence of Dr. Bregman, who couldn't be here today.

My testimony today is intended to document, insofar as the State of Illinois is concerned, that there can only be one course of action shy of Federal intervention for resolving interstate air pollution problems and that the only decisions to be made in the joining of two or more States in a compact are those of an administrative nature.

The Air Pollution Control Act of 1963 charges the Illinois Air Pollution Control Board with the responsibility for maintaining the purity of the air resources of the State consistent with the protection of the normal health, general welfare, and physical property of the people, maximum employment and the full industrial development of the State.

The act further provides that the board shall seek the accomplishment of these objectives through the prevention, abatement, and control of air pollution by all practical and economically feasible methods.

I mention these statutory provisions to emphasize that the basic legal and moral responsibility for the protection of the atmosphere rests with the State. Interstate air pollution problems are merely one inherent factor in the State control program. The State administration, therefore, cannot, and must not, avoid assuming a direct responsibility in the field of air pollution control. Any abdication of the State's responsibility cannot be made without jeopardizing the health, well-being, and the economic life of the citizens of the State.

In dealing with the problems of interstate air pollution, there is a place for authority higher than State government to initiate abatement action. Such authority might be an interstate agency or the Federal Government. But in view of the primacy of State responsibility, the enforcement action of the higher authority must be effected only when the State is unable or unwilling to cope with the problems of controlling interstate air pollution.

In recognition of this basic State responsibility, some mechanism should be set up whereby there could be a mutual evaluation by the adjacent States and the Federal Government of an interstate air pollution problem prior to intervention by a Federal agency. The problems to be evaluated must be limited to those which are directly interstate; that is, where air pollution originating in one State detrimentally affects life, property, or well-being in the other State. The role of the Federal Government today should be the encouragement of interstate compacts for such purposes, although such encouragement has been rather lacking in Illinois. Since there should be no reluctance on the part of a State air pollution control agency to accept its responsibility for protection of the atmosphere, the State agency must, therefore, be responsible for the initial enforcement effort. Illinois statutes, as I understand them, do not permit the State to relinquish this responsibility to an interstate agency.

The precepts which I have just outlined seem to me to be basic and unquestionable. I can foresee, however, a number of problems which might arise should any State party to a proposed compact fail to recognize these statutory responsibilities. It is a possibility, for instance, that a State may voluntarily choose to yield its authority to an interstate agency over a given geographical area. I believe that if Illinois were to choose this course of action it would require authorization by the Illinois General Assembly in the form of specific amendments to the Illinois Air Pollution Control Act.

It is also conceivable that a State agency may wish to call upon the Federal Government to deal with all air pollution problems having interstate implications as, indeed, the Federal Government is authorized to do under the provisions of the Clean Air Act. Should the Illinois Air Pollution Control Board be so inclined, I am most certain

that the Illinois General Assembly would be shocked that the State agency which it created cannot, or would not, deal effectively with such interstate problems. I also find it difficult to imagine that the individual appointments to the board, which are a direct reflection of considered deliberations on the part of the Governor, could act in such an irresponsible manner.

Having accepted the concept of an interstate agency whose authority comes into play only after State action has been exhausted or is lacking, there are a number of matters to which the party States must give consideration and attention. These matters pertain in general to the functioning of the interstate agency. In drafting a compact document, the party State must consider whether or not it is desirable to have a representative of the Federal Government as a member of the interstate agency, and whether or not this particular member is entitled to voting privileges. It will be desirable to define the geographical extent of the interstate authority so that there is no question that this authority extends along the entire common border between the party States or some finite segment of the border.

It is equally important to establish the distance within each State covered by the compact. The draft of the compact must consider the number of persons to be named to membership on the interstate agency and whether or not they are to be representative of segments of society which have an interest in or are likely to be affected by interstate air pollution problems. Such questions as the number of members from each State which shall constitute a quorum and which may be necessary to cause an action by the interstate agency must be determined. Provision should be made for selecting such officers as may be necessary to assure efficient functioning of the agency, and consideration must be given to the size of the technical and clerical staff necessary to carry out the policies of the interstate agency. Certain rules of procedure such as those for hearings and reviews should be specified, and most certainly provision should be made for the periodic reporting of the interstate agency activities to the Governors of the party States.

The financing of an interstate agency may well be a prime factor in determining the extent of the agency's activities. I might also add at this point that this question of financing may serve as a deterrent to a State which would choose to yield its responsibility to an interstate agency, for, indeed, an interstate agency having authority overriding that of the State government must necessarily become involved in the highly complex subject of local taxation or assessment which even when resolved is difficult to put into effect, unless local officials are fully in accord. I would expect that the financing of an interstate agency developed from the concepts which I have briefly described would be through an appropriation by the legislatures of the two party States and through any Federal grants for which such an interstate agency might qualify. You may be interested to know that in our work with the State of Indiana the budget for the proposed interstate agency was deliberately minimized, recognizing the availability of Federal grants, to prevent the interstate organization from becoming a superbureaucratic agency.

I should like to offer a few brief comments on the rulemaking authority of the interstate agency, since this subject can be a deterrent to

the implementation of the interstate machinery unless it is thoroughly understood by both party States. Certainly the interstate agency must possess the authority to establish standards for the enforcement of the compact, but the question arises as to whether these standards should be equivalent to those of either party State or more lenient or more stringent. The solutions to these questions bear upon the question of the uniformity of standards between the two State agencies. It is on this point that I would urge a word of caution for I believe very strongly that the precise degree of limitation on emissions to the atmosphere is not nearly so important as the sum total of the progress being made by either State agency toward the abatement of air pollution. Obviously, a State regulation which provides little or no control is unacceptable, but the ultimate fate of air contaminants following their release to the atmosphere is not so firmly established that an entire compact document need be delayed pending a quibble over one or two percentage points in the realm of high collection efficiency.

I firmly believe that the standards adopted by a interstate agency might well be a combination of the standards in effect in either party State. Since the principle governing the establishment of standards by the interstate agency must necessarily be the same as that of the party States, namely, that such standards be technically feasible and economically reasonable, the standards of the interstate agency, as well as the two party States, must necessarily be nearly equivalent, again permitting pollution abatement progress to be the ultimate goal.

It is well known that of several industries in an area, some may be spending considerable sums toward the installation of effective control equipment while others are doing little or nothing. The immediate goal of the party States, and, in turn, the interstate agency, should be to establish standards which the polluter can meet from both a technical and economic standpoint and to assure that all polluters meet these requirements within a reasonable period of time. Should it then be determined that the further expansion of industrial, commercial, and domestic development will necessitate a cleaner atmosphere and, therefore, a more restrictive limitation on emissions, the results of a variety of research efforts currently underway to resolve such matters must then be formulated into a regulatory action.

In closing, may I emphasize that there is a definite need for an interstate organization and that its functions are well established in accordance with existing State statutes. In initiating and implementing a mechanism for the control of interstate air pollution there must be, as in any course of human endeavor, a mutual appreciation, both technically and administratively, of each party's objectives, problems, and responsibilities. There must be a mutual realization that an interstate endeavor requires the close cooperation of the party States, their local communities, and the Federal Government. The State of Illinois does not intend to abdicate its responsibilities and stands ready at any time to pursue further discussions on this subject with all interested parties.

Senator MUSKIE. Thank you, Mr. Warren. You have raised the question which you consider to be involved in discussions with the State of Missouri on the question of an interstate agency.

Let me ask you this to clarify, for myself, and perhaps the record, the position which the State of Illinois takes. I take it from your state-

ment that you think an interstate agency ought to be established by compact, if possible?

Mr. WARREN. Yes, sir.

Senator MUSKIE. And you think that such an agency ought to have the authority to establish standards which might be a combination of the standards in effect in either party State?

Mr. WARREN. The writing of that legislation should have that as an objective; yes.

Senator MUSKIE. Is it the position of your State that such an agency ought to have the authority independent of either State to enforce those standards?

Mr. WARREN. There is a present act that has been introduced that has not that clause in it, it is simply an investigative agency which would refer interstate problems to the States involved.

Senator MUSKIE. So that under the Illinois conception of the interstate agency, the enforcement would be left to the separate State agencies?

Mr. WARREN. In essence; yes.

Senator MUSKIE. So that what you are talking about is the establishment of a cooperative agency or an institution for cooperation in establishing standards which are to be enforced by the separate States?

Mr. WARREN. Well, yes; that would be our position.

Senator MUSKIE. This would be just another agency, then, for cooperative action. It would not be truly a regional, interstate air pollution control agency?

Mr. WARREN. It could, if these emission standards were a part of the program and they were a part of the two State standards, then this could——

Senator MUSKIE (interrupting). Either State would then have to decide whether or not it would trigger its own enforcement machinery into action?

Mr. WARREN. As it presently stands; yes.

Senator MUSKIE. So it would be a voluntary thing?

Mr. WARREN. No, it would be a little more than voluntary.

Senator MUSKIE. I am not trying to argue what your position ought to be. I am just simply trying to understand what your position is.

Under the compact agency that the State of Illinois feels it could support, the agency would establish standards, presumably, in response to instructions from the principals of each State, which would govern the metropolitan area or the interstate region. In the application of those standards, the State of Missouri and the State of Illinois might have a different view as to how a pollution source in Illinois ought to be controlled. Under your position, as I understand it, the State of Missouri could have no influence, except its powers of persuasion upon the State of Illinois, as to whether or not the application of those standards to the pollution source in Illinois ought to be in accordance with the Missouri policy or the Illinois policy?

Mr. WARREN. No. I understand. I misunderstood you. The compact would be drawn so that it has enforcement; that is, ultimate enforcement in the entire geographically drawn airshed in which it would have jurisdiction.

Senator MUSKIE. Independent of the individual States?

Mr. WARREN. Well, I am not quite certain of that; no.

Senator MUSKIE. Suppose that the compact authority, the agency, would undertake to enforce the standard upon an Illinois pollution source, which the Illinois agencies on their own might not be inclined to apply. Could the compact authority be free to move ahead, notwithstanding that difference in policy?

Mr. WARREN. Under the Illinois law, the Illinois portion of the area could gain an exemption from action by our board through demonstrating that it had as stringent or more stringent standards than we have. This has happened in Chicago where the city of Chicago runs its own metropolitan show under an exemption from the Illinois. This could happen here. This will happen in Indiana when that compact becomes effective.

Senator MUSKIE. To summarize—my staff tells me your 20 minutes is up, which means also my share of the 20 minutes—do I understand that once the standards are established for the compact authority that Illinois agrees that the compact authority will have free and independent enforcement powers?

Mr. WARREN. Not exactly. If these standards meet the requirements of the board and it can gain an exemption.

Senator MUSKIE. I am assuming that if you have the standard-setting part of the compact authority work behind you, you have agreed on what the standards will be. By standards, I assume you include a policy governing variances, exemptions, and so on. Once the policy is established with respect to the performance that can be required of pollution sources, is it your position that the authority should have free and independent enforcement powers?

Mr. WARREN. Well, no, it would have to be under the statutes.

Senator MUSKIE. We are talking about a new statute creating the compact authority. I am just trying to find out what Illinois would agree that statute ought to provide by way of enforcement authority to the compact agency. You don't think that Illinois would agree to giving it free and independent enforcement powers?

Mr. WARREN. The State would have to ratify it; yes.

Senator MUSKIE. Do you think the State would be prepared to ratify it or has its policy been developed that far? That is all I am trying to find out.

Mr. WARREN. It has been developed in the case of the Indiana compact; yes.

Senator MUSKIE. So we can look to that for instruction on this point?

Mr. WARREN. Yes. That has been in the Federal Congress for more than a year now and hasn't been ratified.

Senator MUSKIE. Thank you, sir.

Our next witness was scheduled to be Prof. Paul Steinbicker of St. Louis University. I understand there was some question as to whether he would be here because of illness. Is he here?

If he is not, is there anyone in position to present his statement or his position?

If not, then, I think I shortchanged Mr. Warren on time.

Senator MUSKIE. Our next witness does represent the Industrial Waste Control Council, Chairman Donald Cairns.

May I again apologize to all of you for the fact that our time is limited, but I sense that you understand.

STATEMENT OF DONALD F. CAIRNS, PRESIDENT OF THE INDUSTRIAL WASTE CONTROL COUNCIL

Mr. CAIRNS. My name is Donald F. Cairns, I am plant engineer, Blast Furnace Department, Granite City Steel Co., Granite City, Ill. I represent Granite City Steel on the American Iron & Steel Institute Air & Water Quality Control Committee. I am also the president of the Industrial Waste Control Council, and I am appearing today in that capacity.

The Industrial Waste Control Council counts among its members 85 industries and five business and trade associations in the St. Louis metropolitan area. The manufacturing operations of our members are about evenly divided between Missouri and Illinois. We are an interstate organization.

The council's principal functions are:

(1) to sponsor an exchange of technical knowledge, experiences, and research data to facilitate air and water pollution abatement by the member firms;

(2) to provide a means by which industry can work together to find practical and effective solutions to the many complex problems in the field of air and water pollution abatement.

An increasingly important function of this council has been to cooperate with governmental agencies at all levels providing factual information on air and water pollution to facilitate their efforts.

We believe that a sound working partnership between the people, Government, and industry, with each having mutual respect for the needs and problems of the others, is necessary to bring about the quality of air and water the Nation should have.

The council was formed in 1958 primarily to attack water pollution. The organization was responsible for helping make individual companies more aware of the water pollution problem and helping pass the 1962 $95 million bond issue to build sewage treatment plants on the Missouri side of the Mississippi River.

On the Illinois side of the river at that time, some sewage treatment plants were already functioning, principally in the refinery complex area in and around Wood River. Firms in Alton, Granite City, East St. Louis, and the village of Sauget have continually worked for better water pollution control.

Since its beginning, the council has cooperated with State and local agencies to the fullest extent possible, including the establishment of water quality criteria for the Mississippi River. We are proud of the demonstrated ability of Government and industry to work together on this common problem, and we earnestly desire to seek the same relationship with the agencies concerned with air pollution.

Let me restate what that relationship is. It is a sound working partnership between the people, Government, and industry with each having mutual respect for the needs and problems of the others.

Turning now to air pollution, the control council offered testimony and information on air pollution abatement at hearings and technical meetings of the East-West Gateway Coordinating Council, the Public Safety Committee of the St. Louis Board of Aldermen, the Missouri Air Conservation Commission and the Illinois Air Pollution Control Board.

The council helped draft legislation which led to the establishment of an Air Pollution Control Act for the State of Missouri and provided technical and legal witnesses before the appropriate Senate and House committees in support of this legislation.

Our organization has presented considerable data to the Illinois Air Pollution Control Board and its staff. This has been an ongoing, continuing effort, and has resulted in mutual cooperation and respect.

As you know, the U.S. Public Health Service and local agencies conducted an interstate air pollution study in this area. During that study, industry cooperated with the study executive committee and canvassed firms in this area with a questionnaire to develop emission data.

Let me make one point clear. The members of the industrial waste control council agree that individual companies must take responsibility for reducing the amount of air pollution attributed to industry. The council agrees that practical and effective controls for industrial emissions as well as for automobile exhaust and all other known sources of pollution ultimately will benefit the growth and progress of our entire community.

Air pollution control is a top priority objective of each of the companies represented in the industrial waste control council. A recent sampling of only 10 companies, both large and small, representing most of the major types of industry in the St. Louis bistate area, showed they had spent over $40 million in recent years installing air pollution abatement equipment. It is significant to note that the St. Louis metropolitan area is not dominated by any one class of industry: It has a "department store" of industries, each with its own peculiar pollution problems.

Every segment of industry represented in the industrial waste control council has either already installed air pollution control equipment, or has announced extensive plans for control, or has major research or planning efforts underway. By mid-1967 the two steel mills in this area will be two of the cleanest in the Nation; the chemical companies have spent large sums of money and have announced plans to spend millions more; the electric utility has adopted a time-phased plan for air pollution control which the Public Health Service says is a good one; the cement plants are investigating every feasible control method they can find; the petroleum refineries have high efficiency controls now and are doing more research; the foundry industry has an unusually vigorous control program proposed; the metallurgical plants are spending many dollars to improve their air pollution control facilities; and the coal industry is investing millions in air pollution research programs.

Although most of the criticism for lack of air pollution control in the St. Louis area is generally aimed at industry, the interstate air pollution study indicates that industrial sources are responsible for only 25 percent of the total air pollution problem. Other major sources of pollution—automobiles, buses, trucks, airlines, public dumps, municipal and private incineration, trash and leaf burnings, and so forth—should not be overlooked. Unless all sources of pollution are curtailed, we will have accomplished relatively little to clean up our atmosphere regardless of the progress made by industry.

During September and October 1966, the East-West Gateway Coordinating Council, a bistate council of governments, held three hearings on air pollution for the purpose of recommending a model air pollution control ordinance to be adopted by local governments. The industrial waste control council presented extensive testimony at these hearings on the facts of industrial air pollution control. To fully implement our recommendations, we formulated the clean air program.

The clean air program is a complete set of air pollution control regulations and separate administrative sections for Missouri and Illinois written to comply with existing laws in each State. The separate administrative sections were included so that the program could be adopted by municipalities on both sides of the Mississippi River. The same regulations would apply in both States.

The research that provided the basis for the clean air program was conducted by the top scientists and engineers responsible for air pollution abatement in many of the major companies in the St. Louis community. The technical and scientific papers that were used to formulate the regulations total over 425 typewritten pages.

The clean air regulations are based on the optimum in current air pollution abatement technology. They are the most stringent practicable regulations attainable. They are realistic, but tough. If rigidly enforced, they would do the job of cleaning up air pollution in the entire interstate St. Louis area.

Industries in Missouri and Illinois would be required to spend many millions of dollars to comply with the clean air regulations. But because they were developed by experts in air pollution abatement, we know that companies can plan to meet them and control agencies can enforce them.

To the best of our knowledge, the clean air program is the most stringent plan for controlling air pollution that has ever been proposed by any industry group. It is even more unique since the industry group that offered the plan is an interstate organization.

We would now like to give you a copy of the clean air program and the data on which it is based.

Senator MUSKIE. It will be received by the staff. The staff will examine the document and determine if it should be placed in the record.

(The exhibit is as follows. Text resumes on p. 1079.)

INDUSTRIAL WASTE CONTROL COUNCIL

PROPOSAL FOR A

CLEAN AIR PROGRAM

PART I-A

(ADMINISTRATIVE PROVISIONS - ILLINOIS)

BILL NO. _____, 19___

ORDINANCE NO. _____, 19___

Introduced by _____

AN ORDINANCE

TO PREVENT, ABATE AND CONTROL AIR POLLUTION IN (Name of County, City, etc.), ILLINOIS; ESTABLISHING AIR POLLUTION REGULATIONS; ESTABLISHING AN AIR POLLUTION CONTROL BOARD TO PLAN AND COORDINATE AIR POLLUTION CONTROL ACTIVITIES, TO CONDUCT HEARINGS AND REVIEW APPEALS, TO APPOINT A TECHNICAL ADVISORY COMMITTEE, AND TO APPOINT AN AIR POLLUTION CONTROL OFFICER TO ENFORCE THE REGULATIONS HEREIN ESTABLISHED; PROVIDING ENFORCEMENT AND APPEALS PROCEDURES; AND PROVIDING PENALTIES FOR VIOLATIONS OF THIS CODE.

BE IT ORDAINED BY THE (Board of County Supervisors, City Council, etc.) OF (Name of County, City, etc.), ILLINOIS:

SECTION 1. Short Title. - This Ordinance shall be known and may be cited as the "(Name of County, City, etc.) Air Pollution Control Code of 19___."

SECTION 2. Purpose. - The discharge into the outdoor atmosphere of air contaminants so as to cause air pollution and create a public nuisance is contrary to the public policy of this State as declared in the Illinois Air Pollution Control Act, S.H.A. Chapter 111 1/2, Sections 240.1-17, and of this (County, City, etc.) and in violation of this Ordinance. It is the intent and purpose of this Ordinance to maintain purity of the air resources of this (County, City, etc.) consistent with the protection of the normal health, general welfare and physical property of the people, maximum employment and the full industrial development of this (County, City, etc.). The accomplishment of these objectives shall be sought through the prevention, abatement and control of air pollution by all practical and economically feasible methods. Nothing contained herein shall be deemed to grant to the Board, herein established, any jurisdiction or authority with respect to air pollution existing solely within commercial and industrial plants,

works or shops or to affect the relations between employers and employees with respect to or arising out of any condition of air pollution.

SECTION 3. Definitions. - The following terms as used in this Ordinance, unless the context otherwise requires, shall have the following meanings:

(1) "Air contaminant" is particulate matter, dust, fumes, gas, mist, smoke, or vapor, or any combination thereof.

(2) "Air contaminant source" is any and all sources of emission of air contaminants, whether privately or publicly owned or operated. Without limiting the generality of the foregoing, this term includes all types of business, commercial and industrial plants, works, shops and stores, and heating and power plants and stations, building and other structures of all types, including single and multiple family residences, apartments, houses, office buildings, hotels, restaurants, schools, hospitals, churches and other institutional buildings, automobiles, trucks, tractors, buses and other motor vehicles, garages and vending and service locations and stations, railroad locomotives, ships, boats and other water-borne craft, portable fuel-burning equipment, incinerators of all types, indoor and outdoor, refuse dumps and piles, and all stack and other chimney outlets from any of the foregoing.

(3) "Air Pollution" is presence in the out-door atmosphere of one or more air contaminants in sufficient quantities and of such characteristics and duration as to be injurious to human, plant or animal life or to property, or which unreasonably interfere with the enjoyment of life and property.

(4) "Approved Source" is a source of fuel that has had its fuel tested according to procedures specified by the Air Pollution Control Board, herein established, and whose name appears on the approved source list.

(5) "ASME" is the American Society of Mechanical Engineers.

(6) "ASTM" is the American Society for Testing Materials.

(7) "Authorized Representative" is any individual, firm or corporation designated by a "person" who shall be given authority to act for such "person" in all matters pertaining to the Board. Such authorization must be transmitted to the Board in writing.

(8) "Backyard Incineration" is the burning of material originating on the premises by individuals domiciled on the premises, excluding commercial establishments.

(9) "Blast Furnace" is the furnace and equipment used in connection with the smelting process of reducing metallic ores to molten metal in which primarily oxygen is removed from the ore and gas is produced as a by-product. The furnace and equipment consists of, but is not limited to, the furnace proper, charging equipment, stoves, bleeders, gas dust catcher, gas cleaning devices and other auxiliaries pertinent to the process.

(10) "Board" is the Air Pollution Control Board herein established.

(11) "BOF" - Basic Oxygen Furnace - is a furnance in which the melting and refining of iron is accomplished by the addition at high velocities of large amounts of high purity oxygen to the atmosphere above the surface of the metal bath. The metal is held in a pear-shaped tiltable vessel with a basic refractory lining. Such a furnance includes furnace proper, oxygen lance, scrap and flux charging units, iron transfer units, gas collecting and cleaning equipment and stacks and any other auxiliaries pertinent to the process.

(12) "By-Product Coke Plant" is a plant used in connection with the distillation process to produce coke in which the volatile matter is expelled, collected, and recovered, Such plant consists of, but is not limited to, coal and coke handling equipment, by-product chemical plant and other equipment associated with and attendant to the coking chambers or ovens making up a single battery operated and controlled as a single unit.

(13) "Carbonaceous Fuel" is any form of combustible matter - solid, liquid, vapor or gas, consisting primarily of carbon containing compounds in either fixed or volatile form.

(14) "Catalytic Cracker" is a process used in oil refining to increase the yield of high-octane gasoline from crude oil. A fine, granular sandlike catalyst is used in the process, which catalyst is regenerated continuously by heating in a stream of air.

(15) "Cement Plant" is a process wherein a powder of alumina, silica, lime, iron oxide, and magnesia is burned together in a kiln and finely pulverized and used as an ingredient of mortar and concrete.

(16) "Chimney or Stack" is any conduit, duct, flue or opening of any kind whatsoever arranged to conduct any products of combustion to the atmosphere. It does not include breeching.

(17) "Combustion for Indirect Heating" is the combustion of fuel to produce useable heat that is to be transferred through a heat-conducting materials barrier or by a heat storage medium to a material to be heated so that the material being heated is not contacted by, and adds no substance to, the products of combustion.

(18) "Committee" is the Air Pollution Technical Advisory Committee herein provided for.

(19) "Control Officer" is the Air Pollution Control Officer herein provided for.

(20) "Continuous Ferrous Cupola" is a cupola used by a production foundry or iron or steel works which melts continuously over an extended period of time, such as 8, 16 or 24 hours per day for any number of days per week.

(21) (Here insert "County," "City," etc., followed by description of enacting jurisdiction and geographical area of same to be covered by Ordinance.)

(22) "Domestic Heating Plant" is a plant generating heat for a single family residence, or for two such residences either in duplex or double house form, or for multiple dwelling units in which such plant serves fewer than three apartments. Under this designation are also hot water heaters, stoves, and space heaters used in connection with the foregoing establishments or to heat temporary buildings, such as used by the railroad and construction industries, except when gas fired; provided, however, that like equipment used in multiple dwelling units other than herein described, or used in permanent buildings of commercial or industrial establishments, is not to be construed as included under this designation.

(23) "Electric Furnace" is a furnace in which the melting and refining of metals are accomplished by means of electric energy.

(24) "Foundry Cupola" is a vertical cylindrical furnace for melting iron in a foundry having tuyeres and tapping spouts near the bottom. Typically found in a jobbing foundry, such cupola melts intermittently or just long enough to pour the molds that are ready on the foundry floor, job by job.

(25) "Fuel-Burning, Combustion or Process Equipment or Device" is any furnace, incinerator, boiler, fly-ash collector, electrostatic precipitator, smoke arresting or prevention equipment, stack, chimney, or structure used for the burning of fuel or other combustible materials, or for the emission of products of combustion, or used in connection with any process which generates heat which may emit products of combustion.

(26) "Garbage" is animal and vegetable matter originating in houses, kitchens, restaurants and hotels, produce markets, etc.

(27) "Heating and Reheating Furnace" is a furnace in which metal is heated to permit shaping or forming, or to achieve specific physical properties.

(28) "Incinerator" is combustion apparatus capable of withstanding heat, in which solid, semi-solid, liquid, or gaseous combustible wastes are ignited and burned efficiently and from which the solid residues contain little or no combustible material.

(29) "Multiple chamber incinerator:" Any article, machine, equipment, contrivance, structure or part of a structure, used to dispose of combustible refuse by burning, consisting of three or more refractory lined combustion furnaces in series, physically separated by refractory walls, interconnected by gas passage ports or ducts and employing adequate design parameters necessary for maximum combustion of the material to be burned. The refractories shall have a Pyrometric Cone Equivalent of 31, tested according to the method described in the American Society for Testing Materials, Method C-24.

(30) "New Equipment" is any new or replacement facility or process, the design of which is less than 50% completed on the effective date of these regulations. If equipment is to be altered, repaired or rebuilt at a cost of 30% or more of the replacement cost of the total manufacturing process, it shall be considered new equipment.

(31) "New Fire" shall be held to mean the period during which a fresh fire is being started and does not mean the process of replenishing an existing fuel bed with additional fuel.

(32) "Open Burning" is any fire wherein the products of combustion are emitted into the open air, and are not directed thereto through a stack or chimney.

(33) "Open Air" is all spaces outside of buildings, stacks or exterior ducts.

(34) "Open Fire" is any fire from which the products of combustion are emitted directly into the open air without passing through a stack or chimney.

(35) "Open Hearth Furnace" is a furnace in which the melting and refining of metal is accomplished by the application of heat to a saucer type or shallow hearth in an enclosed chamber. Such furnace consists of, but is not limited to, the furnace proper, checkers, flues and stack and may include a waste heat boiler, an oxygen lance, and other auxiliaries pertinent to the process.

(36) "Particulate Matter" is any material, except uncombined water, that exists in a finely divided form as a liquid or solid at standard conditions.

(37) "Person" is any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, political subdivision, or any other legal entity, or their legal representative, agent or assigns.

(38) "Process" is any action, operation, or treatment embracing chemical, industrial or manufacturing factors, such as, but not limited to, heat-treating furnaces, by-product coke plants, core-baking ovens, mixing kettles, cupolas, blast furnaces, open-hearth furnaces, heating and reheating furnaces, sintering plants, electric steel furnaces, kilns, stills,

dryers, roasters, asphaltic concrete mixing plants, cement plants, and equipment used in connection therewith, and all other methods or forms of manufacturing or processing that may emit smoke, particulate matter or gaseous matter.

(39) "Process Weight" is the total weight of all materials introduced into any specific process. Solid fuels charged will be considered as part of the process weight, but liquid and gaseous fuels and combustion air will not.

(40) "Radioactive Material" is any material, solid, liquid, or gas, that emits ionizing radiation spontaneously.

(41) "Refuse" includes garbage, rubbish and trade wastes.

(42) "Ringelmann Chart" is the chart published and described in the U. S. Bureau of Mines Information Circular 7718, and on which are illustrated graduated shades of grey to black for use in estimating the light obscuring power of smoke.

(43) "Rubbish" are solids not considered to be highly flammable or explosive including, but not limited to, rags, old clothes, leather, rubber, carpets, wood, excelsior, paper, ashes, tree branches, yard trimmings, furniture, tin cans, glass, crockery, masonry, and other similar materials.

(44) "Salvage Operations" is any business, trade or industry engaged in whole or in part in salvaging or reclaiming any product or material, including, but not limited to, metals, chemicals, shipping containers, or drums.

(45) "Sintering Plant" is the plant used in connection with the process of fusing fine particles of metallic ores causing agglomeration of such particles. Such plant consists of, but is not limited to, sintering machines, handling facilities, wind boxes, stack and other auxiliaries pertinent to the process.

(46) "Smoke" is small gas-borned particles resulting from incomplete combustion, consisting predominantly but not exclusively, of carbon, ash and other combustible material, that form a visible plume in the air.

(47) "Standard Conditions" is a gas temperature of 60 degrees Fahrenheit and a gas pressure of 14.7 pounds per square inch absolute. (psia).

(48) "Standard Cubic Foot (SCF)" is the standard cubic foot, a measure of the volume of gas under standard conditions.

(49) "Trade Waste" is all solid or liquid material or rubbish resulting from construction, building operations, or the prosecution of any business, trade or industry including, but not limited to, plastic products, chemicals, cinders and other forms of solid or liquid waste materials.

SECTION 4. Air Pollution Control Board, Establishment. -

(1) There is hereby established an Air Pollution Control Board which shall consist of 9 members who shall be appointed by the (Chairman of Board of County Supervisors, Mayor, etc.), with the advice and consent of the (Board of County Supervisors, City Council, etc.), as follows: One shall be a registered professional engineer as defined in "The Illinois Professional Engineering Act," filed July 24, 1941, as amended, who shall have at least 5 years experience in the field of air pollution control; one shall be a physician, licensed in compliance with the "Medical Practice Act," approved June 30, 1923, as amended, who shall be experienced in the field of industrial medicine; one shall be engaged in a field which is directly related to agriculture or conservation; one shall be actively engaged in the management of a private manufacturing concern; one shall be representative of labor; one shall be engaged in municipal government; and three others shall be selected at large.

(2) The appointed members' terms of office shall be 4 years and until their successors are selected and qualified, except that the terms of those first appointed shall expire as follows:

3 at the end of one year after date of appointment,
2 at the end of 2 years after date of appointment,
2 at the end of 3 years after date of appointment, and
2 at the end of 4 years after the date of appointment as designated by the (Chairman of Board of County Supervisors, Mayor, etc.) at the time of appointment. The terms of all members shall continue until their respective successors have been duly appointed and qualified. If a vacancy occurs in the appointed membership, the (Chairman of Board of County Supervisors, Mayor, etc.) may appoint a member for the remaining portion of the unexpired term created by the vacancy. The (Chairman of Board of County Supervisors, Mayor, etc.) may remove any appointed member for cause.

(3) The Board shall hold at least 4 regular meetings each calendar year at a place and time to be fixed by the Board. The Board shall select at its first meeting one of its members to serve as chairman and another of its members to serve as vice-chairman. At the first regular meeting in each calendar year thereafter, the chairman and vice-chairman for the ensuing year shall be elected. Special meetings may be called by the chairman or by 3 members of the Board upon delivery of written notice to the office of each member of the Board. Five members of the Board shall constitute a quorum.

(4) The (Chairman of Board of County Supervisors, Mayor, etc.) shall appoint an Air Pollution Control Officer who shall be a full-time employee of the (County, City, Etc.) and who shall act as the Board's administrative agent. The Control Officer shall be a registered professional engineer as defined

in "The Illinois Professional Engineering Act," filed July 24, 1941, as amended, who has specialized professional experience in the field of air pollution control.

(5) The Board shall appoint an Air Pollution Technical Advisory Committee which shall consist of not less than five nor more than seven members, any of whom may be non-residents of the (County, City, etc.) and not less than three of whom shall be employees or representatives of major industries in the (County, City, etc.). Each member of the Committee shall be knowledgable in the field of air pollution control and shall be experienced in engineering or science. It shall be the duty of the Committee, on its own initiative or at the request of the Board or the Control Officer, to study, review and analyze, from time to time, advances in technology, changes in air pollution conditions, other pertinent technical matters, and the practical and economically feasible solution of problems, all relating to abatement and control of air pollution, giving consideration to the air pollution regulations herewith adopted and suggested changes or amendments to such regulations. The Committee shall report the results of such study, review and analysis to the Board and to the Control Officer, and any member of the Committee may submit a separate report.

SECTION 5. Powers and Duties of Board. - The Board shall have the following powers and duties:

(1) Prepare and develop a general comprehensive plan for the prevention, abatement or control of air pollution.

(2) Encourage voluntary cooperation by persons or affected groups in restoring and preserving a reasonable degree of purity of air with this (County, City, etc.).

(3) Encourage and conduct studies, investigations and research.

(4) Collect and disseminate information.

(5) Advise, consult and cooperate with agencies of the State, industries, other states and the federal government, and with interested persons or groups.

(6) Represent the (County, City, etc.) in any and all matters pertaining to regional and interstate air pollution.

(7) Accept, receive and administer grants or other funds or gifts for the purpose of carrying out any of the functions of this Ordinance; accept, receive and receipt for federal monies, for and in behalf of the (County, City, etc.) given by the federal government under any federal law to the (County, City, etc.) for air pollution control activities, surveys or programs. Such funds received by the Board pursuant to this section shall be deposited with the

(County, City, etc.) Treasurer and held and disbursed by him in accordance with appropriations of the (Board of County Supervisors, City Council, etc.), provided, that such monies shall be used only for the purposes for which they are contributed and any balance remaining after the conclusion of experiments, investigations and research, shall be returned to the contributor.

(8) Promulgate such internal administrative procedures consistent with the intent and purposes of this Ordinance and the provisions contained herein.

(9) Recommend in writing to the (Board of County Supervisors, City Council, etc.) amendments to this Ordinance in light of advances in technology, changes in air pollution conditions, or for any other appropriate reason in accordance with the intent and purposes of this Ordinance.

(10) Hold hearings and appeals in accordance with procedures prescribed by this Ordinance.

(11) Enter such order or determination upon appeal or otherwise as may be necessary to effectuate the purposes of this Ordinance. In making its orders and determinations hereunder, the Board shall take into consideration all the facts and circumstances bearing upon the reasonableness of the emissions involved including, but not limited to:

(a) the character and degree of injury to, or interference with the protection of the health, general welfare and physical property of the people;

(b) the social and economic value of the air pollution source;

(c) the suitability or unsuitability of the air pollution source to the area in which it is located, including the question of priority of location in the area involved; and

(d) the technical practicability and economic reasonableness of reducing or eliminating the emissions resulting from such air pollution source.

The order or determination of the Board may include such advisory recommendation as the Board may deem appropriate for the control of emissions from any air contaminant source and the reduction of the emission of air contaminants.

(12) Refer any violation of this Ordinance to the (County or City Attorney, etc.) for prosecution or other appropriate legal proceedings in a court of competent jurisdiction to compel compliance with the provisions of this Ordinance.

(13) Settle or compromise in its discretion, with the approval of the (County or

City Attorney, etc.), as the Board may deem advantageous to the (County, City, etc.), any suit for recovery of any penalty or for compelling compliance with the provisions of this Ordinance.

(14) Authorize any agent of the Board to enter at all reasonable times in or upon any private or public property, except the administrative offices of any person or private residences, for the purpose of inspecting and investigating any condition which the Board shall have reasonable cause to believe to be an air pollution source.

(15) Recommend to the (Chairman of Board of County Supervisors, Mayor, etc.) the employment and compensation, within appropriations available therefor, such consultants and technical assistants on a full or part-time basis as may be necessary to carry out the provisions of this Ordinance and prescribe their powers and duties.

(16) Provide such technical, scientific or other services, including the necessary laboratory and other facilities as may be required for the purpose of carrying out the provisions of this Ordinance, from funds appropriated and available for purposes of this Ordinance and secure the assistance of any state educational institution, experiment station, board, department, and officials and employees thereof, or other state agency when it is deemed necessary or beneficial by the Board to carry out the provisions of this Ordinance.

SECTION 6. Delegation by Board of Powers and Duties. - The Board may delegate to the Control Officer such of its powers and duties as described in Section 5, above, as it may deem appropriate, except those provided for in Subsections (7) through (13), inclusive, of that Section.

SECTION 7. Powers and Duties of Control Officer. - The Control Officer shall have the following powers and duties in addition to those which may be delegated to him by the Board as provided in Section 6, above:

(1) The Control Officer shall cause investigations to be made upon the request of the Board or upon receipt of information concerning an alleged violation of this Ordinance and may cause to be made such other investigations as he shall deem advisable. All sampling and testing shall be in accordance with Section 16.

(2) If, in the opinion of the Control Officer, such investigation discloses that a violation does exist, he shall by conference, conciliation and persuasion, endeavor to the fullest extent possible to eliminate such violation.

(3) In case of the failure by conference, conciliation and persuasion to correct or remedy any claimed violation and the filing by the Control Officer of a formal compliant with the Board, the Board may cause to have issued and served upon the person complained against a written notice, together with

a copy of the formal complaint, which shall specify the provision of this Ordinance which such person is said to be in violation, and a statement of the manner in, and the extent to which, such person is said to violate this Ordinance and shall require the person so complained against to answer the charges of such formal complaint at a hearing before the Board at a time not less than 30 days after the date of notice.

(4) The Control Officer shall have the power to grant permits for the installation of new equipment capable of becoming a source of air pollution in accordance with the provisions of this Ordinance. Upon the refusal by the Control Officer to grant such a permit after request therefor, any person requesting such an installation permit shall be entitled to a hearing before the Board.

(5) The Control Officer shall attend all meetings of the Board, but shall not be entitled to a vote.

SECTION 8. Appeals. - Any person against whom an order is issued under this Ordinance may appeal the order to the Board within 30 days, and the appeal shall stay the enforcement of such order. If any order is not appealed within such period, it becomes final.

SECTION 9. Hearings. -

(1) The Board shall set all hearings, on appeal or otherwise, at a time not less than 30 days after the date of the request. The Board may sustain, reverse, or modify any order, or make such other order as the Board deems appropriate under the circumstances.

(2) When the Board schedules a matter for hearing, each party to the proceeding may file written arguments and may appear at such hearing in person or by representative, with or without counsel, and may make oral argument, offer testimony or cross-examine witnesses, or take any combination of such actions.

(3) The Board at the request of any party to the proceeding shall subpoena and compel the attendance of such witnesses as such requesting party may reasonably designate and shall require the production for examination of any book or paper reasonably relating to the matter under investigation at any such hearing.

(4) After due consideration of the written and oral statements, the testimony and arguments that shall be submitted at the hearing, the Board shall issue and enter such final order, or make such final determination as it shall deem appropriate under the circumstances, including the granting of a variance permitted by Section 10, and it shall immediately notify each party to the proceeding thereof in writing by registered mail. In cases in which any party to the proceeding is found to have violated this

Ordinance, the final order or determination shall fix a time, which shall be reasonable under all the circumstances and which may be extended by the Board from time to time, during which the person shall be required to take such measures as may be necessary to prevent the violation and to give periodic progress reports thereon.

(5) Any final order or determination or other final action by the Board shall be approved in writing by at least 5 members of the Board.

(6) At any public hearing, all testimony taken before the Board shall be under oath and recorded stenographically. The transcript so recorded shall be made available to any member of the public or to any party to the proceeding upon payment of the usual charges therefor.

(7) In any such hearings, any member of the Board may issue in the name of the Board notices of hearings requesting the attendance and testimony of witnesses and the production of evidence relevant to any matter involved in any such hearing, and may examine such witnesses.

(8) All hearings shall be had before at least 5 members of the Board.

(9) In all proceedings before the Board with respect to any alleged violation of this Ordinance or any rule or regulation hereunder, the burden of proof shall be upon the Control Officer.

SECTION 10. Variances. -

(1) The Board may grant individual variances beyond the limitations prescribed in this Ordinance, whenever it is found, upon presentation of adequate proof that compliance with any provision of this Ordinance, or any rule, procedure requirement or order of the Board or Control Officer will result in an arbitrary and unreasonable taking of property or in the practical closing and elimination of any lawful business, occupation or activity, in either case without sufficient corresponding benefit or advantage to the people.

(2) In determining under what conditions and to what extent a variance from this Ordinance may be granted, the Board shall give due recognitiion to the progress which the person requesting such variance shall have made in eliminating or preventing air pollution. In such a case the Board shall consider the reasonableness of granting a variance conditioned upon such person effecting a partial abatement of the particular air pollution over a period of time which it shall consider reasonable under the circumstances; or the Board, in conformity with the intent and purpose of this Ordinance to protect health, welfare and property, may prescribe other and different requirements with which the person who receives such variance shall comply.

(3) Any variance granted pursuant to the provisions of this Section shall be

granted for such period of time, not exceeding one year, as shall be specified by the Board at the time of the grant of such variance. Any variance may be granted by the Board upon the condition that the person who receives it shall make such periodic reports to the Board as the Board shall specify as to the progress which such person shall have made toward compliance with any rule or regulation as to which a variance has been granted. Such variance may be extended from year to year by affirmative action of the Board.

(4) Any person seeking a variance shall do so by filing a petition for variance with the Control Officer. The Control Officer shall promptly investigate such petition and make a recommendation to the Board as to the disposition thereof. Upon receiving the recommendation of the Control Officer, the Board may, if such recommendation is for the granting of a variance, do so without hearing. If the recommendation of the Control Officer is against the granting of a variance or the Board, in its discretion, concludes that a hearing would be advisable, then a hearing shall be held as provided in Section 9 hereof, except that the burden of proof shall be on the petitioner.

(5) Upon failure to comply with the terms and conditions of any variance as specified by the Board, the variance may be revoked or modified by the Board after a hearing held upon not less than 30 days' written notice. The notice shall be served upon all persons who will be subjected to greater restrictions if the variance is revoked or modified, or who have filed with the Board a written requestion for notification.

SECTION 11. Formal Program of Air Pollution Control. -

Any person responsible for operating commercial or industrial plants, works, shops, facilities or equipment which were constructed prior to the enactment of this Ordinance may submit to the Board a formal program of air pollution control which shall schedule over a period of time, which is reasonable under the circumstances, either a continued installation of air pollution control devices or the replacement of specified facilities. The Board shall review the formal program submitted by such affected person, and after having considered all the facts and circumstances bearing upon the reasonableness of the emissions involved, shall approve or disapprove the program. After the Board has approved the program, the owner of the facilities shall not be in violation of this Ordinance so long as the program is complied with. Reports of the status of the program shall be submitted annually by the applicant to the Board.

SECTION 12. Failure of Board or Control Officer to Act, Effect of. - Upon the failure of the Control Officer to take action within 30 days after a request for installation permit, petition for variance or formal program of air pollution control, or upon the failure of the Board to enter a final order or determination within 30 days after the final argument in any hearing, the person seeking any of such actions shall be entitled to treat for all purposes such failure to act as a grant of the requested permit, variance, or formal program of air pollution control, or of

a finding favorable to the petitioner in any hearing.

SECTION 13. Emergency Action. -

(1) Notwithstanding any other provision of this Ordinance, whenever it shall appear to the Chairman of the Board, or, in his absence, the Vice-Chairman of the Board, that there exists air pollution of such characteristics and duration as to constitute an immediate and substantial threat to human health and that it creates an emergency requiring immediate action to protect the public health or safety, he may issue an emergency order, with the concurrence of the (Chairman of the County Board of Supervisors, Mayor, etc.) requiring any person so causing air pollution immediately to reduce or discontinue the discharge of air contaminants. The Board, acting through the Control Officer, may thereafter summarily cause the abatement of such violation or may direct the (County or City Attorney, etc.) to obtain an injunction against any such violator.

(2) Such order shall be effective immediately and shall fix a place and time, not later than 24 hours thereafter, for a hearing to be held before the Board. Such hearing shall not be adjourned or set over to a later date except upon the request of the person named in such order. All such hearings shall meet the requirements of Section 9 hereof. Immediately following the completion of such hearing, the Board shall enter a final order continuing its prior order in effect, or revoking or modifying such prior order.

SECTION 14. Judicial Review. - All final orders or determinations of the Board hereunder shall be subject to judicial review pursuant to the provisions of the "Administrative Review Act," approved May 8, 1945, as amended, and the rules adopted pursuant thereto. All final orders and determinations shall be deemd "administrative decisions" as that term is defined in Section 1, "Administrative Review Act."

SECTION 15. Disclosure of Confidential Information Prohibited. - No information relating to secret processes or methods of manufacture or production shall be disclosed at any public hearing or otherwise and all such information shall be kept confidential. Wilful disclosure or conspiracy to disclose confidential information obtained under this Ordinance shall constitute an offense against the (County, City, etc.). Any member of the Board, the Committee, or other (County, City, etc.) official, including the Control Officer and his agents, having knowledge of confidential information who shall wilfully disclose or conspire to disclose such information in violation of this provision shall forfeit his appointment or office and shall be subject to any civil or criminal remedy for such wrongful action which may be available against him.

SECTION 16. Sampling and Testing. -

(1) The Control Officer is hereby authorized to conduct or cause to be con-

ducted, any test or tests of any article, machine, equipment, device, or other contrivance the operation of which, in his opinion, may result in emissions in excess of the limitations in this Ordinance or when, in his judgment, there is evidence that emissions therefrom are exceeding any emission limitation prescribed in this Ordinance. Upon notification by the Control Officer that emission tests are considered necessary, a person may elect to conduct such tests himself. In this event, the person shall notify the Control Officer of this decision and of the time and date of such testing. All tests so conducted shall be performed in accordance with acceptable engineering standards, and a complete detailed test report of such tests shall be submitted to the Control Officer. The Control Officer may stipulate that a representative of his office be present during the conduct of such tests.

(2) Nothing in this Section concerning tests conducted by and paid for by any person or his authorized agent shall be deemed to abridge the rights of the Control Officer or his agents to conduct separate or additional tests on behalf of the (County, City, etc.) at a reasonable time and at the expense of the (County, City, etc.) except as provided in Subsection (3) of this Section.

(3) If emission tests conducted by the (County, City, etc.) as a result of procedures outlined in Subsection (1) of this Section substantiate the violation notice issued, the person or persons liable for the violation shall be responsible for paying all attendant costs in conducting the tests. Provided, however, if a person elects to conduct his own stack emission tests, the person so electing shall pay for these tests irrespective of their outcome.

SECTION 17. Administrative Expenses. - The expenses of the operation of the Board, including those of the Control Officer and the Committee, shall be paid out of funds appropriated therefor by ordinance.

SECTION 18. Injunction to Prevent Further Violation -- Assessment of Penalty. - In the event the Board shall determine that any final order or determination made by it and not then the subject of judicial review is being violated, the Board may cause to have instituted a civil action in any court of competent jurisdiction for injunctive relief to prevent any further violation of such final order or determination or for the assessment of such penalty not to exceed $200 per day for each day such violation continues as the court may deem proper, or both. It shall be the duty of the (County or City Attorney, etc.) to bring such actions, at the request of the Board, in the name of the (County, City, etc.). The penalties provided herein shall not be imposed due to any violation caused by a national emergency or by an act of God, war, strike, riot or other catastrophe.

SECTION 19. Accrual of Actionable Rights; Presumptions. - Persons other than the (County, City, etc.) or the Board shall not acquire actionable rights by virtue of this Ordinance. A determination by the Control Officer or the Board that air pollution or air contamination exists or that this Ordinance has been violated, whether

or not a proceeding or action is brought by the (County, City, etc.), shall not create by reason thereof any presumption of law or finding of fact which shall inure to or be for the benefit of any person other than the (County, City, etc.) or the Board.

SECTION 20. Air Pollution Control Regulations. - The following Regulations, establishing air pollution control standards, are hereby adopted:

(Here insert Regulations contained
in Part II of Clean Air Program)

Regulation I. -

Regulation II. -

Etc. -

SECTION 21. (Here insert Severability, Repealer, or Effective Date clauses, if required.)

Passed by the (Board of County Supervisors, City Council, etc.) of (Name of County, City, etc.), Illinois, this ____ day of _____, A.D., 19____.

ATTEST:

_____
(County, City, etc.) Clerk

_____
(Chairman of Board of County Supervisors, Mayor, etc.)

INDUSTRIAL WASTE CONTROL COUNCIL

PROPOSAL FOR A

CLEAN AIR PROGRAM

PART I-B

(ADMINISTRATIVE PROVISIONS - MISSOURI)

BILL NO. _____, 19___

ORDINANCE NO. _____, 19___

Introduced by _____

AN ORDINANCE

TO PREVENT, ABATE AND CONTROL AIR POLLUTION IN (Name of County, City, etc.), MISSOURI; ESTABLISHING AIR POLLUTION REGULATIONS; ESTABLISHING AN AIR POLLUTION CONTROL BOARD TO PLAN AND COORDINATE AIR POLLUTION CONTROL ACTIVITIES, TO CONDUCT HEARINGS AND REVIEW APPEALS, TO APPOINT A TECHNICAL ADVISORY COMMITTEE, AND TO APPOINT AN AIR POLLUTION CONTROL OFFICER TO ENFORCE THE REGULATIONS HEREIN ESTABLISHED; PROVIDING ENFORCEMENT AND APPEALS PROCEDURES AND PROVIDING PENALTIES FOR VIOLATIONS OF THIS CODE.

BE IT ORDAINED BY THE (County or City Council, Board of Aldermen, etc.) OF (Name County, City, etc.), MISSOURI, AS FOLLOWS:

SECTION 1. Short Title. - This Ordinance shall be known and may be cited as the "(Name of County, City, etc.) Air Pollution Control Code of 19___."

SECTION 2. Purpose. - The discharge into the ambient air of (Name of County, City, etc.) of air contaminants so as to cause or contribute to air pollution is contrary to the public policy of this State as declared in the Missouri Air Conservation Law , RS Mo. Chapter 203 (1965 Supp.), and of this (County, City, etc.) and in violation of this Ordinance. It is the intent and purpose of this Ordinance to maintain purity of the air resources of this (County, City, etc.) to protect the health, general welfare and physical property of the people, maximum employment and the full industrial development of this (County, City, etc.). The accomplishment of this objective shall be sought through the prevention, abatement and control of air pollution by all practical and economically feasible methods. Nothing contained in this Ordinance, however, shall be deemed to grant to the Board, herein established, or any (County, City, etc.) official or agent, any jurisdiction or authority with respect to air pollution existing solely within commercial and industrial plants, works, or shops or to affect any aspect of employer-employee relationships as to health and safety hazards.

SECTION 3. Definitions. - The terms as used in this Ordinance, unless the context otherwise requires, shall have the following meanings:

(1) "Air cleaning device" is any method, process, or equipment which removes, reduces, or renders less obnoxious air contaminants

discharged into the ambient air.

(2) "Air contaminant" is any particulate matter or any gas or vapor or any combination thereof.

(3) "Air contaminant source" is any and all sources of emission of air contaminants whether privately or publicly owned or operated.

(4) "Air pollution" is the presence in the ambient air of one or more air contaminants in quantities, of characteristics and of a duration which directly and proximately cause or contribute to injury to human, plant, or animal life or health or to property or which unreasonably interfere with the enjoyment of life or use of property.

(5) "Ambient air" is all space outside of buildings, stacks, or exterior ducts.

(6) "Approved Source" is a source of fuel that has had its fuel tested according to procedures specified by the Air Pollution Control Board, herein established, and whose name appears on the approved source list.

(7) "ASME" is the American Society of Mechanical Engineers.

(8) "ASTM" is the American Society for Testing Materials.

(9) "Authorized Representative" is any individual, firm, or corporation designated by a "person" who shall be given authority to act for such "person" in all matters pertaining to the Board. Such authorization must be transmitted to the Board in writing.

(10) "Backyard Incineration" is the burning of material originating on the premises by individuals domiciled on the premises, excluding commercial establishments.

(11) "Blast Furnace" is the furnace and equipment used in connection with the smelting process of reducing metallic ores to molten metal in which primarily oxygen is removed from the ore and gas is produced as a by-product. The furnace and equipment consists of, but is not limited to, the furnace proper, charging equipment, stoves, bleeders, gas dust catcher, gas cleaning devices and other auxiliaries pertinent to the process.

(12) "Board" is the Air Pollution Control Board herein established.

(13) "BOF" - Basic Oxygen Furnace - is a furnace in which the melting and refining of iron is accomplished by the addition at high velocities of large amounts of high purity oxygen to the atmosphere

above the surface of the metal bath. The metal is held in a pear-shaped tiltable vessel with a basic refractory lining. Such a furnace includes furnace proper, oxygen lance, scrap and flux charging units, iron transfer units, gas collecting and cleaning equipment and stacks and any other auxiliaries pertinent to the process.

(14) "By-Product Coke Plant" is a plant used in connection with the distillation process to produce coke in which the volatile matter is expelled, collected, and recovered. Such plant consists of, but is not limited to, coal and coke handling equipment, by-product chemical plant and other equipment associated with and attendant to the coking chambers or ovens making up a single battery operated and controlled as a single unit.

(15) "Carbonaceous Fuel" is any form of combustible matter - solid, liquid, vapor or gas, consisting primarily of carbon containing compounds in either fixed or volatile form.

(16) "Catalytic Cracker" is a process used in oil refining to increase the yield of high-octane gasoline from crude oil. A fine, granular sandlike catalyst is used in the process, which catalyst is regenerated continuously by heating in a stream of air.

(17) "Cement Plant" is a process wherein a powder of alumina, silica, lime, iron oxide, and magnesia is burned togther in a kiln and finely pulverized and used as an ingredient of mortar and concrete.

(18) "Chimney or Stack" is any conduit, duct, flue or opening of any kind whatsoever arranged to conduct any products of combustion to the ambient air. It does not include breeching.

(19) "Combustion for Indirect Heating" is the combustion of fuel to produce useable heat that is to be transferred through a heat-conducting materials barrier or by a heat storage medium to a material to be heated so that the material being heated is not contacted by, and adds no substance to, the products of combustion.

(20) "Committee" is the Air Pollution Technical Advisory Committee herein provided for.

(21) "Control Officer" is the Air Pollution Control Officer herein provided for.

(22) "Continuous Ferrous Cupola" is a cupola used by a production foundry or iron or steel works which melts continuously over an extended period of time, such as 8, 16 or 24 hours per day for any number of days per week.

(23) (Here insert "County", "City", etc., followed by description of enacting jurisdiction and geographical area of same to be covered by Ordinance.)

(24) "Domestic Heating Plant" is a plant generating heat for a single family residence, or for two such residences either in duplex or double house form, or for multiple dwelling units in which such plant serves fewer than three apartments. Under this designation are also hot water heaters, stoves, and space heaters used in connection with the foregoing establishments or to heat temporary buildings, such as used by the railroad and construction industries, except when gas fired; provided, however, that like equipment used in multiple dwelling units other than herein described, or used in permanent buildings of commercial or industrial establishments, is not to be construed as included under this designation.

(25) "Electric Furnace" is a furnace in which the melting and refining of metals are accomplished by means of electric energy.

(26) "Foundry Cupola" is a vertical cylindrical furnace for melting iron in a foundry having tuyeres and tapping spouts near the bottom. Typically found in a jobbing foundry, such cupola melts intermittently or just long enough to pour the molds that are ready on the foundry floor, job by job.

(27) "Fuel-Burning, Combustion or Process Equipment Device" is any furnace, incinerator, boiler, fly-ash collector, electrostatic precipitator, smoke arresting or prevention equipment, stack, chimney, or structure used for the burning of fuel or other combustible materials, or for the emission of products of combustion, or used in connection with any process which generates heat which may emit products of combustion.

(28) "Garbage" is animal and vegetable matter originating in houses, kitchens, restaurants and hotels, produce markets, etc.

(29) "Heating and Reheating Furnace" is a furnace in which metal is heated to permit shaping or forming, or to achieve specific physical properties.

(30) "Incinerator" is combustion apparatus capable of withstanding heat, in which solid, semi-solid, liquid, or gaseous combustible wastes are ignited and burned efficiently and from which the solid residues contain little or no combustible material.

(31) "Multiple Chamber Incinerator" is any article, machine, equipment, contrivance, structure or part of a structure, used to dispose of combustible refuse by burning, consisting of three or more refractory lined combustion furnaces in series, physically separated by refractory walls, interconnected by gas passage ports or ducts and employing adequate design parameters necessary for maximum combustion of the material to be burned. The refractories shall have a Pyrometric Cone Equivalent of 31, tested according to the method described in the American Society for Testing Materials, Method C-24.

(32) "New Equipment" is any new or replacement facility or process, the design of which is less than 50% completed on the effective date of these regulations. If equipment is to be altered, repaired or rebuilt at a cost of 30% or more of the replacement cost of the total manufacturing process, it shall be considered new equipment.

(33) "New Fire" shall be held to mean the period during which a fresh fire is being started and does not mean the process of replenishing an existing fuel bed with additional fuel.

(34) "Open Burning" is any fire wherein the products of combustion are emitted into the ambient air, and are not directed thereto through a stack or chimney.

(35) "Open Fire" is any fire from which the products of combustion are emitted directly into the ambient air without passing through a stack or chimney.

(36) "Open Hearth Furnace" is a furnace in which the melting and refining of metal is accomplished by the application of heat to a saucer type or shallow hearth in an enclosed chamber. Such furnace consists of, but is not limited to, the furnace proper, checkers, flues and stack and may include a waste heat boiler, an oxygen lance, and other auxiliaries pertinent to the process.

(37) "Particulate Matter" is any material, except uncombined water, that exists in a finely divided form as a liquid or solid at standard conditions.

(38) "Person" is any individual, partnership, copartnership, firm, company, public or private corporation, association, joint stock company, trust, estate, political subdivision, or any agency, board, department or bureau of the state, or any other legal entity whatever which is recognized by law as the subject of rights and duties.

(39) "Process" is any action, operation, or treatment embracing chemical, industrial or manufacturing factors, such as, but not limited to, heat-treating furnaces, by-product coke plants, core-baking ovens, mixing kettles, cupolas, blast furnaces, open-hearth furnaces, heating and reheating furnaces, sintering plants, electric steel furnaces, ferrous and non-ferrous foundries, basic oxygen process furnaces, kilns, stills, dryers, roasters, asphaltic concrete mixing plants, cement plants, and equipment used in connection therewith, and all other methods or forms of manufacturing or processing that may emit smoke, particulate matter or gaseous matter.

(40) "Process Weight" is the total weight of all materials introduced into any specific process. Solid fuels charged will be considered as part of the process weight, but liquid and gaseous fuels and combustion air will not.

(41) "Radioactive Material" is any material, solid, liquid, or gas, that emits ionizing radiation spontaneously.

(42) "Refuse" includes garbage, rubbish and trade wastes.

(43) "Ringelmann Chart" is the chart published and described in the U. S. Bureau of Mines Information Circular 7718, and on which are illustrated graduated shades of grey to black for use in estimating the light obscuring power of smoke.

(44) "Rubbish" are solids not considered to be highly flammable or explosive including, but not limited to, rags, old clothes, leather, rubber, carpets, wood, excelsior, paper, ashes, tree branches, yard trimmings, furniture, tin cans, glass, crockery, masonry, and other similar materials.

(45) "Salvage Operations" is any business, trade or industry engaged in whole or in part in salvaging or reclaiming any product or material, including, but not limited to, metals, chemicals, shipping containers, or drums.

(46) "Sintering Plant" is the plant used in connection with the process of fusing fine particles of metallic ores causing agglomeration of such particles. Such plant consists of, but is not limited to, sintering machines, handling facilities, wind boxes, stack and other auxiliaries pertinent to the process.

(47) "Smoke" is small gas-borne particles resulting from incomplete combustion, consisting predominately but not exclusively, of carbon, ash and other combustible material, that form a visible plume in the air.

(48) "Standard Conditions" is a gas temperature of 60 degrees Fahrenheit and a gas pressure of 14.7 pounds per square inch absolute. (psia).

(49) "Standard Cubic Foot (SCF)" is the standard cubic foot, a measure of the volume of gas under standard conditions.

(50) "Trade Waste" is all solid or liquid material or rubbish resulting from construction, building operations, or the prosecution of any business, trade or industry including, but not limited to, plastic products, chemicals, cinders and other forms of solid or liquid waste materials.

SECTION 4. Air Pollution Control Board, Establishment. -

(1) There is hereby established an Air Pollution Control Board which shall consist of the (County, City, etc.) Health Commissioner and six others who shall be appointed by the (County Supervisor, Mayor, etc.) with the advice and consent of the (County or City Council, Board of Aldermen, etc.). No more than three of the appointed members shall belong to the same political party. They shall be so selected as to represent industry, labor, agriculture, municipal government and the general public. The member or members representing industry shall be persons experienced in the field of air pollution. The (County Supervisor, Mayor, etc.) shall designate the Chairman of the Board, and shall also designate a Chairman in the event of a vacancy to complete the unexpired term of the chairmanship.

(2) The appointed members' terms of office shall be three years and until their successors are selected and qualified, except that the terms of those first appointed shall be staggered to expire at intervals of one, two and three years after the date of appointment as designated by the (County Supervisor, Mayor, etc.) at the time of appointment. There is no limitation on the number of terms any appointed member may serve. The terms of all members shall continue until their successors have been duly appointed and qualified. If a vacancy occurs in the appointed membership, the (County Supervisor, Mayor, etc.) may appoint a member for the remaining portion of the unexpired term created by the vacancy. The (County Supervisor, Mayor, etc.) may remove any appointed member for cause.

(3) The Board shall hold at least four regular meetings each year and such additional regular meetings as the Chairman deems desirable at a place and time to be fixed by the Chairman. Special meetings may be called by three members of the Board upon delivery of written notice to each member of the Board. Four members of the Board shall constitute a quorum. All

powers and duties conferred upon members of the Board shall be exercised personally by the members and not by alternates or representatives.

(4) The (County Supervisor, Mayor, etc.) shall appoint an Air Pollution Control Officer who shall be a full-time employee of the Department of Public Health and who shall act as the Board's administrative agent. The Control Officer shall be a registered professional engineer as defined in RSMo., Chapter 327, who has specialized experience in the field of air pollution control.

(5) The Board shall appoint an Air Pollution Technical Advisory Committee which shall consist of not less than five nor more than seven members, any of whom may be non-residents of the (County, City, etc.) and not less than three of whom shall be employees or representatives of major industries in the (County, City, etc.). Each member of the Committee shall be knowledgable in the field of air pollution control and shall be experienced in engineering or science. It shall be the duty of the Committee, on its own initiative or at the request of the Board or the Control Officer, to study, review and analyze, from time to time, advances in technology, changes in air pollution conditions, other pertinent technical matters, and the practical and economically feasible solution of problems, all relating to abatement and control of air pollution, giving consideration to the air pollution regulations herewith adopted and suggested changes or amendments to such regulations. The Committee shall report the results of such study, review and analysis to the Board and to the Control Officer, and any member of the Committee may submit a separate report.

SECTION 5. Powers and Duties of Board. - The Board shall have the following powers and duties:

(1) Prepare and develop a general comprehensive plan for the prevention, abatement and control of air pollution in the (County, City, etc.).

(2) Encourage voluntary cooperation by persons or affected groups to achieve the purposes of this Ordinance.

(3) Encourage and conduct studies, investigations and research.

(4) Collect and disseminate information and conduct education and training programs in air pollution.

(5) Advise, consult and cooperate with agencies of the state, political subdivisions, industries, other states and the federal government and with interested persons or groups.

(6) Represent the (County, City, etc.) in all matters pertaining to

regional and interstate air pollution.

(7) Accept, receive and administer grants or other funds or gifts from public and private agencies including the federal government for the purpose of carrying out any of the functions of this Ordinance. Funds received by the Board pursuant to this Section shall be deposited with the (County, City, etc.) Treasurer and held and disbursed by him in accordance with the appropriations of the (County or City Council, Board of Aldermen, etc.).

(8) Promulgate such internal administrative procedures consistent with the intent and purposes of this Ordinance and the provisions contained herein.

(9) Recommend in writing to the (County or City Council, Board of Aldermen, etc.) amendments to this Ordinance in light of advances in technology, changes in air pollution conditions, or for any other appropriate reason in accordance with the intent and purposes of this Ordinance.

(10) Hold hearings and appeals in accordance with the procedures prescribed in this Ordinance.

(11) Enter such order or determination upon appeal or otherwise as may be necessary to effectuate the purposes of this Ordinance. In making its orders and determinations hereunder, the Board shall exercise a sound discretion in weighing the equities involved and the advantages and disadvantages to the person involved and to those affected by air contaminants emitted by such person.

(12) Refer any violation of this Ordinance to the (County or City Attorney, etc.) for prosecution or other appropriate legal proceedings in a court of competent jurisdiction to compel compliance with the provisions of this Ordinance.

(13) Settle or compromise in its discretion, with the approval of the (County or City Attorney, etc.), as the Board may deem advantageous to the (County, City, etc.), any suit for recovery of any penalty or for compelling compliance with the provisions of this Ordinance.

(14) Authorize any agent of the Board to enter at all reasonable times and upon reasonable notice in or upon any private or public property, except the administrative offices of any person or private residences, for the purpose of inspection and investigating any condition which the Board shall have cause to believe to be an air contaminant source. No person shall refuse entry or access, requested for purposes of inspection under this provision, to an authorized officer, employee or agent of the Board who presents appropriate credentials, nor

obstruct or hamper the officer, employee or agent in carrying out the inspection.

(15) Retain, employ, provide for, and compensate, within appropriations available herefor, such consultants, assistants, deputies, clerks, and other employees on a full or part-time basis, authorized by ordinance, as may be necessary to carry out the provisions of this Ordinance and prescribe the times at which they shall be appointed and their powers and duties.

(16) Secure necessary scientific, technical, administrative and operational services, including laboratory facilities, by contract or otherwise, authorized by ordinance, with any educational institution, experiment station, or any board, department, or other agency of any political subdivision or state or the federal government.

SECTION 6. Delegation by Board of Powers and Duties. - The Board may delegate to the Control Officer such of its powers and duties as described in Section 5, above, as it may deem appropriate, except those provided for in Subsections (7) through (13), inclusive, of that Section.

SECTION 7. Powers and Duties of Control Officer. - The Control Officer shall have the following powers and duties in addition to those which may be delegated to him by the Board as provided in Section 6, above:

(1) The Control Officer shall cause investigations to be made upon the request of the Board or upon receipt of information concerning an alleged violation of this Ordinance and may cause to be made such other investigations as he shall deem advisable. All sampling and testing shall be in accordance with Section 16.

(2) If, in the opinion of the Control Officer, the investigation discloses that a violation does exist, he shall by conference, conciliation and persuasion endeavor to eliminate the violation.

(3) In case of the failure by conference, conciliation and persuasion to correct or remedy any claimed violation, the Control Officer may file a formal complaint with the Board requesting that the matter be set down for a hearing. When the Control Officer files a formal complaint, the Board shall order a hearing and cause to have issued and served upon the person complained against a written notice together with a copy of the formal complaint, which shall specify the provision of this Ordinance which the person is alleged to be in violation of, and a statement of the manner in, and the extent to which the person is alleged to violate this Ordinance and shall require the person complained against to answer the charges of the formal complaint at a hearing before the Board at a time not less than thirty days after the date of notice.

(4) The Control Officer shall have the power to approve plans and specifications for any article, machine, equipment, device, or other contrivance, the use of which may cause or control the issuance of air contaminants; but any person responsible for complying with this Ordinance shall determine, unless found by the Control Officer to be inadequate, the means, methods, processes, equipment and operation to comply with this Ordinance. Any person aggrieved by any action of the Control Officer under this Subsection (4) shall be entitled to a hearing before the Board. The Board may sustain, reverse, or modify any action of the Control Officer taken under this provision, or make such other order as the Board shall deem appropriate under the circumstances.

(5) The Control Officer shall attend all meetings of the Board in an advisory capacity; however, he shall not be entitled to a vote.

SECTION 8. Appeals. - Any person against whom an order is issued under this Ordinance may appeal the order to the Board within thirty days, and the appeal shall stay the enforcement of such order. If any order is not appealed within such period, it becomes final.

SECTION 9. Hearings. -

(1) The Board shall set all hearings, on appeal or otherwise, at a time not less than thirty days after the date of the request. The Board may sustain, reverse, or modify any order, or make such other order as the Board deems appropriate under the circumstances.

(2) When the Board schedules a matter for hearing, each party to the proceeding may file written arguments and may appear at the hearing in person or by representative, with or without counsel, and may make oral arguments, offer testimony or cross-examine witnesses, or take any combination of such actions.

(3) The Board at the request of any party to the proceeding shall subpoena and compel the attendance of such witnesses as such requesting party may designate and shall require for examination the production of any book or paper relating to the matter under investigation at the hearing.

(4) After due consideration of the written and oral statements, the testimony and arguments that shall be submitted at the hearing, the Board shall issue and enter the final order, or make such final determination as it shall deem appropriate under the circumstances, including the granting of a variance permitted by Section 10, and it shall immediately notify each party to the proceeding in writing by certified or registered mail. In cases in which any party to the proceeding is found to have violated this Ordinance, the final order or determination shall fix a time, which shall be reasonable under all the circumstances and which may be ex-

tended by the Board from time to time, during which the person shall be required to take such measures as may be necessary to prevent the violation and to give periodic progress reports thereon.

(5) Any final order or determination or other final action by the Board shall be approved in writing by at least four members of the Board.

(6) At any public hearing, all testimony taken before the Board shall be under oath and recorded stenographically. The transcript so recorded shall be made available to any member of the public or to any party to the proceeding upon payment of the usual charges therefor.

(7) In any such hearing, a majority of the members conducting the hearing may issue in the name of the Board notices of hearings and subpoenas requiring attendance and testimony of witnesses and the production of evidence relevant to any matter involved in any such hearing and administer oaths and affirmations and examine witnesses.

(8) In case of refusal to obey a subpoena under this section, a majority of the members of the Board conducting the hearing, may apply to any circuit court having competent jurisdiction for the issuance of an order requiring attendance or production of evidence as the case may require. Subpoenas shall be served as provided by law.

(9) All hearings shall be held before at least four members of the Board.

SECTION 10. Variances. -

(1) The Board may grant individual variances beyond the limitations prescribed in this Ordinance whenever it is found, upon presentation of adequate proof, that compliance with any provision of this Ordinance or any rule, procedure, requirement, or order of the Board or Control Officer will result in an arbitrary and unreasonable taking of property or in the practical closing and elimination of any lawful business, occupation or activity, in either case without sufficient corresponding benefit or advantage to the people; except, that no variance shall be granted where the effect of the variance will permit the continuance of a health hazard; and except, also, that any variance so granted shall not be so construed as to relieve the person who receives the variance from any liability imposed by law or maintenance of a nuisance.

(2) In determining under what conditions and to what extent a variance may be granted, the Board shall exercise a wide discretion in weighing the equities involved and the advantages and disadvantages to the applicant and to those affected by air contaminants emitted by the applicant.

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(3) Variances shall be granted for such period of time and under such terms and conditions as shall be specified by the Board in its order. The variance may be extended by affirmative action of the Board.

(4) Any person seeking a variance shall do so by filing a petition for variance with the Control Officer. The Control Officer shall promptly investigate the petition and make a recommendation to the Board as to the disposition thereof. Upon receiving the recommendation of the Control Officer, if the recommendation is against the granting of a variance, a hearing shall be held if requested as provided in Section 9. If the recommendation of the Control Officer is for the granting of a variance, the Board may do so without a hearing; except, that upon the petition of any person aggrieved by the granting of the variance, a hearing shall be held as provided in Section 9. In any hearing under this Section, however, the burden of proof shall be on the person petitioning for a variance.

(5) Upon failure to comply with the terms and conditions of any variance as specified by the Board, the variance may be revoked or modified by the Board after a hearing held upon not less than thirty days' written notice. The notice shall be served upon all persons who will be subjected to greater restrictions if the variance is revoked or modified, or who have filed with the Board a written request for notification.

(6) Any person responsible for operating commercial or industrial plants, works, shops, facilities or equipment which were constructed prior to the enactment of this Ordinance may submit to the Board a formal program of air pollution control which shall schedule over a period of time, which is reasonable under the circumstances, either a continued installation of air cleaning devices or the replacement of specified facilities. The Board shall review the formal program submitted by such affected person, and after having considered all the facts and circumstances bearing upon the reasonableness of the emissions involved, shall approve or disapprove the program in accordance with the intent and purposes of of this Ordinance. After the Board has approved the program, the owner of the facilities shall not be in violation of this Ordinance so long as the program is complied with. Reports of the status of the program shall be submitted annually by the applicant to the Board.

SECTION 11. Failure of Board or Control Officer to Act, Effect of. - Upon the failure of the Control Officer to take action within thirty days after a request for approval of plans and specifications or petition for variance, or upon the failure of the Board to enter a final order or determination within thirty days after the final argument in any hearing, the person seeking any of the actions shall be entitled to treat for all purposes the failure to act as a grant of the requested approval of plans and specifications or variance or of a finding favorable to the petitioner in any hearing.

SECTION 12. Emergency Conditions - Procedure.

(1) Notwithstanding the provisions of this Ordinance or any other provisions of law to the contrary and without necessity of prior administrative procedures or hearings or at any time during the administrative proceedings where the proceedings have been commenced, if the Control Officer after investigation is of the opinion that any person is discharging or causing to be discharged into the ambient air, directly or indirectly, any air contaminant in violation of this Ordinance and the Control Officer determines that the discharge creates an emergency which requires immediate action to protect the public health, safety, or welfare and that it therefore appears to be prejudicial to the interests of the people of the (County, City, etc.) to delay action, the Control Officer, with the written approval of the (County Supervisor, Mayor, etc.) shall order the person in writing to discontinue immediately the discharge of the contaminants into the ambient air whereupon the person shall immediately discontinue the discharge.

(2) Upon issuance of any such order, the Control Officer shall immediately notify the Board, and the Board shall fix a time and place for a hearing to be held before the Board not later than twenty-four hours after the issuance of the order to investigate and determine the factors causing or contributing to the emergency conditions. A true copy of any such order shall be served upon persons whose interests are directly prejudiced thereby in the same manner as a summons in a civil action may be served. All persons whose interests are prejudiced or affected in any manner by any such order shall have the right to appear in person or by counsel at the hearing and to present evidence relevant to the subject of the hearings. Within twenty-four hours after completion of the hearing, the Board shall affirm, modify or set aside the order of the Control Officer or make such other orders as the Board deems appropriate under the circumstances in accordance and consistent with the evidence adduced and shall notify all persons appearing in person or by counsel of its determination in writing by certified or registered mail.

SECTION 13. Judicial Review. - All final orders or determinations of the Board or the Control Officer hereunder shall be subject to judicial review pursuant to the provisions of RS Mo. Chapter 536. All final orders and determinations shall be deemed "administrative decisions" as that term is defined in Chapter 536. No judicial review shall be available hereunder, however, unless and until all administrative remedies are exhausted.

SECTION 14. Disclosure of Confidential Information Prohibited. - No information relating to secret processes or methods of manufacture or production shall be disclosed at any public hearing or otherwise and all such information shall be kept confidential. Wilful disclosure or conspiracy to disclose confidential information

obtained under this Ordinance shall constitute an offense against the (County, City, etc.). Any member of the Board, the Committee, or other (County, City, etc.) official, including the Control Officer and his agents, having knowledge of confidential information who shall wilfully disclose or conspire to disclose such information in violation of this provision shall forfeit his appointment or office and shall be subject to any civil or criminal remedy for such wrongful action which may be available against him.

SECTION 15. Control Officer to Approve Plans and Specifications before Erection, etc., of Buildings. -

(1) No building or structure shall be constructed, reconstructed or altered when the plans and specifications for such building or structure include any article, machine, equipment, device, or other contrivance the use of which may cause or control the issuance of air contaminants until such plans and specifications have been submitted to the Control Officer and approved by him within thirty days as making adequate provisions for meeting the requirements of this Ordinance. The Control Officer shall approve such plans and specifications if they comply with the intent and purposes of this Ordinance. If the Control Officer does not submit his recommendations within thirty days, the plans and specifications shall be deemed approved.

(2) When plans and specifications of a building or structure as described in Subsection (1) of this Section are submitted to the (Public Works Director, Building Commissioner, etc.) of the (County, City, etc.) for the issuance of a building permit pursuant to the Building Code of the (County, City, etc.), the (Public Works Director, Building Commissioner, etc.) shall, prior to issuance of a permit, transmit the plans and specifications to the Control Officer for his recommendations as provided in Subsection (1) of this Section.

(3) The official of any municipality in the (County, City, etc.) responsible for the issuance of building permits may transmit plans and specifications for any building or structure as described in Subsection (1) of this Section within that municipality to the Control Officer for his recommendations as provided in Subsection (1) of this Section. Failure of the municipal officer to transmit the plans and specifications to the Control Officer does not relieve the person seeking approval from liability for failure to obtain approval of the Control Officer pursuant to Subsection (1) of this Section.

SECTION 16. Sampling and Testing. -

(1) The Control Officer is hereby authorized to conduct or cause to be conducted, any test or tests of any article, machine, equipment, device,

or other contrivance the operation of which, in his opinion, may result in emissions in excess of the limitations in this Ordinance or when, in his judgment, there is evidence that emissions therefrom are exceeding any emission limitation prescribed in this Ordinance. Upon notification by the Control Officer that emission tests are considered necessary, a person may elect to conduct such tests himself. In this event, the person shall notify the Control Officer of this decision and of the time and date of such testing. All tests so conducted shall be performed in accordance with acceptable engineering standards, and a complete detailed test report of such tests shall be submitted to the Control Officer. The Control Officer may stipulate that a representative of his office be present during the conduct of such tests.

(2) Nothing in this Section concerning tests conducted by and paid for by any person or his authorized agent shall be deemed to abridge the rights of the Control Officer or his agents to conduct separate or additional tests on behalf of the (County, City, etc.) at a reasonable time and at the expense of the (County, City, etc.) except as provided in Subsection (3) of this Section.

(3) If emission tests conducted by the (County, City, etc.) as a result of procedures outlined in Subsection (1) of this Section substantiate the violation notice issued, the person or persons liable for the violation shall be responsible for paying all attendant costs incurred by the (County, City, etc.) in conducting such tests. If the tests do not substantiate the violation notice issued, then the (County, City, etc.) shall be responsible for paying all attendant costs in conducting the tests. Provided, however, if a person elects to conduct his own stack emission tests, the person so electing shall pay for these tests irrespective of their outcome.

SECTION 17. Administrative Expenses. - The expenses of the operation of the Board, including those of the Control Officer and the Committee, shall be paid out of funds appropriated therefor by ordinance.

SECTION 18. Penalties. - Any person, firm or corporation violating any provision of this Ordinance shall, upon conviction be fined not more than Two Hundred Dollars ($200.00), and each day of such violation shall constitute a separate offense. Any abatement provided for by this Ordinance shall be in addition to the penalties prescribed in this Section. The penalties provided herein shall not be imposed due to any violation caused by a national emergency or by an act of God, war, strike, riot or other catastrophe.

SECTION 19. Accrual of Actionable Rights; Presumptions. - Persons other than the(County City, etc.) or the Board shall not acquire actionable rights by virtue of this Ordinance. A determination by the Control Officer or the Board that air pollution or air contamination exists or that this Ordinance has been violated,

whether or not a proceeding or action is brought by the(County, City, etc.) shall not create by reason thereof any presumption of law or finding of fact which shall inure to or be for the benefit of any person other than the (County, City, etc.) or the Board.

SECTION 20. Radiation Control. - Nothing herein shall vest in the Board any power with respect to the registration or licensing of any machine, equipment, device or other contrivance which is licensed by the Missouri Commission on Atomic Energy under RS Mo. Chapter 324, or by the Missouri Division of Health under the provisions of RS Mo. Sections 192.400 to 192.490 or by the Atomic Energy Commission under the Atomic Energy Act of 1954, title 42 USC 2011-2281, inclusive, provided the Board shall have authority to regulate the use or operation of any such machine, equipment, device or contrivance capable of being an air contaminant source.

SECTION 21. Air Pollution Control Regulations. - The following Regulations, establishing air pollution control standards, are hereby adopted:

Regulation I -

Regulation II - (Here insert Regulations contained in Part II of Clean Air Program)

Etc.

SECTION 22. (Here insert Severability, Repealer, or Effective Date clauses, if required.)

ADOPTED_____

APPROVED_____

_____
(Chairman of County, City, etc. Council)

ATTEST:_____
(County, City, etc.) Clerk

_____
(County Supervisor, Mayor, etc.)

INDUSTRIAL WASTE CONTROL COUNCIL
PROPOSAL FOR A
CLEAN AIR PROGRAM

PART II
(REGULATIONS)

Regulations I, XVI, XXI, XXII, XXIII, and XXV in Section VIII of the Interstate Air Pollution Study are administrative in nature and are covered in the Administration Section of the Industry Clean Air Program.

Regulation XVIII in the Interstate Study is covered by Regulation XIII in the Clean Air Program.

Regulation I **MAXIMUM ALLOWABLE EMISSION OF PARTICULATE MATTER FROM FUEL BURNING EQUIPMENT USED FOR INDIRECT HEATING**

A. General Provisions

1. This regulation applies to installations in which fuel is burned for the primary purpose of producing steam, hot water, or hot air or other indirect heating of liquids, gases or solids and, in the course of doing so, the products of combustion do not come into direct contact with process materials. Fuels include those such as coal, coke, lignite, coke breeze, fuel oil, and wood, but do not include refuse. When any products or by-products of a manufacturing process are burned for the same purpose or in conjunction with any fuel, the same maximum limitations shall apply.
2. For purposes of this regulation, the heat input shall be the aggregate heat content of all fuels whose products of combustion pass through a stack or chimney. The heat input value used shall be the equipment manufacturers' or designers' guaranteed maximum input, whichever is greater. The total heat input of all fuel burning units at a plant shall be used for computing the maximum allowable amount of particulate matter which may be emitted.

B. Provisions Applicable to Fuel Burning Equipment

1. No person shall cause or permit the emission of particulate matter, caused by combustion of fuel in new or existing fuel burning equipment from any plant in excess of the quantity set forth in Figure 2 of ASME Standard APS - 1 "Recommended Guide for the Control of Dust Emission--Combustion for Indirect Heat Exchangers," approved June 15, 1966. This publication is hereby made a part of this regulation by reference.

2. The amount of particulate matter emitted shall be measured according to the American Society of Mechanical Engineers "Power Test Codes - FIC - 27" dated 1957 and entitled, "Determining Dust Concentration in a Gas Stream." This publication is hereby made a part of this regulation by reference. Any other method approved by the Control Officer may be used in accordance with good professional practice.

3. The heat content of coal shall be determined according to ASTM D-271 Laboratory Sampling and Analysis of Coal and Coke or D-2015 Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorimeter, or equivalent methods in future revisions of these standards.

Regulation II USE OF FUEL IN HAND-FIRED EQUIPMENT PROHIBITED

A. General

1. This regulation shall apply to all fuel-burning equipment including, but not limited to furnaces, heating and cooking stoves and hot water furnaces. It shall not apply to wood-burning fireplaces and wood-burning stoves in dwellings, nor to fires used for recreational purpose, nor to fires used solely for the preparation of food by barbecuing.

2. Hand-fired fuel-burning equipment in any stove, furnace, or other fuel-burning device in which fuel is manually introduced directly into the combustion chamber.

B. Prohibition

1. On and after the dates specified in the following schedule it shall be unlawful to operate any hand-fired fuel burning equipment.

Approximate geographical boundary enclosed by a circular area, centered at the centerline of Eads Bridge	Date on and after which said hand-fired fuel-burning equipment shall not be used
3-mile radius	2 years After
7-mile radius	3 years passage of
all other parts of the city of St. Louis and St. Louis County and areas of St. Clair and Madison Counties west of a line one-mile north and east of state route 159 and following the eastern boundaries of townships covering the bluff line to the south boundary of St. Clair County.	4 years the ordinance

2. The Board shall select and publish specific boundaries of areas provided for in subsection B (1), in general consonance therewith.

3. The Board may order that any hand-fired fuel-burning equipment not be used at any time earlier than the schedule in section B (1) whenever such equipment has been found in violation of any air contaminant emission regulation on three or more occasions in any 6 months.

4. The Board may order that hand-fired fuel-burning equipment may be sealed (or removed from any building) when it is found that such equipment is being used subsequent to the dates given in the schedule in subsection B (1).

5. The prohibitions of the use of hand-fired fuel-burning equipment provided for in this regulation shall not apply to any installation when it can be shown beyond reasonable doubt that the building in which such installation is located will be demolished prior to 6 years after this regulation is put into effect.

Regulation III REGULATION OF EMISSION OF PARTICULATE MATTER FROM INDUSTRIAL PROCESSES

A. General Provisions

1. This regulation applies to any operation, process, or activity except the burning of fuel for indirect heating in which the products of combustion do not come into direct contact with process materials and except the burning of refuse and except the processing of salvageable material by burning.

2. Process weight per hour is the total weight of all materials introduced into any specific process which process may cause any discharge of particulate matter. Solid fuels charged will be considered as part of the process weight, but liquid and gaseous fuels and combustion air will not. For a cyclical or batch operation, the process weight per hour will be derived by dividing the total process weight by the number of hours in one complete operation from the beginning of any given process to the completion thereof, excluding any time during which the equipment is idle. For a continuous operation, the process weight per hour will be derived by dividing the process weight for a typical period of time.

3. Emission tests relating to this regulation shall be made following the standards in ASME "Power Test Codes PTC 27" dated 1957 and entitled "Determining Dust Concentration in a Gas Stream," or other recognized and accepted methods of measuring emissions from industrial processes.

B. Emission Limitations

1. Except as provided for in section B (2) no person shall cause, suffer, allow, or permit the emission of particulate matter in any one hour from any source in excess of the amount shown in Table 1 (page No.) for the process weight allocated to such source.

2. No person shall cause, suffer, allow, or permit the emission of particulate matter from any source in a concentration in excess of 0.40 grains per standard cubic foot of exhaust gases. If provisions of this subsection B (2) would permit a greater emission of particulate matter per hour than allowed by subsection B (1), the provision of this subsection B (2) shall not apply, except that the following regulations shall apply to specific processes.

a. Catalytic Crackers in the Petroleum Refining Industry:

(1) Existing processes which are equipped with electrostatic precipitators, cyclose separators, or other dust collection devices or systems having an overall efficiency of 99% or better shall be deemed in compliance with this regulation.

b. Cement Plants:

(1) All new cement plants shall be equipped with gas cleaning devices to reduce the particulate matter in the gas discharged to the atmosphere so that it does not exceed 0.10 grains per standard cubic foot of exhaust gas.

C. Existing Foundry Cupolas and Foundry Open Hearth Furnaces:

(1) All existing foundry cupolas and foundry open hearth furnaces shall be equipped with gas cleaning equipment to reduce particulate matter discharged to the atmosphere in accordance with the following table:

Process Weight per hour lbs.	Maximal Allowable Discharge per hour lbs.
1,000	3.05
2,000	4.70
3,000	6.35
4,000	8.00
5,000	9.65
6,000	11.30
7,000	12.90
8,000	14.30
9,000	15.50
10,000	16.65
12,000	18.70
16,000	21.60
18,000	22.80
20,000	24.00
30,000	30.00
40,000	36.00
50,000	42.00
60,000	48.00
70,000	49.00
80,000	50.50
90,000	51.60
100,000	52.60

d. Iron and Steel (Basic)

(1) Blast Furnaces

(a) All blast furnaces constructed subsequent to the enactment of these rules and regulations shall be equipped with gas cleaning devices and so operated as to reduce the particulate matter in gases discharged to the atmosphere after burning to contain no more than 0.10 grains of particulate matter per standard cubic foot.

(b) Excess blast furnace gas being bled into the atmosphere shall contain no more than 0.25 grains of particulate matter per standard cubic foot and shall be burned as bled into the atmosphere.

(c) The provisions of subsection "b" and "c" immediately above shall not apply during irregular movements of the furnace burden when it is necessary to open the relief valves at the top of the furnace for safe operation.

(2) By-Product Coke Plants

(a) When charging a battery of coke ovens, smoke shall be permitted from such battery of an appearance, density or shade darker than No. 2 of the Ringelmann Chart for a period or periods aggregating not more than 20 minutes in any 60-minute period.

(b) When pushing coke from a battery of coke ovens, smoke shall be permitted from such battery of an appearance, density or shade darker than No. 2 of the Ringelmann Chart for a period or periods aggregating not more than 20 minutes in any 60-minute period.

(c) Coke oven doors, frames and ovens shall be so maintained that smoke or fumes darker than No. 2 of the Ringelmann Chart will not escape to the atmosphere.

(3) Continuous Ferrous Cupolas:

(a) Cupolas for continuous ferrous production constructed subsequent to the enactment of the rules and regulations shall be equipped with gas cleaning devices to reduce the particulate matter in the gas discharged into the atmosphere so as not to exceed 0.20 grains per standard cubic foot.

(4) Sintering Plants, Open Hearth Furnaces, Electric Furnaces, and Basic Oxygen Furnaces

(a) All open hearth furnaces, electric furnaces, sintering plants, and basic oxygen furnaces, constructed subsequent to the enactment of these rules and regulations, shall be equipped with gas cleaning devices to reduce the particulate matter in the gas discharged to the atmosphere so as not to exceed 0.10 grains per standard cubic foot.

e. Exceptions Due to Maintenance or Breakdowns

(1) This rule is a general clause which provides for certain cases which in normal operating procedure might cause emissions over the levels required in other rules. Increased control of emissions during these relatively short periods of time would require controls which are not economically justifiable in all cases for the improvement in emissions received.

3. Additional Process Regulations

Where it can be demonstrated that a process cannot comply with the process weight Table 1, within the limits of technological and economic feasibility, the person operating such a process may apply for a specific process regulation based on grain loading per standard cubic foot of exhaust gases. Such values shall in no instance exceed the basic limitation in Section B. 2., above.

Table 1

Process Weight Rate		Rate of Emission	Process Weight Rate		Rate of Emission
Lb/Hr	Tons/Hr	Lb/Hr	Lb/Hr	Tons/Hr	Lb/Hr
100	0.05	0.551	16,000	8.00	16.5
200	0.10	0.877	18,000	9.00	17.9
400	0.20	1.40	20,000	10.	19.2
600	0.30	1.83	30,000	15.	25.2
800	0.40	2.22	40,000	20.	30.5
1,000	0.50	2.58	50,000	25.	35.4
1,500	0.75	3.38	60,000	30.	40.0
2,000	1.00	4.10	70,000	35.	41.3
2,500	1.25	4.76	80,000	40.	42.5
3,000	1.50	5.38	90,000	45.	43.6
3,500	1.75	5.96	100,000	50.	44.6
4,000	2.00	6.52	120,000	60.	46.3
5,000	2.50	7.58	140,000	70.	47.8
6,000	3.00	8.56	160,000	80.	49.0
7,000	3.50	9.49	200,000	100.	51.2
8,000	4.00	10.4	1,000,000	500.	69.0
9,000	4.50	11.2	2,000,000	1,000.	77.6
10,000	5.00	12.0	6,000,000	3,000.	92.7
12,000	6.00	13.6			

Interpolation of the data in this table for process weight rates up to 60,000 lb/hr shall be accomplished by use of the equation $E = 4.10\ P^{0.67}$, and interpolation and extrapolation of the data for process weight rates in excess of 60,000 lb/hr shall be accomplished by use of the equation;

$E = 55.0\ P^{0.11} - 40$, where E = rate of emission in lb/hr and

P = process weight rate in tons/hr.

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Regulation IV — REFUSE NOT TO BE BURNED IN FUEL BURNING PLANTS

No person shall burn or cause or permit the burning of refuse in any installation which was designed for the primary purpose of burning fuel.

Regulation V OPEN BURNING RESTRICTIONS

A. Refuse Burning Restrictions

1. No person shall dispose of refuse by open burning, or cause, suffer, allow, or permit open burning of refuse.

2. In areas where no public or commercial refuse collection service is available on the effective date of this regulation, the open burning of refuse on residential premises, of refuse originating in dwelling units on the same premises, shall not be in violation of this regulation until such refuse collection service becomes available or until 3 years from the effective date of this regulation, whichever is sooner.

3. Regardless of provisions of subsections A (1) and A (2) of this regulation, open burning of refuse on residential premises of refuse originating in dwelling units on the same premises shall not be a violation of this regulation in areas of low population density. The Board after consultation with public agencies concerned with refuse collection and disposal, shall select and publish the specific boundaries of areas in which such open burning of refuse will not be in violation of this regulation. In selecting such areas, he shall use a density of 100 dwelling units or less per square mile as an approximate definition of areas of low population density and he shall give due consideration to the desirability of having restrictive air pollution control regulations within the conterminous area comprising the St. Louis metropolitan area air pollution basin. The Board shall select and publish revised boundaries, as described above, from time to time as population density changes.

4. Any open burning of refuse permitted by subsection A (2) or A (3) of this regulation shall be permitted only between the hours of 10:00 a.m. and 4:00 p.m.

B. Prohibition of Salvage Operations by Open Burning

No person shall conduct or cause or permit the conduct of a salvage operation by open burning.

C. Restrictions on Open Burning of Trade Wastes

1. No person shall cause or permit the disposal of trade wastes by open burning, except as provided in subsection C (2) of this regulation.

2. The open burning of trade wastes may be permitted when it can be shown by a person that such open burning is absolutely necessary and in the public interest. Any person intending to engage in open burning of trade wastes shall file a request to do so with the Control Officer. The application shall state the following:

a. The name, address, and telephone number of the person submitting the application.

b. The type of business or activity involved.

c. A description of the proposed equipment and operating practices, the type, quantity, and composition of trade wastes to be burned, and the expected composition and amount of air contaminants to be released to the atmosphere.

d. The schedule of burning operations.

e. The exact location where open burning will be used to dispose of trade waste.

f. Reasons why no method other than open burning can be used for disposal of trade waste.

g. Evidence that the proposed open burning has been approved by any fire department which may have jurisdiction. Upon approval of the application by the Control Officer of the application, the person may proceed with the operation without being in violation of subsection C (1).

D. Restrictions on Open Burning of Agricultural Wastes

1. The burning of plant life is prohibited. Provided that the open burning of plant life grown on the premises in the course of any agricultural operation may be permitted when it can be shown that such open burning is necessary and that no fire hazard will occur. Any person intending to dispose of plant life by open burning shall file a request to do so with the Control Officer on forms provided by him. Such form may require the provision of such information as the Board may reasonably need to determine the air pollution aspects of the situation and whether the request should be granted. The applicant shall furnish the Control Officer evidence that the proposed open burning has been approved by any fire department which may have jurisdiction. Upon approval of the application by the Control Officer the person may proceed with the operation without being in violation of this subsection D (1).

2. Any open burning permitted under provisions of subsection D (1) of this regulation shall be permitted only between the hours of 10:00 a.m. and 4:00 p.m. and only at times when the actual or forecast surface wind speed, as given by the local U.S. Weather Bureau is 5 miles per hour or greater.

E. Restriction on Open Burning of Tree Leaves

1. The open burning of tree leaves in such manner as to cause nuisance, detriment, or annoyance to any person or the public is prohibited.

2. The open burning of leaves is prohibited except between the hours of 10:00 a.m. and 4:00 p.m.

3. All open burning of leaves shall be prohibited (5 years after this ordinance provision is put into effect) except in areas of low population density. Such areas of low population density shall be specified by the Board in the same manner as described in subsection A (3) of this regulation.

NOTES CONCERNING SECTIONS A AND E OF ORDINANCE PROVISION VI

1. The City of St. Louis will not need subsections A (2), A (3), and A (4).

2. In St. Louis County, all of sections A and E should be adopted. However, provision should be made to ensure that political subdivisions smaller than the county are still permitted to adopt and enforce ordinances and regulations restricting open burning of leaves and refuse, which are consistent with the county regulation. These smaller political subdivisions should be encouraged to do so. However, the county should adopt the regulations to provide for action in unincorporated areas and in areas where smaller political subdivisions fail to act.

3. In Illinois, the same principles apply to State regulations applicable in Madison and St. Clair Counties, as stated above for St. Louis County. In some respects, this is at variance with an existing State regulation. The matter will have to be considered by the Illinois Air Pollution Control Board.

4. Before Section E of Regulation VI is enforced, it is recognized that the various political subdivisions must provide an alternate means for tree leaves disposal.

Regulation VI INCINERATORS

A. General Provisions

1. This regulation shall apply to any incinerator used to dispose of refuse or other wastes by burning and the processing of salvable material by burning. Notwithstanding definitions in other regulations, as used in this regulation the word refuse includes garbage, rubbish, trade wastes, leaves, salvable material, agricultural wastes, and other wastes. The word incinerator, as used in this regulation, includes incinerators and other devices, structures, or contrivances used to burn refuse (as defined herein) or to process refuse by burning.

2. The burning capacity of an incinerator shall be the manufacturer's or designer's guaranteed maximum rate or such other rate as may be determined by the Control Officer in accordance with good engineering practice. In case of conflict, the findings of the Board shall govern.

3. The amount of particulate matter emitted from any incinerator shall be determined according to the American Society of Mechanical Engineers "Power Test Codes - PTC 27" dated 1957 and entitled "Determining Dust Concentration in a Gas Stream." This publication is hereby made a part of this regulation by reference. In calculating the amount of particulate matter in stack gas, the loading shall be adjusted to 12 percent carbon dioxide in the stack gas. The carbon dioxide produced by burning of any liquid or gaseous fuel in the incinerator shall be excluded from the calculation to 12 percent carbon dioxide. Emissions

shall be measured when the incinerator is operating at its maximum capacity or at any other burning rate during which emission of particulate matter is greater, when expressed as grains per standard dry cubic-foot of stack gas.

B. Restriction of Emissions of Particulate Matter from Incinerators

1. No person shall cause or permit the emission of particulate matter from the stack or chimney of any incinerator in excess of 0.3 grains of particulate matter per standard dry cubic foot of exhaust gas.

2. No incinerator shall be used for the burning of refuse unless such incinerator is a multiple chamber incinerator. Existing incinerators which are not multiple chamber incinerators may be altered, modified, or rebuilt as may be necessary to meet this requirement. The Control Officer may approve any other alteration or modification to an existing incinerator if such be found by him to be equally effective for the purpose of air pollution control as a modification or alteration which would result in a multiple chamber incinerator. All new incinerators shall be multiple chamber incinerators, provided that the Control Officer may approve any other kind of incinerator if he finds in advance of construction or installation that such other kind of incinerator is equally multiple chamber incinerator.

C. Exceptions for Low Population Density Areas

The provisions of subsections B (1) and B (2) of this regulation shall not apply to any incinerator or residential premises used to burn refuse arising from domestic activities on the same premises in areas of low population density. The Board shall select and publish the specific boundaries of areas in which subsections B (1) and B (2) of this regulation do not apply. In selecting such areas, he shall use a density of 100 dwelling units or less per square mile as an approximate definition of areas of low population density and he shall also give due consideration to the desirability of having restrictive air pollution control regulations within the coterminous area comprising the St. Louis metropolitan area air pollution basin. The Board shall select and publish revised boundaries, in the manner described in the foregoing, from time to time as population density changes.

D. Permitted Hours of Operation

No person shall operate or cause or permit the operation of any incinerator at any time other than between the hours of 10:00 a.m. and 4:00 p.m. This restriction shall not apply to incinerators having a refuse burning capacity of five tons per hour or more.

Note: A time schedule for compliance will need be incorporated in section B (2). It is suggested that large incinerators be controlled first and smaller ones later, perhaps on the following schedule:

2000 pounds per hour	- 12 months
1000 - 1999 pounds per hour	- 18 months
500 - 999 pounds per hour	- 24 months
All	- 30 months

Regulation VII RESTRICTION OF EMISSION OF BLACK SMOKE

A. Restrictions Applicable to All Fuel Burning Equipment

No person shall discharge into the atmosphere from any fuel-burning installation, black smoke of a shade or density equal to or darker than that designated as No. 2 on the Ringelmann Chart. For a period or periods aggregating not more than six minutes in any sixty minutes, black smoke darker than that designated above will be allowed.

B. Method of Measurement

The Ringelmann Chart published and described in the U.S. Bureau of Mines Information Circular 7718 or the U.S. Public Health Service Smoke Inspection Guide as described in the Federal Register, Title 42, Chapter 1, Subchapter F, Part 75 shall be used in grading the shade of black smoke. The Control Officer may specify other means of measurement which give comparable results or results of greater accuracy. The two publications described in this subsection are hereby made a part of this regulation by reference.

Regulation VIII PREVENTING PARTICULATE MATTER FROM BECOMING AIR-BORNE

A. No person shall cause or permit the handling or transporting or storage of any material in a manner which allows or may allow unnecessary amounts of particulate matter to become air-borne.

B. No person shall cause or permit a building or its appurtenances or a road, or a driveway, or an open area to be constructed, used, repaired or demolished without applying all such reasonable measures as may be required to prevent particulate matter from becoming air-borne. The Board may require such reasonable measures as may be necessary to prevent particulate matter from becoming air-borne including but not limited to paving or frequent cleaning of roads, driveways and parking lots; application of dust-free surfaces; application of water; and the planting and maintenance of vegetative ground cover.

Regulation IX RESTRICTION OF EMISSIONS OF SULFUR DIOXIDE FROM USE OF FUEL

A. General Provisions

1. This regulation shall apply to any installation in which fuel is burned and in which the sulfur dioxide emission is largely due to the content of the fuel burned, and in which the fuel is burned primarily to produce heat.

2. For purposes of this regulation, a fuel-burning installation is any single fuel-burning furnace or boiler or other unit, device, or contrivance in which fuel is burned or any grouping of two or more such furnaces or boilers or other units, devices, or contrivances on the same premises or otherwise located in close proximity to each other and under control of the same person. The capacity of such installations shall be the manufacturer's or designer's guaranteed maximum heat input rate.

3. The method for determining the percent of sulfur in coal shall be that described in ASTM D-271 Laboratory Sampling and Analysis of Coal and Coke or equivalent method approved by the Control Officer. The method for determining the heat content of coal shall be described in ASTM D-271 Laboratory Sampling and Analysis of Coal and Coke or D-2015 Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorificmeter. All coal analyses and heat contents are to be made on a dry basis. Moisture content of coal is to be determined in all cases and results recorded to facilitate calculations of actual pollutants. The method for determining the sulfur content of fuel oil shall be that described in ASTM: D-129-52 Standard Method of Test for Sulfur in Petroleum Products and Lubricants by the Bomb Method or ASTM D-1552 High Temperature Method.

The method for determining the heat content of fuel oil shall be that described in ASTM: D-240-50 Standard Method of Test for Heat of Combustion of Liquids by the Parr Bomb Calorimeter or other method giving comparable results.

The testing methods specified in this subsection A (3) are hereby made a part of this regulation, by reference. A certified copy of each is on file in the office of the Board.

4. The Control Officer is authorized to take samples of any fuel by any appropriate means for the sampling of the quantity which he finds, at any reasonable time or place, for purposes of determining compliance with this regulation. Where applicable, the following methods will be used.

For coal:	ASTM: D-492 Sampling Coal Classified According to ash content.
	ASTM: D-2013 Preparing Coal Sample for Analysis.
	ASTM: D-2234 Mechanical Sampling of Coal.
For oil:	ASTM: D-270-55T Tentative Method of Sampling Petroleum Products.

B. Restrictions Applicable to Fuel-Burning Installations

Combustion units of existing or new facilities or buildings shall burn or be designed to burn the lowest sulfur content fuel that is reasonably available. In determining reasonable availability, the factors to be considered include among others, price, firmness of supply, extent of existing pollution, and assurance of supply under adverse weather and natural disaster conditions. Other factors such as source confirguration, stack height, and stack gas treatment shall be considered in determining the allowable sulfur content of the fuel.

Regulation X

INFORMATION ON SALES OF FUELS TO BE PROVIDED AND MAINTAINED

A. Tickets to be Furnished and Retained

Every delivery of coal or residual fuel oil, except from an approved source, when first delivered to a consumer or wholesaler in the jurisdiction must be accompanied by a ticket prepared in triplicate and containing at least the name and address of the seller and the buyer; the grade of fuel; and the source of the fuel, which must be an approved source. Tickets on delivery of coal shall also show the ash content of the coal. One copy of each ticket shall be kept by the person delivering the fuel and be retained for one year; one copy is to be given to the recipient of the fuel to be retained for one year; and, upon request, within 30 days after delivery of the fuel, the delivering party shall mail one copy to the Board.

B. Lists May Be Published

The Board is authorized to publish lists of approved sources or other descriptive lists of fuels available in the area which meet the requirements of regulations.

Regulation XI CERTAIN COALS TO BE WASHED

A. Certain Coals To Be Washed

It shall be unlawful for any person to import, sell, offer for sale, expose for sale, exchange, deliver or transport for use and consumption in the central urbanized area as shown in Section VIII, Figure 2 of the Interstate Report any coal which as mined contains in excess of 2 per cent sulfur or 12 per cent ash on a dry basis. Any such coal before importation, sale, transportation, or use in the central urbanized area shall have been cleaned by a process known as washing so that it shall contain no more than 12 per cent ash on a dry basis. The term "washing" is meant to include purifying, cleaning, or removing impurities from coal by mechanical process, regardless of cleaning medium used. Outside the central urbanized area coal other than washed may be used provided the emission of particulate matter will be no more than that allowed in Regulation I Section B (1).

B. Testing Methods

The method for determining ash and sulfur content of coal shall be as described in ASTM D-271, Laboratory Sampling and Analysis of Coal and Coke, or equivalent method approved by the Control Officer which publication is hereby made a part of this regulation by reference.

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C. Samples May be Taken

The (Head of the air pollution control agency) is authorized to take samples of any coal at any reasonable time or place for purposes of determining compliance with this regulation, in accordance with ASTM D-492, sampling coals classified according to ash content, D-2234 mechanical sampling of coal, and D-2013 preparing coal samples for analysis, which publications are hereby made a part of this regulation by reference.

Regulation XII EMISSION OF CERTAIN SULFUR COMPOUNDS RESTRICTED

A. This regulation shall apply to all emissions except those in which both -

1. fuel is burned primarily to produce heat, and
2. the sulfur compound emission is due primarily to the sulfur in the fuel burned.

B. No person shall cause or permit the emission into the atmosphere from any source specified in Paragraph A of this Regulation XII, gases containing more than 2,000 parts per million by volume of sulfur dioxide.

C. No person shall cause or permit the emission into the atmosphere from any sulfuric acid plant, gases containing more than 70 milligrams per cubic meter of sulfuric acid or sulfur trioxide or any combination thereof (expressed as sulfuric acid).

D. No person shall cause or permit the emission into the atmosphere from any source specified in Paragraph A of this Regulation XII except sulfuric acid plants, gases containing more than 200 milligrams per cubic meter of sulfuric acid or sulfur trioxide or any combination thereof (expressed as sulfuric acid).

E. Where a separate source of air pollution is a scavenger or recovery plant, recovering pollutants which would otherwise be emitted to the atmosphere, the Air Pollution Control Officer may allow the operation of such recovery plant where the total emission of pollutants is substantially less with the plant in operation than when closed, even though the concentration exceeds that permitted by Paragraph B of this Regulation XII.

(Paragraph E is similar to the Los Angeles Control District regulation.)

Regulation XIII CONTROL OF ODORS IN THE AMBIENT AIR

A. No person shall emit odorous matter such as to cause an "objectionable" odor:

1. On or adjacent to residential, recreational, institutional, retail sales, hotel or educational premises.
2. On or adjacent to industrial premises when air containing such odorous matter is diluted with 20 or more volumes of odor-free air.
3. On or adjacent to premises other than those in 1 and 2 when air containing such odorous matter is diluted with four or more volumes of odor-free air.

B. The above requirement shall apply only to "objectionable" odors. An odor will be deemed objectionable when 30 per cent or more of the people exposed to it believe it to be objectionable in usual places of occupancy. Sample size to be more than 40 people.

Regulation XIV REQUIREMENTS FOR CONSTRUCTION OF NEW GASOLINE STORAGE FACILITIES

A. General

1. For purposes of this regulation, the term "gasoline" is defined as petroleum distillate having a Reid vapor pressure of 4 pounds or greater.

2. For purposes of this regulation, the term "submerged fill pipe" is defined as any fill pipe the discharge opening of which is entirely submerged when the liquid level is 6 inches above the bottom of the tank. "Submerged fill pipe" when applied to a tank which is loaded from the side is defined as any fill pipe the discharge opening of which is entirely submerged when the liquid level is 18 inches above the bottom of the tank.

B. Petroleum Storage Tanks

1. After the effective date of this regulation, no person shall build or install or permit the building or installation of any stationary tank, reservoir or other container of more than 40,000 gallons capacity which will or might be used for storage of any petroleum distillate having a vapor pressure of 1.5 pounds per square inch absolute or greater under actual storage conditions, unless such tank, reservoir or other container is to be a pressure tank capable of maintaining working pressures sufficient at all times to prevent hydrocarbon vapor or gas loss to the atmosphere or is designed, and will be built, and equipped with one of the following vapor loss control devices:

a. A floating roof, consisting of a pontoon type or double-deck type roof, which will rest on the surface of the liquid contents and be equipped with a closure seal, or seals, to close the space between the roof edge and tank wall. The control equipment to be provided for in this subsection B (1) shall not be permitted if the gasoline or petroleum distillate to be stored will have a vapor pressure of 12.0 pounds per square inch absolute or greater under actual storage conditions. All tank gauging and sampling devices shall be built so as to be gas-tight except when gauging or sampling is to take place.

b. A vapor recovery system, consisting of a vapor-gathering system capable of collecting the hydrocarbon vapors and gases discharged and a vapor-disposal system capable of processing such hydrocarbon vapors and gases so as to prevent their emission to the atmosphere and with all tank gauging and sampling devices gas-tight except when gauging or sampling is taking place.

c. Other equipment or means of equal efficiency for purposes of air pollution control as may be approved by the Control Officer.

C. Submerged Fill Pipes Required

1. After the effective date of this regulation, no person shall build or install or permit the building or installation of a stationary gasoline storage tank with a capacity of 250 gallons or more unless such tank is equipped with a permanent submerged fill pipe or is a pressure tank as described in subsection B (1) of this regulation, or is fitted with a vapor recovery system as described in subsection B (1) (b) of this regulation.

Regulation XV CIRCUMVENTION

No person shall willfully and intentionally cause or permit the installation or use of any device of any means which, without resulting in reduction in the total amount of air contaminant emitted, conceals or dilutes an emission of air contaminant which would otherwise violate an air pollution control regulation. This regulation shall not apply when the only violation involved is violation of a regulation based on concentration or presence of one or more air contaminants at locations beyond the premises on which a source or sources are located.

Regulation XVI POLICY ON COMPLIANCE OF EXISTING PLANTS, PROCESSES, AND EQUIPMENT

A. Emission Standards for Existing Equipment:

1. Any process equipment or any indirect heat exchanger having been completed within ten (10) years prior to the effective date of this regulation shall be permitted a grace period of forty-eight (48) months after the effective date to install control equipment necessary to meet the emission limits specified in these regulations.

2. Any process equipment or any indirect heat exchanger having been completed between ten (10) to fifteen (15) years prior to the effective date of this regulation shall be permitted a grace period of sixty (60) months after the effective date to install control equipment necessary to meet the emission limits specified in these regulations.

3. Any process equipment or any indirect heat exchanger having been completed over fifteen (15) years prior to the effective date of this regulation shall be permitted a grace period of seventy-two (72) months after the effective date to install control equipment necessary to meet the emission limits specified in these regulations.

4. The burning of refuse in an existing combustion chamber serving an indirect heat exchanger is prohibited unless the heat exchanger is designed specifically for the burning of such material.

(NOTE: The above schedule of compliance is identical to Section 2-2.110 of the draft of proposed Rules and Regulations of the Illinois Air Pollution Control Board, dated September 29, 1966.)

Mr. CAIRNS. Thank you, Mr. Chairman.

At this point, I would like to share with you some of our biggest problems involved in the quest for clean air.

There are two philosophies of control afoot.

One holds that regulations should be adopted which may not be attainable at this time but hopefully will be in the future. In order to keep those being regulated from being constantly in violation of the regulations, the control agency would presumably issue variances—a device for legal relief from the standards. Gentlemen, variances do not abate air pollution.

The other philosophy holds that practical and effective regulations which are attainable now will provide the motivation to install the needed controls. Such standards can be enforced and cleaner air is obtained faster. As new technology is developed, the standards can be upgraded.

We hold to this latter philosophy.

Senator MUSKIE. Would that latter philosophy exclude variances?

Mr. CAIRNS. No, sir. There may still be a need, a demonstrated need, and extenuating circumstances for variances.

Senator MUSKIE. So they are really not mutually exclusive approaches?

Mr. CAIRNS. Sir?

Senator MUSKIE. They are not really mutually exclusive approaches?

Mr. CAIRNS. They are neither collectively exhaustive nor mutually exclusive, as we would state in statistics.

The regulations contained in the clean air program, those endorsed by the East-West Gateway Coordinating Council, and those adopted by the Illinois Air Pollution Control Board are also in accord with the latter approach.

A few more problems should be brought to your attention. More efficient hardware that costs less to install and operate must be developed. More research is needed to discover the effects of low concentration exposure of various pollutants for extended periods on man, animals, vegetation, and materials. Simultaneously, there must be much more research to find methods to control sulfur compounds, oxides of nitrogen, carbon monoxide and carbon dioxide, and other subtances, which are products of man's activities.

A major attribute of this area evolves out of its proximity to one of the Nation's greatest natural resources. We are situated here on the threshold of one of the largest sources of raw materials in the United States, the nearby bituminous coal reserves of Illinois. This coal is as much a part of our natural heritage as is the air around us; yet, the paradox is that the use of the coal is claimed to be a misuse of the air because of the sulfur in the coal. We cannot afford to sacrifice either resource so we must find a way to make them compatible. I will not recite the extensive research programs underway on sulfur control by the coal and utility industries and the Public Health Service because you are no doubt already acquainted with them. I will state that the economic health of this area depends in large measure on our ability to use the nearby coal supplies, and we must not arbitrarily discard their use. There is no alternate source of energy economically available to us.

Money is a scarce resource. Various tax credit and accelerated depreciation schedules for pollution control equipment have been proposed to the Congress. The return of money to the firm by these devices would make funds available at a faster rate for pollution control equipment. We believe these proposals warrant careful consideration.

I would like to make one final point. We do not believe there is a void in this area on the part of industry or government in air pollution control. The Governors and the Legislatures of Illinois and Missouri have proposed an interstate compact on air pollution control. We endorse this move.

In summary: the industrial waste control council seeks a sound working partnership between the people, government, and industry with each having mutual respect for the needs and problems of the others.

Industry must be progressive.

Government must be realistic.

The people must be understanding.

I would like to thank you for inviting us back again, Senator Muskie, for your rescheduled hearing.

If it pleases the committee, at this time I would like to call four members of the industrial waste control council to help me answer any questions you might have.

Mr. Bruce E. Kester, director of research of Missouri Portland Cement Co.; Mr. Joseph Mullen, who will be representing the Midwest Coal Producers Institute, Inc. today; Mr. John F. McLaughlin, manager of production engineering for Union Electric Co.; and Mr. Jack Munie, plant manager of Monsanto.

If there are any questions, we would attempt to answer them.

Senator MUSKIE. Let me ask two or three to begin with. First of all, your statement reflects what is a fact in connection with air pollution control, water pollution control, or others. That is, that those in government are inclined to think that industry doesn't have the sufficient sense of urgency to deal with these problems, and that those in industry think of government as having too great a sense of urgency in going about these problems. The government influence in all these matters is, of course, the puppet, and realism is required from both sides, I suspect.

Let me ask you this. You have indicated that you offered the clean air program formulated by industry. It was stated by an earlier witness that the gateway council rejected the interstate study recommendations for the program here in the St. Louis area, and that the gateway council rejected those recommendations and endorsed what amounted to the industry package. Would you want to comment upon that statement?

Mr. CAIRNS. Yes, Senator; I would. I don't have the east-west gateway regulations with me at the moment, but as I recall them, they are, in the main, the interstate study regulations modified, where necessary, to meet the needs of modern technology.

Senator MUSKIE. Is there available any analysis of the changes that were made and why that the committee might have for its enlightenment?

Mr. CAIRNS. Yes. East-West Gateway made, and I presume that this document is in their records, an annotation regulation by regula-

tion of what the interstate study recommended, what the industrial waste control council recommended, and——

Senator MUSKIE (interrupting). So there are three, really?

Mr. CAIRNS. This annotation was in that fashion.

Senator MUSKIE. I will ask the staff to insure that we get this analysis so that we may include it in the record.

(The exhibit is as follows. Text resumes on p. 1106.)

EAST-WEST GATEWAY COORDINATING COUNCIL COMPARISON OF INTERSTATE AIR POLLUTION STUDY WITH INDUSTRIAL WASTE CONTROL COUNCIL PROPOSAL FOR A CLEAN AIR PROGRAM, CITY OF ST. LOUIS BILL 134, AND COUNTY OF ST. LOUIS BILL 286

Regulation I: Definitions

General content of IAPS regulation.—Definitions of pertinent terms.

Industrial waste control council proposal.—Indicates that their "Administrative Section" will be submitted at a later time.

St. Louis City bill 134 (Sec. 4).—Includes some additional definitions many of which pertain to the City's administrative structure.

St. Louis County bill 286 (Sec. 040).—Includes some additional definitions many of which pertain to the County's administrative structure.

Regulation II: Maximum allowable emission of particulate matter from fuel burning equipment used for indirect heating

General content of IAPS regulation.—Provides limits of particulate matter emission with larger heating units having proportionally lower limits. A separate table of limits is provided for spreader stokers.

Industrial Waste Control Council proposal.—(Included in their Reg. I.) They recommend use of limits as set forth in figure 2 of ASME Standard APS–1 "Recommended Guide For The Control of Dust Emission-Combustion for Indirect Heat Exchangers", approved June 15, 1966. (This regulation was not published in time for use by the Interstate Air Pollution Study)

St. Louis City bill 134 (Sec. 10D).—Adds requirement that after three years no one shall use coal in non-residential fuel burning equipment unless devices preventing 99% of particulate matter are included. After five years no one shall use coal in fuel burning equipment for heat or hot water purposes, (except for sale off premises).

St. Louis County bill 286 (Sec. 050, 052, 054).—Same as IAPS.

Regulation III: Use of fuel in hand-fired equipment prohibited

General content of IAPS regulation.—Makes it unlawful to use hand-fired fuel equipment after 2, 3, or 4 years depending upon distance of equipment from Eads Bridge.

Industrial Waste Control Council proposal.—(Included in their Reg. II.) No change recommended.

St. Louis City bill 134 (Sec. II).—No change.

St. Louis County bill 286 (Sec. 060).—No conflict.

Regulation IV: Restriction of emission of particulate matter from industrial processes

General content of IAPS regulation.—Limits particulate emissions by process weight. (Provides for alternate limits based upon source gas volume.) Places a maximum limit on particulate matter of 0.30 grains per standard cubic foot of exhaust gases.

Industrial Waste Control Council proposal.—(Included in their Reg. III.) Proposes increasing limit on particulate matter from 0.30 to 0.40 grains per standard cubic foot of exhaust gases.

Revises process weight method by establishing separate specific limits for:

A. Existing Catalytic Crackers in the Petroleum Refining Industry
B. New cement plants.
C. Existing Foundry Cupolas and Foundry Open Hearth Furnaces.
D. Iron and Steel
    1. New Blast Furnaces.
    2. Operating By-Product Coke Plants.

3. New continuous Ferrous Cupolas.
4. New Sintering Plants, Open Hearth Furnaces, Electric Furnaces and Basic Oxygen Furnaces.

E. Exceptions due to maintenance or breakdowns. Establishes separate process regulations by grain loading where technological or economic feasibility is demonstrated.

St. Louis City bill 134 (Sec. 13).—Provides a different Process Weight Rate Chart which is less restrictive for small operations but more restrictive (perhaps 10% to 20%) for large operations.

Does not provide the alternate limits based upon source gas volume.

Includes same 0.30 G/SCF limit of particulate matter in exhaust gases.

St. Louis County bill (Sec. 070, 072).—Same as IAPS.

Note: The City of Bellefontaine Neighbors has recommended different control measures especially regarding cement plants. Included are proposals for lower process weight limits, different time periods for sampling, air quality goals for various specific land uses, and a regulation requiring maintenance of equipment.

Regulation V: Refuse not to be burned in fuel burning plants

General content of IAPS regulation.—Prohibits burning of refuse in any unit designed for fuel burning.

Industrial Waste Control Council proposal.—No change.

St. Louis City bill 134 (Sec. 13).—No change.

St. Louis County bill 286 (Sec. 080).—No change.

Regulation VI: Open burning restrictions

General content of IAPS regulation.—Prohibits open burning of refuse in close in area. In areas where refuse collection service is unavailable allows three year period to phase out. In these areas limits burning to 10:00 a.m. to 4:00 p.m. Prohibits salvage burning operation. Prohibits burning trade waste except by permit. Prohibits agricultural burning except by permit. Restricts burning of leaves to 10:00 a.m. to 4:00 p.m. and prohibits burning after five years in close in area.

Industrial Waste Control Council proposal.—No change.

St. Louis City bill 134 (Sec. 14).—No conflict.

St. Louis County bill 286 (Sec. 090, 092, 094, 096, 098, 099).—Basically similar to IAPS. Prohibits burning of leaves and grass. Adds meteorological conditions to times when open burning may be permitted.

Regulation VII: Incinerators

General content of IAPS regulation.—Restricts particulate emission from large incinerators to 0.2 and small incinerators to 0.3 grains per standard dry cubic foot of exhaust gas. Requires refuse incinerators to be multiple chamber on equal. Allows exception for residences in low density area. Limits small incinerators to use between 10:00 a.m. and 4:00 p.m. Provides 2½ year time schedule for phasing into multiple chamber incinerators.

Industrial Waste Control Council proposal.—(Included in their Regulation VI) Allows both large and small incinerators to emit 0.3 grains per SCF of particulate matter. No other changes.

St. Louis City bill 134 (Sec. 15).—No conflict.

St. Louis County bill 286 (Sec. 110, 112, 114, 116).—Basically same as IAPS.

Regulation VIII: Restriction of emission of visible air contaminants

General content of IAPS regulation.—Limits *any existing source* from discharging any *air contaminant* of No. 2 or darker on the Ringlemann Chart. (Existing incinerators exempted). New installations limited to Ringlemann No. 1 or darker. In each of above, *equivalent opacity* of non-black smoke contaminants are included. Exceptions of six minutes of No. 2 per 60 minutes are allowed. Exceptions for uncombined water are provided. Exceptions for certain iron & steel operations are provided.

Industrial Waste Control Council proposal.—(Included in their Regulation VII) Limits any "fuel-burning installation" from discharging "black smoke" of Ringlemann No. 2 or greater. Rejects the use of the *opacity equivalents* described above.

St. Louis City bill 134 (Sec. 16).—On existing installations prohibits contaminants of No. 1½ or greater Ringlemann. On new installations same control as IAPS. The ordinance does utilize opacity equivalents.

Provides same exceptions as IAPS but not the iron and steel exceptions.

St. Louis County bill 286 (Sec. 120, 122, 124, 126).—Basically same as IAPS.

Regulation IX: Preventing particulate matter from becoming air-borne

General content of IAPS regulation.—Authorizes Agency to take reasonable measures to prevent particulate matter from becoming air-borne.

Industrial Waste Control Council proposal.—No change.

St. Louis City bill 134 (Sec. 17).—No change.

St. Louis County bill 286 (Sec. 130).—No change.

Regulation X: Restriction of emissions of sulfur dioxide from use of fuel

General content of IAPS regulation.—No fuel burning installations of greater than 2000 million BTU's per hour, after acceptable technology has been developed, shall emit greater than 2.3 lbs. of SO_2 per million BTU, nor shall burn coal with 1.4% or more sulfur nor oil with 2.0% or more sulfur. Until such time no such installation shall burn fuels having a higher average sulfur content than the fuels used during the previous 12 months.

For fuel burning installations of less than 2000 million BTU per hour, no more than 1.4% coal and 2.0% oil, may be burned during various winter months increasing from 2 months to 4 months by schedule. It further makes it unlawful to sell or deliver coal or oil not meeting the standards.

Industrial Waste Control Council proposal.—To be submitted at a later time.

St. Louis City bill 134 (Sec. 18).—Instead of "after suitable technology" this ordinance sets 12–31–71, for limiting sulfur dioxide from large plants to 2 lbs. per million BTU (IAPS says 2.3 lbs.). Similar limit on sulfur content of coal is included but fuel oil is limited to 1.8% instead of 2%.

For smaller installations the 1.4% and 1.8% regulations pertain to the entire year, not just winter months.

St. Louis County bill 286 (Sec. 140, 142, 144, 146).—Puts latest date of 12–31–69 for large units to comply with sulfur dioxide emission limits of 2.3 lbs.

Puts latest date of 12–31–71 for 1.4% coal and 2.0% oil burning.

Inserts dates of 1967, 1968, 1969 in timetable of IAPS for smaller installations prohibition of high sulfur fuels in certain winter months. Otherwise concurs with IAPS.

Regulation XI: Information on sales of fuels to be provided and maintained

General content of IAPS regulation.—Requires a ticket in triplicate for coal or fuel oil showing seller, buyer, grade, source and ash content of coal.

Industrial Waste Control Council proposal.—No change.

St. Louis City bill 134 (Sec. 19).—Some additional data on fuel characteristics is required. Some additional description of use of tickets is included.

St. Louis County bill 286 (Sec. 150).—Requires ticket to show sulfur content of coal.

Regulation XII: Certain coals to be washed

General content of IAPS regulation.—Requires coal of greater than 2% sulfur or 12% ash to be washed and reduced to less than 12% ash.

Industrial waste control council proposal.—To be submitted at a later time.

St. Louis City bill 134.—

St. Louis County bill 286 (Sec. 160).—Lowers sulfur content limit from 2% to 1.4%. Otherwise same as IAPS.

Regulation XIII: Emission of certain settleable acids and alkaline substances restricted

General content of IAPS regulation.—Regulates downwind fallout of acidic or alkaline substances by measuring downwind and upwind fallout.

Industrial Waste Control Council proposal.—Recommends deletion of this regulation.

St. Louis City bill 134.—No change.

St. Louis County bill 286 (Sec. 170, 180).—No change.

Regulation XIV: Emission of certain sulfur compounds restricted

General content of IAPS regulation.—Prohibits emission of gases with more than 2000 PPM of SO_2 from existing sources or 300PPM of SO_3 from new sources. Prohibits emission of gases with more than 70 milligrams per cu meter of sulfuric acid or sulfur trioxide from existing sources, or more than 35 milligrams per cu meter of same from new source. Limits emission of SO_2 sulfuric acid, sulfur trioxide, and hydrogen sulfide by concentration and frequency in ambient air off premises.

Industrial Waste Control Council proposal.—Included in their Regulation XII. Establishes 2,000 ppm of SO_2 as limit of emission of gases.

Establishes 70 milligrams per cu. meter of sulfuric acid or sulfur trioxide as limit of emission of gases from sufuric acid plants.

Establishes 200 milligrams per cu. meter of sulfuric acid or sulfur trioxide as limit of emission of gases from any source except a sulfuric acid plant.

Provides for recovery plant operation.

St. Louis City bill 134 (Sec. 21).—Has lower limit than IAPS for existing source SO_2 emission (1000ppm instead of 2000ppm). Other requirements basically same as IAPS.

St. Louis County bill 286 (Sec. 190, 192).—Minor changes from IAPS, (Co. ordinance Sec. 240 repeats regulation of Sec. 192.5 with more detail).

Regulation XV: Additional air quality control measures may be required when sources are clustered in a small land area

General content of IAPS regulation.—Allows Agency to impose additional requirements when within a circular 2 miles diameter area, excessive particulate or SO_2 emissions exist. If a new installation would cause these excessive emissions, only the new plant shall be subject to more restrictive requirements.

Industrial Waste Control Council proposal.—Recommends deletion of this regulation.

St. Louis City bill 134 (Sec. 27).—No change, but public hearings are required to implement.

St. Louis County bill 286 (Sec. 750).—No change.

Regulation XVI: Variances

General content of IAPS regulation.—Prescribes means of granting variances by Board if serious hardship without corresponding benefit or advantage to the public prevails.

Industrial Waste Control Council proposal.—Indicates that their "Administrative Section" will be submitted at a later date.

St. Louis City bill 134 (Sec. 31).—Commissions authorized to grant variances if certain findings are made.

St. Louis County bill 286 (Sec. 750).—No change.

Regulation XVII: Control of odors in the ambient air

General content of IAPS regulation.—Prohibits emissions causing objectionable odors, with higher standards in residential type areas and lower standards involving dilution in industrial areas.

Declares odor objectionable when 15% of those exposed so determine, with sample size to be at least 20 people.

Industrial Waste Control Council proposal.—No change in requirements, but increase to 30% the percent required to determine an odor objectionable, and increase sample size to at least 40 people.

St. Louis City bill 134.—

St. Louis County bill 286 (Sec. 220).—No change.

Regulation XVIII: Control of odors from processing of animal matter

General content of IAPS regulation.—Prohibits emissions from reduction of animal matter unless incinerated or processed to eliminate odor. Any other odor shall be so handled to avoid odors or nuisances in neighborhood of plant.

Industrial Waste Control Council proposal.—Covered by their Regulation XIII described in IAPS Regulation XVII analysis.

St. Louis City bill 134 (Sec. 22).—Basically same as IAPS if temperature in line 10, p. 30 of 1200° F is inserted.

St. Louis County bill 286 (Sec. 230).—No major change.

Regulation XIX: Emission of visible air contaminants from internal combustion engines

General content of IAPS regulation.—Prohibits emission of visible air contaminants for longer than 10 consecutive seconds for a portable or stationary engine or a motor vehicle. Also prohibits same from a motor vehicle after the vehicle has moved more than 100 yards from a place where the vehicle was stationary. Eliminates uncombined water from aforementioned provisions.

Industrial Waste Control Council proposal.—No comparable regulation included.

St. Louis City bill 134 (Sec. 24).—No change.

St. Louis County bill 286 (Sec. 300, 310, 315, 320, 330, 340).—An elaborate system of control of motor vehicle emissions is established. County powers to issue

permits, licenses, etc., are enumerated. Provides for new and used car crankcase and exhaust control devices.

Regulation XX: Approval of planned installations, land use plans and zoning regulations required

General content of IAPS regulation.—Requires Agency to approve building permit if heating or processing is involved. Provides for liaison with land use planning and requires review of land use plans before adoption. Provides for liaison with zoning agencies and requires review of zoning actions before adoption.

Industrial Waste Control Council proposal.—No comparable regulation included.

St. Louis City bill 134.—No comparable regulation included.

St. Louis County bill 286.—No comparable regulation included.

Regulation XXI: Air pollution nuisances prohibited

General content of IAPS regulation.—Prohibits emissions which cause nuisance or damage.

Industrial Waste Control Council proposal.—Indicates that their "administrative section" will be submited at a later time.

St. Louis City bill 134 (Sec. 23).—Prohibits nuisance within ½ mile of City limits.

St. Louis County bill 286 (Sec. 260).—More detailed description of nuisance.

Regulation XXII: Measurement of emissions of air contaminants

General content of IAPS regulation.—Authorizes Agency to require emitter to make or have made tests of emissions. Agency itself may conduct tests.

Industrial Waste Control Council proposal.—Indicates that their "administrative section" will be submitted at a later date.

St. Louis City bill 134 (Sec. 26).—No change.

St. Louis County bill 286 (Sec. 270).—No change.

Regulation XXIII: Submission of emission information-authority

General content of IAPS regulation.—Authorizes Agency to require information for inventory purposes.

Industrial Waste Control Council proposal.—Indicates that their "administrative section" will be submitted at a later date.

St. Louis City bill 134.—

St. Louis County bill 286 (Sec. 274).—No change.

Regulation XXIII: Submission of emission information-authority

General content of IAPS regulations.—Authorizes Agency to require information for inventory purposes.

Industrial Waste Control Council proposal.—Indicates that their "administrative section" will be submitted at a later date.

St. Louis County bill 134.—

St. Louis County bill 286 (Sec. 274).—No change.

Regulation XXVI: Requirements for construction of new gasoline storage facilities

General content of IAPS regulation.—Requires all new petroleum distillate storage tanks of over 40,000 gallons capacity to have certain vapor loss control devices. Also requires all new gasoline storage tanks of over 250 gallon capacity to have submerged fill pipe or equal device.

Industrial Wast Control Council proposal.—No change.

St. Louis City bill 134 (Sec. 25).—No change.

St. Louis County bill 286 (Sec. 230, 282, 284, 286).—Also requires conversion of existing tanks of 250 gallon or more capacity by 1–1–1970. Also controls gasoline specifications.

Regulation XXV: Entry onto premises-authority

General content of IAPS regulation.—Grants Agency right to reasonable entry.

Industrial Waste Control Council Proposal.—Indicates that their "administrative section" will be submitted at a later time.

St. Louis City bill 134.—

St. Louis County bill 286.—

Regulation XXVI: Circumvention

General content of IAPS regulation.—Prohibits concealing or dilution of emissions which do not result in reduction of total amount of contaminants.

Industrial Waste Control Council proposal.—Included in their Regulation XV. Add "willfully and intentionally" to prohibition above.

St Louis bill 134.—

St. Louis County bill 286 (Sec. 760).—No change.

ADDITIONAL REGULATIONS

Industrial Waste Control Council proposal.—In their Regulation XVI they propose regulations for existing equipment as follows:

1. Equipment less than 10 years old shall have 48 months to reach emission limits.
2. Equipment 10 to 15 years years old shall have 60 months to reach emission limits.
3. Equipment more than 15 years old shall have 72 months to reach emission limits.

Burning of refuse in existing equipment is prohibited unless equipment is specifically designed therefor.

General content of regulation.—It should be understood that sections pertaining to Administrative Structure will have to be added by the various agencies who adopt the ordinance.

St. Louis City bill 134 (Sec. 5, 6, 7, 8, 9).—Relates to the Structure of the Division, Qualifications of the Commissioner, Powers & Duties of the Commissioner, an Advisory Council, the Appeals and Variance Board.

St. Louis City bill 134 (Sec. 28, 29, 30, 32, 33, 34, 35, 36, 37).—Describes method of enforcement. Prescribes emergency procedure. Confidentiality of Records. Judicial Review. Remedies Preserved. Penalty Clause. Separability. Emergency Clause.

St. Louis County bill 268 (Sec. 400 etc.).—Establishes permits to construct and use certain installations. Requires information for above purposes. Prohibits disclosure of Secret Processes. Provides method of review. Requires registration of certain installations. Establishes fee schedules. Provides for sealing right of entry & emergencies. Establishes procedures of notice. Provides for a Scientific Committee and an Emergency Action Committee. Provides for Sampling Stations. Provides guidelines for Chief of Agency. Establishes Alert Limits. Provides for Agency, authority, hearings, Board, appeals and variances.

REVISED PROPOSAL FOR AIR POLLUTION CONTROL REGULATIONS FOR THE INTERSTATE ST. LOUIS METROPOLITAN AREA

(Prepared by the technical representatives of the governmental agencies of the interstate air pollution study.)

FOREWORD

These revised proposed regulations were prepared after the hearings of the East-West Gateway Coordinating Council held on September 27 and October 11 and 19, 1966. Consideration was given to the views expressed at these hearings by various individuals and group representatives.

These proposed regulations are designed for application in the Greater St. Louis Metropolitan Area Air Pollution basin, and such other area as necessary to enhance administrative feasibility. The areas included are as follows:

1. The City of St. Louis, Missouri
2. St. Louis County, Missouri
3. The western parts of Madison and St. Clair Counties in Illinois, that part west of a line one mile north and east of state route 143 in the Alton area and following the eastern boundaries of townships covering the bluff line to the south boundary of St. Clair County. These townships are, Fort Russell, Edwardville, Collinville, Caseyville, Centerville, Stookey and Sugar Loaf.

Control of pollution sources in other parts within and adjacent to the Greater St. Louis Metropolitan area is expected to be brought about under provisions of the laws and regulations of the States of Illinois and Missouri. These may or may not be different from the proposed regulations herewith.

The regulations herein do not cover administrative or procedural aspects which may need to be included in an ordinance or regulation.

Regulation I: Definitions

A. As used in the air pollution regulations of (jurisdiction), except as otherwise specifically provided in such regulations and except where the context indicates otherwise, the following words shall have the meaning ascribed to them in this regulation:

1. *Air contaminant.*—Any smoke, soot, fly ash, dust, cinders, dirt, fumes, gases, vapors, liquids, particulate matter, or odorous matter.

2. *Air pollution.*—(The definition of air pollution should be consistent with the respective state law.)

Illinois.—"Air Pollution" is present in the outdoor atmosphere of one or more air contaminants in sufficient quantities and of such characteristics and duration as to be injurious to human, plant or animal life or to property, or which unreasonably interfere with the enjoyment of life and property.

Missouri.—"Air pollution", the presence in the ambient air of one or more air contaminants in quantities of characteristics and of a duration which directly and proximately cause or contribute to injury to human, plant, or animal life or health or to property or which unreasonably interfere with the enjoyment of life or use of property.

3. *Approved source.*—A source of fuel that has had its fuel tested according to procedures specified by the (Head of the air pollution control agency) and whose name appears on the approved source list.

4. *ASTM.*—The American Society for Testing Materials.

5. *Existing.*—Things, such as equipment, machines, devices, articles, contrivances or installations which are in being at a stated time except that any such existing equipment, machine, device, article, contrivance or installation which is altered, repaired or rebuilt at a cost of 30 percent or more of its replacement cost shall be reclassified as "new", as defined in this regulation.

6. *Multiple chamber incinerator.*—Any article, machine, equipment, contrivance, structure or part of a structure, used to dispose of combustible refuse by burning, consisting of three or more refractory lined combustion furnaces in series, physically separated by refractory walls, interconnected by gas passage ports or ducts and employing adequate design parameters necessary for maximum combustion of the material to be burned. The refractories shall have a Pyrometric Cone Equivalent of 31, tested according to the method described in the ASTM, Method C–24–56.

7. *New.*—Things, such as equipment, machines, devices, articles, contrivances or installations built or installed on or after a stated time, and things or installations existing at said stated time which are later altered, repaired or rebuilt at a cost of 30 percent or more of their replacement cost.

8. *Open burning.*—The burning of any matter in such manner that the products of combustion resulting from the burning are emitted directly into the open atmosphere without passing through a stack, duct, or chimney.

9. *Particulate matter.*—Any material, except uncombined water, which exists in a finelly divided form as a liquid or solid at standard conditions.

10. *Persons.*—Any individual, firm, public or private corporation, association, business trust, company, partnership, contractor, supplier, installer, user, operator or owner, or any political subdivision or employee thereof.

11. *Process weight.*—The total weight of all materials introduced into a source operation, including solid fuels, but excluding liquids and gases used solely as fuels, and excluding air introduced for purposes of combustion.

12. *Refuse.*—Any combustible waste material containing carbon in a free or combined state, other than liquids or gases.

13. *Salvage operation.*—Any business, trade, industry or other activity conducted in whole or in part for the purpose of salvaging or reclaiming any product or material such as metals or chemicals.

14. *Smoke.*—Small gas-borne particles resulting from combustion, consisting of carbon, ash, and other material.

15. *Source gas volume.*—That volume of gases arising from a process or other source operation.

16. *Source operation.*—The last operation preceding the emission of an air contaminant, which operation (a) results in the separation of the air contaminant from the process materials or in the conversion of the process materials into air contaminants, as in the case of combustion fuel; and (b) is not an air pollution abatement operation.

17. *Standard conditions.*—A gas temperature of 60 degrees Fahrenheit and a gas pressure of 14.7 pounds per square inch absolute.

18. *Trade waste.*—Solid, liquid, or gaseous material resulting from construction or the prosecution of any business, trade or industry, or any demolition operation including, but not limited to, plastics, cartons, grease, oil, chemicals and cinders.

Regulation II: Maximum allowable emission of particulate matter from fuel burning equipment used for indirect heating

A. General provisions

1. This regulation applies to installations in which fuel is burned for the primary purpose of producing steam, hot water, or hot air or other indirect heating of liquids, gases, or solids and, in the course of doing so, the products of combustion do not come into direct contact with process materials. Fuels include those such as coal, coke, lignite, coke breeze, fuel oil, and wood but do not include refuse. When any products or by-products of a manufacturing process are burned for the same purpose or in conjunction with any fuel, the same maximum emission limitations shall apply.

2. The heat content of coal shall be determined according to ASTM method D–271–64 Laboratory Sampling and Analysis of Coal and Coke or ASTM method D–2015–62T Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorimeter.

3. For purposes of this regulation, the heat input shall be the aggregate heat content of all fuels whose products of combustion pass through a stack or stacks. The heat input value used, shall be the equipment manufacturer's or designer's guaranteed maximum input, whichever is greater. The total heat input of all fuel burning units at a plant or on a premise shall be used for determining the maximum allowable amount of particulate matter which may be emitted.

4. For purposes of this regulation, stack height shall be as follows:

(a) Stack height, for purposes of Regulation II, is defined as the vertical distance from the location at which gases passing through the stack enter the atmosphere to the earth's surface under the stack.

(b) The provisions of subsection A–4(a) apply in cases wherein there is only one stack serving a plant or premise and to cases in which there is more than one stack, all of equal height. In cases involving more than one stack all of equal height, the stack height shall be the height of one of such stacks.

(c) When a plant or premise has more than one stack and the stack heights are unequal, a weighted average stack height shall be used for purposes of determining maximum allowable emissions. This weighted average stack height shall be calculated in the following manner:

(1) Determine the heat input of each fuel burning unit (expressed in BTU per hour). Add together the heat inputs of the units venting to each stack. If a single unit vents to more than one stack, prorate the BTU input to each stack in proportion to exhaust gas flows.

(2) Determine the height of each stack, measured in feet.

(3) Multiply the total heat input of units vented through each stack as determined in (1) by the height of the stack to which discharged.

(4) Add together the values obtained from (3).

(5) Add together the heat input for all of the units of the plant or premise.

(6) Divide the sum obtained in step (4) by the sum obtained in step (5). The quotient (result) is the weighted average stack height expressed in feet.

(d) The stack height determined for a plant or premise in the manner prescribed in subsections (a), (b), or (c) of this subsection 4 shall be reduced by the difference in elevation, if any, between the elevation of the ground at the base of the stack or stacks and any other point having a higher elevation and lying within one mile of the stack.

5. The amount of particulate matter emitted shall be measured according to the American Society of Mechanical Engineers, "Power Test Codes—PTC—27" dated 1957 and entitled "Determining Dust Concentration in a Gas Stream." Any other method approved by the (Head of the air pollution control agency) may be used in accordance with good professional practice.

6. BTU means British Thermal Units.

B. Emission limitations

1. No person shall cause or perimt the emission of particulate matter from any fuel burning installation used for indirect heating from any stack or chimney in excess of the quantity determined from the graph embodied in this regulation, as used in accordance with the following instructions:

(a) Determine the total heat input of the installation using provisions of subsections A–2 and A–3 of this regulation. If the heat input is less than 50 mil-

lion BTU/hour, the allowable emission is always 0.6 pounds of particulate matter per million BTU and total emissions in pounds per hour may be determined as prescribed in step (h) below.

(b) Determine the stack height for the installation using provisions of subsection A–4 of this regulation.

(c) Locate a point representing the heat input of the installation on the scale of the graph marked "Total Capacity of Installation."

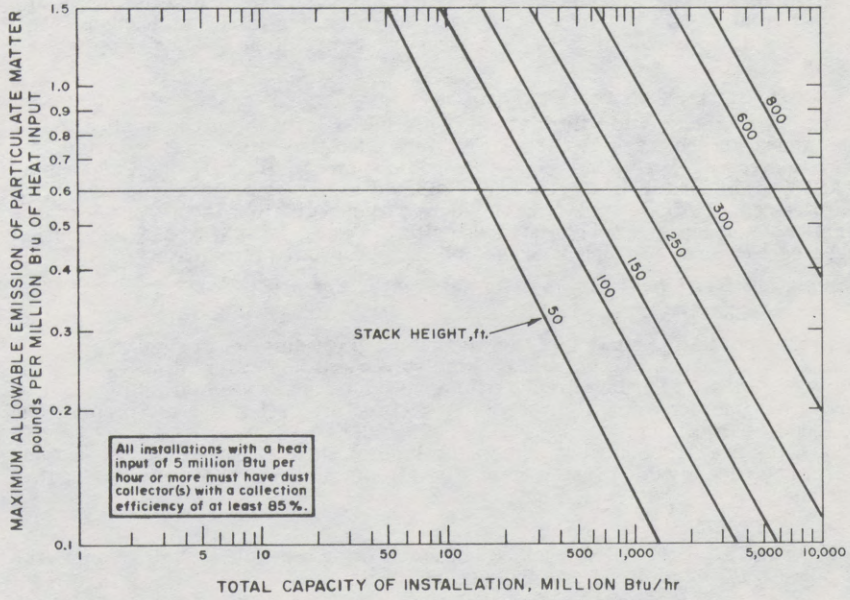
(d) From the point located in step (c), draw a line across the graph perpendicular to the scale marked "Total Capacity of Installation."

(e) Locate the sloping line on the graph which represents the stack height for the installation, as determined in step (b), interpolating between lines, if necessary. If stack height is less than 50 feet, use the line designated as 50 feet.

(f) Locate the point where the line drawn in step (d) intersects the sloping stack height line selected in step (e).

(g) Draw a line from the point located in step (f) perpendicular to the scale on the graph marked "Maximum Allowable Emission of Particulate Matter." The point where the line drawn intersects this scale is the value for the maximum allowable emission of particulate matter expressed in pounds of particulate matter per million BTU of heat input.

ST. LOUIS INTERSTATE AIR POLLUTION STUDY
GRAPH FOR REGULATION II
(Based on ASME Publication Described in Text)



(h) If desired, the total maximum allowable emission of particulate matter expressed in pounds per hour may be obtained by multiplying the allowable emission value obtained in step (g) by the total heat input obtained in step (a). If the heat input is less than 50 million BTU/hour the allowable emission in pounds per hour is always 0.6 multiplied by the total heat input.

(i) The maximum allowable particulate matter emission rates determined in the manner prescribed in subsections B–1(a) through B–1(h) shall apply when all of the gases from indirect heating units at a plant or on a premise are discharged to the atmosphere from a single stack. When the gases from a plant or premise are discharged to the atmosphere from more than one stack, the maximum allowable particulate matter emission rate determined as prescribed in the said subsections shall be reduced by dividing the value obtained by using preceding provisions of this subsection B–1 by a factor taken from the following list for the number of stacks involved.

Factor to be used to divide into the value obtained from use of subsections B–1(a) through B–1(H).

Number of stacks:	
1	1.00
2	1.19
3	1.32
4	1.41
5	1.50
6 or more	1.56

2. No person shall cause or permit the emission of particulate matter from fuel burning equipment used for indirect heating from any single stack or chimney in a quantity greater than 0.6 pounds per million BTU of heat input to the equipment discharging to such stack or chimney.

3. All installations having a total heat input rate of 5 million BTU or more per hour shall be equipped with particulate matter emission control equipment which will remove at least 85 percent of the particulate matter in the gases arising from the installation and to be discharged to the atmosphere.

4. No person shall cause or permit the emission of any particles larger than 60 microns in diameter from any stack subject to provisions of this regulation.

C. Procedure when more than one provision of this regulation applies

When two or more provisions of this regulation specify a maximum allowable particulate emission applicable in a particular case, the one resulting in the lowest total weight of emission of particulate matter to the atmosphere shall apply and the others shall not apply, except that subsection B–4 shall apply in all cases.

D. Reference to ASME publication

The provisions of this Regulation II are based in part, on the publication of the American Society of Mechanical Engineers entitled "Recommended Guide for the Control of Dust Emission—Combustion for Indirect Heat Exchangers" (ASME Standard No. PS–1; 1966). Should cases arise in connection with enforcement of this Regulation II wherein this regulation is in some way not applicable or does not adequately deal with the case, the said ASME publication shall be used as a reference in developing an appropriate procedure.

Regulation III: Use of fuel in hand-fired equipment prohibited

A. General

1. This regulation shall apply to all fuel-burning equipment including, but not limited to furnaces, heating and cooking stoves and hot water furnaces. It shall not apply to wood-burning fireplaces and wood-burning stoves in dwellings, nor to fires used for recreational purposes, nor to fires used solely for the preparation of food by barbecuing.

2. Hand-fired fuel-burning equipment in any stove, furnace, or other fuel-burning device in which fuel is manually introduced directly into the combustion chamber.

B. Prohibition

1. On and after the dates specified in the following schedule it shall be unlawful to operate any hand-fired fuel burning equipment.

Approximate geographical boundary enclosed by a circular area, centered at the centerline of Eads Bridge	Date on and after which said handfired, fuel-burning equipment shall not be used
3-mile radius	2 years after passage of the ordinance.
7-mile radius	3 years after passage of the ordinance.
All other parts of the area to which this regulation applies	4 years after passage of the ordinance.

2. The (Head of the air pollution control agency) shall select and publish specific boundaries of areas provided for in subsection B–1, in general consonance therewith.

3. The (Head of the air pollution control agency) may order that any hand-fired fuel-burning equipment not be used at any time earlier than the schedule in section B–1 whenever such equipment has been found in violation of any air contaminant emission regulation on three or more occasions in any 6 months.

4. The (Head of the air pollution control agency) may order that handfired fuel-burning equipment (may be sealed) or (removed from any building) when

it is found that such equipment is being used subsequent to the dates given in the schedule in subsection B–1.

5. The prohibitions of the use of hand-fired fuel-burning equipment provided for in this regulation shall not apply to any installation when the owner thereof can show beyond reasonable doubt that the building in which such installation is located will be demolished prior to 6 years after this regulation is put into effect.

NOTE.—B–1 pertains to the air pollution basin expanded by administrative action to include all other parts of the City of St. Louis and St. Louis County and areas of Madison and St. Clair Counties west of a line one mile north of state route 143 and following the eastern boundaries of townships covering the bluff line to the south boundary of St. Clair County thence west to the Mississippi River.

Regulation IV: Restriction of emission of particulate matter from industrial processes

A. General provisions

1. This regulation applies to any operation, process, or activity except the burning of fuel for indirect heating in which the products of combustion do not come into direct contact with process materials and except the burning of refuse and except the processing of salvageable material by burning.

2. Process weight per hour is the total weight of all materials introduced into any specific process which process may cause any discharge of particulate matter. Solid fuels charged will be considered as part of the process weight, but liquid and gaseous fuels and combustion air will not. For a cyclical or batch operation, the process weight per hour will be derived by dividing the total process weight by the number of hours in one complete operation from the beginning of any given process to the completion thereof, excluding any time during which the equipment is idle. For a continuous operation, the process weight per hour will be derived by dividing the process weight for a typical period of time by the number of hours in such period.

3. Emission tests relating to this regulation shall be made following the standards in ASME "Power Test Codes PTC 27" dated 1957 and entitled "Determining Dust Concentration in a Gas Stream."

B. Emission limitations

1. Except as provided for in subsection B–2, no person shall cause, suffer, allow, or permit the emission of particulate matter in any one hour from any source in excess of the amount shown in Table 1 for the process weight allocated to such source.

TABLE 1

Process weight rate		Rate of emission	Process weight rate		Rate of emission
Pounds per hour	Tons per hour	Pounds per hour	Pounds per hour	Tons per hour	Pounds per hour
100	0.05	0.551	16,000	8.00	16.5
200	.10	.877	18,000	9.00	17.9
400	.20	1.40	20,000	10.00	19.2
600	.30	1.83	30,000	15.00	25.2
800	.40	2.22	40,000	20.00	30.5
1,000	.50	2.58	50,000	25.00	35.4
1,500	.75	3.38	60,000	30.00	40.0
2,000	1.00	4.10	70,000	35.00	41.3
2,500	1.25	4.76	80,000	40.00	42.5
3,000	1.50	5.38	90,000	45.00	43.6
3,500	1.75	5.96	100,000	50.00	44.6
4,000	2.00	6.52	120,000	60.00	46.3
5,000	2.50	7.58	140,000	70.00	47.8
6,000	3.00	8.56	160,000	80.00	49.0
7,000	3.50	9.49	200,000	100.00	51.2
8,000	4.00	10.4	1,000,000	500.00	69.0
9,000	4.50	11.2	2,000,000	1,000.00	77.6
10,000	5.00	12.0	6,000,000	3,000.00	92.7
12,000	6.00	13.6			

NOTE.—Interpolation of the data in this table for process weight rates up to 60,000 pounds per hour shall be accomplished by use of the equation $E=4.10p^{0.67}$, and interpolation and extrapolation of the data for process weight rates in excess of 60,000 pounds per hour shall be accomplished by use of the equation $E=55.0p^{0.11}-40$, where E=rate of emission in pounds per hour and P=process weight rate in tons per hour.

2. The limitations established by subsection B–1 shall not require the reduction of particulate matter concentration, based on the source gas volume, below the concentration specified in Table 2 for such volume; provided that, for the purposes of this subsection B–2 the person responsible for the emission may elect to substitute a volume determined according to the provisions of subsection B–3; and provided further that the burden of showing the source gas volume or other volume substituted therefor, including all the factors which determine such volume and the methods of determining and computing such volume, shall be on the person seeking to come within the provisions of this subsection B–2.

TABLE 2

Source gas volume, SCFM [1]	Concentration, Gr/SCF [2]	Source gas volume, SCFM [1]	Concentration, Gr/SCF [2]
7,000 or less	0.100	120,000	0.040
8,000	.096	140,000	.038
9,000	.092	160,000	.036
10,000	.089	180,000	.035
20,000	.071	200,000	.034
30,000	.062	300,000	.030
40,000	.057	400,000	.027
50,000	.053	500,000	.025
60,000	.050	600,000	.024
80,000	.045	800,000	.021
100,000	.042	1,000,000 or more	.020

[1] Standard cubic foot per minute.
[2] Grain per standard cubic foot.

3. Any volume of gases passing through and leaving an air pollution abatement operation may be substituted for the source gas volume of the source operation served by such air pollution abatement operation, for the purposes of subsection B–2, provided such air pollution abatement operation emits no more than 40 percent of the weight of particulate matter entering thereto; and provided further that such substituted volume shall be corrected to standard conditions and to a moisture content no greater than that of any gas stream entering such air pollution abatement operation.

4. No person shall cause, suffer, allow, or permit the emission of particulate matter from any source in a concentration in excess of 0.30 grain per standard cubic foot of exhaust gases. If provisions of this subsection B–4 would permit a greater emission of particulate matter per hour than allowed by subsection B–1, the provision of this subsection B–4 shall not apply.

Regulation V: Refuse not to be burned in fuel-burning plants

No person shall burn or cause or permit the burning of refuse in any installation which was designed for the primary purpose of burning fuel.

Regulation VI: Open burning restrictions

A. Refuse burning restrictions

1. No person shall dispose of refuse by open burning, or cause, suffer, allow, or permit open burning of refuse.

2. In areas where no public or commercial refuse collection service is available on the effective date of this regulation, the open burning of refuse on residential premises, of refuse originating in dwelling units on the same premises, shall not be in violation of this regulation until such refuse collection service becomes available or until 3 years from the effective date of this regulation, whichever is sooner.

3. Regardless of provisions of subsections A–1 and A–2 of this regulation, open burning of refuse on residential premises of refuse originating in dwelling units on the same premises shall not be a violation of this regulation in areas of low population density. The (Head of the air pollution control agency), after consultation with public agencies concerned with refuse collection and disposal, shall select and publish the specific boundaries of areas in which such open burning of refuse will not be in violation of this regulation. In selecting such areas, he shall use a density of 100 dwelling units or less per square mile as an approximate definition of areas of low population density and he shall give due consideration to the desirability of having restrictive air pollution control regulations within the conterminous area comprising the St. Louis metropolitan area air pollution basin. The (Head of the air pollution control agency)

shall select and publish revised boundaries, as described above, from time to time as population density changes.

4. Any open burning of refuse permitted by subsection A–2 or A–3 of this regulation shall be permitted only between the hours of 10:00 a.m. and 4:00 p.m.

B. Prohibition of salvage operations by open burning

No person shall conduct or cause or permit the conduct of a salvage operation by open burning.

C. Restrictions on open burning of trade wastes

1. No person shall cause or permit the disposal of trade wastes by open burning, except as provided in subsection C–2 of this regulation.

2. The open burning of trade wastes may be permitted when it can be shown by a person that such open burning is absolutely necessary and in the public interest. Any person intending to engage in open burning of trade wastes shall file a request to do so with the (Head of the air pollution control agency). The application shall state the following:

(a) The name, address, and telephone number of the person submitting the application.

(b) The type of business or activity involved.

(c) A description of the proposed equipment and operating practices, the type, quantity, and composition of trade wastes to be burned, and the expected composition and amount of air contaminants to be released to the atmosphere.

(d) The schedule of burning operations.

(e) The exact location where open burning will be used to dispose of trade waste.

(f) Reasons why no method other than open burning can be used for disposal of trade waste.

(g) Evidence that the proposed open burning has been approved by any fire department which may have jurisdiction. Upon approval of the application by the (Head of the air pollution control agency), the person may proceed with the operation without being in violation of subsection C–1.

D. Restrictions on open burning of agricultural wastes

1. The burning of plant life is prohibited. Provided that the open burning of plant life grown on the premises in the course of any agricultural operation may be permitted when it can be shown that such open burning is necessary and that no fire hazard will occur. Any person intending to dispose of plant life by open burning shall file a request to do so with the (Head of the air pollution control agency) on forms provided by him. Such form may require the provision of such information as the (Head of the air pollution control agency) may reasonably need to determine the air pollution aspects of the situation and whether the request should be granted. The applicant shall furnish the (Head of the air pollution control agency) evidence that the proposed open burning has been approved by any fire department which may have jurisdiction. Upon approval of the application by the (Head of the air pollution control agency) the person may proceed with the operation without being in violation of this subsection D–1.

2. Any open burning permitted under provisions of subsection D–1 of this regulation shall be permitted only between the hours of 10:00 a.m. and 4:00 p.m. and only at times when the actual or forecast surface wind speed, as given by the local U.S. Weather Bureau is 5 miles per hour or greater.

E. Restriction on open burning of tree leaves

1. The open burning of tree leaves in such manner as to cause nuisance, detriment, or annoyance to any person or the public is prohibited.

2. The open burning of leaves is prohibited except between the hours of 10:00 a.m. and 4:00 p.m.

3. All open burning of leaves shall be prohibited (5 years after this ordinance provision is put into effect) except in areas of low population density. Such areas of low population density shall be specified by the (Head of the air pollution control agency) in the same manner as described in subsection A–3 of this regulation.

NOTES.—Concerning Sections A and E of Regulation VI.

1. The City of St. Louis will not need subsections A–2, A–3 and A–4.

2. In St. Louis County, all of sections A and E (as well as all other sections) should be adopted. However, provision should be made to ensure that political subdivisions smaller than the county are still permitted to adopt and enforce

ordinances and regulations restricting open burning of leaves and refuse, which are consistent with county regulation. These smaller political subdivisions should be encouraged to do so. However, the county should adopt the regulations to provide for action in unincorporated areas and in areas where smaller political subdivisions fail to act.

3. In Illinois, the same principles apply to State regulations applicable in Madison and St. Clair Counties, as stated above for St. Louis County. In some respects, this is at variance with an existing State regulation. The matter will have to be resolved by the Illinois Air Pollution Control Board.

Regulation VII Incinerators

A. General provisions

1. This regulation shall apply to any incinerator used to dispose of refuse or other wastes by burning and the processing of salvable material by burning. Notwithstanding definitions in other regulations, as used in this regulation the word refuse includes garbage, rubbish, trade wastes, leaves, salvable material, agricultural wastes, and other wastes. The word incinerator, as used in this regulation, includes incinerators and other devices, structures, or contrivances used to burn refuse (as defined herein) or to process refuse by burning.

2. The burning capacity of an incinerator shall be the manufacturer's or designer's guaranteed maximum rate or such other rate as may be determined by the (Head of the air pollution control agency) in accordance with good engineering practice. In case of conflict, the findings of the (Head of the air pollution control agency) shall govern.

3. The amount of particulate matter emitted from any incinerator shall be determined according to the American Society of Mechanical Engineers "Power Test Codes—PTC 27" dated 1957 and entitled "Determining Dust Concentration in Gas Stream." In calculating the amount of particulate matter in stack gas, the loading shall be adjusted to 12 percent carbon dioxide in the stack gas. The carbon dioxide produced by burning of any liquid or gaseous fuel in the incinerator shall be excluded from the calculation to 12 percent carbon dioxide. Emissions shall be measured when the incinerator is operating at its maximum capacity or at any other burning rate during which emission of particulate matter is greater, when expressed as grains per standard cubic foot of stack gas.

B. Restriction of emissions of particulate matter from incinerators

1. No person shall cause or permit the emission of particulate matter from the stack or chimney of any incierator in excess of the following:

(a) Incinerators with a maximum refuse burning capacity of 200 or more pounds per hour, 0.2 grains of particulate matter per standard cubic foot of exhaust gas.

(b) All other incinerators, 0.3 grains of particulate matter per standard cubic foot of exhaust gas.

C. Multiple chamber incinerators required

1. No incinerator shall be used for the burning of refuse unless such incinerator is a multiple chamber incinerator. Existing incinerators which are not multiple chamber incinerators may be altered, modified, or rebuilt as may be necessary to meet this requirement. The (Head of the air pollution control agency) may approve any other alteration or modification to an existing incinerator if such be found by him to be equally effective for the purpose of air pollution control as a modification or alteration which would result in a multiple chamber incinerator. All new incinerators shall be multiple chamber incinerators, provided that the (Head of the air pollution control agency) may approve any other kind of incinerator if he finds in advance of construction or installation that such other kind of incinerator is equally effective for purposes of air pollution control as an approved multiple chamber incinerator.

D. Exceptions for low population density areas

The provisions of subsections B–1 and C–1 of this regulation shall not apply to any incinerator on residential premises used to burn refuse arising from domestic activities on the same premises in areas of low population density. The (Head of the air pollution control agency) shall select and publish the specific boundaries of areas in which subsections B–1 and C–1 of this regulation do not apply. In selecting such areas, he shall use a density of 100 dwelling units or less per square mile as an approximate definition of areas of low population density

and he shall also give due consideration to the desirability of having restrictive air pollution control regulations within the coterminous area comprising the St. Louis metropolitan area air pollution basin. The (Head of the air pollution control agency) shall select and publish revised boundaries, in the manner described in the foregoing, from time to time as population density changes.

E. Permitted hours of operation

No person shall operate or cause or permit the operation of any incinerator at any time other than between the hours of 10:00 a.m. and 4:00 p.m. This restriction shall not apply to incinerators having a refuse burning capacity of five tons per hour or more.

NOTE.—A time schedule for compliance will need be incorporated in subsection C–1. It is suggested that large incinerators be controlled first and smaller ones later, perhaps on the following schedule:

	Months
2000 pounds per hour or more	12
1000–1999 pounds per hour	18
500–999 pounds per hour	24
All	30

Section D will not be needed in the City of St. Louis.

Regulation VIII: Restriction of emission of visible air contaminants

A. Restrictions applicable to existing installations

1. No person shall discharge into the atmosphere from any single source of emission whatsoever any air contaminant of a shade or density equal to or darker than that designated as No. 2 on the Ringelmann Chart, or

2. Of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in subsection A–1 of this regulation.

3. This section A shall not apply to incinerators.

B. Restrictions applicable to all incinerators and other new source operations

1. No person shall discharge into the atmosphere from any incinerator or any new source of emission whatsoever any air contaminant of a shade or density equal to or darker than that designated as No. 1 on the Ringelmann Chart, or

2. Of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in subsection B–1 of this regulation.

C. Exceptions

1. A person may discharge into the atmosphere from any single source of emission for a period or periods aggregating not more than six minutes in any sixty minutes air contaminants of a shade or density not darker than No. 2 on the Ringelmann Chart.

2. Of such opacity as to obscure an observer's view to a degree not greater than does smoke described in subsection C–1 of this regulation.

3. Where the presence of uncombined water is the only reason for failure of an emission to meet the requirements of sections A or B of this regulation, such sections shall not apply.

4. The provisions of this regulation shall not apply to motor vehicles.

5. The provisions of section A of this regulation shall not apply to the following, however, the most modern and effective concepts and practices shall be applied to the control of pollutants:

(a) Transfer of molten metals
(b) Emissions from transfer ladles
(c) Coke ovens when pushing coke from ovens
(d) Water quenching of coke after discharge from ovens

D. Method of measurement

1. The Ringelmann Chart published and described in the U.S. Bureau of Mines Information Circular 7718 or the U.S. Public Health Service Smoke Inspection Guide as described in the Federal Register, Title 42, Chapter 1, Subchapter F, Part 75 shall be used in grading the shade or opacity of visible air contaminant emissions. The (Head of the air pollution control agency) may specify other means of measurement which give comparable results or results of greater accuracy.

Regulation IX: Preventing particulate matter from becoming air borne

A. Dust from handling and transporting materials to be controlled

No person shall cause or permit the handling or transporting or storage of any material in a manner which allows or may allow (unnecessary) or (preventable) amounts of particulate matter to become air-borne.

B. Dust from activities and premises to be controlled

No person shall cause or permit a building or its appurtenances or a road, or a driveway, or an open area to be constructed, used, repaired or demolished without applying all such reasonable measures as may be required to prevent particulate matter from becoming air-borne. The (Head of the air pollution control agency) may require such reasonable measures as may be necessary to prevent particulate matter from becoming air-borne including but not limited to paving or frequent cleaning of roads, driveways and parking lots; application of dust-free surfaces; application of water; and the planting and maintenance of vegetative ground cover.

Regulation X:

A. General provisions

1. This regulation shall apply to any installation in which fuel is burned and in which the sulfur dioxide emission is largely due to the sulfur content of the fuel burned, and in which the fuel is burned primarily to produce heat.

2. For purposes of this regulation, a fuel-burning installation is any single fuel-burning furnace or boiler or other unit, device, or contrivance in which fuel is burned or any grouping of two or more such furnaces or boilers or other units, devices, or contrivances on the same premises or otherwise located in close proximity to each other and under control of the same person. The capacity of such installations shall be the manufacturer's or designer's guaranteed maximum heat input rate.

3. The method for determining the percent of sulfur in coal shall be that described in ASTM D–271–64 Laboratory Sampling and Analysis of Coal and Coke or equivalent method approved by the ((Head of the air pollution control agency). The method for determining the heat content of coal shall be as described in ASTM D–271–64 Laboratory Sampling and Analysis of Coal and Coke or D–2015–62T Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorimeter. All coal analysis and heat contents are to be made on a dry basis. Moisture content of coal is to be determined in all cases and results recorded to facilitate calculations of actual pollutants.

The method for determining the sulfur content of fuel oil shall be that described in ASTM D–129–54 Standard Method of Test for Sulfur in Petroleum Products and Lubricants by the Bomb Method. The method for determining the heat content of fuel oil shall be that described in ASTM D–240–64 Standard Method of Test for Heat of Combustion of Liquids by the Parr Bomb Calorimeter or other method giving comparable results.

4. The (Head of the air pollution control agency) is authorized to take samples of any fuel by any appropriate means, in any quantity which he finds necessary, at any reasonable time or place, for purposes of determining compliance with this regulation. Where applicable, the following sampling methods will be used.

For coal:

ASTM: D–492–48 (1958) Sampling Coal Classified According to Ash Content.

ASTM: D–2013–65T Preparing Coal Sample for Analysis.

ASTM: D–2234–65T Mechanical Sampling of Coal.

For oil:

ASTM: D–270–65 Tentative Method of Sampling Petroleum Products.

B. Restrictions applicable to fuel-burning installations with a capacity of 2,000 million or more British thermal units per hour

1. After acceptable technology has been developed no person shall cause or permit the emission of sulfur dioxide to the atmosphere from any fuel-burning installation with a capacity of 2,000 million or more British Thermal Units per hour in an amount greater than 2.3 pounds of sulfur dioxide per million British thermal Units of heat input to the installation.

2. After acceptable technology has been developed no person shall burn or permit the burning in any fuel-burning installation with a capacity of 2,000 million or more British Thermal Units per hour of any coal containing more than 1.4 percent sulfur or of any oil containing more than 2.0 percent sulfur unless it

is shown by a person desiring to burn a fuel containing a higher percentage of sulfur that the installation in which the fuel is to be burned is equipped in such manner that the requirements of subsection B–1 will be met.

3. On and after the effective date of this regulation and until the requirements of subsection B–1 of this regulation are met, no fuel-burning installation with a capacity of 2,000 million or more British Thermal Units per hour shall burn a fuel or fuels having a higher average sulfur content than the fuel or fuels used in such installation during the 12 months prior to the effective date of this regulation based on BTU content. For purposes of determining compliance with this subsection B–3 the average sulfur content of all fuel or fuels used for the 12-month period prior to the effective date of this regulation shall be determined by averaging the sulfur content of all fuel used during such period, on the basis of pounds of sulfur per million British Thermal Units heating value of the fuel or fuels. This computed average sulfur content shall not be exceeded during any 12-month period after the effective date of this regulation, when determined on the same averaging basis.

Persons responsible for installations subject to section B of this regulation shall furnish (Head of the air pollution control agency) such data as he may reasonably require to determine whether an installation is being operated in compliance with this subsection B–3 of this regulation.

C. Restrictions applicable to fuel-burning installations with a capacity of less than 2,000 million British thermal units per hour

1. During the months of December 1967 and January 1968 no person shall burn or permit the burning of any coal containing more than 2.25 percent sulfur or of any fuel oil containing more than 2.0 percent sulfur, in any fuel-burning installation having a capacity of less than 2,000 million British Thermal Units per hours.

2. During the months of November and December 1968 and January and February 1969 no person shall burn or permit the burning of any coal containing more than 2.0 percent sulfur in any fuel burning installation having a capacity of less than 2,000 million British Thermal Units per hour.

3. During the months of October, November and December of 1969 and January, February and March of 1970 and during these same six months in all years thereafter, no person shall burn or permit the burning of any coal containing more than 2.25 percent coal or any fuel oil containing more than 2.0 percent sulfur in any fuel-burning installation having a capacity of less than 2,000 million British Thermal Units per hour.

4. The limitations on sulfur in fuel in subsections 1, 2, and 3 of this section C shall not apply if a person can show that emissions of sulfur dioxide to the atmosphere from a source operation will not exceed 2.3 pounds of sulfur dioxide per million British Thermal Units of heat input to the installation.

5. The ultimate goal for the maximum allowable sulfur content of coal is 1.4 percent. Subsections 1, 2, and 3 of this section C do not require achievement of this goal. Therefore, two years after the effective date of this regulation, and every two years thereafter, this section C shall be reviewed by the (regulation-making body) for the purpose of determining whether it is appropriate to lower the limits on the sulfur content of coal to less than 2.25 percent. If no reduction is made in the 2.25 percent, for whatever reason, the limitation of 2.25 percent shall continue in effect.

D. Method of calculating sulfur content of coal

All stated values for sulfur in coal used in this Regulation X are for analyses conducted on a dry basis but calculated to include normal moisture.

E. Unlawful conduct

It shall be unlawful for any person to import, sell, offer for sale, expose for sale, exchange, deliver or transport for use and consumption in the (jurisdictional area) or to use or consume any fuel which is not from an approved source or which does not meet the requirements of this regulation unless it is shown by any such person that emission of sulfur dioxide from use of such fuel will not exceed 2.3 pounds of sulfur dioxide per million British Thermal Units of heat input to the installation in which it is to be burned.

NOTES pertaining to Regulation X:

A committee should be officially appointed to determine means of meeting provisions of this regulation and ultimate goals for fuel quality. Such a committee, primarily technical in nature but with an elected public official as a member ex officio, would prepare, in not over a 1-year period a steam electric

utility air-use plan which would indicate the alternate methods available to meet the air-use limitations for this class of sources, and would present costs, methods, and time schedules (not to exceed 5 years) for reaching the air quality goals. A similar plan should be prepared for other coal burning plants within 2 years and should be implemented as soon as possible.

The values of 2.3 pounds sulfur dioxide per million BTU's, 1.4 percent sulfur coal, and 2.0 percent sulfur oil are based on sulfur limitations needed to reach an air quality goal of 0.1 ppm, 24-hour average not to be exceeded over 1 percent of the time during any 3-month period. As such they are themselves goals which could be reached by other means than straight reduction of sulfur content of fuels. For example, the source configuration could be changed to fit the diffusion capacity of the air, or different fuels could be substituted in part to fit the diffusion characteristics of the air. Since the air-use plan and percent reduction are based on fuels currently in use in the urbanized area, the percent sulfur in fuel oil, currently estimated to average 1.6 percent, should not be increased until the sulfur ascribed to other fuel has decreased proportionately.

A 5- to 10-year period is suggested for reducing the allowable sulfur content in coal set forth in section C from 2.25 percent to 1.4 percent. Step-at-a-time action should be taken by the governmental subdivisions involved. The phased approach to implementing fuel changes is based on the air pollution characteristics of the area. If economic, market, labor, or other considerations indicate, it would, of course, be desirable to have uniform requirements for sulfur in fuel for the entire year. In that way the regulatory program would be materially simplified.

Regulation XI: Information on sales of fuels to be provided and maintained

A. Tickets to be furnished and retained

Every delivery of coal or residual fuel oil when first delivered to a consumer or wholesaler in the (jurisdiction) must be accompanied by a ticket prepared in triplicate and containing at least the name and address of the seller and the buyer; the grade of fuel; and the source of the fuel, which must be an approved source. One copy of each ticket shall be kept by the person delivering the fuel and be retained for one year; one copy is to be given to the recipient of the fuel to be retained for one year; and, upon request, within 30 days after delivery of the fuel, the delivering party shall mail one copy to the (air pollution control agency).

B. Lists may be published

The (Head of the air pollution control agency) is authorized to publish lists of approved sources or other descriptive lists of fuels available in the area which meet the requirements of regulations.

Note pertaining to Regulation XI:

This regulation is designed to provide for the type of fuel control system now in operation in the City of St. Louis. It is not complete in itself. Additional items that might be included in a fuel control system are (a) issuance of permits to fuel dealers, (b) requiring the bonding of fuel dealers, (c) sampling and analysis of fuel deliveries to large consumers and distributors and (d) determining which sources of coal and fuel oil are "approved sources".

Regulation XII: Certain coals to be washed

A. Certain coals to be washed

It shall be unlawful for any person to import, sell, offer for sale, expose for sale, exchange, deliver or transport for use and consumption in the (jurisdiction) or to use or consume in the (jurisdiction) any coal containing in excess of 2 percent sulfur or 12 percent ash on a dry basis as mined, before importation, sale, transportation, or use in the (jurisdiction) shall have been cleaned by a process known as washing so that it shall contain no more than 12 percent ash on a dry basis. The term "washing" is meant to include purifying, cleaning, or removing impurities from coal by mechanical process, regardless of cleaning medium used.

B. Testing methods

The method for determining ash and sulfur content of coal shall be as described in ASTM D–271–64, Laboratory Sampling and Analysis of Coal and Coke, or equivalent method approved by the (Head of the air pollution control agency).

C. Samples may be taken

The (Head of the air pollution control agency) is authorized to take samples of any coal at any reasonable time or place for purposes of determining compliance with this regulation.

D. Exception

This regulation shall not apply if a person proposing to use unwashed coal can show that the emission of sulfur dioxide from the plant in which the coal is to be burned will emit no more than 2.3 pounds of sulfur dioxide per million BTU's of heat input to the installation and that emission of particulate matter will be no more than that allowed by applicable regulations.

Regulation XIII: Emission of certain settleable acids and alkaline substances restricted

A. General provisions

This regulation shall apply to all emissions from any source or any premises.

B. Method of measurement

1. The fallout sampling devices used in determining compliance with this regulation shall consist of circular glass dishes 15 centimeters in diameter. The dishes shall be supported on a nearly horizontal surface not larger than the dish. The dish bottom shall be at least 3 feet above the earth or other surface on which its support is resting. The dish shall be coated with a solution of thymol blue, ammonia water solution and gelatin dried to a yellow color in a vacuum oven at room temperature. Prepared dishes shall be stored in a desiccator at 40 percent relative humidity, or in plastic bags.

2. Fallout sampling devices shall be put in place at one or more locations up-wind and down-wind of premises at locations beyond the premises on which a source or sources are located. They shall be left exposed to substances settling out of the ambient air for a period of one hour. The presence of red-colored spots visible to the naked eye on the samplers used to measure fallout of acidic substances shall mean that acidic substances have settled out of the air. The presence of blue-colored spots visible to the naked eye on the samplers used to measure fallout of alkaline substances shall mean that alkaline substances have settled out of the air. The number of spots visible on samplers exposed up-wind of a premise is to be subtracted from the number of spots visible on samplers exposed down-wind of the same premise. The difference in the number of spots, if any, shall be construed to be attributable to emissions occurring on the premise under investigation.

3. In lieu of the test methods specified in B–1 and B–2 any other method approved by the (Head of the air pollution control agency) may be used.

C. Emissions restricted

No person shall cause or permit the emission from any source or premises of substances having acidic or alkaline properties in such manner and amounts that the fallout rate of acidic or alkaline substances at any place where an adverse effect could occur down-wind of such source or premises is over five spots more per hour at the down-wind sampling site than at the up-wind site, as measured in the manner described in section B of this regulation.

NOTE.—This regulation is for the purpose of controlling large size particles. These particles settle out of the air readily and are capable of being controlled fully by available control technology.

Regulation XIV: Emission of certain sulfur compounds restricted

A. General provisions

1. Section B of this regulation shall apply to all source operations except those in which both—

(a) fuel is burned primarily to produce heat, and

(b) the sulfur compound emission is due primarily to the sulfur in the fuel burned.

2. Section C shall apply to all emissions from any source or sources whatsoever.

3. The method of measuring sulfur trioxide and sulfuric acid or any combination thereof in stack gases shall be as described in "Atmospheric Emissions from Sulfuric Acid Manufacturing Processes," Public Health Service Publ. 999–AP–13, Pages 61–66 and 85–87.

4. The method of measuring hydrogen sulfide in the ambient atmosphere shall be that described in the paper entitled "A Low Cost Sampler for Measurement of Low Concentrations of Hydrogen Sulfide," by Sensenbaugh and Hemeon and published in Air Repair, Volume 4, May 1954.

5. The method of measuring sulfur dioxide in stack gases shall be as described in "Atmospheric Emissions From Sulfuric Acid Manufacturing Processes", Public Health Service Publ. 999–AP–13, pages 85–87.

6. The method of measuring sulfur trioxide and sulfuric acid or any combination thereof suspended in the ambient atmosphere shall be as described in the paper entitled "Determination of Particulate Acid in Town Air", by B. T. Commins and published in the Analyst, volume 88, May 1963.

7. The method of measuring sulfur dioxide in the ambient atmosphere shall be the West and Gaeke method as described in "Selected Methods for the Measurement of Air Pollutants", Public Health Service Publ. No. 999–AP–11, May, 1965 or the conductimetric method described in "ASTM Standards on Methods of Atmospheric Sampling and Analysis," 2d edition, Method D 1355–60. Method A, page 11.

8. Other test methods approved by the (Head of the air pollution control agency) may be used.

B. Concentration of sulfur compounds in emissions restricted

1. No person shall cause or permit the emission into the atmosphere from any existing source specified in subsection A–1 of this regulation, gases containing more than 2000 parts per million by volume of sulfur dioxide or 500 parts per million by volume of sulfur dioxide from any new source.

2. No person shall cause or permit the emission into the atmosphere from any existing source specified in subsection A–1 of this regulation, gases containing more than 70 milligrams per cubic meter of sulfuric acid or sulfur trioxide or any combination thereof or 35 milligrams per cubic meter of sulfuric acid, sulfur trioxide or any combination thereof from any new source (expressed as sulfuric acid).

3. Where a source operation which would or does emit sufur compounds to the atmosphere is a scavenger plant or recovery plant, recovering sulfur compounds which would otherwise be emitted to the atmosphere, and such scavenger plant is not a sulfuric acid manufacturing operation, the (Head of the air pollution control agency) may authorize the operation of such recovery plant where the total emission of sulfur compounds is reduced by at least 95 percent with the plant in operation compared to emissions when it is not operating, even though the concentrations of sulfur compounds in emissions to the atmosphere exceed those permitted by subsection B–1 or B–2 of this Regulation XIV.

C. Emission of sulfur compounds in certain amounts and manner restricted

1. No person shall cause or permit the emission of sulfur dioxide from any premises in such manner and amounts that the concentrations and frequencies attributable to such emission exceed those shown in the following table in the ambient air at any occupied place beyond the premises on which the source is located.

Concentration [1]	Averaging time	Maximum allowable frequency
0.25 parts per million or more	5 minutes	Once in any 8 hours.
0.10 parts per million or more	1 hour	Once in any 4 days.
0.05 parts per million or more	24 hours	Once in any 90 days.

[1] Parts per million by volume.

2. No person shall cause or permit the emission of sulfuric acid or sulfur trioxide or any combination thereof from any premises in such manner and amounts that the concentrations and frequencies attributable to such emission exceed those shown in the following table in the ambient air at any occupied place beyond the premises on which the source is located.

Concentration [1] of sulfuric acid or sulfur trioxide or any combination thereof	Averaging time	Maximum allowable frequency
0.03 mg./m.^{3} or more	30 minutes or more	Once in any 48 hours.
0.01 mg./m.^{3} or more	24 hours	Once in any 90 days.

[1] Milligrams per cubic meter at standard conditions, measured and calculated as sulfuric acid.

3. No person shall cause or permit the emission of hydrogen sulfide from any premises in such manner and amounts that the concentrations attributable to such emissions in the ambient air at any occupied place beyond the premises on which the source is located exceed a concentration of 0.03 parts per million by volume for any averaging period of 30 or more minutes on more than two occasions in any 5-consecutive-day period, or 0.05 parts per million by volume for any averaging period of 30 or more minutes more than two times per year.

4. In any situation in which multiple sources of the pollutants regulated in subsections C–1, C–2, and C–3 cause air quality levels to exceed two times any of those given in said subsections, the maximum allowable concentrations which may be caused by each large source shall be decreased by such factor as may be necessary to prevent ambient air concentrations from exceeding two times those given in said subsections. For purposes of this subsection C–4, a large source is defined as one which emits pollutants in such manner or amounts as to cause ambient air concentrations of these pollutants in excess of one-fifth of the concentrations stated in subsections C–1, C–2, or C–3.

D. More restrictive limitation to apply

In any situation in which more than one requirement of this Regulation XIV is applicable, the most restrictive provision shall govern.

Regulation XV: Additional air quality control measures may be required when sources are clustered in a small land area

A. Areas to which this regulation applies

1. This regulation shall apply to areas in which there are one or more existing major sources and/or proposed new major sources of particulate matter in any circular area with a diameter of two miles (including sources outside jurisdiction) from which the sum of particulate emissions allowed from major sources by regulations of general application are or would be greater than 2000 tons per year or 500 pounds per hour. For purposes of this regulation, "major sources" include coal bruning units with a heat input capacity of 100 million or more BTU's per hour, refuse burning plants with a refuse burning capacity of five or more tons per hour, and industrial processes having a process weight rate of ten or more tons per hour.

2. This regulation shall apply in areas in which there are one or more existing major sources and/or proposed new major sources of sulfur dioxide in any circular area with a diameter of two miles from which the sum of sulfur dioxide emissions from major sources allowed by regulations of general application are or would be greater than 1000 tons for any consecutive three months or 1000 pounds per hour. For purposes of this regulation, "major sources" include coal or oil burning units with a heat input of 100 million or more BTU's per hour and industrial processes which emit one or more tons of sulfur dioxide per day.

B. (Body empowered to act on variances) may prescribe more restrictive air quality control measures

1. In areas where this regulation applies, as specified in section A herein, the (body empowered to act on variances) may prescribe air quality control requirements that are more restrictive and more extensive than provided in regulations of general application. Such measures shall provide for air resource and land-use management within these areas for the purpose of obtaining the best feasible air quality in the particular area and for the (jurisdiction) as a whole, consistent with air quality standards prescribed by regulations or otherwise.

The air quality control measures prescribed by the (body empowered to act on variances) may include, without limiting the same, additional reduction of emissions, modifications of fuel or process material, specified operating time schedules, use of tall stacks, relocation of sources, and other measures. In the event that a proposed new installation will cause the sum of allowable emissions to exceed those given in section A herein and thus make this regulation apply, only the proposed new plant shall be subject to more restrictive or extensive requirements.

NOTE.—These requirements should be incorporated in a special use permit issued by the appropriate procedure in the jurisdiction. Language should be inserted here to provide for this.

2. In considering the need for and the nature of any air quality control measures to be imposed which are more restrictive or more extensive than those provided in regulations of general application the (body empowered to act on variances) shall consider, among others, such matters as: (a) dispersion of emission; (b) ability of the atmosphere to disperse pollutants; (c) existing and anticipated land use; (d) stack heights; (e) existing and anticipated air quality; (f) existing and anticipated emissions; (g) expected service life of sources; (h) cost of additional control measures; and (i) feasibility and impact of various possible ways to preserve or improve air quality. To the extent feasible, the (body empowered to act on variances) shall confer and work with all persons who would be affected by any special air quality control measures.

NOTE PERTAINING TO REGULATION XV

These air pollution regulations are designed to achieve certain air quality in the general atmosphere. In most cases, the generally applicable emission control and other regulations are adequate for these purposes. However, in a few cases where one or more pollution sources are, or will be, located in a relatively small area, compliance with regulations of general application may not result in satisfactory air quality. Since it is not feasible to write regulations which will be suitable in each such special case, this regulation is to provide a formalized procedure for arriving at any necessary more restrictive air quality control measures needed to ensure satisfactory air quality in the most equitable manner possible.

Regulation XVI:

A. Application for variance

Any person subject to the air pollution regulations of the (air pollution control agency) may apply to the (Head of the air pollution control agency) for a variance from such regulation or any order of the (Head of the air pollution control agency). The application shall be filed on forms provided by the (Head of the air pollution control agency) who may require submission of such information as he may reasonably require to bring out all pertinent facts in the case. The (Head of the air pollution control agency) shall examine the application and all pertinent facts relating thereto and promptly transmit the application along with his findings, recommendations, and records of the matter to the (body authorized to grant variances). The (body authorized to grant variances), within 20 days, shall conduct a hearing on the matter.

The (Head of the air pollution control agency) may also request and he shall be granted a hearing before the (body authorized to grant variances) on any matter involving a variance.

B. Hearing to be held

The (body authorized to grant variances) shall serve notice of the time and place of a hearing on a variance upon the applicant, if any, and upon the (Head of the air pollution control agency), not less than 10 days prior to such hearing.

C. Conditions for granting variance

The (body authorized to grant variances) may grant a variance from any regulation or order of the (Head of the air pollution control agency) if its finds that compliance with the regulation or order from which a variance is sought would produce serious hardship without a corresponding benefit or advantage to the people. The (body authorized to grant variances) shall exercise a wide discretion in weighing the equities involved in each case. The (body authorized to grant variances) may prescribe other and different requirements not more onerous, applicable to any situation for which a variance is sought. However, no variance may permit or authorize the maintenance of a nuisance, or a danger to public health or safety.

D. Duration of variance

Variances shall be granted by the (body authorized to grant variances) for such periods of time and, upon such conditions as permitted by applicable laws, such variance may be renewed provided a request for renewal is submitted by the applicant to the (Head of the air pollution control agency). If the (Head of the air pollution control agency) approves of the renewal, no hearing need be held. If he disapproves, the (body authorized to grant variances) shall conduct a new hearing. At such hearing, the (body authorized to grant variances) shall decide whether the variance should be renewed, revoked, or modified.

E. Variance may be revoked or modified

The (body authorized to grant variances) may, after a hearing, revoke or modify any variance it has issued, at any time.

Regulation XVII:

A. Emission of certain odorous matter prohibited

No person shall emit odorous matter such as to cause an "objectionable" odor:

1. On or adjacent to residential, recreational, institutional, retail sales, hotel or educational premises.

2. On or adjacent to industrial premises when air containing such odorous matter is diluted with 20 or more volumes of odor-free air.

3. On or adjacent to premises other than those in 1 and 2 when air containing such odorous matter is diluted with four or more volumes of odor-free air.

B. Objectionable odor defined

The requirements of section A shall apply only to "objectionable" odors. An odor will be deemed objectionable when 15 percent or more of a sample of people exposed to it believe it to be objectionable in usual places of occupancy. Sample size is to be at least 20 people or 75 percent of those exposed if fewer than 20 people are exposed.

Regulation XVIII: Control of odors from processing of animal matter

A. General

1. For purposes of this regulation the word "reduction" is defined as any heated process, including rendering, cooking, drying, dehydrating, digesting, evaporating, and protein concentrating.

2. The provisions of this regulation shall not apply to any device, machine, equipment, or other contrivance used exclusively for the processing of food for human consumption.

B. Odor control equipment required on reduction processes

1. No person shall operate or use any device, machine, equipment or other contrivance for the reduction of animal matter unless all gases, vapors, and gas-entrained effluents from such faciilty are incinerated at a temperature of not less than 1,200 degrees Fahrenheit for a period of not less than 0.3 second, or processed in such manner as determined by the (Head of the air pollution control agency) to be equally or more effective for the purpose of air pollution control. In making the determination the (Head of the air pollution control agency) shall consider the nature and quantity of animal matter being processed.

A person incinerating or processing gases, vapors, or gas-entrained effluents pursuant to this rule shall provide, properly install and maintain, in good working order and in operation, devices as specified by the (Head of the air pollution control agency) for indicating temperature, pressure, or other operating conditions.

C. Other odor control measures required

1. Effective devices and/or measures shall be installed and operated such that no vent, exhaust pipe, blow-off pipe or opening of any kind shall discharge into the outdoor air any odorous matter, vapors, gases, or dusts or any combination thereof which create odors or other nuisances in the neighborhood of the plant.

2. Odor producing materials shall be confined and handled in a manner such that odors produced within or outside the plant from such materials are controlled. Accumulation of odor producing materials resulting from spillage or other escape shall not be permitted.

3. Odor bearing gases, vapors, fumes, or dusts arising from materials in process shall be confined at the point of origin so as to prevent liberation of odorous matter into the work-room and the confined gases, vapors, fumes, or dusts shall be treated before discharge to the atmosphere, as required in subsection C–1.

D. Enclosure of building may be required

Whenever dust, fumes, gases, mist, odorous matter, vapors, or any combination thereof escape from a building used for processing of animal matter in such manner and amount as to cause a nuisance or to violate the odor control regulation of the (jurisdiction), the (Head of the air pollution control agency) may order that the building or buildings in which processing, handling and storage are done be tightly closed and ventilated in such a way that all air and gases and air or gas borne material leaving the building are treated by incineration or

other effective means for removal or destruction of odorous matter or other air contaminants before discharge to the open air.

Regulation XIX: Emission of visable air contaminants from motor vehicles

A. Emission of visible air contaminants limited

No person shall cause or permit the emission of visible air contaminants from a motor vehicle which is:

1. Of a shade or density equal to or darker than that designated as No. 1 on the Ringelmann Chart, or

2. Of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in subsection A–1 of this regulation.

B. Exceptions

1. A person may cause or permit the emission of visible air contaminants from a motor vehicle for a period not exceeding five seconds at a time which is:

(a) Of a shade or density not darker than that designated as No. 2 on the Ringelmann Chart, or

(b) Of such opacity as to obscure an observer's view to a degree not greater than does smoke described in subsection B–1(a) of this regulation.

2. When the presence of uncombined water is the only reason for failure of an emission to meet the requirements of this regulation, the provisions of this regulation shall not apply.

Regulation XX: Approval of planned installations, land use plans and zoning regulations required

A. Review of plans and approval

1. The (building department or other office responsible) shall not issue a permit for the erection, construction, resconstruction, alteration or occupancy of any building or structure when the plans and specifications for such structure or occupancy include any fuel-burning or refuse burning device, or any chimney or smoke stack, or the occupancy of any building for industrial purposes, until such plans and specifications have been submitted to the (Head of the air pollution control agency) and approved by him within 30 days as making adequate provisions for meeting the requirements of this ordinance. If the (Head of the air pollution control agency) does not submit his recommendations to the (building department or other office responsible) within 30 days, the plans or specifications shall be deemed approved.

B. Planning agency land use plans—preparation and approval

1. Planning agencies will, in preparing land-use plans, obtain and use information supplied by the (air pollution agency) concerning:

(a) air quality
(b) air pollutant emissions
(c) air pollution meteorology
(d) air quality goals
(e) air pollution effects

2. The (air pollution agency) will review all land-use plans prior to formal adoption and prepare recommendations that must be adequately considered in the plan adoption process.

C. Zoning agency regulations—preparation and approval

1. Zoning control agencies will, in preparing regulations, obtain and use information supplied by the (air pollution agency) concerning:

(a) air quality
(b) air pollutant emissions
(c) air pollution meteorology
(d) air quality goals
(d) air quality goals
(e) air pollution effects

2. The (air pollution agency) will review all zoning regulations and proposed changes in zoning classifications prior to formal adoption and prepare recommendations that must be adequately considered in the regulation adoption and zoning change process.

NOTE.—In some jurisdictions it may be better to arrange for the approval of construction plans directly by the air pollution control agency rather than through the building department, as has been provided in section A of this Regulation XX.

Regulation XXI: Air pollution nuisances prohibited

A. Nuisance prohibited

No person shall cause or permit the discharge from any source whatoever such quantities of air contaminants or other material which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health, or safety of any such persons or the public or which cause or have a tendency to cause injury or damage to business or property.

B. Other regulations not to authorize nuisance

Nothing in any other regulation concerning emission of air contaminants or any other regulation relating to air pollution shall in any manner be construed as authorizing or legalizing the creation or maintenance of a nuisance as described in section A of this regulation.

Regulation XXII: Measurement of emissions of air contaminants

A. Responsible persons to have tests made

The (Head of the air pollution control agency) may require any person responsible for emission of air contaminants to make or have made tests to determine the emission of air contaminants from any source, whenever the (Head of the air pollution control agency) has reason to believe that an emission in excess of that allowed by an air pollution regulation of the (air pollution control agency) is occurring. The (Head of the air pollution control agency) may specify testing methods to be used, in accordance with good professional practice. The (Head of the air pollution control agency) may observe the testing. All tests shall be conducted by reputable, qualified personnel. The (Head of the air pollution control agency) shall be given a copy of the test results in writing and signed by the person responsible for the tests.

B. (Head of the Air Pollution Control Agency) may make tests

The (Head of the air pollution control agency) may conduct tests of emissions of air contaminants from any source. Upon request of the (Head of the air pollution control agency), the person responsible for the source to be tested shall provide necessary holes in stacks or ducts and such other safe and proper sampling and testing facilities, exclusive of instruments and sensing devices as may be necessary for proper determination of the emission of air contaminants.

Regulation XXIII: Submission of emission information—authority

The (Head of the air pollution agency) may require the submission of air pollutant information from any or all potential sources for purposes of maintaining an air pollutant emission inventory.

Regulation XXIV: Requirements for construction of new gasoline storage facilities

A. General

1. For purposes of this regulation, the term "gasoline" is define as petroleum distillate having a Reid vapor pressure of 4 pounds or greater.

2. For purposes of this regulation, the term "submerged fill pipe" is defined as any fill pipe the discharge opening of which is entirely submerged when the liquid level is 6 inches above the bottom of the tank. "Submerged fill pipe" when applied to a tank which is loaded from the side is defined as any fill pipe the discharge opening of which is entirely submerged when the liquid level is 18 inches above the bottom of the tank.

B. Petroleum storage tanks

1. After the effective date of this regulation, no person shall build or install or permit the building or installation of any stationary tank, reservoir or other container or more than 40,000 gallons capacity which will or might be used for storage of any petroleum distillate having a vapor pressure of 1.5 pounds per square inch absolute or greater under actual storage conditions, unless such tank, reservoir or other container is to be a pressure tank capable of maintaining working pressures sufficient at all times to prevent hydrocarbon vapor or gas loss to the atmosphere or is designed, and will be built, and equipped with one of the following vapor loss control devices:

(a) A floating roof, consisting of a pontoon type or double-deck type roof, which will rest on the surface of the liquid contents and be equipped with a clos-

ure seal, or seals, to close the space between the roof edge and tank wall. The control equipment to be provided for in this subsection B–1(a) shall not be permitted if the gasoline or petroleum distillate to be stored will have a vapor pressure of 12.0 pounds per square inch absolute or greater under actual storage conditions. All tank gauging and sampling devices shall be built so as to be gas-tight except when gauging or sampling is to take place.

(b) A vapor recovery system, consisting of a vapor-gathering system capable of collecting the hydrocarbon vapors and gases discharged and a vapor-disposal system capable of processing such hydrocarbon vapors and gases so as to prevent their emission to the atmosphere and with all tank gauging and sampling devices gas-tight except when gauging or sampling is taking place.

(c) Other equipment or means of equal efficiency for purposes of air pollution control as may be approved by the (Head of the air pollution control agency).

C. Submerged fill pipes required

1. After the effective date of this regulation, no person shall build or install or permit the building or installation of a stationary gasoline storage tank with a capacity of 250 gallons or more unless such tank is equipped with a permanent submerged fill pipe or is a pressure tank as described in subsection B–1 of this regulation, or is fitted with a vapor recovery system as described in subsection B–1(b) of this regulation.

Regulation XXV: Entry onto premises—authority

In the general performance of his duties the (air pollution officer and other authorized personnel) are hereby authorized to enter at all reasonable hours upon and into any buildings, establishments, premises, and enclosures in or from which they have reason to believe the provisions of this (ordinance) are being violated, to inspect or examine such buildings, establishments, premises, or enclosures, and to collect and preserve evidence of all facts as to violations of this (ordinance).

Regulation XXVI: Circumvention

No person shall cause or permit the installation or use of any device or any means which, without resulting in reduction in the total amount of air contaminant emitted, conceals or dilutes an emission of air contaminant which would otherwise violate an air pollution control regulation. This regulation shall not apply when the only violation involved is violation of a regulation based on concentration or presence of one or more air contaminants at locations beyond the premises on which a source or sources are located.

GENERAL NOTES

1. Regulations providing for operating permit systems and registration systems:

The legislative body enacting ordinances should consider the merits of permit and registration systems for program administration and select the system that meets the jurisdictions program needs and objectives.

2. Area of application of these regulations:

In the Illinois part of the area, a section defining the area of application of the regulations will be needed.

3. Copies of publications mentioned in these regulations:

A section should be provided in any final ordinance which would require the (Head of the air pollution control agency), to keep on file in his office at least one copy of all such publications and to make the same available to any person for inspection.

Senator MUSKIE. I would like to ask a second question. What is the policy of the two States, Illinois and Missouri, toward the idea of an effective interstate compact agency to deal with this problem. Now, you endorse the idea of an interstate compact?

Mr. CAIRNS. Yes, sir.

Senator MUSKIE. How do you envision the kind of an interstate compact agency which you would endorse relative to setting of standards, relative to enforcement powers, and relative to independence from the two States?

Mr. CAIRNS. Let me say this, Senator, as a Council we have not addressed ourselves directly to this problem on the matter of setting policy on the steering committee. I would be less than frank with you if I didn't tell you I have some strong opinions on that of a personal nature, and to that end I would answer your question this way. The compact would be drawn, as I see it, to cope with interstate air pollution, and to that end the compact authority, composed of equal membership from the two States and encompassing the entire common boundary between the two States——

Senator MUSKIE (interrupting). Not including a Federal——

Mr. CAIRNS (interrupting). It would include a Federal tie breaker. Recognizing that we have equal representation from either of the two States or from both States, rather, there is a possibility of a stalemate or a tie.

I would say that the commissioners should vote at large and not on the State unit vote rule, so that you have the best chance of having a majority for action of the interstate compact.

Further, I feel that the interstate compact commission as it relates to interstate air pollution should have powers to adopt rules and regulations which supersede those of the party States or any of their subdivisions, and further that they would have the powers to enforce those regulations. To that extent I agree with Mr. Warren. I would say that wherever we can do this job with the State agency which is already a vital body, then the States should seize their responsibility and go about it so that the load is taken from the interstate compact commission, except in those situations where the State is unable to cope with it, in which case the compact commission would cope with it.

Senator MUSKIE. And who would make the decison as to whether or not——

Mr. CAIRNS (interrupting). The compact commission, if it is interstate air pollution.

Senator MUSKIE. And the compact commission would decide whether or not it was interstate air pollution?

Mr. CAIRNS. Yes, sir.

Senator MUSKIE. So you think of it as an agency having free and independent enforcement powers?

Mr. CAIRNS. Insofar as it regards interstate air pollution, not a boundless thing that would be a super agency of some nature. If you had a situation, say, where Missouri, Illinois, and Kentucky all come together and you have compacts among these three States, I can see some overlapping of jurisdiction here that may be administratively very difficult to cope with.

Senator MUSKIE. Let me ask you a very specific, simple, and practical question. Suppose that the Commission, in existence under the plan that you have sketched out here, and a pollution source in Illinois is considered by the Missouri members of the commission to be an interstate source of air pollution, harmful to the citizens of Missouri and the compact area. The representatives of Illinois on the compact disagree, say it is not, and the Federal tie breaker says that it is.

Mr. CAIRNS. Missouri just prevailed. I would hope that we would get 10 people appointed to these commissions who would consider the public at large rather than the individual State boundary.

Senator MUSKIE. I would agree. And I think there is some merit to your observation that they ought to try to avoid so-called State unit voting. I think that if you can make it truly an interstate agency representative of the people of the area, rather than the two States, you might have a healthy evolution. Whether as a matter of practical human psychology you would expect that to develop, I don't know. I have some misgivings about it.

Mr. CAIRNS. To pull an old phrase out, Senator, hope springs eternal in the human breast.

Senator MUSKIE. I take it you had in mind more than one representative of each State?

Mr. CAIRNS. Yes, sir.

Senator MUSKIE. Did you have any particular number in mind?

Mr. CAIRNS. Oh, to be consistent, I guess, with what has, as I understand it, been introduced in both legislatures to date, five members from each State, and this should be sufficient to provide the metropolitan area here with representation as well as the outstate areas along the common border.

Senator MUSKIE. You are thinking of one representative of the Federal Government?

Mr. CAIRNS. It would only take one to break a tie, sir

Senator MUSKIE. That is, if the two States votes as a unit?

Mr. CAIRNS. No. Say three from Missouri and two from Illinois teamed up against their opposite numbers. You still have a tie, and the Federal tie breaker can break it.

Senator MUSKIE. You know, I am almost tempted to suggest that you are a dreamer.

Mr. CAIRNS. Gentlemen, I thank you, sir.

Senator MUSKIE. Mr. Cairns, I know Senator Randolph has some questions and I have taken up more than my share of the time.

Senator RANDOLPH. Talking about this tie breaker let me tell a story which might fit in here: A chairman of an industrial corporation was ill in a hospital and he received a telegram from the members of the board. They wished him a prompt and complete recovery, and then added that the vote was 11 to 9. So we can't have any unanimity, perhaps.

Mr. Cairns, you speak of the contributions made by industry to cleaner air. You indicate that the electric utility firms have adopted a plan which the Public Health Service says is a good one. How much does that plan encompass?

Mr. CAIRNS. I wonder, Senator, if we could ask Mr. McLaughlin, who is a representative of Union Electric, to cope with that.

Senator RANDOLPH. I think it is important if the Public Health Service has looked on it with favor.

Mr. MCLAUGHLIN. They said it was a good air use plan. I am not sure whether your question is related to the dollar figure that Mr. Cairns had developed. I can very briefly state the plan which is to move our new large plants far away from the downtown area and build, put some units in a little bit earlier than we would otherwise do, to shut down some of the plants in the urban area where our air pollutants are high. By this we will have estimated we will reduced our emissions in the area where the SO_2 pollutants have been measured to be high by 68 percent by 1971. This is our air use plan. We will

have one plant located 20 miles north of St. Louis, another 35 miles west, and one plant 17 miles south, and this will effectively reduce emissions, as I say, by 68 percent.

In addition to that, we are putting high efficiency dust collectors on every unit that we put in. Our latest plant, we are putting in a 99.5-percent-efficiency collector. Our total investment in this type of equipment is on the order of $14 million. I am not sure I responded to your question.

Senator RANDOLPH. Yes; I think you have.

Senator MUSKIE. I think Senator Randolph inquired as to whether or not we could get this, whether this plan is reduced to writing.

Mr. MCLAUGHLIN. Yes; we have presented this to the Missouri commission. I have a copy of it with me and I will give you a copy of my presentation before the Missouri commission which describes this plan.

Senator MUSKIE. Do we have the details of the other proposals that you described in your statement, Mr. Cairns?

Mr. MCLAUGHLIN. Actually, I think it is in that blue book really.

Senator MUSKIE. If it is in the blue book, we have it.

Mr. MCLAUGHLIN. Yes, sir.

Mr. CAIRNS. I take it, Senator, when you queried about the details of the other plans, some of those are spelled out in the data that is developed in the blue book. In fact, I think all of them are in greater or lesser detail as the situation dictated.

Senator RANDOLPH. The response covers the point I wanted to raise.

I would also call attention to the contribution which has been indicated by Mr. Cairns by chemical companies. I know something of the Monsanto program in Pennsylvania. I wonder if we could have that discussed.

Mr. MUNIE. I am Jack Munie. I am plant manager of Monsanto's Queeny plant down on South Second Street. I am in no position to discuss this program in detail in Pennsylvania. I do know that Monsanto is working in cooperation with Metropolitan Edison at that point. It is in Portland, Pa. It is to determine the feasible or economical means of recovering the sulfur dioxide from the stacks in its boiler plant.

I believe that this system that is being worked on, it is quite expensive but quite feasible in boiler plants and in power-producing plants around the country. It should become quite a feasible method of coping with this.

Senator RANDOLPH. I should add, Mr. Chairman, as you well know, that we are attempting to have the person or persons who are very familiar with this subject as it relates to the effort in Pennsylvania to testify at the hearings in Washington, D.C. I felt since Monsanto was identified here with the area, perhaps it would be important to highlight at least, the effort in connection with sulfur dioxide which is being carried forward.

Mr. MUNIE. This is an effort to remove it as it comes up the stack.

Senator MUSKIE. I take it that there is greater prospect of success in that approach than there is in the approach of reducing the sulfur content of the basic fuel itself?

Mr. MUNIE. At the moment it appears that way; yes, sir.

Senator MUSKIE. Would you think that an economically feasible means of reducing it in the stack is within reach?

Mr. MUNIE. It is in reach in large boiler plants such as public utilities, I believe. Again, I have to qualify myself. I am plant manager of a local plant and can't really speak for that operation.

(Subsequently Mr. Munie submitted the following letter:)

MONSANTO CO.,
St. Louis, Mo., April 11, 1967.

Senator EDMUND S. MUSKIE,
Chairman, U.S. Senate Subcommittee on Air and Water Pollution,
U.S. Senate Office Building, Washington, D.C.

DEAR SENATOR MUSKIE: At the hearing before your subcommittee in St. Louis on April 4, Senator Randolph inquired as to the current status of Monsanto Company's developments on the removal of sulfur dioxide from power house stacks where high sulfur coal is burned as fuel. As manager of the St. Louis plant of Monsanto, I was not familiar with the day-by-day progress of this project which is the responsibility of one of the other divisions of my company.

For the record of your subcommittee's hearing, I would like to submit the following information provided by Dr. Joseph Stites, Monsanto's Project Manager for this very important research.

Monsanto and Metropolitan Edison Company, of Reading, Pennsylvania, are building a multimillion dollar prototype plant at Metropolitan Edison's Portland, Pennsylvania, generating station to study a process for removing sulfur dioxide from flue gas. The prototype plant uses commercially available equipment, but is designed to treat only 5 per cent of the flue gas from the Portland Unit #2.

The process involves taking hot (900°F) flue gas off the coal-fired boiler and passing it through a highly efficient (99.5%) electrostatic precipitator to remove fly-ash. The cleaned, hot gases are then directed through a catalytic converter where sulfur dioxide is oxidized to sulfur trioxide. Then the hot gases are cooled to condense sulfuric acid, which is removed from the gas stream by a Brink Mist Eliminator (an air pollution control device developed by Monsanto research). The clean cooled gases are finally sent to the stack.

The process is being designed to remove 90 per cent of the sulfur values from the flue gas. The process is still under development and many engineering problems have yet to be solved before it is ready for commercial application.

Completion of construction of the prototype plant is scheduled for mid-1967. Process design for commercial units may be available by early 1968.

Preliminary estimates indicate that the process can be installed on large new power plants for $20—30/kilowatt of generating capacity.

We believe that the recovered sulfuric acid will be of commercial quality. Sale or use of this acid will assist greatly in amortizing the investment in the recovery system and will help alleviate the world sulfur shortage.

Thank you for your courtesy in accepting the above comments as a more specific answer to Senator Randolph's question.

Very truly yours,

D. E. MUNIE,
Plant Manager, J. F. Queeny Plant.

Senator MUSKIE. If the optimism has filtered out that far, the committee ought to share it.

Mr. MCLAUGHLIN. As a representative of a company who would have to apply this process, I would say that our view of this thing is that we are quite a little ways away from having a practical operating process. The Missouri commission regulation states that we need to comply with an SO_2 concentration by 1970, which would, in effect, require the use of this process by 1970, and I can assure you that it is our understanding, from a search of what is going on, that we will not be able to use this process by 1970 or any other process for removal of SO_2. There is a lot of research being done and I think there is optimism being expressed, but as far as the timing of it, it is quite a number of years away, in our opinion.

Senator RANDOLPH. I think, Mr. Chairman, to continue on this point, the coal industry has made certain representations in reference to emissions of sulfur dioxide in the interstae air pollution study area. This is true, isn't it?

Mr. MCLAUGHLIN. Yes, sir.

Senator RANDOLPH. And as I understand it—and I would rather have a representative speak, if he would speak for the Midwest Coal Producers Institute—I have understood that the use of coal by commercial and residential heating plants has been reduced from the 960,000 tons in 1963 to 405,000 tons in 1965. Is that correct?

Mr. MULLAN. That is correct.

Senator RANDOLPH. And it is further projected that by 1970 this trend of decreasing usage will result in 90 percent reduction to a figure of 96,000 tons of coal. Is this obsolescence that sets in?

Mr. MULLAN. A combination of obsolescence and some of the legislation that has been passed banning the use of hand firing and so forth, which we did not object to.

Senator RANDOLPH. I understand that the interstate sudy and technical committee reports did not include this fact in reference to the reduction.

Mr. MULLAN. In reviewing the data we found this had been omitted.

Senator RANDOLPH. You are not being critical; you are simply indicating that mistakes can occur?

Mr. MULLAN. Yes; we all have problems.

Senator RANDOLPH. Would you object to placing in the record the statement which has been made on this subject backed by figures and charts?

Mr. MULLAN. No objection at all.

Senator RANDOLPH. I do that to conserve time, Mr. Chairman. I think your statement bears close study by the subcommittee.

(The material referred to follows:)

MID-WEST COAL PRODUCERS INSTITUTE, INC., STATEMENT ON EMISSIONS OF SULFUR DIOXIDE IN THE INTERSTATE AIR POLLUTION STUDY AREA

The Interstate Air Pollution Study stated that to reach its goal of 0.1 ppm SO_2 24 Hour Average 99% of the time it is necessary to reduce the emission of sulfur dioxide 61%. Its technical committee in a report dated November 14th, 1966 stated that as a first step the reduced emissions from the Venice and Cahokia power plants and the use of coal of 2.0% sulfur or less would result in an SO_2 reduction of 43%.

The coal industry submits that this same first step over-all reduction will be attained by 1970 without placing a limitation on the sulfur content of coal, through the reduced emissions from commercial and residential heating plants. The use of coal by these users has been reduced from the 960,000 tons in 1963 shown in the Study Report to 405,000 tons in 1965. It is projected that by 1970 this trend of decreasing usage will result in a 90% reduction to 96,000 tons of coal. The Study Report confirms a reduction, but the Interstate Study and Technical Committee reports did not include this fact in the calculations.

Further reductions by 1975 thru the phasing out of Cahokia power plant and decreased operation of Venice power plant will reduce SO_2 emissions another 5%.

The attached figures tabulate this information. The reductions attributable to coal are considered, but no data are shown for the other substantial reductions of SO_2 from other sources. The U.S. Public Health Service reduction figure due to the banning of open burning is shown. The attached figures show that the reduced emissions of SO_2 from burning coal by 1970 represent 42% of the total SO_2 emissions and 48% of the SO_2 from coal sources, and by 1975 47% and 54%, respectively.

The coal industry proposes that a Technical Advisory Committee as suggested in the Industrial Waste Control Council Clean Air Program or an Air-Use Plant committee as suggested in the Interstate Report be appointed for the area to assure attaining of a goal. It should:

1. Maintain a continuing emission inventory of all SO_2 sources and a record of ambient air levels,
2. Keep abreast of technical developments for further reductions which will result from the expanding research programs.
3. Recommend to control agencies changes in rules and regulations required to meet advancing technology and the needs to reach a long-term goal,
4. Continually study what that goal should be,
5. Submit progress reports to control agencies every six months or more frequently if the Committee so determines.

The coal industry stands ready to provide the necessary coal use data upon which to base an emission inventory. Other sources would have to provide similar information. Control agencies would have to establish a sampling network and provide that data to the Committee.

Projected emissions of sulfur dioxide

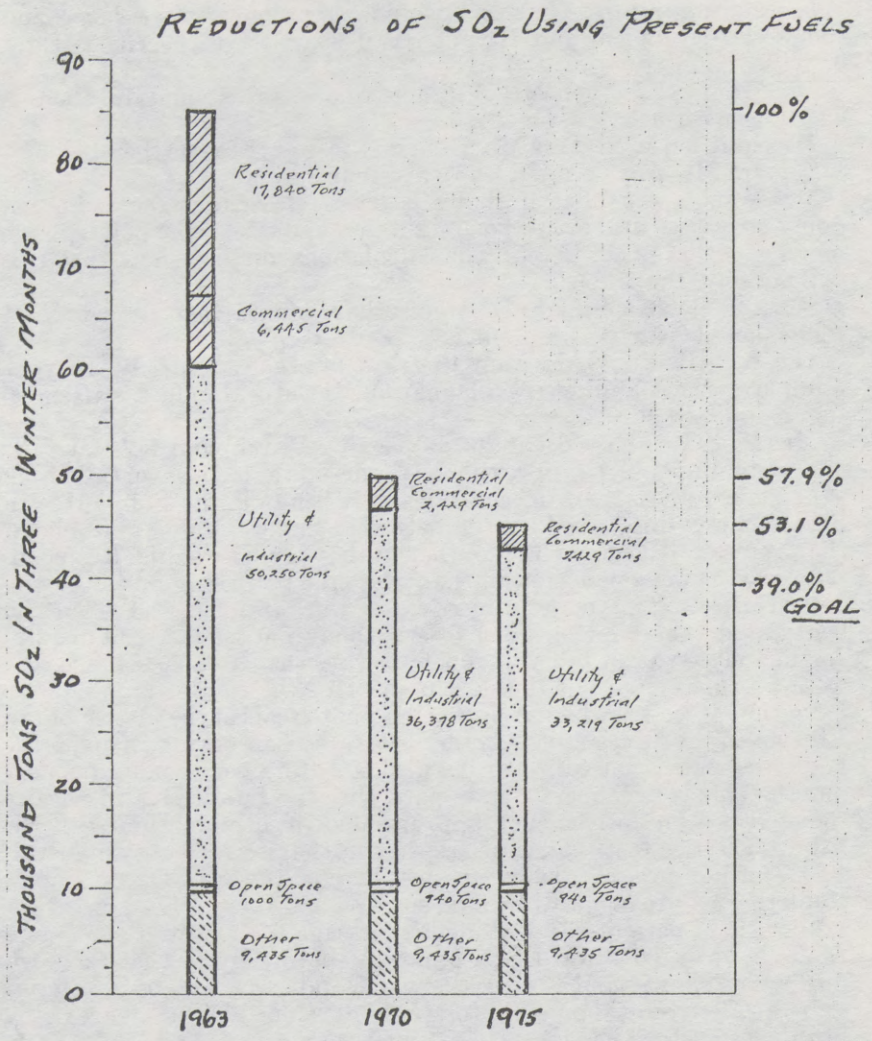
	Tons SO_2 for 3 winter months	
	All sources	Coal only
Present SO_2 emissions in central urbanized area—tons	84,970	74,535
Reductions:		
Residential and commercial (90 percent by 1970)	−21,856	−21,856
Correction St. Louis City industrial (3.7 to 3.3 percent sulfur)	−372	−372
Utility, reduction by 1970	13,504	−13,504
Ban open burning	−60	0
Total reductions (tons, 42.1 percent; coal only, 47.9 percent)	−35,792	−35,732
Subtotal of emissions in 1970	49,178	38,803
Utility, additional reduction by 1975 (tons, 4.8 percent; coal only, 5.6 percent)	−4,159	−4,159
Total of emissions in 1975 (tons, 46.9 percent reduction; coal only, 53.5 percent reduction)	45,019	34,644
Goals:		
Interstate report recommends a 61-percent reduction—		
Of—tons	51,831	45,466
To—do	33,139	29,069
Thus, additional reduction required to meet goal of 61 percent—		
In 1970—percent	18.9	13.1
In 1975—do	14.1	7.5

Mr. MULLAN. I want to stress further that the Public Health Service did make a very comprehensive study of the area, and the fact that figures were missed is a natural situation, when you realize the mass of information that they had to correlate and put together. Going further, we asked them if this information had been included in the records. They honestly said that they did not know. We went to their test center. We met with them and did the calculations together with them, and following this met with the East-West Gateway Coordinating Council, which you have heard referred to, and a representative of the Public Health Service was at that meeting and verified our calculations at the meeting.

Senator RANDOLPH. I think that will be shown, Mr. Chairman, by the record. I am not sure there is any difficulty in having an admission made of the error.

Is that right?

Mr. MULLAN. No.



Senator RANDOLPH. I don't want to be arbitrary. I merely wanted to spell out that it was a mistake.

Mr. MULLAN. In fact, one of the gentlemen we worked with, Mr. Williams, who worked with us, is here.

Mr. WILLIAMS. This was not a mistake.

Mr. MULLAN. I believe I called it an omission rather than a mistake.

Senator RANDOLPH. I believe I perhaps used the word "mistake" rather than you.

Mr. SCHUENEMAN. You will recall the graph in the draft we prepared here. It shows the downward trend in the use of coal in industrial and commercial use. I did not know we recognized it was going on.

Mr. MULLAN. You did recognize it was going on, Mr. Schueneman. You did note it on a graph, but you forgot to include it in calculations.

Senator RANDOLPH. Is that right, Mr. Schueneman?

Mr. SCHUENEMAN. That is my understanding. It is a large and complicated problem and I can't recall exactly whether he is right or we are right.

Mr. MULLAN. I asked Mr. Williams who was there and did the calculations with me.

Mr. SCHUENEMAN. May Mr. Williams answer? He was there.

Senator MUSKIE. Yes, sir, let Mr. Williams answer.

Mr. WILLIAMS. What it shows is briefly this, that the reduction going on is a natural event, you might say, and due to the powerplants moving out, are considered. The calculations further show that this will not solve the problem.

Senator RANDOLPH. Thank you. I have no further discussion. I felt we should clarify this point.

Senator MUSKIE. I do want to ask a final question only. In your opinion, is the coal industry a laggard or is the coal industry attempting to do a job?

Mr. MULLAN. The coal industry began research, and let's take the one contaminant SO_2, approximately a decade ago. In essence, I think this was before some of the activities were begun in the Public Health Service along this line. We recognized that this was going to be one of the problem areas, and the fact that in that period we didn't come up with the answer doesn't mean that we weren't working on it. As you fully realize, when you go into research, they all look good when you begin, and they all look good to everybody but the accountant, unfortunately. We can tell you about 15 ways that it can't be done. We were a primary part of the development of the catalystic gas phase oxidation processes which is now being put to scale at the Metropolitan Edison Co., by Monsanto, and others. We are also working on dolomitic additives which you will hear testified to before your committee next month. This is in cooperation, in part, with the Public Health Service themselves. Our own agency appropriated, in combination with the Edison Electric Institute, which represents the electric utility industry, a $4.3 million program last year, just directed toward SO_2. So I don't think that we are laggard. I would suggest, and I strongly suggest this, I know it is part of the President's message to Congress, that more funds be directed toward SO_2 removal, specifically to that fact. Industry has shown, and I think the utility industry is a good example, that the electrostatic precipitators were developed and they are being installed. We don't have the device to control SO_2.

Senator RANDOLPH. You are saying that technological advancement is in process?

Mr. MULLAN. That's right. I'm not sure if any of your staff were at the press conference held by Dr. Middleton on Friday in which this direct question was asked of his staff, and Dr. Ludwig, who is, if I misname it, I believe it is Assistant Director of the National Center for Air Pollution Control, made the statement that these devices were still 5 years away from practical application.

Senator RANDOLPH. Mr. Chairman, I would like to add that it is incumbent on industry that it move as quickly as possible. I feel that we both share this thinking, and there is no use in throwing brickbats

at any particular industry per se, but only to stimulate and, if necessary, to move into effective regulation, giving a cushion of time for industry to do the job. Hopefully, I believe industry can, in partnership with government, effect these advances.

Mr. MULLAN. Our opinion is that it can. It has to be in that period of time.

Senator MUSKIE. I think that is a good note to close on.

Thank you very much, gentlemen.

Mr. CAIRNS. Mr. Chairman, I would seek 1 minute of the committee's time to intercede on behalf of the State of Illinois so they can clarify their position on the interstate compact, and we yield.

Mr. WARREN. Thank you, Mr. Cairns.

Our views on the interstate compact, to state it very briefly, would be that the interstate agency would take up problems which would, of of course, be of an interstate nature, have the power to pass emission limits, and enforce control, but would first employ the enforcement mechanisms of each State before it would have the power to go in itself. In other words, it could use the machinery of existing municipal, county, and State organizations on either side of the border, but would also be empowered to come forward with controls where a State was lax or where a State failed to take action. An example is provided in the Illinois-Missouri area where (1) an interstate agency acting under compact between Illinois and Missouri would have a primary function of determining that a case of interstate air pollution does exist, (2) having thus determined, it would submit the case of interstate air pollution to the proper State, municipal, or other governmental body having jurisdiction, and (3) if this latter agency fails to act, defaults, or is otherwise unable to resolve the case of interstate air pollution, the interstate agency would have the standards, power, equipment, personnel, and technical staff to carry out the necessary abatement enforcement.

Senator MUSKIE. I think that is a clarification.

I might say in closing that the principal reason we came to St. Louis was to consider this interstate situation and what might be done or what is being done that might be useful in national application. I have already made note that Missouri's two Senators, Senator Symington and Senator Long, regret that they could not be here today and together emphasize this interstate problem as one in which they have particular concern.

With that, may I express the appreciation of the committee for the attendance of these excellent witnesses and their testimony, for the interest on the part of the public at large, as evidenced by this attendance this morning. We appreciate your patience in recognizing our time problem.

Senator RANDOLPH. Senator Muskie, I would like to add this word: I don't think we get excited because witnesses present different points of view; we expect this and we understand it. It is only when people are indifferent to a problem such as this that I think we are frightened. I feel that here in St. Louis that the people are very aware and knowledgeable and that we are going to find some answers.

Senator MUSKIE. Thank you very much.

I will at this time place in the record a letter from the American Association of University Women.

(The letter referred to is as follows:)

AMERICAN ASSOCIATION OF UNIVERSITY WOMEN,
February 4, 1967.

Senator EDMUND S. MUSKIE,
Subcommittee on Air and Water Pollution,
Senate Office Building,
Washington, D.C.

DEAR SENATOR MUSKIE: The St. Louis Metropolitan Area Branches of the American Association of University Women have been active in developing public awareness and interest in air pollution in our various communities. We have jointly sponsored a conference on this subject at Washington University, have attended meetings of the East-West Gateway Coordinating Council, the Missouri Air Conservation Commission and other bodies dealing with air pollution control, and have offered statements at several public hearings on the subject.

We have consistently supported the recommendations in the Air Resource Management Program for Metropolitan St. Louis, a program developed after a three year Interstate Survey under the auspices of many public agencies concerned with the quality of St. Louis air.

We are convinced that uniform, airshed-wide standards, regulations and enforcement are required to provide adequate air pollution control for metropolitan St. Louis. Events of recent weeks have persuaded us that a regional, inter-state compact is the best method for obtaining this type of control, and we therefore urge this Committee to use all means in its power to facilitate such a compact. We would anticipate that under the compact a commission would be set up, composed of members from both Illinois and Missouri, and a representative of the Federal government, and that the commission would be adequately financed and have broad powers to set standards, monitor sources of pollution, and secure enforcement of its decisions.

We would like to have the compact provide for as much regional, state and local autonomy as is consonant with prompt establishment and application of uniform air quality standards and regulations in substantial agreement with those recommended in the Interstate Survey already referred to. We recognize however that the readiness of the Federal government to formulate and enforce standards when local measures fail to protect health and property is an indispensable asset to air pollution control.

We believe that appropriate action by this Committee will go far to produce an effective compact for the bistate St. Louis Metropolitan region.

A duplicate copy of this letter is being sent to you in care of the Air Conservation Commission of the State of Missouri, Division of Health, Jefferson City, for adequate filing purposes.

Very truly yours,

BETTY H. RANDS, *President.*

Senator MUSKIE. With that, the hearing is adjourned.

(Whereupon, at 12:10 p.m., the subcommittee adjourned.)

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