

74
In 8/4

1019

89-48
In 8/4
7/16/88

89-48

CLEAN AIR ACT AMENDMENTS OF 1966

GOVERNMENT
Storage

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

EIGHTY-NINTH CONGRESS
SECOND SESSION

ON

H.R. 13199, S. 3112

BILLS TO AMEND THE CLEAN AIR ACT SO AS TO AUTHORIZE GRANTS TO AIR POLLUTION CONTROL AGENCIES FOR MAINTENANCE OF AIR POLLUTION CONTROL PROGRAMS IN ADDITION TO PRESENT AUTHORITY FOR GRANTS TO DEVELOP, ESTABLISH, OR IMPROVE SUCH PROGRAMS; MAKE THE USE OF APPROPRIATIONS UNDER THE ACT MORE FLEXIBLE BY CONSOLIDATING THE APPROPRIATION AUTHORIZATIONS UNDER THE ACT AND DELETING THE PROVISION LIMITING THE TOTAL OF GRANTS FOR SUPPORT OF AIR POLLUTION CONTROL PROGRAMS TO 20 PER CENTUM OF THE TOTAL APPROPRIATION FOR ANY YEAR; EXTEND THE DURATION OF THE PROGRAMS AUTHORIZED BY THE ACT; AND FOR OTHER PURPOSES

SEPTEMBER 27, 1966

Serial No. 89-48

Printed for the use of the Committee on Interstate and Foreign Commerce

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1966

69-400 O

KSU LIBRARIES
A11900 807028 ✓

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE

HARLEY O. STAGGERS, West Virginia, *Chairman*

WALTER ROGERS, Texas	WILLIAM L. SPRINGER, Illinois
SAMUEL N. FRIEDEL, Maryland	J. ARTHUR YOUNGER, California
TORBERT H. MACDONALD, Massachusetts	SAMUEL L. DEVINE, Ohio
JOHN JARMAN, Oklahoma	ANCHER NELSEN, Minnesota
LEO W. O'BRIEN, New York	HASTINGS KEITH, Massachusetts
JOHN E. MOSS, California	WILLARD S. CURTIN, Pennsylvania
JOHN D. DINGELL, Michigan	GLENN CUNNINGHAM, Nebraska
PAUL G. ROGERS, Florida	JAMES T. BROYHILL, North Carolina
HORACE R. KORNEGAY, North Carolina	JAMES HARVEY, Michigan
LIONEL VAN DEERLIN, California	ALBERT W. WATSON, South Carolina
J. J. PICKLE, Texas	TIM LEE CARTER, Kentucky
FRED B. ROONEY, Pennsylvania	
JOHN M. MURPHY, New York	
DAVID E. SATTERFIELD III, Virginia	
DANIEL J. RONAN, Illinois	
J. OLIVA HUOT, New Hampshire	
JAMES A. MACKAY, Georgia	
JOHN J. GILLIGAN, Ohio	
CHARLES P. FARNSLEY, Kentucky	
JOHN BELL WILLIAMS, Mississippi	
BROCK ADAMS, Washington	

W. E. WILLIAMSON, *Clerk*

KENNETH J. PAINTER, *Assistant Clerk*

Professional Staff

ANDREW STEVENSON
KURT BORCHARDT

JAMES M. MENDER, Jr.
WILLIAM J. DIXON

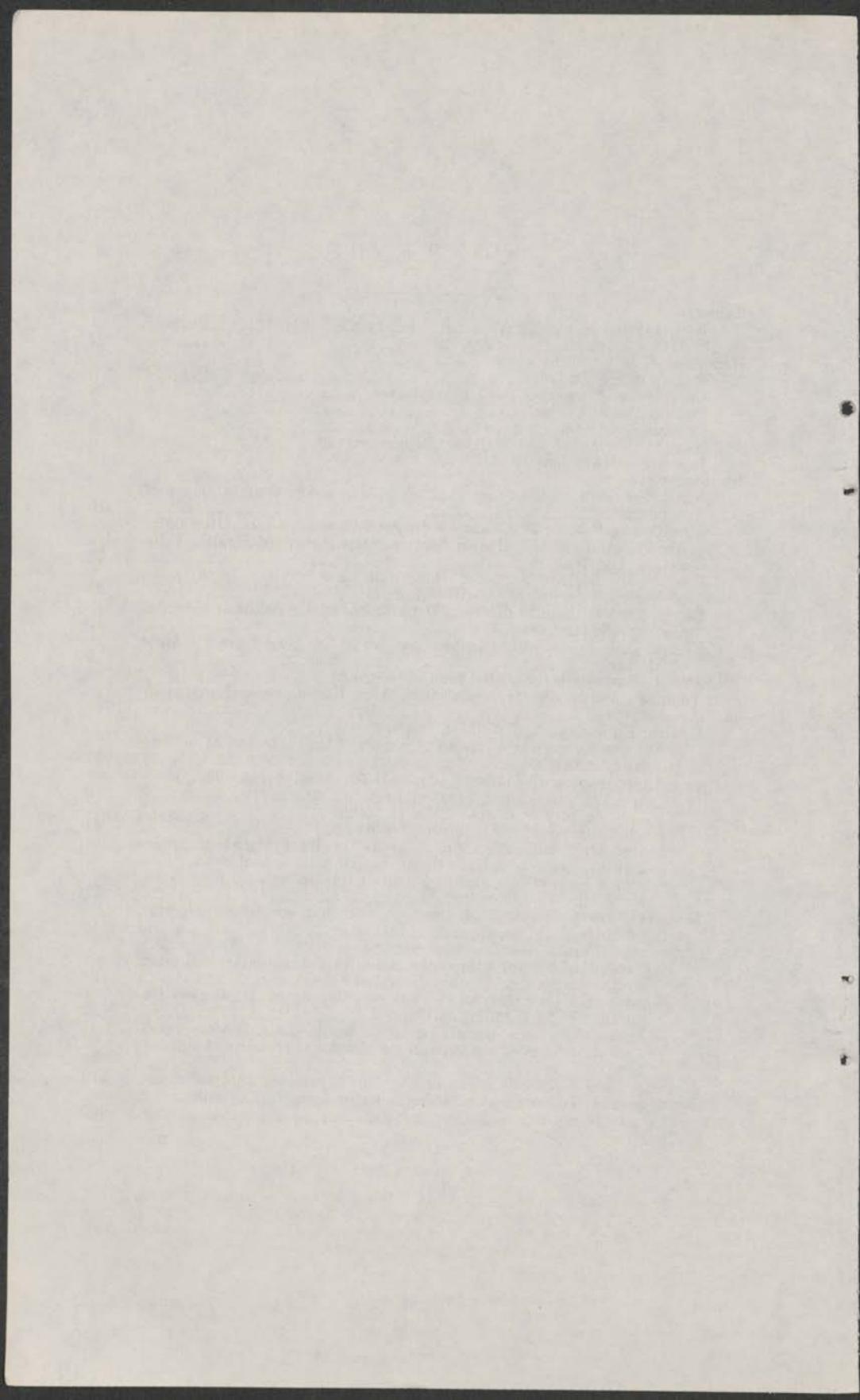
SUBCOMMITTEE ON PUBLIC HEALTH AND WELFARE

JOHN JARMAN, Oklahoma, *Chairman*

LEO W. O'BRIEN, New York	WILLIAM L. SPRINGER, Illinois
PAUL G. ROGERS, Florida	ANCHER NELSEN, Minnesota
DAVID E. SATTERFIELD III, Virginia	TIM LEE CARTER, Kentucky
JAMES A. MACKAY, Georgia	
JOHN J. GILLIGAN, Ohio	

CONTENTS

Text of—	Page
H.R. 13199.....	1
S. 3112.....	2
Report on H.R. 13199 by—	
Bureau of the Budget.....	6
Comptroller General of the United States.....	8
Federal Power Commission.....	6
General Services Administration.....	8
Health, Education, and Welfare, Department of.....	3
Interior, Department of the.....	5
Statement of—	
Kops, Gerald S., second vice chairman, Milwaukee County Board of Supervisors.....	10
MacKenzie, Vernon G., Assistant Surgeon General, Chief, Division of Air Pollution, Public Health Service, Department of Health, Education, and Welfare.....	27
Prindle, Dr. Richard A., Chief, Bureau of State Services, Department of Health, Education, and Welfare.....	23
Rehm, Fred R., deputy director, Department of Air Pollution Control, County of Milwaukee, Wis.....	10
Vivian, Hon. Weston E., a Representative in Congress from the State of Michigan.....	9
Additional information submitted for the record by—	
American Public Power Association, Alex Radin, general manager, statement of.....	120
Health, Education, and Welfare, Department of:	
Abatement actions initiated under the Clean Air Act as of September 29, 1966.....	77
Appropriation limitations proposed for fiscal years 1967, 1968, and 1969, background material relating to.....	73
Budgetary estimates, 1967-72 (table).....	75
Health hazards of air pollution, report on.....	41
Letter dated July 27, 1966, re action of Department in implementing section 103(a) (4) and (5)(B), with attachment, "Programs Under Way and in Prospect for Reducing Sulfur Oxide Emissions from Combustion Sources".....	77
Mayors, U.S. Conference of, John J. Gunther, executive director, letter from.....	119
Milwaukee County Board of Supervisors:	
Air pollution control ordinances and rules and regulations adopted by the Milwaukee County Board of Supervisors.....	83
Tentative 5-year plan and objectives, County of Milwaukee Department of Air Pollution Control.....	12
Wisconsin statutes pertaining to property taxes, income taxes, and air pollution abatement installations (effective August 1, 1966).....	16
National Coal Association, Stephen F. Dunn, president, letter from.....	119
Pennsylvania, Department of Health, letter from C. L. Wilbar, Jr., M.D., secretary of health.....	125



CLEAN AIR ACT AMENDMENTS OF 1966

TUESDAY, SEPTEMBER 27, 1966

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

The subcommittee met at 10 a.m., pursuant to call, in room 2218, Rayburn Office Building, Hon. John Jarman (chairman of the subcommittee) presiding.

Mr. JARMAN. The subcommittee will please come to order. The hearings today are on H.R. 13199, S. 3112, and related bills extending the Clean Air Act.

In general, these bills would extend that act, which presently expires June 30, 1967, for additional periods ranging from 3 to 5 years, and provide an increase in the authorization for appropriations for the current fiscal year from \$35 to \$46 million.

S. 3112 and H.R. 13199 were each introduced at the request of the administration, and S. 3112 was reported to the Senate with amendments which were agreed to and the bill then passed the Senate on July 12 by a rollcall vote of 80 yeas and no nays.

It is my hope that we can complete these hearings as expeditiously as possible so that we can report a bill to the full committee at the earliest possible date.

At this point in the record there will be included copies of the bills and the agency reports thereon.

(The bills and reports referred to follow :)

[H.R. 13199, 89th Cong., 2d sess.]

A BILL To amend the Clean Air Act so as to authorize grants to air pollution control agencies for maintenance of air pollution control programs in addition to present authority for grants to develop, establish, or improve such programs; make the use of appropriations under the Act more flexible by consolidating the appropriation authorizations under the Act and deleting the provision limiting the total of grants for support of air pollution control programs to 20 per centum of the total appropriation for any year; extend the duration of the programs authorized by the Act; 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 "Clean Air Act Amendments of 1966."

CONSOLIDATION OF APPROPRIATION CELLINGS

SEC. 2. Section 306 of the Clean Air Act is amended to read as follows:

"SEC. 306. There are hereby authorized to be appropriated to carry out this Act, \$46,000,000 for the fiscal year ending June 30, 1967, and such sums as may be necessary for each succeeding fiscal year ending prior to July 1, 1973."

CLEAN AIR ACT AMENDMENTS OF 1966

AUTHORIZATION OF MAINTENANCE GRANTS FOR AIR POLLUTION CONTROL PROGRAMS AND REMOVAL OF TWENTY PERCENT CEILING

SEC. 3. (a) (1) Subsection (a) of section 104 of the Clean Air Act (33 U.S.C. 1857c(a)) is amended to read as follows:

"SEC. 104. (a) The Secretary is authorized to make grants to air pollution control agencies in an amount up to two-thirds of the cost of developing, establishing, or improving, and grants to such agencies up to one-half of the cost of maintaining, programs for the prevention and control of air pollution: *Provided*, That the Secretary is authorized to make grants to intermunicipal or interstate air pollution control agencies (described in section 302(b) (2) and (4)) in an amount up to three-fourths of the cost of developing, establishing, or improving, and up to three-fifths of the cost of maintaining, regional air pollution control programs. As used in this subsection, the term 'regional air pollution control program' means a program for the prevention and control of air pollution in an area that includes the areas of two or more municipalities, whether in the same or different States."

(2) Subsection (b) of such section 104 is amended by striking out "under" in the first sentence and inserting in lieu thereof "for the purposes of", and by inserting in the third sentence the word "control" after "air pollution".

(b) Subsection (c) of such section 104 is amended to read as follows:

"(c) Not more than 12½ per centum of the total of funds appropriated or allocated for the purposes of subsection (a) of this section shall be granted for air pollution control programs in any one State. In the case of a grant for a program in an area crossing State boundaries, the Secretary shall determine the portion of such grant that is chargeable to the percentage limitation under this subsection for each State into which such area extends."

[S. 3112, 89th Cong., 2d sess.]

AN ACT To amend the Clean Air Act so as to authorize grants to air pollution control agencies for maintenance of air pollution control programs in addition to present authority for grants to develop, establish, or improve such programs; make the use of appropriations under the Act more flexible by consolidating the appropriation authorizations under the Act and deleting the provision limiting the total of grants for support of air pollution control programs to 20 per centum of the total appropriation for any year; extend the duration of the programs authorized by the Act; 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 "Clean Air Act Amendments of 1966".

CONSOLIDATION OF APPROPRIATION CEILINGS

SEC. 2. (a) Section 306 of the Clean Air Act is amended to read as follows:

"SEC. 306. There are hereby authorized to be appropriated to carry out this Act, \$46,000,000 for the fiscal year ending June 30, 1967, \$70,000,000 for the fiscal year ending June 30, 1968, and \$80,000,000 for the fiscal year ending June 30, 1969."

(b) Section 209 of such Act is hereby repealed.

AUTHORIZATION OF MAINTENANCE GRANTS FOR AIR POLLUTION CONTROL PROGRAMS AND REMOVAL OF 20 PER CENTUM CEILING

SEC. 3 (a) (1) Subsection (a) of section 104 of the Clean Air Act (42 U.S.C. 1857c (a)) is amended to read as follows:

"SEC. 104. (a) The Secretary is authorized to make grants to air pollution control agencies in an amount up to two-thirds of the cost of developing, establishing, or improving, and grants to such agencies up to one-half of the cost of maintaining, programs for the prevention and control of air pollution: *Provided*, That the Secretary is authorized to make grants to intermunicipal or interstate air pollution control agencies (described in section 302(b) (2) and (4)) in an amount up to three-fourths of the cost of developing, establishing, or improving, and up to three-fifths of the cost of maintaining, regional air pollution control programs. As used in this subsection, the term 'regional air pollution control program' means a program for the prevention and control of air pollution in an area that includes the areas of two or more municipalities, whether in the same or different States."

(2) Subsection (b) of such section 104 is amended by striking out "under" in the first sentence and inserting in lieu thereof "for the purposes of", and in the next to the last sentence by inserting a comma after the word "funds" and adding "for other than non-recurrent expenditures," and in the same sentence after the word "pollution", the word "control".

(b) Subsection (c) of such section 104 is amended to read as follows:

"(c) Not more than 12½ per centum of the total of funds appropriated or allocated for the purposes of subsection (a) of this section shall be granted for air pollution control programs in any one State. In the case of a grant for a program in an area crossing State boundaries, the Secretary shall determine the portion of such grant that is chargeable to the percentage limitation under this subsection for each State into which such area extends."

Passed the Senate July 12, 1966.

Attest:

EMERY L. FRAZIER,
Secretary.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
Washington, D.C., September 27, 1966.

Hon. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This letter is in response to your request for a report on H.R. 13199, "To amend the Clean Air Act so as to authorize grants to air pollution control agencies for maintenance of air pollution control programs in addition to present authority for grants to develop, establish, or improve such programs; make the use of appropriations under the Act more flexible by consolidating the appropriation authorizations under the Act and deleting the provision limiting the total of grants for support of air pollution control programs to 20 per centum of the total appropriation for any year; extend the duration of the programs authorized by the Act; and for other purposes." The bill would carry the short title "Clean Air Act Amendments of 1966".

This report is also addressed to a similar companion bill, S. 3112, which (as amended in the Senate) is pending before your Committee.

These bills are intended to carry out proposals announced by the President in his Message of February 23, 1966, on Preserving Our Natural Heritage.

We strongly recommend the enactment of this legislation. For the reason stated below, we recommend that this be done in the version passed by the Senate, with one additional amendment.

(1) *Consolidation, extension, and increase of appropriation authorization.*—The Clean Air Act now authorizes appropriations, except for title II, only through the current fiscal year (1967) for which it authorizes \$35 million; for carrying out title II relating to control of air pollution from motor vehicles, enacted last year, it authorizes appropriations through fiscal year 1969 for which \$1,470,000 is authorized. H.R. 13199 is designed to amend section 306 of the Clean Air Act to consolidate the appropriation authorizations for the entire Act and extend them through fiscal year 1972. To this end, the bill would authorize for such purposes appropriations of \$46 million for the fiscal year 1967 and such sums as may be necessary for each of the five succeeding fiscal years. Through inadvertence, the repeal of the separate authorizations (in § 209 of the Act) was omitted from the House bill; the omission is supplied in the Senate version. In the Senate passed bill, the appropriation authorization has been amended to extend only through fiscal year 1969, and the Senate bill authorizes \$70,000,000 for fiscal year 1968 and \$80,000,000 for fiscal year 1969 in place of open-end authorizations.

The figures contained in the Senate bill are based on estimates furnished by this Department at the request of the Public Works Committee. However, neither the estimates underlying the appropriation ceiling in § 306 of the present Act nor the estimates furnished to the Senate Committee in connection with S. 3112 include any amounts for construction (and initial equipment) of facilities for which authority was conferred on us by section 103(d) of the Act enacted last year, nor would the inclusion of this item in annual appropriation ceilings be a suitable approach. We therefore recommend that the following sentence be added at the end of the proposed revision of § 306 of the Act: "The foregoing limitations shall be exclusive of such sums as may be required for construction (including initial equipment) of facilities pursuant to section 103(d)."

As a by-product of industrialization and urbanization, air pollution continues to be a widespread and growing hazard to the health and welfare of the United States. Although important progress has been made in the brief period since enactment of the Act in 1963, a sustained and accelerated effort is needed if the promise of that Act to prevent and control air pollution is to be fulfilled. We therefore urge favorable consideration of the proposed extension and consolidation of, and increase in, appropriation authorization, with the modification as to construction above recommended.

In our judgment, such consolidation is highly desirable in order to insure that the administration of the regulatory program to control pollution from motor vehicles, required under title II of the Act, will not be impaired by circumstances that could not be anticipated nor provided for under the present separate authorization. If activities under title II were provided for in the same authorization as other program activities, any unexpected increase or decrease in cost might be absorbed by appropriate program adjustments. Such flexibility is of considerable importance, especially because title II of the Clean Air Act prohibits the sale of motor vehicles not in conformance with applicable regulations and the industry will of necessity, in order to protect itself, need a certificate of conformity from the Secretary with respect to a representative test vehicle before marketing vehicles of that class; an undue delay on our part in testing vehicles for conformance, caused by lack of leeway to adjust funds, would work an intolerable hardship and dislocation upon the automobile industry and the economy generally.

Another example which points out the need for consolidation of appropriation authority to achieve flexibility arises from the action of Congress during its consideration last year of the title II legislation. A provision was added in Committee whereby the Secretary, upon application from a motor vehicle manufacturer, is required to issue a certificate of compliance, applicable to a production run, if after appropriate tests a new vehicle is found to meet the prescribed standards. But our cost estimates were furnished to the Committee before this provision was added, yet no corresponding change was made in the title II appropriation authorization to reflect the added cost of vehicle or engine testing which would be required under this provision. Consolidation of appropriation authorization would permit such problems to be dealt with administratively within the scope of the whole Act.

(2) *Grants for maintenance of air pollution control programs.*—The bills would amend § 104(a) of the Clean Air Act to add—to the present authority for grants to develop, establish, or improve air pollution control programs—an authorization for the Secretary to make grants to air pollution control agencies in an amount up to one-half of the cost of *maintaining* programs for the prevention and control of air pollution, and to make grants to intermunicipal or interstate air pollution control agencies in an amount up to three-fifths of the cost of maintaining regional air pollution control programs. (The U.S. Code citation for § 104 of the Act should be 42 U.S.C. 1857c(a), as in the Senate bill, rather than 33 U.S.C. 1857c(a).) The bills would also change section 104(a) of the Act to remove the limitation that no more than 20 percent of the sums appropriated annually under the Act may be used to make grants under that section. The bills would also provide technical amendments to section 104(b) of the Clean Air Act for clarification purposes. The Senate bill (as passed by the Senate) would in addition amend section 104(b) by providing that in order to maintain eligibility for grants an agency need no longer meet its *total* level of expenditures of non-Federal funds for the prior fiscal year for air pollution control; the agency would only have to match its level of *recurrent* expenditures.

Additionally, both bills would amend section 104(c) of the Clean Air Act to provide that in the case of a grant for a program in an area crossing State boundaries, the Secretary would determine the portion of such grant that is chargeable to the 12½ percent limitation imposed by the Act for air pollution control program grants in any one State.

Section 104 of the Act at present authorizes grants to air pollution control agencies only in support of the cost of developing, establishing, or improving programs for the prevention and control of air pollution. This approach authorizes a Federal role limited to providing an initial stimulation of program improvement and subsequent withdrawal of support on the assumption or hope that non-Federal funds will be available to substitute for the Federal share. We believe that this limited role is not adequate for dealing with the problem nationally, nor appropriate for full implementation of the declared Federal

policy. In enacting the Clean Air Act, the Congress established this policy through its finding, as contained in section 101, "that the prevention and control of air pollution at its source is the primary responsibility of States and local government; and . . . that Federal financial assistance and leadership is essential for the development of cooperative Federal, State, regional, and local programs to prevent and control air pollution". The maintenance and continuation of expanded efforts by State and local air pollution control agencies will require in the future not only stimulatory grant assistance but sustaining grants as well. Sustaining grants, as proposed by these bills, will more adequately reflect the strong Federal interest and responsibility in air pollution control and should significantly improve the effectiveness of programs in giving impetus to greater State and local action.

The above-mentioned modification, contained in the Senate bill, of the maintenance-of-effort requirement of § 104(b) of the Clean Air Act—which would apply to both the new maintenance grants and the establishment and improvement grants under existing law—is substantially as suggested by us in testimony before the Senate Committee. The present law (the third sentence of § 104(b)) provides that no agency may receive a grant during any fiscal year if its expenditures of non-Federal funds for air pollution programs will be less than such expenditures in the preceding fiscal year. Over a period of years, many factors may justifiably cause the level of expenditures necessary to maintain an effective program to fluctuate, such as, for example, non-recurring costs of equipment or facilities acquisition, or the conduct of special studies concerning air quality, special types of sources, or other matters. S. 3112 was therefore amended to modify § 104 of the Act by excluding non-recurring expenditures from the requirement of matching the prior year's expenditures. This is practical. Where the overall workability of the program is not impaired, fluctuations in expenditures resulting from changes in non-recurring costs should not make agencies ineligible for Federal Matching grant support.

The bills, as above stated, would also amend section 104 of the Clean Air Act to delete the provision limiting the total for grants in support of air pollution control programs to 20 percent of the total appropriation under the Act for any year. The existing limitation is undesirable, we believe, in imposing a fixed relationship between such grant funds and the total appropriations for all Federal air pollution activities. Air pollution and the possibilities for control action are subject to rapid change. Over a period of time, the pattern of needs and desirable program balance with respect to research, technical assistance, training, Federal abatement activities, grants to State and local control agencies, and other activities may vary considerably. We therefore believe it would be wise to leave the determination of the relative emphasis to be given to each of these activities to judgments based upon overall requirements existing at any given time.

In conclusion, for the reasons stated above, we urge the prompt enactment of this legislation, with the improvements and corrections contained in the Senate-passed version and the additional amendment (relating to construction and initial equipment) above recommended.

We are advised by the Bureau of the Budget that the enactment of legislation as above proposed would be in accord with the program of the President.

Sincerely,

JOHN W. GARDNER,
Secretary.

DEPARTMENT OF THE INTERIOR,
Washington, D.C., September 27, 1966.

HON. HARLEY O. STAGGERS,
*Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives,
Washington, D.C.*

DEAR MR. STAGGERS: Your Committee has requested this Department's report on H.R. 13199, a bill "To amend the Clean Air Act so as to authorize grants to air pollution control agencies for maintenance of air pollution control programs in addition to present authority for grants to develop, establish, or improve such programs; make the use of appropriations under the Act more flexible by consolidating the appropriation authorizations under the Act and deleting the provision limiting the total of grants for support of air pollution control programs to 20 per centum of the total appropriation for any year; extend the duration of the programs authorized by the Act; and for other purposes."

The bill is intended to extend and increase the appropriation authorization for title I of the Clean Air Act, as amended. It extends the program to June 30, 1973, and authorizes an annual appropriation of \$46 million for the fiscal years beginning June 30, 1967, through June 30, 1973. It also removes the percentage limitation on the amount of appropriations available for grants for air pollution control programs.

This program is administered by the Department of Health, Education, and Welfare, and we defer to its views.

The Bureau of the Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely yours,

CHARLES F. LUCE,
Acting Secretary of the Interior.

BUREAU OF THE BUDGET,
Washington, D.C., September 27, 1966.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce, House of Representatives, Rayburn House Office Building, Washington, D.C.

DEAR MR. CHAIRMAN: Your letter of March 7, 1966, requested the views of the Bureau of the Budget on H.R. 13199, "To amend the Clean Air Act so as to authorize grants to air pollution control agencies for maintenance of air pollution control programs in addition to present authority for grants to develop, establish, or improve such programs; make the use of appropriations under the Act more flexible by consolidating the appropriation authorizations under the Act and deleting the provision limiting the total of grants for support of air pollution control programs to 20 per centum of the total appropriation for any year; extend the duration of the programs authorized by the Act; and for other purposes."

This bill carries out proposals contained in the President's Message of February 23, 1966, "Preserving Our Natural Heritage." We are therefore in full accord with the intent of the legislation. However, for the technical reasons outlined in the report of the Department of Health, Education, and Welfare on H.R. 13199 and S. 3112, we prefer enactment of the Senate version of the bill (S. 3112) with the amendment noted in the report of the Department of Health, Education, and Welfare.

The HEW amendment concerns the need to provide for the construction of facilities within the authorization ceilings proposed in the Senate version of the bill. HEW has suggested language to deal with this matter. We would suggest that the Committee consider as a possible alternative to the HEW language the language contained in section 2 of H.R. 13199 authorizing "such sums as may be necessary."

Subject to the above comment, we favor the enactment of the Senate version of H.R. 13199 (S. 3112) as being part of the President's legislative program.

Sincerely yours,

WILFRED H. ROMMEL,
Assistant Director for Legislative Reference.

FEDERAL POWER COMMISSION,
Washington, D.C., August 26, 1966.

HON. HARLEY O. STAGGERS,
Chairman, Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: In response to your request of March 7, 1966, we enclose three copies of the report of the Federal Power Commission on the subject bill, H.R. 13199.

We contemplate release of this report by the Commission to the public within three working days from the date of this letter unless there is a request that its release be withheld.

The Bureau of the Budget advises us that there would be no objection to the presentation of this report from the standpoint of the program of the President.

Sincerely,

LEE C. WHITE, *Chairman.*

FEDERAL POWER COMMISSION REPORT ON H.R. 13199

The proposed amendments in this bill, which relate principally to the authorization and financing of Federal grants, would extend the duration of the air pollution control programs under the Clean Air Act (42 U.S.C. 1857-1857I) until July 1, 1973; authorize grants for maintenance as well as development, establishment or improvement of such programs; and make the use of appropriations for direct research and abatement activities under the Act more flexible by consolidating the appropriation authorizations, increased to \$46,000,000 for fiscal 1966-1967, and by deleting the provision which limited the total of grants for the support of air pollution control programs to 20% of the total appropriation for any year.

The Congressional concern for control of air pollution is manifested in ways which affect the electric utility industry by the Clean Air Act of 1963; the Clean Air Act Amendments of 1965; and the further amendments now pending to expand the existing program. The Act now provides federal grants to technical and financial assistance to state and local agencies to help them develop air pollution control and prevention programs. Thus Congress is encouraging local regulation of stack emissions and other pollution sources. It is now proposed also to provide grants toward maintenance of these regulatory programs once initiated. The Clean Air Act also provides for federal regulation of automotive pollutants and for federal contribution for research and development.

The Federal Power Commission does not administer research programs or pollution control and abatement programs under the Clean Air Act, nor is it responsible for any grants or financial assistance programs thereunder. This Commission's interest in air pollution problems stems from the use of fossil fuels in the generation of electric energy. The Commission's National Power Survey Report, issued in 1964, gives prominent recognition to the problems of air and water pollution and their significance in relation to the design, location, and operation of large thermal-electric plants and the report points up the possibilities for combatting air pollution through mine-mouth generation and greater interconnection of utility systems. The air pollution issue has been presented to us in a number of gas certificate matters under the Natural Gas Act involving boiler fuel uses of gas in metropolitan areas. Increasing use of large nuclear plants for baseloading also will alleviate air pollution in many areas. Unlike plants operated with fossil fuels, nuclear plants do not emit organic wastes or carbon dioxide.

Because it is more difficult to control emissions from multiple sources like automobiles than to control single sources like power plants, the possibility of electric-powered cars is of particular interest to air pollution officials, as well as the electric power industry. The automobile is the chief source of the air pollution problems plaguing a number of large metropolitan areas. Some engineering research has been going on with respect to such matters as the amount, character and control of automotive exhaust and crankcase emissions, but with less than complete success, so far as we are able to determine. We believe that a balanced research program will continue to devote funds to such conventional research.

In order to maintain a balanced research program with respect to auto exhaust emissions, substantial funds should be provided for research and development of cleaner burning fuels, and reduction or elimination of pollutants emitted from conventional internal combustion engines. We believe such research will have an immediate as well as significant long-term effect on the air pollution problem without producing the corresponding adverse financial impact on state and federal tax revenues.

Electric-powered automobiles, however, are a new way of attacking the air pollution problem and if successful, could contribute greatly to its solution. Although there has been a revival of interest and some progress in vehicles of this type in recent years, some important technological breakthroughs are still required before they can compete successfully with the gasoline-powered automobile. Presently available battery-operated vehicles have a maximum range of approximately 75 miles between charges. If such cars can be produced and operated at sufficiently low cost and the range limitation overcome, they might achieve considerable popularity as the second or third car in a household, to be used for relatively short errands. Much progress remains to be made in this field, as well as in the development of the fuel cell as a practical and economical source of power for this purpose. (See Report of the Surgeon

General, "Motor Vehicles, Air Pollution, and Health," H. Doc. No. 489, 87th Cong., 2d Sess., p. 29.)

The Federal air pollution program offers great opportunity for the electric utility industry, particularly in the research sphere. In commenting last year to the Senate Public Works Committee on the Clean Air Amendment bill (S. 306, 89th Cong.), the Federal Power Commission urged that Federal air pollution control research be directed in part to revolutionary advancements, such as rechargeable batteries for motor vehicles and electrified mass transportation, to handle at least part of the traffic now driven by internal combustion engines. The Commission noted that energy conversions in modern electric power plants are far more efficient than those in internal combustion auto engines, so that the total pollutant potential would decrease, and the combustion refuse would be concentrated where it could be better controlled. The batteries would normally be charged during the night, when power system loads are at a minimum, thus further improving the efficiencies of the electric power system operations. The Commission recognized the electric battery research support by Edison Electric Institute, but concluded that the present scale of the effort is not likely to result in rapid progress. Since enactment of the 1965 Clean Air Amendment (P.L. 89-272, 79 Stat. 992), the Administration has proposed a modest initial appropriation for 1967 to the Department of Health, Education and Welfare of one hundred thousand dollars for planning research to explore alternatives to the internal combustion gasoline engine, particularly in the area of fuel cells and battery-operated vehicles. See the President's 1967 Budget Message (H. Doc. No. 335), Vol. 112 *Cong. Rec.* (January 24, 1966), p. 857, 862; House Appropriations Subcommittee Hearings, 89th Cong., 2d Sess., Part 3, pp. 559-560. We strongly urge that any further plans for undertaking and financing air pollution research programs provide for intensified research and development of rechargeable storage batteries and fuel cells suitable for widespread use in motor vehicles as an appropriate measure for aiding in the solution of the acute automotive air pollution problems now confronting our large metropolitan areas. More active Federal support and leadership in this important field, in our opinion, would tend to stimulate non-governmental research efforts and give added incentive to the industries concerned to carry forward developmental work along these lines.

While the Commission recognizes the importance of appropriate measures to further air pollution control, we offer no comments on the merits of the amendments proposed in H.R. 13199 and their fiscal aspects, except to suggest that serious consideration be given to the adequacy of authorizations for research and development of electrified mass transportation media and of rechargeable storage batteries and fuel cells for motor vehicular use, in addition to the funding of traditional air pollution research areas.

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, D.C., April 5, 1966.

HON. HARLEY O. STAGGERS,
*Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.*

DEAR MR. CHAIRMAN: This is in reference to your letter of March 7, 1966, requesting our comments on H.R. 13199, a bill to amend the Clean Air Act.

We have no special information concerning the subject matter of the bill and therefore have no recommendations as to the merits of the proposal.

It is noted that section 3(a)(1) of the bill has an erroneous citation. The reference to "33 U.S.C. 1857c(a)" should be "42 U.S.C. 1857c(a)."

Sincerely yours,

FRANK H. WEITZEL,
Assistant Comptroller General of the United States.

GENERAL SERVICES ADMINISTRATION,
Washington, D.C., April 16, 1966.

HON. HARLEY O. STAGGERS,
*Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: Your letter of March 7, 1966, requested such comments as the General Services Administration may desire to make on H.R. 13199, 89th

Congress, a bill "To amend the Clean Air Act so as to authorize grants to air pollution control agencies for maintenance of air pollution control programs in addition to present authority for grants to develop, establish, or improve such programs; make the use of appropriations under the Act more flexible by consolidating the appropriation authorizations under the Act and deleting the provision limiting the total of grants for support of air pollution control programs to 20 per centum of the total appropriation for any year; extend the duration of the programs authorized by the Act; and for other purposes."

The purpose of the bill is stated in the title.

Inasmuch as the proposed legislation would not affect the functions and responsibilities of GSA, we have no comment to make as to the desirability of the enactment of H.R. 13199.

The Bureau of the Budget has advised that, from the standpoint of the Administration's program, there is no objection to the submission of this report to your Committee.

Sincerely yours,

LAWSON B. KNOTT, Jr.,
Administrator.

Mr. JARMAN. The first witness this morning is our colleague from Michigan, Hon. Weston E. Vivian. Mr. Vivian, we will be glad to hear you at this time.

STATEMENT OF HON. WESTON E. VIVIAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MICHIGAN

Mr. VIVIAN. Mr. Chairman, I am very interested in H.R. 17101, a bill which will strengthen and continue the effort for a cleaner atmosphere. As I believe you are aware, I have submitted bill H.R. 16368, a companion bill. I appreciate the opportunity to testify this morning and I urge the approval of this legislation. Before I begin, let me commend the pioneering work of your committee on abatement of air pollution, especially the constructive way in which you have fostered the program already under way under Public Law 84-159.

Several months ago, the Subcommittee on Science, Research, and Development, of which I am a member, of the Committee on Science and Astronautics, initiated a series of hearings to determine the adequacy of current technology for pollution abatement. A report is being prepared which will detail our findings, but I want to bring to your consideration at this time several personal observations from these hearings which should be of interest in connection with H.R. 17101.

At least three critical problems deserving increased attention were evident in our brief review of air pollution.

First, we heard that even if we adopt and put into full use the most advanced methods of eliminating pollutants from the exhaust gases of internal combustion engines, nevertheless, by 1980, we will still suffer from a smog level equal to today's level in our most troubled cities. The automobile "population explosion" will be great enough to simply wipe out the gains made in each individual car.

We must begin now to develop an alternative means of propulsion for personal transportation devices. Fuel cells, novel gas turbines, and batteries all offer promise.

Second, the enormous quantities of sulfur oxides emitted from the stacks of fossil fuel powerplants constitute a continuing threat in many urban areas. When mixed in stagnant air with dispersed dust particles, sulfur dioxide can hasten the death of the ill, the weak and

the old, and bring breathing discomfort to many others. The Donora, Pa. and London, England disasters remind us of the grave, potential hazard posed. Because our supplies of low sulfur content coals are small and costly to mine, and because our demand for fossil fuels rises year by year, it is essential that we find ways either to remove sulfur from the available fuels, or to remove the sulfur oxides from the stack gases. Every gas cleaning process tried so far has been quite costly. More research should be stimulated. Furthermore, our local, State, and National agencies need more definite information on what maximum concentration of sulfur dioxide is allowable in air in populous areas, so that meaningful air quality standards can be set to guide enforcement actions.

Finally, year by year, the carbon dioxide content of the earth's atmosphere appears to have increased, even though slightly, as we have increased combustion of carbon fuels worldwide. Is this continuing increase of consequence? A number of competent scientists believe that the "greenhouse" atmosphere warming effect supposedly produced by the increasing carbon dioxide content is very alarming. Are they right? What are the remedies? Immediate worldwide conversion to nuclear power? What hazards does that pose? Decisions in this field of enormous consequence may face the coming generation. Let us help them by accumulating the facts now that will be needed for any competent decisions.

Mr. Chairman, a number of other areas of needed research in air pollution were uncovered in our review, and I am sure your careful questioning of expert witnesses may have revealed many more. It appears to be sad, but true, that our great urban areas may never again have really clean air. But with your efforts they can at least look forward to no further worsening of the situation, and hopefully, at least somewhat, cleaner air. Without further and timely research on this question, however, the days of the future may be literally, as well as figuratively, dark indeed.

Mr. JARMAN. Are there any questions? If not, we thank you for your appearance, Mr. Vivian.

Mr. VIVIAN. Thank you, Mr. Chairman.

Mr. JARMAN. Our next witness will be Mr. Gerald H. Kops, supervisor, Milwaukee County Courthouse.

STATEMENT OF GERALD H. KOPS, SECOND VICE CHAIRMAN, MILWAUKEE COUNTY BOARD OF SUPERVISORS; AND FRED R. REHM, DEPUTY DIRECTOR, DEPARTMENT OF AIR POLLUTION CONTROL, COUNTY OF MILWAUKEE, WIS.

Mr. KOPS. Mr. Chairman and members of the committee, my name is Gerald H. Kops, and I am second vice chairman of the Milwaukee County Board of Supervisors, and chairman of the legislative committee of that board.

I wish to thank you for the opportunity to appear at your hearing today and I would like to introduce you to Mr. Fred R. Rehm, the deputy director of Milwaukee County's Department of Air Pollution Control and our technical expert in the matters of air pollution.

Mr. Rehm is a graduate, registered professional chemical engineer who has published many technical articles in this field. Mr. Rehm

has held chairmanships of numerous committees of the Air Pollution Control Association, the American Society of Mechanical Engineers, the American Public Works Association and many other technical societies.

At the present time, he serves as an incineration consultant to the National Academy of Sciences and as a radiological consultant to the Department of Defense for whom he has directed various fallout projects at five of the Nexada atomic test series.

He has been asked by the U.S. Public Health Service to appear on the program of the 1966 National Air Pollution Conference in Washington in December. Mr. Rehm will present a statement representing the views of the Milwaukee County Board of Supervisors concerning bill H.R. 13199.

Thank you very much, Mr. Rehm.

Mr. REHM. Mr. Chairman and members of the committee, my name is Fred R. Rehm, and I am deputy director of Milwaukee County's Department of Air Pollution Control. I wish to thank the committee for the opportunity to appear here today and to present the views of the Milwaukee County Board of Supervisors with regard to H.R. 13199—the 1966 Amendments to the Clean Air Act.

Milwaukee County initiated one of the first countywide, or regional, air pollution control programs in this country in June 1948. A full-time, well-staffed, air pollution control program has been underway in this community since that time.

You will note that Milwaukee County, therefore, preceded the Federal Government into the air pollution control field by 7 years and that we preceded even much troubled Los Angeles County in this effort.

A city of Milwaukee smoke and air pollution control program had been in effect in this area since 1904, and was one of the first such programs in any major city of this country. I would be remiss if I did not point out that Milwaukee County has taken significant steps and has made considerable progress in its program to clean the air of this community. We have operated a well-equipped laboratory for 16 years and are one of the pioneer air pollution control agencies in the measurement of air pollution emissions at the source—the effective and logical point for controls.

We have devoted full-time, effective attention to our multitude of stationary sources of air pollution and have also devoted due attention to our motive power sources (autos, trucks, buses, trains) and to the many marine sources that are frequent visitors to our excellent port facilities.

It is not my intention to take this committee's valuable time to detail for you the progress in Milwaukee County's active air pollution control program. To do so would be an affront on this committee; however, the above brief account of this background will be helpful to you to understand our present position with respect to H.R. 13199.

By the same token that we admit to considerable progress in our efforts to date, we are the first to admit that a great deal more must be done to cope with this rapidly evolving field as man is compelled to learn to live with, and to control, his ever-increasing aerial wastes.

To this end, the Milwaukee County Board of Supervisors at its meeting of September 15, 1966, unanimously approved a 10-point 5-year plan and objectives for its air pollution control program which

when implemented will continue Milwaukee County in the forefront of those major cities seeking and finding workable solutions to this growing problem.

With the support of Milwaukee County, the State of Wisconsin was one of the first States in the Nation to enact favorable income and property tax concessions for the installation of air pollution control facilities. Such legislation has been in effect since 1953 and was again modified to be effective August 1, 1966, to provide the most liberal tax considerations for air pollution control facilities in the Nation.

I will not burden this committee with details of our 5-year plan and objectives, nor of the newest Wisconsin tax benefits. Instead, I have appended a copy of both of the documents detailing these two items to my prepared statement for inclusion in the record, if the committee so chooses.

Mr. JARMAN. They will be received.
(The information referred to follows:)

COUNTY OF MILWAUKEE DEPARTMENT OF AIR POLLUTION CONTROL TENTATIVE
5-YEAR PLAN AND OBJECTIVES

1. CONDUCT AN AIR QUALITY MONITORING AND ASSESSMENT PROGRAM

In November, 1965 an application was filed for a Federal grant under the Clean Air Act (Public Law 88-206) to conduct an air quality monitoring program. In this project, a comprehensive study is planned to assess the extent and trends of the *gas and suspended particulate matter phase* of the air pollution problem of this community. Twenty-four-hour-per-day, seven-day-a-week studies will be made of the concentration of some of the more serious air pollutants—SO₂, NO₂, O₃, HC, CO, and suspended particulates—at 5 or 6 different locations over a two- to three-year period. As a result of the initial study, this project may lead the Department to—

(a) An extension of the continuous monitoring program for a number of years for any one, or more, of the above pollutants where concentrations of these pollutants are measured that approach a serious level.

(b) The initiation of a source emission inventory of any one, or more, of these pollutants found to exist in concentration levels considered to be approaching serious proportions.

(c) Establish the effect on pollutant concentrations of local meteorological and topographical conditions—for example, the effect of Lake Michigan's on-shore and off-shore breezes on pollution buildup, the effect of southerly winds bringing Chicago area pollution to add to our own emission sources, etc.

(d) Make recommendations for legislation to establish source emission limitations for any, or all, pollutants reaching serious concentration levels.

Status

1. We have been notified that we will shortly receive an approval Certificate from the U.S. Public Health Service that we have qualified for the U.S. grant and that we can proceed as per our project application by advancing local funds until U.S. funding is received (\$12,978 for each of three years). Preliminary work on this project has been initiated.

Needed to implement

1. It is becoming increasingly evident that the Department will need the services of a skilled equipment and laboratory technician to service, maintain and operate the growing amount of scientific equipment acquired by the Department to operate effectively and efficiently in this field. To ignore this need will mean the dilution and diversion of our limited professional, technical resources from the important stack testing program. Such a need will probably be more definitely established after the first year of study under this grant. It is believed that the U.S. funds can be diverted to cover three-fourths the cost of this new position under our grant. This man will be used in data analysis and evaluation of the monitoring study and in the upkeep and servicing of the

\$22,000 of electronic laboratory and field test equipment the Department *presently* has on hand and the approximately \$8,000 of new equipment that will be acquired under this project. Estimated cost—\$9,500/year.

2. ESTABLISH A CONTINUING TRAINING AND PUBLIC INFORMATION PROGRAM

The Department has been delegated the responsibility by law to—

Publish and disseminate information on air pollution reduction and control and to enlist the cooperation of civic, technical, scientific and educational societies.

With the growing public awareness and the rapid technological developments in the air pollution field, there is a rapidly developing need for the Department to establish an organized training and public information program. The need exists at present for the Department to—

(a) Organize, develop, and conduct technical training courses for the following categories of people:

- (1) Industrial Plant Engineers.
- (2) Architects and Consultants.
- (3) Heating, Sheet Metal and Ventilation Contractors.
- (4) Operating Engineers and Firemen.
- (5) Incinerator Contractors.
- (6) Inservice Training for Department Inspectors.

(b) Publish periodically a news or information piece aimed at the general public to acquaint them with the Department's efforts, programs and developments in this field.

(c) Augment and expand the publication of its technical reports on specific air pollution problems and solutions.

(d) Assist in fulfilling the increasing number of requests for public, civic and technical society speaking engagements.

Needed to implement

1. The need for a technically oriented training and public information man has been established to carry out all four of these functions. A position having these duties and responsibilities should be sought immediately.

Estimated Cost—\$9,000/year.

3. CONTINUE THE DEVELOPMENT AND ENACTMENT OF COMPREHENSIVE RULES AND REGULATIONS GOVERNING NEW NONCOMBUSTION PROCESS INSTALLATIONS

The Advisory Board, aided by the Department's staff, has undertaken the development of comprehensive Rules and Regulations governing all *New Installations* capable of adding air pollutants to the community's atmosphere. Upon development of proposed Rules and Regulations, the Advisory Board has assisted the Department in seeking favorable action by the County Board on its recommendations. To date, comprehensive Rules and Regulations and Permitting programs to have been adopted for New Combustion Process and Incinerator Installations. The following general areas require similar treatment, it is felt, and in this approximate order of importance relative to the contribution of these processes to the community's air pollution:

- (a) Metallurgical Processes.
- (b) Construction Industry Processes.
- (c) Driers, Kilns, Oven Processes.
- (d) Organic Solvent Processes.
- (e) Grain Processes.

Status

1. Rules and Regulations and Permitting programs have been established and adopted for New Combustion and Incinerator Installations within the past 1½ years and 6 months, respectively. No new staff was added to implement these programs.

2. The research, industry contact, development, writing and legislative guidance in the realization of the earlier programs have largely been as the almost exclusive effort of the Department's Deputy Director. It is expected that this same employee will carry the basic work load in all future efforts to establish a sound and reasonable technical legislative program in the remaining fields. It is expected that the time table involved here to completely establish a Permitting program covering all of these new process installations will extend beyond a

5-year period under the current method of approach because of the extensive time demands involved in developing such a comprehensive Legislative program which then in each case must be implemented by the establishment of a working Permitting and Inspection Program. The implementation of this program will require a second source test team consisting of a Test Engineer and Test Engineering Aide. Even as of now, the present single source test team is falling badly behind as they are being diverted to other assignments (general air quality monitoring, specific area studies, augmenting the incineration permitting program, etc.).

Needed to implement

1. There is a definite need established by the present permitting system (Combustion Process, Incinerators) for a Supervisory Inspector position to be established from a promotional examination from our Inspector specialist ranks. As soon as Rules and Regulations and a Permitting system are established in the Non-Combustion process field, the need for this position will be urgent. Estimated Cost—\$9,500/year.

2. A need is rapidly becoming evident for a second source test team as the Permitting program is expanded to the Non-Combustion process field. This will entail the addition of two men for this function (Test Engineer, Test Engineering Aide). Estimated Cost—\$15,000/year.

4. ESTABLISH A COUNTYWIDE LICENSING PROGRAM FOR HEATING AND VENTILATION CONTRACTORS, OPERATING ENGINEERS AND FIREMEN, AND INCINERATOR CONTRACTORS AND SUPPLIERS

At the request and initiation of the Heating, Ventilation and Sheet Metal Contractors, and their affiliated Labor organizations, legislation was enacted (which became effective in November, 1965) permitting Milwaukee County to license Heating and Air Conditioning Contractors. It is felt that such a program, if initiated, should logically be administered by this Department as it is currently in regular contact with this segment of our local industry in its present permitting program covering the combustion fields.

It is also felt that a County-wide licensing program covering Operating Engineers and Firemen is needed to strengthen the control of air pollution caused by operating personnel. At present, only a City of Milwaukee licensing program of these groups is in effect. Outside the City of Milwaukee, there are no uniform requirements for personnel operating heating and power equipment, all of which are potential sources of serious air pollution emissions.

Needed to implement

1. The development of a suitable Milwaukee County Ordinance under Statute Section 59.07 (89) Heating and Air Conditioning Contractors, should be undertaken and enacted to implement this program. The industry and labor groups involved have met with the Department and have indicated in informal talks that this Department (they feel) is the logical one to administer this program which is aimed at upgrading the industry, as well as the air pollution problem. Enactment of this legislation will require the addition of one man and secretarial help to administer this program. Estimated Cost—\$11,000/year.

2. State legislation and a County Ordinance will be required to permit Milwaukee County to establish a County-wide licensing program covering Operating Engineers and Firemen. Such a program should be patterned after, and be an extension of, the present successful City of Milwaukee program—but should cover all of Milwaukee County. The Labor organizations involved have unsuccessfully tried to establish a State-wide licensing program of these skills. A County-wide program would be an acceptable intermediate step to these groups, as well as providing an effective tool in the control of air pollution caused by irresponsible operation of equipment capable of emitting air pollutants. It is expected that the same employees handling the Heating and Ventilation Contractors licensing program could be utilized in the conduct of this program. The training and public information division would augment these efforts.

5. SEEK CLEARER AND EXPANDED LEGISLATIVE AUTHORITY IN THE ODOR CONTROL FIELD

At the present time, the Department's statutory authority in this field needs clarification and expansion to permit control actions in this important phase of the community's air pollution problem. Odor problems are becoming an in-

creasing factor in the total air pollution control problem and require attention initially at the legislative level.

6. EXPLORE THE POSSIBILITY FOR PROVIDING A REGIONAL AIR POLLUTION CONTROL PROGRAM THROUGH THE SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

It is becoming increasingly evident that a regional approach to air pollution control may be needed covering the counties abutting Milwaukee County, along with Milwaukee County. Since air pollutants do not respect political boundaries, and the concentrations are instead governed by natural air basins, it would appear proper to give some consideration and planning to a Regional approach to its control. Precedence for such approach has been established in other areas—such as San Francisco Bay Area where 5 or 6 counties have set up a single unified control program governing all units. Because of the present great urbanization trends in the former rural areas of contiguous counties, it will be necessary that they establish some form of air pollution control programs less our local effective efforts are negated by inattention to this problem by counties "upwind" of Milwaukee County.

Needed to implement

A possible approach to be considered in studying this proposal is—

Expansion of Milwaukee County's program to cover this air basin and urbanized areas. Such a study might best be made by the Southeastern Wisconsin Regional Planning Commission. This approach could be implemented by providing air pollution control services to municipalities in neighboring counties and communities by Milwaukee County on a contract basis.

To implement a program of this type, much study is needed, and Statutory authority will be required.

7. INITIATE A PROGRAM LEADING TO THE GRADUAL IMPROVEMENT OR ELIMINATION OF "FLUE-FED" INCINERATORS IN MULTISTORY BUILDINGS IN MILWAUKEE COUNTY

In their present state, most existing flue-fed incinerators are major contributors to air pollution (soot, char and odors) in the downtown, apartment house and commercial business districts of this and most large urban areas. Within the past year, the National Academy of Sciences (after a careful study of this problem) has recommended that this type of incinerator be prohibited in new construction unless it incorporates many air pollution control features—the principal feature being a wet scrubber unit. This same report suggests methods for upgrading existing units of this type—this also incorporates adding scrubbers prior to the discharge of these units to the atmosphere. The report also recommends discontinuance or abolishment of the operation of these units, if such improvements are not incorporated after a specified period of time depending on local considerations. These type installations, we know, are the principal sources of air pollution in the above-described districts. It is felt that the location and performance evaluation of all such units be initiated promptly by Department personnel and a "phasing out or upgrading" program be established in the hundreds, and possibly thousands, of such existing units being used in Milwaukee County.

Needed to implement

1. The initiation of a location and evaluation survey by Department personnel.
2. The development and enactment of suitable local legislation to deal with this problem.

It is felt that the legislation establishing time limits under such a program should await initiation and implementation of a County-wide Refuse Disposal Program. Additional personnel needs cannot be estimated at this time until details of such a program are developed.

8. COMMENCE A STRONG ENFORCEMENT PROGRAM AGAINST OPEN FIRE OR BARREL-TYPE BURNING OF GARBAGE, TREES, AND DEMOLITION MATERIAL IN MILWAUKEE COUNTY

Once a County-wide Refuse Disposal Program is implemented, it is planned to initiate a strong enforcement program aimed at the open fire and back-yard burning of garbage as is being practiced at present in large areas in certain sections of Milwaukee County. This practice is a major contributor to the community's air pollution problem. Also, it is intended that a strong enforce-

ment effort will be directed toward public and private burning of trees, brush and demolition debris. The County-wide Refuse Disposal Program will be designed to provide suitable facilities to burn these materials with little or no air pollution. Enforcement must await and follow the realization of these facilities.

9. REVIEW OF EXISTING EMISSION LIMITATIONS WITH RESPECT TO COMPATIBILITY WITH AVAILABLE TECHNOLOGY

A survey will show that Milwaukee County's air pollution emission limitations, while amended in 1962, are not compatible with technological advances in this field or to the technology of the emission source. These limitations should be reviewed thoroughly with the thought of making them commensurate with our growing needs and with the technology involved. The review should result in a study which will recommend to the County Board a feasible plan, and when adopted will properly reflect both the technological aspects of the emission source and the technological developments in the field of air pollution control.

10. A THOROUGH STUDY AND REVIEW OF THE DEPARTMENT'S ORGANIZATIONAL AND SALARY SCHEDULES SHOULD BE PERFORMED

It can be definitely demonstrated that salary schedules for all positions in this growing and important field have lagged far behind other areas in this country. This is particularly true at the higher echelons of the Departmental staffing. There is a national shortage of trained technical, administrative, supervisory and inspectional personnel in this rapidly evolving field. Salary schedules locally have not begun to keep pace with this worsening condition as more and more cities, counties, states and the Federal government initiate and expand their air pollution control activities. The increased governmental attention to this problem has caused industry to enter and seek top qualified personnel in this field to stay ahead and abreast of these governmental efforts. This has further contributed to the shortage of qualified engineer-administrators, scientists and technicians. A thorough re-evaluation of the Department's organization and salary schedule is in order to prevent loss of our top qualified people to other groups. At the top levels, salary schedules are as much as 50% to 70% higher in other communities as compared to present Milwaukee County levels.

WISCONSIN STATUTES PERTAINING TO PROPERTY TAXES, INCOME TAXES, AND AIR POLLUTION ABATEMENT INSTALLATIONS (EFFECTIVE AUGUST 1, 1966)

70.11 Property Exempted From Taxation. The property described in this section is exempted from general property taxes:

(21) Treatment Plant and Pollution Abatement Equipment; Lagoon Lands.

(a) All property purchased, constructed, installed and operated with the approval of the committee on water pollution, state board of health, a city council, a village board or county board pursuant to s. 59.07 (53) or (85) for the purpose of abating or eliminating pollution of the air, and all property purchased, constructed, installed and operated with the approval of the department of resource development for the purposes of abating or eliminating pollution of the waters of the state.

(b) A prerequisite to exemption under this subsection shall be the requirement of filing an annual calendar year operating statement on such pollution elimination or abatement property with the department of taxation on or before April 1 of each year.

(c) In computing operating costs, taxpayers that have elected amortization deduction under s. 71.04 (2b) shall claim such accelerated amortization as a deduction in the annual operating statement required to be filed under par. (b). Once a property, covered by this subsection, has been fully amortized or depreciated and amortized no further deduction shall be allowed under this subsection in the computation of gain or loss from operating such pollution abatement properties. No loss from operation in a previous year shall be allowed under this subsection as a carry-forward adjustment to the current year's operating statement required hereunder.

(d) The books and records of owners of property covered by this subsection shall be open to examination by representatives of the department of resource development, state board of health and department of taxation.

71.04 Deductions from Gross Income of Corporations. Every corporation, joint stock company or association shall be allowed to make from its gross income the following deductions:

(2b) In lieu of the allowance for depreciation for any taxable year or part thereof beginning after December 31, 1952, the owner may elect the write off of the balance not previously deducted in years prior to the 1966 calendar year or corresponding fiscal year for waste treatment plant and pollution abatement equipment purchased or constructed and installed pursuant to order or recommendation of the committee on water pollution, state board of health, city council, village board or county board pursuant to s. 59.07 (53) or (85) in the 1966 calendar year or corresponding fiscal year. Any waste treatment plant and pollution abatement equipment purchased or constructed and installed in the 1966 calendar year or corresponding fiscal year, or in a subsequent year, pursuant to order or recommendation of the committee on water pollution, department of resource development, state board of health, city council, village board or county board pursuant to s. 59.07 (53) or (85) may be deducted in the year of cash disbursement for same.

(a) Written notice of election to take amortization of any treatment plant and pollution abatement equipment under this subsection must be filed with the department of taxation on or before the filing date of the return for the first taxable year for which such election under this subsection is made in respect to such plant and equipment. Such notice shall be given on such forms and in such manner as the department of taxation may by rule prescribe.

(b) The taxpayer shall file with the department of taxation at the time of his election under this subsection copies of recommendations, orders and approvals issued by the department of resource development, state board of health, city council, village board or county board pursuant to s. 59.07 (53) or (85) in respect to such treatment plant and pollution abatement equipment, and such other documents and data relating thereto as the department by rule requires.

(c) No deduction shall be allowed under this subsection on other than depreciable property, except that where wastes are disposed of through a lagoon process such lagooning costs and the cost of land containing such lagoons shall be subject to the accelerated amortization provided for under this subsection.

(d) In no event shall accelerated amortization, or depreciation and accelerated amortization deductions be permitted in excess of the cost of the asset subject to the provisions of this subsection.

71.05 Modifications, Transitional Adjustments and Election of Deductions for Natural Persons and Fiduciaries.

(1) Modifications. (b) Subtract, to the extent included in federal taxable or adjusted gross income:

5. In lieu of the allowance for depreciation for any taxable year or part thereof beginning after December 31, 1952, the owner may elect the write off of the balance not previously deducted in years prior to the 1966 calendar year or corresponding fiscal year for waste treatment plant and pollution abatement equipment purchased or constructed and installed pursuant to order or recommendation of the committee on water pollution, state board of health, city council, village board or county board pursuant to s. 59.07 (53) or (85) in the 1966 calendar year or corresponding fiscal year. Any waste treatment plant and pollution abatement equipment purchased or constructed and installed in the 1966 calendar year or corresponding fiscal year, or in a subsequent year, pursuant to order or recommendation of the committee on water pollution, department of resource development, state board of health, city council, village board or county board pursuant to s. 59.07 (53) or (85) may be deducted in the year of cash disbursement for same.

(a) Written notice of election to take amortization of any treatment plant and pollution abatement equipment under this subdivision must be filed with the department of taxation on or before the filing date of the return for the first taxable year for which such election under this subdivision is made in respect to such plant and equipment. Such notice shall be given on such forms and in such manner as the department by rule prescribes.

(b) The taxpayer shall file with the department at the time of his election under this subdivision copies of recommendations, orders and approvals issued by the department of resource development, state board of health, city council,

village board or county board pursuant to s. 59.07 (53) or (85) in respect to such treatment plant and pollution abatement equipment, and such other documents and data relating thereto as the department by rule requires.

(c) No deduction shall be allowed under this subdivision on other than depreciable property, except that where wastes are disposed of through a lagoon process such lagooning costs and the cost of land containing such lagoons shall be subject to the accelerated amortization provided for under this subdivision.

(d) In no event shall accelerated amortization, or depreciation and accelerated amortization deductions be permitted in excess of the cost of the asset subject to this subdivision.

Mr. REHM. Milwaukee County welcomed the advent of the Federal Government into the field of air pollution in 1955. We have since witnessed the growth of the Federal air pollution program from the original areas of research and training to the present program which includes, in addition to the original areas, enforcement authority, the establishment of air quality criteria and the provision for making grants to State and local air pollution control agencies.

We have been in close touch with all areas of Federal activity both as they affect our local program and because of our demonstrated interest and concern in these matters. At the time of the enactment of Public Law 88-206, the Clean Air Act, we were in close touch with the congressional hearings on this proposed legislation.

In 1963, the Milwaukee County Board took a position supporting H.R. 6518, which was the principal House bill which formed the basis for the Clean Air Act. We were very pleased particularly with section 104—grants for support of air pollution control programs of H.R. 6518 which provided for grant support to establish and maintain programs for the prevention and control of air pollution.

You can imagine our dismay, then, when the conference committee report on the Clean Air Act adopted the amended Senate version of S. 432 as the basis for writing the final grant provisions of the Clean Air Act. In its present form, the Clean Air Act provides grant support only to develop, establish, or to improve air pollution control programs.

The Clean Air Act further provides that "No agency shall receive any grant under this section during any fiscal year when its expenditures of non-Federal funds for air pollution programs will be less than its expenditures were for such programs during the preceding fiscal year."

The net effect of the two eleventh hour changes to section 104 of Public Law 88-206 precluded Milwaukee County from receiving any substantial Federal grant support for its air pollution control program. Since Milwaukee County had acted in 1948 to establish an effective air pollution control program, its current level of activity precluded the need for any large-scale improvement in its program.

Similarly, it was true that the other 40 to 50 communities like Milwaukee County, that had developed advanced air pollution control programs prior to 1963 were precluded from benefitting to any extent from the Federal grant support program.

In effect, the Clean Air Act penalized those farsighted communities that had acted on their own initiative to deal with this problem to the advantage of those communities that had been laggard in this respect. Our Milwaukee County Board of Supervisors does not think that this is fair or proper, nor do they feel that this was the intent of the Congress.

The present Clean Air Act could actually promote the fragmentation of our countrywide air pollution control program by making our constituent municipalities eligible for virtual unlimited grant support to develop and establish air pollution control programs of their own, whereas limited grant support would be available to improve the more highly developed countywide program.

However, there appears to be no concerted effort in our community to do so at this time in view of the previous determination that this was a logical and desirable countywide function. Similarly, this is the case in other areas of the country where effective regional programs have been maintained.

This is in direct contradiction with the expressed intent of the Congress to encourage regional air pollution control efforts. It is our feeling, also, that an effective national air pollution control program at the State and local level, will require sustaining grants in addition to the stimulatory grant assistance provided by the Clean Air Act.

In H.R. 13199, we in Milwaukee County see constructive amendment of the Clean Air Act to overcome the major shortcomings and objections that we have detailed above. We also see in H.R. 13199, a progressive step forward in the Federal Government's program to develop cooperative Federal, State, regional, and local programs to prevent and control air pollution.

We would caution you, however, to seriously consider further amending section 104(b) of the Clean Air Act along the lines proposed in the statement of Mr. Vernon G. MacKenzie before the Special Subcommittee of Air and Water Pollution, U.S. Senate Committee on Public Works, on June 14, 1966.

In this statement, Mr. MacKenzie urged taking into consideration the local levels of nonrecurring costs of equipment or facilities acquisition and the conduct of special studies of air quality or specific types of air pollution sources in establishing the eligibility for Federal grant support.

We note that the U.S. Senate has taken cognizance of this recommendation in adopting an amended version of S. 3112 in July of this year. We feel that where the overall workability of the air pollution control program is not impaired, fluctuations in expenditures should not make agencies ineligible for Federal grant support.

On July 12, 1966, the Milwaukee County Board of Supervisors unanimously affirmed its support of H.R. 13199 and urges the enactment of this bill in an amended form that incorporates the recommendations of Mr. MacKenzie with regard to nonrecurring expenses. We are confident that this will prove to be a valuable step in meeting and dealing with the growing problem of community air pollution.

Thank you, Mr. Chairman.

Mr. JARMAN. Thank you, gentlemen, for being with us. The Chair will have just one question. With your full-time staffed air pollution control program in Milwaukee County, what amount of money goes into that program of yours?

Mr. REHM. We are budgeting at the rate of approximately \$200,000 a year, representing in the neighborhood of 20 cents per capita annually.

Mr. JARMAN. Is part of that Federal funds?

Mr. REHM. We have only received approximately \$13,000 of Federal grant support. It is because we are at the level of activity as I indi-

cated in our testimony that we have not been eligible for improvement support or we have not felt the need for additional improvement support.

Mr. JARMAN. So much of your activity and effort along this line goes back prior to the Federal entry?

Mr. REHM. Since we have been in it since 1948, we have accomplished a great deal and, therefore, the need is not as urgent as in other localities.

Mr. JARMAN. Thank you very much. Mr. O'Brien.

Mr. O'BRIEN. Is it your position that the way the law is now it tends to fragment the operations in this field; that it is an inducement to areas other than Milwaukee, for example, to reach out for this Federal money? Then they will do something that should be coordinated on a regional basis. Is that correct?

Mr. REHM. Yes, this is very possible and such a circumstance arose in the past year within our community.

Mr. O'BRIEN. You have only received \$13,000 in spite of the fact that you have been one of the foremost areas in this field?

Mr. REHM. This is all we have applied for, Congressman.

Mr. O'BRIEN. That is all you could apply for?

Mr. REHM. Reasonably, true.

Mr. O'BRIEN. I don't like to raise this point but it does seem to me in listening to your testimony that you feel that in a sense, the Senate is beginning to catch up with what the House wanted to do 3 years ago.

Mr. REHM. I think this is a very correct methods of stating our position.

Mr. O'BRIEN. We so seldom get top billing in Washington that I like to strain the point a little bit.

Mr. REHM. It is well taken, Congressman.

Mr. O'BRIEN. There is one other question I have here. Does the Senate bill this year dip into that question of maintenance which seems to be the core of your argument?

Mr. REHM. Yes, sir. We are in accord with the Senate adopted version in July.

Mr. O'BRIEN. Then in that particular area, if we were inclined to go along with the Senate, we would have no disagreement with you?

Mr. REHM. As you stated, this was your original contention and we will go along with you.

Mr. O'BRIEN. Thank you. I think that is a good point at which to quit, Mr. Chairman. I have no further questions.

Mr. JARMAN. Mr. Nelsen.

Mr. NELSEN. Thank you, Mr. Chairman. I think in your testimony you referred to the fact that in no case could a State cut back on its expenditures. If they qualify for Federal funds, they in turn would be expected to continue at the State level at the same level as they had previously done. You made some reference to that.

Mr. REHM. The present Clean Air Act has this requirement.

Mr. NELSEN. As I recall in the committee hearings, there was some fear expressed that if the Federal Government stepped into it that the State might back away from the activity as had been previously engaged in so that the net gain would be very little. We might step it up from national and they might cut back from State level, that that was the purpose.

Mr. REHM. I think in all good conscience in the adopted version satisfactory performance levels must be maintained and this will insure local participation at the State and local levels. I think this would overcome this particular objection. As stated in the amended and passed Senate version, I think this accomplishes this end.

In other words, we are not attempting to shift the cost of this totally to the Federal Government. As we have demonstrated in the past, we have all good intentions to maintain an active program in our area.

Mr. NELSEN. It seems to me that there is a wee bit of a tendency at the national level now to move more in the direction of making funds available to the various States in many programs and leaving more of the decision to the States as to where they think it can best be applied. There might be great merit to some flexibility in that direction.

Mr. REHM. We would welcome this and we see this developing attitude.

Mr. NELSEN. Thank you, Mr. Chairman.

Mr. JARMAN. Mr. Rogers.

Mr. ROGERS of Florida. Thank you, Mr. Chairman. What are your major pollution problems in your area, would you say?

Mr. REHM. Up to the last few years, Congressman, our problem has been principally particulate or solid in nature. It stemmed principally from solid discharges. We are seeing and are experiencing a growing awareness of the need to deal more thoroughly with the gas phase pollutants, the things of common interest that have come to the fore naturally, sulfur dioxides and oxides of nitrogen, hydrocarbons—the gas phase pollutants.

Up to this time, our attention has been particularly directed to particulates or solids.

Mr. NELSEN. Will the gentleman yield? A friend of mine recently painted his house white and woke up in the morning and it was green. Would this be a gas of some kind?

Mr. REHM. Yes; it was probably hydrogen sulfide depending on the state of the green.

Mr. NELSEN. Thank you.

Mr. ROGERS of Florida. Do you have any guidelines that you use now for industry in your area?

Mr. REHM. Yes; very much so. We have had emission limitations in effect since 1948 and in 1962, we revised and strengthened these emission limitations. We have as part of our statement a copy of a 5-year plan enacted earlier this month which will further strengthen these emission limitations.

Mr. ROGERS of Florida. Could you submit for the record your limitations so that we could see those? Could you furnish the committee that.

Mr. REHM. I would be happy to do so.

(For information requested, see p. 83.)

Mr. ROGERS of Florida. In other words, do you have a monitoring system?

Mr. REHM. We have maintained in Milwaukee County, because of our principal interest in solids, a 70-station monitoring program since 1951 on a monthly basis.

Mr. ROGERS of Florida. Give us some examples of the solids.

Mr. REHM. This is dust, soot fall, things of this type. This program has been maintained since 1951 at between 60 to 70 stations.

In addition to this, we measure the suspended particulate matter in the air. We filter out solids and measure the suspended particulate matter. One the one grant that we have applied for, we are awaiting receipt of equipment, now on order, to measure and do more extensive gas phase monitoring which would include sulfur dioxide, hydrocarbons, ozone nad oxides of nitrogen on a continuous around-the-clock basis.

Mr. ROGERS of Florida. When it reaches a certain level, this activates your regulation and what happens?

Mr. REHM. No; we have not felt the need for the type of thing that Los Angeles has done. Fortunately, we are located from a topographical and meteorological standpoint in such a manner that we have benefited from our Lake Michigan breezes and the concentrations of gas phase pollutions or the photochemical smog have not built up to the point at which we feel that we need an alerting type system as Los Angeles has felt the need for.

Instead, our activities have been directed to limiting particulate emissions principally dust, fly ash, soot, and these sort of things from all types of emission sources, incinerators, powerplants, asphalt plants, et cetera, the whole gamut of stationary sources.

Mr. ROGERS of Florida. Have you any schedule where you require suspension of operations at all?

Mr. REHM. No, sir.

Mr. ROGERS of Florida. You have not had to get into that?

Mr. REHM. Fortunately, no.

Mr. ROGERS of Florida. Simply control methods to reduce?

Mr. REHM. Right.

Mr. ROGERS of Florida. And has this been successful?

Mr. REHM. We feel very much so in the particulate phase. We have made considerable progress.

Mr. ROGERS of Florida. What has been your progress?

Mr. REHM. There has been approximately a 50-percent reduction in the rate of deposits of solids in our area since the beginning of our program despite the fact that we have had rapid evolution and growth in industry in our area.

Mr. ROGERS of Florida. Is this still too high?

Mr. REHM. It is too high in certain locations, yes. We intend and hope to further decrease these levels.

Mr. ROGERS of Florida. In what period of time? Within your 5-year period?

Mr. REHM. We have set forth hopefully that we can bring these levels down to more tolerable levels within the 5-year program.

Mr. ROGERS of Florida. On the gas pollution, how do you stand there or do you know yet because you have not gotten your monitor?

Mr. REHM. We have done spot checking over the years and have, therefore, felt that this problem must await the areas of more principal interest which has been particulates, and this evaluation of our gas phase pollution problem was such that we felt no great urgency in view of our limited staff, and so forth, to get into this.

Now, just since June, when we have been doing some monitoring in this area, we noted that within this month of September 1966, that in our downtown area of Milwaukee County that we measured oxidant levels that on four occasions approached the eye irritation level and this was a great shock to us, to me particularly inasmuch as I have

not been completely convinced that this was a problem, at least not in our area.

Mr. ROGERS of Florida. Do you attribute this mostly to automobile exhaust or to what?

Mr. REHM. I would say at this point, because of the location where we made these measurements, yes, largely automobile contributions to a photochemical smog problem.

Mr. ROGERS of Florida. What about coal burning or oil burning? What effect does this have or have you made a determination?

Mr. REHM. We have not been able to monitor the sulfur dioxide emissions to any great extent and I think this would be their principal contribution to pollution, since we have largely controlled the fly ash emission problem from such sources.

Mr. ROGERS of Florida. If you find that so what would you do, put a limitation on?

Mr. REHM. We have not crossed that bridge yet but with the present state of the art, the only effective means of control at the present time would be to limit the sulfur content of the fuel as no economic solution has been developed to remove sulfur from the exhaust products.

Mr. ROGERS of Florida. Are there any present guidelines that could be used in this?

Mr. REHM. Of course, I think the pioneering effort in this area at the present time is that which has been set by New York City most recently.

Mr. ROGERS of Florida. Thank you very much. Thank you, Mr. Chairman.

Mr. JARMAN. Mr. Rehm, Mr. Kops, we appreciate your being with us to help make our record on this important subject.

Mr. REHM. Thank you, Mr. Chairman.

Mr. KOPS. Thank you, Mr. Chairman.

Mr. JARMAN. Our next witness is Dr. Richard A. Prindle, Chief, Bureau of State Services, U.S. Department of Health, Education, and Welfare and Vernon G. MacKenzie, Assistant Surgeon, Chief, Division of Air Pollution. It is nice to have you with us.

STATEMENT OF DR. RICHARD A. PRINDLE, CHIEF, BUREAU OF STATE SERVICES, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Dr. PRINDLE. In the interest of your time, I would like to submit my statement and excerpt certain passages.

Mr. JARMAN. Thank you, sir.

(Dr. Prindle's statement follows:)

STATEMENT OF DR. RICHARD A. PRINDLE, CHIEF, BUREAU OF STATE SERVICES, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. Chairman and members of the subcommittee, I am pleased to have this opportunity to participate in these hearings on air pollution which will bear so significantly on the Nation's efforts to achieve a more healthful environment. No one who knows the history of our country can be unaware that we were very late in recognizing the need to preserve and protect the natural resources on which a wholesome human environment is so dependent. We have succeeded in creating the most technologically advanced and economically prosperous society in the history of mankind, and we have achieved unprecedented levels of agricultural and industrial productivity, but in accomplishing this, we indulged in what we

now regard as intolerable waste and destruction of our natural resources. There can be no doubt that we have derived immense benefit from our steadily increasing ability to alter the environment, but neither can there be any doubt that, through lack of foresight, we have also unnecessarily marred the face of our country.

It was not until late in the 19th Century that we began to see the vital connection between conservation of natural resources and protection of the public health and welfare. Moreover, our progress in understanding this relationship has been uneven. Our initial steps were concerned with the hazards inherent in some of the more flagrant abuses of our natural environment. There is now general agreement, for example, that, if we are to cut down many acres of forest each year, we must also plant new trees; that is, if we are to raise bumper crops on our farmland, we must also replenish the soil; and that, if we are to strip millions of tons of minerals from the surface of the earth, we must also heal the scars that such mining operations produce.

But in many other areas, and particularly with respect to contamination of such resources as air and water, we are only beginning to approach a full understanding of the connection between man's health and well-being and the quality of his environment. That we have been tardy in this area is not surprising, for environment contamination is generally a slow process, and some of the most important health and welfare hazards posed by such contamination are essentially subtle and insidious.

Our scientific knowledge and understanding of the ways in which we threaten ourselves by contaminating our national environment are still far from complete. This is not to say, however, that those who have seriously examined the problem are in doubt as to the existence of significant health and welfare hazards arising from the increasing contamination of the air we breathe.

In dealing with air pollution, we have just two choices basically. We can move energetically to curtail what is now a serious problem, or we can do less than is necessary and allow the problem to become critical, which, at our present pace of population increase and economic growth, would not take long. In dealing with other problems affecting the environment we have, with few exceptions, followed the latter course, and we know from experience that it is more costly, both in terms of human health and welfare and in terms of dollars.

If we were to neglect our limited air resource to the extent we have neglected other resources in the past, the consequences would be intolerable. We can treat polluted water before we drink it, but we must breathe the air, with its burden of pollution, as it comes to us.

The effects of air pollution are serious now. In economic losses alone, air pollution costs the country billions of dollars a year through injury to vegetation and livestock, corrosion and soiling of materials and structures, depression of property values, and interference with ground and air transportation.

Of even greater significance are the adverse effects of air pollution on human health. Here we must be concerned not just with the threat of severe air pollution episodes capable of causing acute illness and death, but also with the hazards of long-continued exposure to the levels of air pollution which are common in many American communities. A growing body of scientific evidence indicates that exposure to ordinary levels of air pollution adversely affects the health of many people and is associated with the occurrence and worsening of chronic respiratory diseases and with premature death.

Air pollution is related to increased mortality from cardiorespiratory disorders, increased susceptibility to respiratory disease, and interference with normal respiratory function. Specific diseases associated in one degree or another with air pollution are emphysema, chronic bronchitis, asthma, lung cancer, and non-specific respiratory infections (i.e., the common cold).

We must also face the fact that the problem of air pollution, which is already serious, is steadily growing and worsening. In this country, the trends of economic expansion, urban growth, technological progress, and increasing use of motor vehicles all tend toward increased pollution potential. Over one-half of our population now lives on less than one percent of the land area of the United States, and by 1970, it is expected that two-thirds of an even greater population will be concentrated in the same small area.

As our population grows and as personal income rises, so will there be increases in demands for goods and services, in needs for heat and power, and in the quantities of waste products to be disposed of. By the year 2000, for example, overall energy use in this country is expected to increase three-fold, and 80 percent of the increase will depend on the use of fossil fuels, the combustion of which is already a major factor in the air pollution problems faced by most communities.

There is, however, no good reason why these trends must be accompanied by a further deterioration of our atmosphere. We have available the technical means for preventing or minimizing the discharge of most types of contaminants by the use of control equipment or through such means as industrial process modification or fuel substitution. For a few other contaminants for which such procedures are not now available at socially acceptable costs, current research can be expected to make new tools available within a relatively short period in the future. Also, in recent years, there have been many indications of a fundamental change in the national response to the problem of air pollution—a change which is manifested in rising public demands for increased control efforts on the part of both government and industry.

The Clean Air Act of 1963 and the Clean Air Act Amendments of 1965 have given all levels of government greatly improved tools for the control of air pollution. Mr. Vernon MacKenzie, Chief of the Division of Air Pollution, will present a full description of the progress the Clean Air Act has made possible. I should like to comment very briefly on the significance of this legislation on the Nation's efforts to deal with air pollution.

The provisions of this Act have served us well. We have initiated several interstate abatement actions which will ultimately benefit millions of people; we have published standards which will bring all new automobiles under control during the 1968 model year; we have increased our research efforts and have made progress toward the control of sulfur oxides, oxidants and other gaseous pollutants which were once clearly beyond our reach; through the matching-grants provision of the Clean Air Act, State and local control programs have been able to increase their budgets by more than 65 percent nationally. The activities carried out under the Clean Air Act have, in very direct ways, stimulated all levels of government, industry, and the public to exert greater effort toward the control of air pollution sources.

It should be stressed that the Federal Government alone cannot do the job. State and local governments and the private sector must assume additional responsibilities in combating air pollution. And the public must be better informed as to the actual and potential hazards of pollution.

We are encouraged by the progress that we have made, but we have only begun to scratch the surface. The problem not only remains serious, it continues to grow at a faster rate than our efforts to cope with it.

Mr. MacKenzie will comment in some detail on S. 3112, which would expand the Federal authority to give financial assistance to State and local air pollution control agencies. Experience during the past two and one-half years has proved that the Clean Air Act indeed has the potential of producing a marked increase in the Nation's ability to deal with air pollution. We have moved a step forward but the step could be only temporary were it not for this bill which you now have under consideration.

Enactment of this legislation would permit the Department of Health, Education, and Welfare to expand and improve the financial assistance activities which have already been of considerable benefit to States and local governments. Moreover, it would insure the continued maintenance of State and local programs for the control of air pollution. It would authorize an increase of some \$9 million in our appropriation for the coming Fiscal Year and would extend the authorization for the Federal program. In short, Mr. Chairman, enactment of the bill will enable us to continue and augment the vital work we have begun under the Clean Air Act.

This country is in the first stages of the greatest effort it has ever made to improve the quality of those environmental resources so essential to our health and welfare. Our efforts are guided by the principle that every citizen, regardless of where he lives, is entitled to protection against such hazards as air pollution through enlightened governmental action, whether at the local, State, or national level, and through cooperation among government, industry, and the scientific community.

Dr. PRINDLE. I am pleased to have this opportunity to participate in these hearings on air pollution which will bear so significantly on the Nation's efforts to achieve a more healthful environment. We have had a long history in this country concerning the problems of national resources on which a wholesome human environment is so dependent.

It was not until late in the 19th century that we began to see the vital connection between conservation of natural resources and protec-

tion of the public health and welfare. Our progress in understanding this relationship has been uneven. Our initial steps were concerned with the hazards inherent in some of the more flagrant abuses of our natural environment.

With respect to contamination of such resources as air and water, we are only beginning to approach a full understanding of the connection between man's health and well-being and the quality of his environment.

That we have been tardy in this area is not surprising, for environmental contamination is generally a slow process, and some of the most important health and welfare hazards posed by such contamination are essentially subtle and insidious.

Our scientific knowledge and understanding of the ways in which we threaten ourselves by contaminating our natural environment are still far from complete. However, that is not to say that those who have seriously examined the problem are in doubt as to the existence of significant health and welfare hazards arising from the increasing contamination of the air we breathe.

In dealing with air pollution, we have had just two choices basically. We can move energetically to curtail what is now a serious problem, or we can do less than is necessary and allow the problem to become critical, which, at our present pace of population increase and economic growth, would not take long.

In dealing with other problems affecting the environment we have, with few exceptions, followed the latter course, and we know from experience that it is more costly, both in terms of human health and welfare and in terms of dollars.

The effects of air pollution are serious now. In terms of injury to vegetation and livestock, corrosion and soiling of material and structures, depression of property values, and interference with ground and air transportation.

But of even greater significance are the adverse effects of air pollution on human health. Here we must be concerned not just with the threat of severe air pollution episodes capable of causing acute illness and death, but also with the hazards of long-continued exposure to the levels of air pollution which are common in many American communities.

A growing body of scientific evidence indicates that exposure to ordinary levels of air pollution adversely affects the health of many people and is associated with the occurrence and worsening of chronic respiratory diseases and with premature death.

Air pollution is related to increased mortality from cardiorespiratory disorders, increased susceptibility to respiratory disease, and interference with normal respiratory function. Specific diseases associated in one degree or another with air pollution are emphysema, chronic bronchitis, asthma, lung cancer, and nonspecific respiratory infections, that is the common cold.

There is no good reason why the trend that we anticipate in the years to come as a result of our growing economy must be accompanied by the further deterioration of our atmosphere. We have available the technical means for preventing or minimizing the discharge of most types of contaminants by the use of control equipment or through such means as industrial process modification or fuel substitution.

For a few other contaminants for which such procedures are not now available at socially acceptable costs, current research can be expected to make new tools available within a relatively short period in the future.

There have also been many indications of a fundamental change in the national response to the problem of air pollution—a change which is manifested in rising public demands for increased control efforts on the part of both government and industry.

The Clean Air Act of 1963 and the Clean Air Act Amendments of 1965 have given all levels of government greatly improved tools for the control of air pollution. I should like to comment very briefly on the significance of this legislation on the Nation's efforts to deal with air pollution.

The provisions of this act have served us well. We have initiated several interstate abatement actions which will ultimately benefit millions of people; we have established standards which will bring all new automobiles under control during the 1968 model year; we have increased our research efforts and have made progress toward the control of sulfur oxides, oxidants, and other gaseous pollutants which were once clearly beyond our reach; and through the matching-grants provision of the Clean Air Act, State and local control programs have been able to increase their budgets by more than 65 percent nationally.

The activities carried out under the Clean Air Act have, in very direct ways, stimulated all levels of government, industry, and the public to exert greater effort toward the control of air pollution sources.

It should be stressed that the Federal Government alone cannot do the job. State and local governments and the private sector must assume additional responsibilities in combating air pollution. And the public must be better informed as to the actual and potential hazards of pollution.

Mr. MacKenzie will comment on S. 3112, and the House version thereof.

I would like to add that I feel that that enactment of this legislation would permit the Department of Health, Education, and Welfare to expand and improve the financial assistance activities which have already been of considerable benefit to States and local governments.

Moreover, it would insure the continued maintenance of State and local programs for the control of air pollution. It would authorize an increase of some \$9 million in our appropriation for fiscal year 1967 for the Federal program. In short, Mr. Chairman, enactment of the bill will enable us to continue and augment the vital work we have begun under the Clean Air Act.

Thank you. I would like to have Mr. MacKenzie give you a little detail about the progress of the program and I would be happy to answer your questions.

Mr. JARMAN. That would be fine.

**STATEMENT OF VERNON G. MacKENZIE, ASSISTANT SURGEON
GENERAL, CHIEF, DIVISION OF AIR POLLUTION, PUBLIC HEALTH
SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE**

Mr. MacKENZIE. Mr. Chairman and members of the subcommittee, in the interest of conserving your time, I also have a statement that I would like to submit for the record and to summarize very briefly here.

(Mr. MacKenzie's prepared statement follows:)

STATEMENT OF VERNON G. MACKENZIE, ASSISTANT SURGEON GENERAL, CHIEF, DIVISION OF AIR POLLUTION, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. Chairman and members of the committee, the adoption of the Clean Air Act in December 1963 and the enactment of major amendments to it in October 1965 gave the Federal Government a mandate to provide leadership and assistance in the national effort to control air pollution. I am pleased to have an opportunity to review the progress of the Federal air pollution program under that legislation and to supplement Dr. Prindle's testimony on the bills you have under consideration.

In the two and one-half years since the adoption of the Clean Air Act, far-reaching changes have taken place in the air pollution activities of the Department of Health, Education, and Welfare—changes which constitute important steps toward the creation of a truly dynamic national program capable of meeting more effectively the threat of air pollution in all of the diverse ways in which it affects the lives and well being of the American people. I will discuss some of the ways in which the Department of Health, Education, and Welfare, for its part, has begun meeting its responsibilities under the Clean Air Act and the 1965 amendments.

One of the primary objectives of the Clean Air Act is to stimulate greatly increased air pollution control activity at the State and local levels of government. The Act reaffirmed the national policy that State and local governments have a basic responsibility for the prevention and control of community air pollution problems, and, for the first time, authorized awarding of Federal funds directly to State and local agencies to assist them in meeting that responsibility. Under provisions of the Clean Air Act, grants can be made for any of three purposes—the development of new air pollution control programs, the establishment of programs already authorized by local or State law, or the improvement of existing programs.

The response to this new Federal activity has indeed been heartening. Awards in Fiscal Years 1965 and 1966 totaled \$9.18 million, the full amount appropriated by the Congress; thus far in Fiscal 1967, from funds available under a Continuing Resolution of the Congress, we have made new awards totaling \$437,000. In all, grants have been made to 120 local, State, and regional agencies. In addition, we now have a backlog of 25 applications, totaling about \$500,000, from agencies which are eligible for awards but for which funds are not currently available.

In all parts of the country, State and local governments have chosen to inaugurate new or improve existing air pollution programs with the assistance from Federal grants. Totally, including both Federal and non-Federal spending, the funds available for State and local air pollution programs have increased by about 65 percent since the adoption of the Clean Air Act. On an annual basis, some \$20 million is now being invested in State and local regulatory programs—about \$5.1 million at the State level and about \$14.9 million at the local level. This amount of money is far from adequate, but it does compare favorably with the combined State and local spending of \$12.7 million in 1963.

Of the agencies that have received Federal grants under the Clean Air Act, 57 are developing new programs. Another 23 are establishing programs which had already been legally authorized but not activated. Thus, as a direct result of the Federal grants activity, efforts are now being made which, if fully successful, will bring a total of 80 new air pollution programs into being. In addition, 40 agencies have received grants to assist in the improvement of existing programs.

In short, the response of State and local agencies has been encouraging, but it is important to recognize that our work is only beginning. The fact is that a great many cities and States are still without the services of truly effective control programs. Although encouraging progress is being made, we still have a long way to go before State and local agencies will be adequately authorized and equipped to enforce regulations for the prevention and control of air pollution.

In brief, Mr. Chairman, there are still many serious deficiencies in State and local air pollution control efforts in nearly all parts of the country. To achieve a really significant degree of improvement will require a much greater effort in

the months and years ahead than has been made at any time in the past. A great deal of new local and State legislation will be needed. More trained manpower will be needed. Local and State agencies must not only redouble their efforts to prevent new air pollution problems from developing, but, at the same time, must begin dealing more effectively with the many obvious sources of air pollution which remain uncontrolled in virtually every city and town. Not least important, an increased investment of public funds will be needed to achieve and sustain the high level of control activity that is so clearly called for by our knowledge of the present and probable future dimensions of the air pollution problem.

In his testimony, Dr. Prindle emphasized that a share of the needed funds must come from the Federal Government. To provide this assistance, we recommend that the Congress give favorable consideration to the pending legislation, which would amend the Clean Air Act to authorize Federal financial assistance to control agencies on a continuing basis and remove the existing provision limiting the total of grants to air pollution control programs to 20 percent of our total annual budget. In our view, adoption of this legislation is essential to permit the Federal Government to continue to meet its national responsibility for helping State and local governments to cope with the mounting problem of air pollution.

Also, the Federal Government must be prepared to deal with serious air pollution problems which are inherently beyond the reach of State and local agencies. Air pollution affecting interstate areas is a prime example. Even where people living in such areas are able to insist on effective control of air pollution sources within their own communities, they are powerless to prevent pollution from reaching them from sources in another State. To provide a means of dealing with such situations, the Clean Air Act authorized Federal action to abate interstate air pollution problems.

Thus far, this new Federal authority has been invoked in nine interstate areas, including, most recently, the area in which our Nation's Capitol is located. In terms of the number of people affected, the most significant case concerns interstate air pollution in the metropolitan New York and northern New Jersey area. In two interstate areas, abatement action has been undertaken at the request of States affected by pollution originating outside their boundaries. The first such case involved pollution from a feed and fertilizer plant in eastern Maryland affecting people in Delaware. The second involved emissions from a pulp mill in northern New York affecting people in Vermont. In both instances, the Secretary has issued recommendations calling for prompt and effective control of the interstate problems. To assess the present and possible future need for additional Federal abatement action, we have begun technical surveillance activities in other interstate areas across the country.

In the 1965 Amendments to the Clean Air Act, major new authority was provided for Federal action to deal with one of the most important single factors in the contemporary air pollution problem—the growing problem of motor vehicle pollution. Under this authority for the establishment and enforcement of national standards, Secretary Gardner has issued standards which will apply to new gasoline-powered passenger cars and light trucks, including both American-made and imported vehicles, beginning with the 1968 model year. This means such motor vehicles must be equipped or designed to comply with Federal standards for the control of the two predominant sources of motor vehicle emissions—the exhaust tailpipe and the crankcase. The standards call for significant reductions in tailpipe emissions of hydrocarbons and carbon monoxide, as well as 100 percent control of crankcase emissions.

As new cars equipped to comply with the Federal standards replace older, uncontrolled cars, and as the standards are revised in accordance with improvements in control technology and an in scientific knowledge of the harmful effects of motor vehicle pollution, we fully expect to see a significant reduction in this important national problem. But this does not provide a permanent solution to the problem. This important point was emphasized by Secretary Gardner in December 1965; "It is important to bear in mind," the Secretary said, "that with the increase in the number of automobiles projected for the remainder of this century, the pollution problem could become even more serious than it is today."

We estimate, Mr. Chairman, that by about 1980, motor vehicles will be so numerous that present approaches to controlling pollution from the internal combustion engine will be totally inadequate. If the public is to be protected against the threat of a steadily worsening motor vehicle pollution problem, new approaches to dealing with it must be found. Ultimately, if our present

dependence on motor vehicles for a major portion of our transportation needs continues, we will almost certainly need to develop virtually pollution-free power sources for motor vehicles.

The need to control emissions from diesel engines is an important aspect of the problem of motor vehicle pollution; indeed, from the standpoint of someone driving behind a diesel bus or truck, it may well seem the most important. I suspect that no other aspect of the problem makes so many people so indignant or so uncomfortable on so many occasions. The 1965 Amendments to the Clean Air Act provided authority under which the Secretary can establish national standards for the control of diesel emissions. A number of technical problems relating to the control of diesel emissions must be resolved before such standards can be established.

The functions of conducting and supporting research and training activities are an integral part of the Federal air pollution program under the provisions of the Clean Air Act and the 1965 amendments. In the past three years, we have expanded and accelerated our efforts in both of these important areas of activity.

In the area of research on the health hazards of air pollution, the early efforts of many scientists concerned with this problem produced a substantial body of evidence associating air pollution with illness and death from a number of respiratory diseases, including asthma, bronchitis, emphysema, and lung cancer. Though we are pursuing our investigations of the connection between air pollution and specific diseases, we are placing increasing emphasis on identifying and assessing the significance of earlier manifestations of the adverse effects of air pollution—such as changes in respiratory function that may be precursors of chronic disease.

In the area of technology for the control of air pollution, the knowledge and skills needed to control most major sources have been available for several years. Our present and projected future research efforts in this area relate principally to improving the effectiveness and reducing the cost of existing control methods. Of particular importance in this connection are the efforts we are making to accelerate the development of effective, low-cost methods of dealing with the problem of sulfur oxide pollution arising from fuel combustion. These efforts are described in detail in the report submitted to you on July 27, 1966, Mr. Chairman.

In the area of training activities, our efforts have been expanded three-fold, in terms of expenditures, since the adoption of the Clean Air Act. A major share of the increase has been directed toward helping to enlarge the supply of technical personnel qualified to work in the air pollution control field. We are currently supporting graduate training programs at 19 universities and providing aid to individual graduate students under a fellowship program. In addition, short-term training courses are conducted at the Taft Sanitary Engineering Center and in other locations, primarily to improve the technical competence of individuals already working in the air pollution field.

The major purpose of our training activities is, of course, to help meet the increasing manpower needs of local and State air pollution programs. The shortage of trained personnel is becoming a serious obstacle to the needed expansion of State and local control activities. For a variety of reasons, many State and local agencies are unable to recruit and retain personnel who have been trained under the auspices of the Federal Government. The result is that most of our trainees ultimately have been finding employment with industry or universities. We are currently seeking ways of channeling more of these people to State and local programs.

Technical assistance in dealing with specific air pollution problems is another area in which the needs of State and local agencies are increasing. Two types of activity account for most of our effort in this area. The first involves assistance to State and local governments in assessing their air pollution problems and planning control programs. Among the places where we are currently providing assistance for major projects are northwestern Indiana, the Washington, D.C. metropolitan area, the Kanawha Valley in West Virginia, and the City of Chicago; in addition, we provided extensive assistance for the major air pollution study just completed in the St. Louis metropolitan area—a comprehensive study that provides a sound basis for control action both in the city of St. Louis and in the surrounding areas of Missouri and Illinois.

The second major purpose of our technical services activity is to gather and publish reliable technical information on air pollution control problems associated with specific industries. This effort is intended primarily to assist State and local control officials in dealing with such problems, but it is, of course, of

direct benefit of the industries concerned. Work is now in progress on surveys of the pulp and paper industry, manufacturing of phosphoric acid and related phosphate fertilizers, and various segments of the chemical industry. A report on sulfuric acid manufacturing, one of the largest segments of the chemical industry, was issued several months ago. We expect to begin work next year on surveys of other industries.

The final item in my progress report on the Federal air pollution program concerns the control of air pollution at Federal installations. In the Clean Air Act, the Congress expressed its intent that Federal agencies should not contribute to community air pollution problems. To this end, the Clean Air Act called on all Federal agencies to cooperate with the Department of Health, Education, and Welfare in dealing with air pollution problems arising from their activities. In this connection, we have greatly increased our liaison with other Federal agencies and, in many cases, provided technical assistance in dealing with specific air pollution sources.

On several occasions, President Johnson has called on all Federal agencies to observe exemplary practices in the control of air pollution problems which their activities may create. An Executive Order embodying this directive has been issued. To implement it, Secretary Gardner has issued detailed instructions for the control of air pollution from Federal facilities. These instructions apply to new as well as existing facilities; their application should result in significant progress toward reducing the contribution with Federal activities make to the total problem of air pollution in American communities.

In summary, Mr. Chairman, our experience during the past two and one-half years has shown that the Clean Air Act can indeed produce a marked increase in the Nation's ability to deal with the mounting problem of air pollution. But we must not forget that we have only begun our work. In most communities, the air is no cleaner than it was two and one-half years ago; in many places, the burden of pollution has increased. And, as Dr. Prindle has emphasized, it threatens to increase still further in the years to come.

The bills you have under consideration, Mr. Chairman—specifically, H.R. 13199 and S. 3112—will enable the Federal Government to provide further help to cities and States which are trying to deal with their air pollution problems. A major feature of these bills is authority for awarding of Federal funds to State and local governments to help them meet the costs of maintaining effective control programs; this would be in addition to our existing authority to award grants to help in creating new programs or improving existing programs. The new grant authority, in our opinion, is necessary to carry out the Federal Government's obligation to help meet the national need for sustained local and State efforts to cope with the problem of air pollution. For this reason, we strongly recommend adoption of legislation authorizing maintenance grants to State and local air pollution control agencies.

To improve the workability of the grants program, we recommend amendment, as provided in S. 3112 as passed by the Senate, of that provision of Section 104(b) of the Clean Air Act which requires that "No agency shall receive any grant under this section during any fiscal year when its expenditures of non-Federal funds for air pollution programs will be less than its expenditures were for such programs during the preceding fiscal year." Over a period of years, Mr. Chairman, many factors may justifiably cause fluctuations in the level of expenditures necessary to maintain control programs. Examples include non-recurring costs of equipment of facilities acquisition and the conduct of special studies of air quality or specific types of air pollution sources. In view of these facts, we consider desirable the amendment of this section of the Act as provided in S. 3112 now pending before you.

Mr. Chairman, my final comment on the pending legislation relates to the authorizations for appropriations for the Federal air pollution program. The bills, in addition to extending the time of appropriation authority, would consolidate the appropriation authorizations contained in sections 209 and 306 of the Clean Air Act. In our judgment, such consolidation is highly desirable in order to insure that the administration of the regulatory program to control pollution from motor vehicles, under Title II of the Act, will not be impaired by unpredictable circumstances not anticipated nor provided for under a separate appropriation authorization for Title II. The flexibility provided by a consolidation of appropriation authorities is of considerable importance in assuring the ability of the Secretary to administer equitably Title II of the Act. While we would prefer an open-ended appropriation authority, as provided in H.R. 13199, a limitation in the amounts authorized for fiscal years 1968 and

1969, as provided in S. 3112, would be acceptable. However, if such limitations by fiscal year are to be incorporated, we recommend strongly that such appropriation ceilings not be made applicable to the authority for the construction of facilities under section 103(d) of the Act. Such non-recurring expenditures should not be permitted to interfere with the ability to carry out necessary functions under the Act.

Mr. Chairman, if you have any questions, we will be glad to try to answer them.

Mr. MACKENZIE. I am glad to have an opportunity to supplement Dr. Prindle's testimony on the bills that you have before you. The adoption of the Clean Air Act in December 1963, and the enactment of major amendments to it in October 1965 gave the Federal Government a mandate to provide leadership and assistance in the national effort to control air pollution.

In the 2½ years since the adoption of the Clean Air Act, far-reaching changes have taken place in the air pollution activities of the Department of Health, Education, and Welfare—changes which constitute important steps toward the creation of a truly dynamic national program capable of meeting more effectively the threat of air pollution in all of the diverse ways in which it affects the lives and well-being of the American people.

I would like to discuss just a few of the ways in which the Department of Health, Education, and Welfare, for its part, has begun meeting its responsibilities under the Clean Air Act.

One of the primary objectives of the Clean Air Act is to stimulate greatly increased air pollution control activity at the State and local levels of government. Under the provisions of the Clean Air Act, grants can be made for any of three purposes—the development of new air pollution control programs, the establishment of programs already authorized by local or State law, or the improvement of existing programs.

The response to this new Federal activity has indeed been heartening. In all parts of the country, State, and local governments have chosen to inaugurate new or improve existing air pollution programs with the assistance from Federal grants.

Totally, including both Federal and non-Federal spending, the funds available for State and local air pollution programs have increased by about 65 percent since the adoption of the Clean Air Act in 1963.

As a direct result of the Federal grants activity, efforts are now being made which, if fully successful, will bring a total of 80 new air pollution programs into being. In addition, 40 agencies have received grants to assist in the improvement of existing programs.

In short, the response of State and local agencies has been encouraging. But it is important to recognize that our work is only beginning. The fact is that a great many cities and States are still without the services of truly effective control programs.

Although encouraging progress is being made, we still have a long way to go before State and local agencies will be adequately authorized and equipped to enforce regulations for the prevention and control of air pollution.

In brief, Mr. Chairman, there are still many serious deficiencies in State and local air pollution control efforts in nearly all parts of the country. To achieve a really significant degree of improvement will require a much greater effort in the months and years ahead than has been made at any time in the past.

In his testimony, Dr. Prindle emphasized that a share of the needed funds must come from the Federal Government. To provide this assistance, we recommend that the Congress give favorable consideration to the pending legislation, which would amend the Clean Air Act to authorize Federal financial assistance to control agencies on a continuing basis and remove the existing provision limiting the total of grants to air pollution control programs to 20 percent of our total annual budget.

Mr. Chairman, in my prepared statement, I include some detail about progress which is being made in other elements of the Federal air pollution program relating to the control and abatement of interstate air pollution problems, the regulation of pollutant emissions from motor vehicles which will begin with the 1968 model year, and our research on the causes, effects, and control of air pollution and other activities under the Clean Air Act.

If I might summarize our experience, it is that during the past 2½ years, we have full evidence that the Clean Air Act can indeed produce a marked increase in the Nation's ability to deal with the mounting problem of air pollution. But we must not forget that we have only begun our work.

In most communities, the air is no cleaner that it was 2½ years ago; in many places, the burden of pollution has increased.

The bills you have under consideration, Mr. Chairman—more specifically, H.R. 13199 and S. 3112—will enable the Federal Government to provide further help to cities and States which are trying to deal with their air pollution problems.

A major feature of these bills would be the new authority for awarding of Federal funds to State and local governments to help them meet the costs of maintaining effective control programs; this would be in addition to our existing authority to award grants to help in creating new programs or improving existing programs.

The new grant authority, in our opinion, is necessary to carry out the Federal Government's obligation to help meet the national need for sustained local and State efforts to cope with the problems of air pollution. For this reason, we strongly recommend adoption of legislation authorizing maintenance grants to State and local air pollution control agencies.

To improve the workability of the grants program, we recommend amendment, as provided in S. 3112 as passed by the Senate, of that provision of section 104(b) of the Clean Air Act which requires that "No agency shall receive any grant under this section during any fiscal year when its expenditures of non-Federal funds for air pollution programs will be less than its expenditures were for such programs during the preceding fiscal year."

Over a period of years, Mr. Chairman, many factors may justifiably cause fluctuations in the level of expenditures necessary to maintain control programs. Examples include nonrecurring costs of equipment of facilities acquisition and the conduct of special studies of air quality or specific types of air pollution sources.

In view of these facts, we consider desirable the amendment of this section of the act as provided in S. 3112 now pending before you.

Mr. Chairman, my final comment on the pending legislation relates to the authorizations for appropriations for the Federal air pollution programs. The bills, in addition to extending the time of appropria-

tion authority, would consolidate the appropriation authorizations contained in sections 209 and 306 of the Clean Air Act.

In our judgment, such consolidation is highly desirable in order to insure that the administration of the regulatory program to control pollution from motor vehicles, under title II of the act, will not be impaired by unpredictable circumstances not anticipated nor provided for under a separate appropriation authorization for title II.

The flexibility provided by a consolidation of appropriation authorities is of considerable importance in assuring the ability of the Secretary to administer equitably title II of the act. While we would prefer an open-ended appropriation authority, as provided in H.R. 13199, a limitation in the amounts authorized for fiscal years 1968 and 1969, as provided in S. 3112, would be acceptable.

However, if such limitations by fiscal year are to be incorporated in the legislation, we recommend strongly that such appropriation ceilings not be made applicable to the authority for the construction of facilities under section 103(d) of the act. Such nonrecurring expenditures should not be permitted to interfere with the ability to carry out necessary functions under the act.

Mr. Chairman, if you have any questions, we will be glad to try to answer them.

Mr. JARMAN. Gentlemen, we appreciate your precise and effective presentation on this tremendously important program. May I ask as to the funding of the program. The bills call for \$46 million for the next fiscal year, an increase of \$9 million as I understand it over the present authorization.

What is that additional money needed for?

Mr. MACKENZIE. The additional money would be needed primarily to initially implement the provisions of the legislation which is now pending before you—for implementing the new grant program, for maintaining and sustaining air pollution control program activities by State and local governments.

Mr. JARMAN. I notice that the Senate report refers to the increase being in part necessitated by an expanded program of research into control of sulfur emissions, automobile exhaust emissions, and the added cost of the maintenance grant program.

Mr. MACKENZIE. Yes, sir. We have contemplated, but we have no clearances yet from the Bureau of the Budget, the submission of a supplemental appropriation request within the additional appropriation authority that would be provided. This request would include funds for the implementation of the grant program which I have mentioned as the principal item.

In addition, there are two other items that are under consideration, one relating to acceleration of research on the problem of controlling sulfurous pollution, principally from combustion sources, and, second to provide additional funds needed in the regulatory program relating to the control of emissions from motor vehicles.

Mr. JARMAN. Under the bills as originally introduced, it called for the \$46 million for fiscal year ending June 30, 1967, and then an open-end authorization proposed through 1973. The Senate has set figures of \$70 million for fiscal 1968 and \$80 million for fiscal 1969. What is your understanding of how these figures were arrived at?

Mr. MACKENZIE. During the period when the Senate committee was considering this legislation, the chairman of the committee requested

information from us as to our technical judgment of the sums that would be necessary to implement the Clean Air Act as amended and as proposed for amendment for the next several years.

The figures that are included in the Senate-passed version of S. 3112 are essentially the figures which we provided to the committee for the fiscal years 1968 and 1969.

Mr. JARMAN. The figures that you would anticipate if you operated under the open-end authorization?

Mr. MACKENZIE. Yes, sir. These are our technical estimates.

Mr. JARMAN. If you operate under an open-end authorization, what is your overall estimate through 1973?

Mr. MACKENZIE. Mr. Chairman, I can provide these figures for the record. I do not have them with me.

Mr. JARMAN. Do you remember roughly what the amount would total?

Mr. MACKENZIE. This would not exceed, in any single year as I remember the figures, \$100 million. It would be less than that.

(The information requested appears on p. 75.)

Mr. MACKENZIE. I excluded from this estimate the cost of any facility that may be constructed under the authority in section 103 of the Clean Air Act, to provide facilities for our own operations.

Mr. JARMAN. Thank you very much.

Mr. O'Brien?

Mr. O'BRIEN. Yes, I would like to ask a question. What was the appropriation for the last fiscal year?

Mr. MACKENZIE. The appropriation for the present fiscal year which has passed the House but has not yet been enacted by the Senate is approximately \$35½ million.

Mr. O'BRIEN. \$35½ million. Was this \$46 million for the fiscal year ending June 30 next budgeted?

Mr. MACKENZIE. Yes, sir. There was a contingency item included in the President's budget as transmitted to the Congress contingent on the passage of new legislation.

Mr. O'BRIEN. Yes. Now, the new fiscal year by the time this bill would be signed would be 3 or 4 months old, would it not?

Mr. MACKENZIE. I can't anticipate the schedule of the Congress in that matter. I would accept your judgment on this.

Mr. O'BRIEN. Then what harm would be done to the program if we were to take that into consideration and reduce that figure for the fiscal year ending June 30, 1967, to \$35 million?

Mr. MACKENZIE. Well, Mr. O'Brien, the current appropriation exceeds the figure that you have mentioned. That is, it is higher than \$35 million.

Mr. O'BRIEN. For the full fiscal year?

Mr. MACKENZIE. For the current fiscal year, yes, for present authorities under the Clean Air Act. In addition, if the \$46 million figure is reduced, it will prevent certainly the full implementation of the new authority for the additional grant program which is authorized in H.R. 13199 and S. 3112.

In addition, I would like to mention one other item. We have a very urgent need for additional funds to finance our activities on the regulatory control of motor vehicle pollution. Some members of this committee may recall that last year, at the time the amendments to the Clean Air Act including title II of the act pertaining to the control

of emissions from motor vehicles was pending, the provisions of the pending legislation were then amended to provide for an additional mechanism for administering the controls which would be adopted.

At the same time that this amendment was adopted, during passage of this legislation in the House, there was no corresponding change made in the appropriation authority under title II of the act which would take into account the additional testing that would be required for us to conduct under the terms of the amended legislation.

So that we are in urgent need of supplementary funds to effectively carry out title II of the Clean Air Act this year.

Mr. O'BRIEN. Is it not your position judging from your testimony that, while much has been accomplished under existing authorization, that you have been to a large extent shuffling rapidly to keep barely even?

Mr. MACKENZIE. I think we are doing a little bit more than keeping even and I hope that in the next few years this is going to actually reach an improvement. We are not making very much of an improvement now. I agree with you. I think we are essentially holding our own.

Mr. O'BRIEN. That is the point I am making, that in justification of the larger amount that you have gotten many communities into this, there is effort and the situation would have been a lot worse if we had not moved into the field; but nevertheless, the conditions that we are experiencing are not improving as a whole because the pollution is getting ahead of the remedy. Is that correct?

Mr. MACKENZIE. I mentioned that we are getting, I think as a result of our activities, about 80 new air pollution control programs across the country.

Mr. O'BRIEN. I understand.

Mr. MACKENZIE. You don't have any real results from these yet but for the years ahead we are laying a foundation now for real progress.

Mr. O'BRIEN. But if we stayed at the present pace, the point I am making is that it probably would outgrow the core, isn't that probably true?

Mr. MACKENZIE. It seems that this in fact would occur.

Dr. PRINDLE. If I may interrupt, I think in my own prepared statement there are some comments about the growth of the population, the growth of the gross national product, and so forth, that would lead one to this conclusion. Yes, sir.

Mr. O'BRIEN. You mentioned that about \$20 million is being spent on an annual basis at the State and local levels which is less than the Federal contribution at this stage.

Mr. MACKENZIE. Yes, sir.

Mr. O'BRIEN. Do you anticipate if the program is stepped up that the State and local spending will move up correspondingly?

Mr. MACKENZIE. Yes, sir. I certainly do.

Mr. O'BRIEN. You don't anticipate that they will sit back and look at a couple of hundred million dollars from the Federal Government and say "Well, let Uncle Sam do it"?

Mr. MACKENZIE. No, sir. I see real evidence of a desire on the part of State and local agencies to move ahead in this field and I think with appropriate stimulation and assistance from the Federal Government, this will be done.

Mr. O'BRIEN. I think that that is true in many many of these programs. I think that we have asked questions in this committee many times, will this program or that program stifle local initiative? We have had it with the building of medical colleges. We have had it with practically every area involved in public health. I am very heartened to notice as time passes that the predictions came true, that there was no draining off of private contributions to medical colleges, no lessening of effort at the State and local levels.

In so many of our programs I think that is not true but I am not going to go mentioning any programs now because they have nothing to do directly with health. I think in certain of the programs that we have had here in this Congress there has been a complete abandonment at the local level letting the Government take over the whole bit but I must say with all due respect to HEW that that has not occurred with your particular program.

Thank you very much, Mr. Chairman.

Mr. JARMAN. Mr. Nelsen.

Mr. NELSEN. No questions, thank you.

Mr. JARMAN. Mr. Rogers.

Mr. ROGERS of Florida. Thank you, Mr. Chairman. You say you are spending over \$35 million. I believe title I gave an authorization for fiscal 1967 of \$35 million and title II, \$845,000.

Mr. MACKENZIE. Yes, sir.

Mr. ROGERS of Florida. And this amount has been appropriated?

Mr. MACKENZIE. The total amount pending is \$35,577,000, sir.

Mr. ROGERS of Florida. And you think now you are prepared to take a jump. What is suggested in the Senate act, up to \$46 million for 1967?

Mr. MACKENZIE. Yes, sir.

Mr. ROGERS of Florida. I understood you had applications pending of \$500,000.

Mr. MACKENZIE. These are pending applications which we are unable to fund, from State and local agencies.

Mr. ROGERS of Florida. If we give you \$46 million, you could, of course?

Mr. MACKENZIE. Yes.

Mr. ROGERS of Florida. What would you use the rest of that money for?

Mr. MACKENZIE. Of the additional \$10 million which has been mentioned, \$7 million would be for implementation of the new grants program which would be authorized by the legislation pending before you.

Mr. ROGERS of Florida. Which would allow us to support up to 50 percent going programs?

Mr. MACKENZIE. Yes, sir.

Mr. ROGERS of Florida. Do you think this really is a good idea or should we try to encourage them to do more?

Mr. MACKENZIE. I think this is a way to encourage them to do more.

Mr. ROGERS of Florida. Suppose we say "You initiate a new one and then we will help you maintain that" rather than going in and supporting programs that they are now carrying on?

Mr. MACKENZIE. I think there is need, Mr. Rogers, to give a commitment to the State and local agencies that this is not a one-shot affair, that there will be a continuing support from the Federal Government.

Mr. ROGERS of Florida. I am saying suppose we say now "We are not going in and fund what you are doing presently."

Mr. MACKENZIE. We are not going to do this under the proposal.

Mr. ROGERS of Florida. Then why put it in the law?

Mr. MACKENZIE. It does not say this, sir.

Mr. ROGERS of Florida. It would be interpreted that way. Then you have no objection to our making it clear in the law that it will be new programs that could be expected to have some maintenance funds.

Mr. O'BRIEN. Would the gentleman yield?

I think that is clear to what was stated by the representative from Milwaukee, that you can have a fragmentation of a program. You have got a going operation, we will say, in Milwaukee and there are Federal funds so you have people reaching out from that area for money and you have a confused hodgepodge instead of a regional development. Is that correct?

Mr. MACKENZIE. We would not like to see anything that would fragment regional programs. Every effort should be made to develop and encourage regional programs. I think the legislation that is pending here would do this. I would not recommend that any change be made that would change that situation.

Mr. ROGERS of Florida. I would be concerned that we go in and undertake obligations that are already being well carried out for existing programs. If they have improvements in those programs—

Mr. MACKENZIE. Mr. Rogers, the legislation pending in S. 3112 and H.R. 13199 would provide that the Federal Government would support up to 50-percent of the total cost of ongoing programs. There is also a provision, however, that the Federal money cannot be used to substitute for State or local money, in that reductions in State and local expenditures cannot be made except as they may be related to nonrecurring expenses.

Mr. ROGERS of Florida. I would want to go into this very thoroughly so that we would not get in the position of going in and just funding programs that are currently being funded, but you feel that this would not be done.

Mr. MACKENZIE. This would not be done.

Mr. ROGERS of Florida. Then you would have no objection to our making clear in the language that this would not be done?

Mr. MACKENZIE. We felt that it was clear in the language, sir.

Mr. ROGERS of Florida. I understood from the testimony of the previous witnesses that they felt it would come in to give maintenance to ongoing present programs. At least that is what I understood from reading his statement. Maybe I misinterpreted but I will check into this thoroughly. What have you reported to the Congress in your semiannual reports on air pollution from automobile exhaust? When was the latest report submitted?

Mr. MACKENZIE. The latest report, I believe, was submitted in June. We have made semiannual reports on this subject since the legislation was enacted and have recounted progress in our research on the problem and also with respect to the promulgation of standards and requirements for compliance therewith by manufacturers or importers of new motor vehicles.

Mr. ROGERS of Florida. These requirements will be effective on the 1968 automobiles, is that correct?

Mr. MACKENZIE. That is correct, sir.

Mr. ROGERS of Florida. And what will that actually do? How will it affect the percentage of emissions and so forth? Could you give us a quick rundown?

Mr. MACKENZIE. Yes. Very briefly, the regulations which are now in effect will importantly reduce two classes of pollutants emitted from motor vehicles; first, hydrocarbons coming essentially from unburned fuel; and second, carbon monoxide which is a toxic gas. This will be accomplished in part by requiring essentially 100-percent control of the emissions from crankcases of automobiles.

Mr. ROGERS of Florida. This is no problem for the industry as I understand it.

Mr. MACKENZIE. This has been done by the industry since 1963, but not to the extent that is now required.

Mr. ROGERS of Florida. Yes.

Mr. MACKENZIE. The regulations will also require reduction in emissions in the exhaust system by roughly two-thirds of the quantity of unburned hydrocarbons and of carbon monoxide that would otherwise be emitted.

Mr. ROGERS of Florida. What are the remaining pollutants that will be injected into the air?

Mr. MACKENZIE. There is a third major type of pollution in the exhaust from many motor vehicles, namely, the oxides of nitrogen for which effective control measures have not yet been developed. In addition on the vehicle as a whole, there is also evaporation of fuel from the fuel tank and from the carburetor for which no regulations have yet been promulgated.

Mr. ROGERS of Florida. I see. How many people do you have involved in research on the automobile emission problem in-house?

Mr. MACKENZIE. There are 31 positions budgeted for research relating to automotive emissions.

Mr. ROGERS of Florida. How many people are in your shop now?

Mr. MACKENZIE. There are roughly a little less than 700.

Mr. ROGERS of Florida. 700. Where are they mostly located?

Mr. MACKENZIE. They are mostly located in our laboratories in Cincinnati.

Mr. ROGERS of Florida. Are you doing any work on an electric motor?

Mr. MACKENZIE. We are proposing this year to inaugurate an evaluation of the possibilities of developing essentially new propulsion systems for motor vehicles that would be less pollution prone than the current type of engines.

Mr. ROGERS of Florida. Are you making any progress?

Mr. MACKENZIE. Included in this would be an evaluation of the possibilities of developing electrically driven vehicles. We don't know enough about it yet in my opinion to make any definitive statements. We have looked to see where research is going on on this problem.

As I recall it, there is, so far as we have been able to find out, about \$9 million a year being spent in Government and about \$9 million by private sources related to development of electric systems for driving automobiles.

Mr. ROGERS of Florida. And where is the \$9 million in Government being spent, in your shop?

Mr. MACKENZIE. No, sir.

Mr. ROGERS of Florida. Where?

Mr. MACKENZIE. Primarily in the Department of Defense and other departments.

Mr. ROGERS of Florida. I see. Could you give us a listing of those departments and a rundown?

Mr. MACKENZIE. Insofar as we have developed this, we will be glad to, yes.

(The information requested, when supplied, will be found in the committee files.)

Mr. ROGERS of Florida. Have you been working with industry on trying to develop an electric motor for an automobile power system?

Mr. MACKENZIE. We have not reached that stage yet, Mr. Rogers.

Mr. ROGERS of Florida. Have you made any overtures to them?

Mr. MACKENZIE. We have discussed the matter with them, yes.

Mr. ROGERS of Florida. What reaction have you gotten?

Mr. MACKENZIE. I think the reaction is quite variable. Some of them are, let us say, enthusiastic and others are very dubious that it will ever come about.

Mr. ROGERS of Florida. I understood that there was a public announcement that one of the major companies is doing significant research in this area.

Mr. MACKENZIE. More than one is.

Mr. ROGERS of Florida. More than one?

Mr. MACKENZIE. Yes, sir.

Mr. ROGERS of Florida. Don't you think it would be a good idea for you to encourage this and try to get some cooperative effort between what we are doing and what they are doing?

Mr. MACKENZIE. This is the major purpose of our initial activity this year, sir.

Mr. ROGERS of Florida. Are you trying to coordinate with Defense at all, with regard to the work that they are doing?

Mr. MACKENZIE. We haven't reached that stage. We are not doing anything on a major scale yet so that it is a little difficult for us to attempt to coordinate something.

Mr. ROGERS of Florida. I misunderstood you. I thought you were doing something.

Mr. MACKENZIE. We are exploring the field and evaluating the feasibility of this development. This is what we propose to do this year and we consider that this is a necessary initial step before we determine whether we should go further and if so, how.

Mr. ROGERS of Florida. I noticed in your statement you said that " * * * we will almost certainly need to develop virtually pollution-free sources for motor vehicles."

Mr. MACKENZIE. Yes, sir.

Mr. ROGERS of Florida. If that is the goal and this is what you are trying to do and this is the only way to reach the pollution problem, I would think we are moving rather slowly if we really have not made any contact and are just in discussion.

Mr. MACKENZIE. We have discussed here primarily electric propulsion systems. There are other systems for driving automobiles which have a low pollution potential. We have been interested in turbine engines for example, and have obtained a turbine engine in an automobile for test purposes and evaluated this.

Very briefly, the pollutant emissions from such type of engine are very materially less than the reciprocating type of engine commonly used at the present time. The pollution ranges from roughly 10 to 15 percent of the emissions of hydrocarbons and carbon monoxide that come from the usual type of engine.

The oxides of nitrogen emissions are somewhat higher but, on the tests that we have made, they are also less than those that come from the existing type of reciprocating engine.

Mr. ROGERS of Florida. I am sure the committee would be interested in receiving some information on what you are doing. I would think some coordination in Government and with industry would be very desirable in this field. I think the committee would be very interested in following your efforts along this line.

Mr. MACKENZIE. We would certainly expect to report to the Congress in the reports to which you have made reference, sir.

Mr. ROGERS of Florida. On page 10, you refer to health hazards of air pollution: "the early efforts of many scientists concerned with this problem produced a substantial body of evidence associating air pollution with illness and death from * * *" various diseases. Have you any figures that you could submit to the committee on that?

Mr. MACKENZIE. We would be glad to submit a statement as to this giving references and similar matters if this would be helpful.

Mr. ROGERS of Florida. I think this would be helpful to pinpoint what we have been able to find so far.

(The information requested follows:)

THE HEALTH HAZARDS OF COMMUNITY AIR POLLUTION

INTRODUCTION

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 may even be 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."

This report summarizes some of that evidence. It approaches the subject from both the standpoint of research relating to the occurrence and worsening of specific respiratory diseases or the occurrence of illness and death among urban dwellers and from the standpoint of research on the effects of specific air pollutants or classes of pollutants. For brevity, the latter portion deals only with a few of the most important of the pollutants present in community air—sulfur oxides, oxidants, particulates, hydrocarbons, and oxides of nitrogen. Though this summary is focused primarily on the association between air pollution and respiratory disease, which is clearly the major health problem posed by the contemporary air pollution problem, it includes some discussion of other health effects.

The adverse effects of air pollution on human health are undoubtedly most serious in those urban communities which have the greatest concentrations of air pollution sources and people. A great many of the epidemiological and statistical studies mentioned in the body of this report was made in large metropolitan areas, ranging in population from the millions down to the tens of thousands. Among them are such places as New York and Los Angeles, at the upper end of the population scale, as well as such smaller cities as Nashville and Buffalo.

But the health hazards of air pollution clearly are not limited to cities above a certain size. A great many small communities in the United States suffer to some extent from air pollution problems—problems which differ in degree from those experienced by large cities and which may be less complex but are nonetheless likely to produce adverse health effects on the people exposed to them. In addition, any community with a few uncontrolled air pollution sources of appreciable size may experience occasional build-ups of pollution in the air, resulting in widespread though often unnoticed increases in illness and death, during periods of adverse meteorological conditions. This can happen, and has happened, in places as large as New York City as well as such a small industrial community as Donora.

The evidence is clear that health can be subtly but seriously threatened by daily exposure to polluted community air. We are concerned, not only with the so-called normal healthy individual, upon whom adverse effects may not be manifested until there have been many years of exposure, but also with infants and children, elderly people, and persons already afflicted with respiratory and cardiovascular disorders, all of whom may have an above average susceptibility to the adverse effects of pollutants in the air. In short, what is already known about

the relationship of air pollution to illness, disability, and premature death, together with considerations of prudence in the protection of public health, leave no doubt that the contemporary air pollution problem is a threat to the lives and the health of millions of people in all parts of the country.

ACUTE EFFECTS

The most dramatic illustrations of adverse health effects due to air pollution have been the acute episodes in which serious illness due to sharp increases in air pollution concentrations was sudden in onset and in some cases fatal in outcome. The best known are those in the Meuse Valley, Belgium (1930);¹ Donora, Pennsylvania (1948);² London (1952 and 1962);^{3,4} and New York City (1953).⁵ Excess deaths over normal expectancy ranged from 17 in Donora to 4000 in the 1952 London smog. In six other recorded episodes in the British Isles prior to 1952, going as far back as 1873, excess deaths ranged from 75 to 692 and totaled over 2500.⁶ In all these instances, most of the fatalities occurred among persons who were already suffering from chronic cardiorespiratory disorders.

Sensational and tragic as these acute episodes are, health authorities are even more concerned today with the slow, insidious effects on human lungs of air pollution levels which are much lower but continued every day and year after year. That air pollution does indeed increase the prevalence or severity of chronic respiratory diseases has been stated with more and more certainty by outstanding authorities. In addition to chronic bronchitis and emphysema, bronchial asthma has been linked to air pollution, as has also an acute respiratory ailment, the common cold. And other pollutants besides cigarette smoke which man inhales regularly have been singled out—and for similar reasons—as possibly contributing to the rapid growth of lung cancer.

The evidence which associates air pollution with chronic obstructive ventilatory disease and lung cancer comes from three types of investigations: statistical studies of morbidity and mortality, epidemiological studies, and clinical and laboratory studies of animals—and, in some cases, of humans—exposed to various pollutants, singly or in combination. The results of such studies are indicated below.

LUNG CANCER

Deaths from cancer of the lung, especially among males, have been increasing rapidly in recent years.⁷ Also notable is the striking urban-rural differential in lung cancer mortality. As Kotin has stated, "The most satisfactory explanation for the consistent observation of an increased incidence of lung cancer in urban populations is exposure to polluted air."⁸

It is important to note that cancer of the lung is believed to reflect the interaction of multiple factors. It is highly unlikely that there is but one etiologic agent, and therefore, it may never be possible to disentangle completely all the factors involved. However, it is believed that research work now under way, or contemplated, will permit ultimately an assessment of the role of several external factors in the causation of lung cancer.⁹

Presently available evidence of the possible role of air pollution in the etiology of lung cancer is based on the findings of a number of research projects in the epidemiological, physicochemical, and biological fields. Air pollution has been in-

¹ Firket, J. (Secretary): Sur les causes des accidents survenus dans la vallée de la Meuse, lors des brouillards de Décembre 1930. Bull. Acad. Roy. Med. Belg. 11: 683-741, 1931.

² Schrenk, H. H., et al.: Air Pollution in Donora, Pa. Epidemiology of the Unusual Smog Episode of October 1948, Public Health Bulletin No. 306, Federal Security Agency, Washington, D.C., 1949.

³ Ministry of Health: Mortality and Morbidity during the London Fog of December 1952. Report by a Committee of Departmental Officers and Expert Advisers Appointed by the Minister of Health. Reports on Public Health and Medical Subjects, no. 95, H.M. Stationery Office, 1954.

⁴ Fog and Frost. British Med. J. 2: 1626 (Dec. 15) 1962.

⁵ Greenburg, L., et al.: Report of an air pollution incident in New York City, Nov. 1953. Pub. Health Rep. 77: 7-16 (Jan.) 1962.

⁶ Major Smog Disasters. In: Clean Air Yearbook, 1963-1964. National Society for Clean Air, London, England, p. 34.

⁷ Bailar, J. C., III, King, H., and Mason, M. J.: Cancer Rates and Risks. USDHEW, PHSP 1148, U.S. Government Printing Office, Washington, D.C., 1964.

⁸ Kotin, P. and Falk, H. L.: Atmospheric factors in pathogenesis of lung cancer. Adv. Cancer Res. 7: 475-514, 1963.

⁹ Nelson, H.: Carcinogenic implications of inhaled pollutants. Arch. Environ. Health 8: 100-104 (Jan.) 1964.

criminated to the extent that it is held to be partially responsible for the increase in lung cancer, or at least to be an aggravating factor in this disease.¹⁰ Most informed opinion, however, considers cigarette smoking to be a much more significant agent.

Four independent studies have shown that previous longtime residence in other countries with different degrees of air pollution was associated with varying incidence of lung cancer, the variation in frequency being dependent upon or associated with the factor of exposure to polluted air in the earlier parts of life. Thus, in groups of immigrants to New Zealand and to Australia from Great Britain, where air pollution levels are far higher than in comparatively unindustrialized New Zealand and Australia, lung cancer mortality was higher than among native New Zealanders and Australians, respectively, even though they were all from a similar ethnic background and had similar smoking habits.^{11, 12} Similarly, in a group of immigrants to South Africa from Great Britain, the mortality from lung cancer was higher than among white South Africans, who smoke even more than the British.^{13, 14} In a Norwegian group emigrant to the United States,¹⁵ it was found that the lung cancer occurrence was intermediate between that of Norwegians who stayed at home and that of native Americans, being about three-quarters the rate for native Americans, whereas the rate in Norway—where there is much less air pollution—is only half the American rate.

Deaths from lung cancer have a rate in the largest metropolitan areas in the United States which is twice the rural level.¹⁶ A difference remains even after full allowance is made for differences in smoking patterns. In general, the rate is in direct proportion to city size, as is also the degree of air pollution.¹⁷

In "Smoking and Death Rates" (1958), by Hammond and Horn,¹⁸ this illuminating comment was made: "As expected, the death rate due to lung cancer * * * was found to be higher in urban than in rural areas. The age-standardized death rate was 34 per 100,000 in rural areas, as compared with 56 per 100,000 in cities of over 50,000 population. However, cigarette smoking is more common among city dwellers than among men in rural areas. Standardized for smoking habits as well as for age, the rate was 39 per 100,000 in rural areas and 52 per 100,000 in cities of over 50,000 population. Thus, when standardized for both factors, the rate was still 25 percent lower in rural areas than in large cities."

Several British studies provide further confirmation on this point.

Stocks and Campbell, who had conducted in earlier study (1955),¹⁹ said that their studies suggested that "abolition of cigarette smoking might be expected to reduce the deaths of men in Liverpool from lung cancer by about one-half, and three-quarters of the remaining half would be due to some local cause only slightly present in the rural area and most likely to be some kind of air pollution." Stocks was more specific in 1960. In summarizing some later studies he stated: "Lung cancer mortality is strongly correlated with smoke density in the atmosphere in 26 areas of Northern England and Wales, in 45 districts of Lancashire and the West Riding of Yorkshire, and in 30 county boroughs, whilst similar though weaker correlations are found within Greater London."²⁰

¹⁰ Shimkin, M. B.: Science and Cancer, PHS Pub. No. 1162, USDHEW, National Cancer Institute, 1964.

¹¹ Eastcott, D. F.: The epidemiology of lung cancer in New Zealand. *Lancet* 1:37-39 (Jan. 7) 1956.

¹² Dean, G.: Lung cancer in Australia, *Med. J. Australia*, 49:1003-1006 (June 30) 1962.

¹³ Dean, G.: Lung cancer among white South Africans. *Brit. Med. J.* 2:852-857 (Oct. 31) 1959.

¹⁴ Dean, G.: Lung cancer among white South Africans, Report on a further study. *Brit. Med. J.* 5267:1959-1605 (Dec. 16) 1961.

¹⁵ Haenszel, W.: Cancer mortality among foreign-born in the United States. *J. Natl. Cancer Inst.* 26:37-132 (Jan.) 1961.

¹⁶ Anderson, R. J.: Epidemiologic studies of air pollution. *Dis. Chest* 42:474-481 (Nov.) 1962.

¹⁷ Haenszel, W., et al: Tobacco Smoking Patterns in the United States. Public Health Monograph No. 45, USDHEW, PHSP 463, U.S. Government Printing Office, Washington, D.C. 1956.

¹⁸ Hammond, E. C., and Horn, D.: Smoking and death rates—report on forty-four months of follow-up of 187,783 men. II. Death rates by cause. *J.A.M.A.* 166:11, 1294-1308 (March 15) 1958.

¹⁹ Stocks, P., and Campbell, J. M.: Lung cancer death rates among nonsmokers and pipe and cigarette smokers. An evaluation in relation to air pollution by benzopyrene and other substances. *Brit. Med. J.* 4945:923-929 (Oct. 15) 1955.

²⁰ Stocks, P.: Relations between atmospheric pollution in urban and rural localities and mortality from cancer, bronchitis and pneumonia, with particular reference to 3, 4 benzopyrene, beryllium, molybdenum, vanadium and arsenic. *Brit. J. Cancer* 14:379-418, 1960.

Laboratory investigations have provided further clues. In one study, a selected strain of mice, sensitized with influenza virus and then exposed to ozonized gasoline, similar to photochemical smog, developed bronchogenic cancer of the type which humans have.²¹⁻²² In another recent study, repeated intratracheal administrations to a group of hamsters of benzo (a) pyrene in particulate form, carried by an inert dust, induced 100 percent incidence of bronchogenic carcinoma.²³ The pollutant used in this last study, benzo (a) pyrene, is one of the commonest carcinogens in the community air over our cities.

There is some evidence that the combined effects of cigarette smoking and urban residence in their association with lung cancer are much more than additive.²⁴ In this connection, it is widely held that air pollution is a highly significant component of urban residence.

Smoking has been shown to inhibit ciliary action in the respiratory tree, and thus may make the lungs more vulnerable to the harmful effects of air pollution.²⁵ But air pollution too inhibits ciliary action and may in turn make the lungs more vulnerable to the effects of smoking.²¹ Supplementing the epidemiological findings and the results of laboratory and other studies. The concept that polluted air contributes to carcinogenesis is based, according to Kotin,²⁶ on the following experimental considerations.

1. Carcinogenic agents have been identified in the polluted air of essentially all cities in which they have been sought.
2. The stability and survival of carcinogenic hydrocarbons in the atmosphere are compatible with the postulated biological effect.
3. Bio-assay has established the carcinogenic properties of the compounds identified in and extracted from polluted air.
4. Alteration in function and structure of the respiratory epithelium of representative mammalian species has been demonstrated following exposure to a broad spectrum of environmental irritants.
5. Carcinogenic agents and respiratory irritants occur in the atmosphere in a physical state that is compatible with a biological effect on exposed intact host.
6. Soot recovered from human lungs has been shown to be free of the carcinogen, 3:4-benzopyrene (indicating that this carcinogen has been deposited in the lungs)

CHRONIC BRONCHITIS

In Great Britain, nearly 10 percent of all deaths and more than 10 percent of all industrial absences due to illness are caused by chronic bronchitis.²⁷ It is becoming evident that this condition, or one very similar to it, has a higher prevalence in this country than we had thought.²⁸ One investigation in the United States, using the same criteria as the British—that is, chronic productive cough, most days, for three months of two successive years—found chronic bronchitis in 21 percent of a series of males 40 to 59 years of age.²⁹

Cigarette smoking and air pollution are accepted in Great Britain as distinct causes of chronic bronchitis.³⁰ Positive associations with mortality from this disease have been shown by all these air pollution indexes: population density,³¹

²¹ Kotin, P., and Falk, H. L.: Air pollution and lung cancer. In: Proceedings, National Conference on Air Pollution, USDHEW, PHS Pub. No. 1022, U.S. Government Printing Office, Washington, D.C., 1963.

²² Kotin, P., and Falk, H. L.: II. The experimental induction of pulmonary tumors in strain-A mice after their exposure to an atmosphere of ozonized gasoline. *Cancer* 9:910-917 (Sept.-Oct.) 1956.

²³ Saffioti, U., et al: Experimental studies of the conditions of exposure to carcinogens for lung cancer induction. *J. APCA* 15:23-25 (Jan.) 1965.

²⁴ Haenszel, W., et al: Lung cancer mortality as related to residence and smoking histories. I. White males. *J. Natl. Cancer Inst.* 28, 947-1001 (April) 1962.

²⁵ Ballenger, J. J.: Experimental effect of cigarette smoke on human respiratory cilia. *New Eng. J. Med.* 263: 832-835, 1962.

²⁶ Kotin, P.: Air pollution with cancerigenic substances. *Acta Union Internationale Contre le Cancer* 19: 3-4, 469-471, 1963.

²⁷ Fletcher, C. M.: Chronic bronchitis: Its prevalence, nature, and pathogenesis. *Am. Rev. Resp. Dis.* 80:483-494, 1959.

²⁸ Ferrels, B. G., Jr. and Anderson, D. O.: The prevalence of chronic respiratory disease in a New Hampshire town. *Am. Rev. Resp. Dis.* 86:165-177 (Aug.) 1962.

²⁹ Gocke, T. M., and Duffy, B. J.: Epidemiology of chronic bronchitis in Jersey City. *Arch. Int. Med.* 110:606-614 (Nov.) 1962.

³⁰ Holland, W. W., et al: Respiratory disease in England and the United States. *Arch. Environ. Health* 10: 338-343 (Feb.) 1965.

³¹ Fletcher, C. M.: Chronic bronchitis, smoking, and air pollution. In: James, G., and Rosenthal, T. (editors): *Tobacco and Health*. Charles C. Thomas, Springfield, Ill., 1962.

amount of fuel used,³² sulfur dioxide air levels,^{33,34} settled dust measures,³⁵ airborne dust measures,³⁶ and decreased visibility.³⁷ Persons known to suffer from chronic bronchitis, and kept under regular observation, showed a worsening of their symptoms on days of higher air pollution.³⁸

PULMONARY EMPHYSEMA

Morbidity and mortality from pulmonary emphysema are increasing rapidly in the United States.³⁷ In the 10-year period from 1950 through 1959, deaths among males from this cause rose from less than 1.5 per hundred thousand population to near 8 per hundred thousand.³⁸ The extent and cost of this disease are further indicated by social security figures. Of 286,434 persons who received monthly payments for disability in 1962, 17,630 or 6.2 percent were suffering from emphysema.³⁹ This percentage was exceeded only by those who had arteriosclerotic heart disease. Social Security disability payments to persons for whom emphysema is the primary medical diagnosis are estimated at about \$60 million a year.

Patients with pulmonary emphysema improve when they are protected from exposure to irritant air pollution. One study demonstrated that when such patients are placed in a room in which the outdoor air of a smoggy Los Angeles day has been purified by electrostatic precipitation and charcoal filtration, they express subjective relief and also show objective improvement after 24 hours.⁴⁰ The fact that emphysema seems to be increasing especially in urban areas also points to air pollution as a possible contributing factor, as does also the striking urban-rural gradient found for deaths from emphysema.⁴¹ Data for white males and white females on an age-adjusted basis show that the rates are about twice as high in urban areas as in rural areas.

CHRONIC CONSTRICTIVE VENTILATORY DISEASE

The effort required for breathing is increased as a result of inhaling irritant air pollutants. Studies have shown that such pollutants, at levels which are reached at times in urban environments, can cause constriction in the air passages.^{42,43} This might contribute to a persistent nonspecific respiratory condition known as chronic constrictive ventilatory disease. While healthy persons may not notice the extra breathing effort imposed by airway constriction, this added burden may become unbearable for persons whose lungs or hearts are already functioning marginally because of respiratory disease.

BRONCHIAL ASTHMA

This is another condition which is often made worse by air pollution. Since there is a long list of stimuli which are capable of triggering asthmatic attacks, it is difficult to ascertain the role of air pollutants. It has long been known that occupational exposure to certain dusts and vapors, including many which are sometimes found in substantial concentration in the air over our cities,

³² Daly, C.: Air pollution and causes of death. *Brit. J. Prev. Soc. Med.* 13: 14-27 (Jan.) 1959.

³³ Pemberton, J. and Goldberg, C.: Air pollution and bronchitis. *Brit. Med. J.* 4887: 567-573 (Sept. 4) 1954.

³⁴ Burn, J. L., and Pemberton, J.: Air pollution, bronchitis, and lung cancer. *Int. J. Air & Water Poll.* 7: 5-16 (Jan.) 1963.

³⁵ Stocks, P.: Cancer and bronchitis mortality in relation to atmospheric deposit and smoke. *Brit. Med. J.* 5114: 74-79 (Jan. 10) 1959.

³⁶ Reid, D. D.: General epidemiology of chronic bronchitis. *Proc. Roy. Soc. Med.* 49: 767-780, 1956.

³⁷ Mortality Analysis and Summary. In: *Vital Statistics of the United States 1960*, Vol. II, Sec. 1. USDHEW, PHS, National Vital Statistics Division.

³⁸ A Study of Pollution—Air, A Staff Report to the Committee on Public Works, United States Senate. U.S. Government Printing Office, Washington, D.C., 1963.

³⁹ Disability Applicants Under the Old-Age, Survivors, and Disability Insurance Program, 1962, Selected Data, USDHEW, Social Security Adm., Div. of the Actuary, Baltimore, A:A: 4, April 1964.

⁴⁰ Motley, H. L., et al.: Effect of polluted Los Angeles air (smog) on lung volume measurements. *J. A.M.A.* 171:1469-1477 (Nov. 14) 1959.

⁴¹ Merrill, M. H.: Public health responsibilities and program possibilities in chronic respiratory diseases. *Am. J. Pub. Health* 53:25-33 (March) 1963.

⁴² Speizer, F. E., and Ferris, E. C.: The prevalence of chronic non-specific respiratory disease in road tunnel employees. *Am. Rev. Resp. Dis.* 88:205-212 (Aug.) 1963.

⁴³ Prindle, R. A., et al.: Comparison of pulmonary function and other parameters in two communities with widely different air pollution levels. *Am. J. Pub. Health* 53:200-216 (Feb.) 1963.

can trigger asthmatic attacks. And the Donora catastrophe provided a striking example of local aggravation of asthmatics (with a number of deaths reported), caused by fumes emanating from steel and other manufacturing plants, under conditions favorable for their accumulation.²

In New Orleans, epidemic outbreaks of "asthmatic attacks" have been associated with certain local wind conditions.^{44, 45} At first, spontaneous underground combustion in abandoned city disposal dumps had seemed to be incriminated. However, a recent study suggests that there is more than one point source of air pollution causing an asthmatic-type disease in New Orleans, and there are probably multiple sources.⁴⁶

There have been other instances—one in Pasadena,⁴⁷ another in Nashville⁴⁸—in which air pollutants have been shown, in epidemiological studies, to precipitate attacks of bronchial asthma in known cohorts of asthmatics. The mechanism by which airborne materials precipitate attacks of asthma is not yet known, but the significant fact is that asthma, or an asthmalike disease, can be induced by man-made community air pollutants.

For bronchial asthma due to natural airborne allergenic agents (pollen and spores), see below: Effects of aeroallergens.

"YOKOHAMA ASTHMA"

As long ago as 1946, many cases of a respiratory disorder commonly referred to as "Yokohama asthma" appeared among American troops stationed in the highly industrialized Yokohama area of Japan, and soon spread to dependents who were living in that area. Later the same condition was noted among our military personnel in the Tokyo area.^{49, 50, 51, 52} Earlier studies indicated that the disease correlated best with air contaminants and smog. Severe attacks have been observed to be more frequent in the winter months, when smoke and fumes from the heavily industrialized Kanto Plain (Tokyo-Yokohama area) attain ground level concentrations so intense that they represent a hazard to low-flying small aircraft. Removal of affected personnel from the area, especially if early, usually results in recovery. However, permanent damage has resulted in patients who were not promptly removed from the area.^{53, 54}

"Tokyo-Yokohama asthma" is still under detailed study, but several important conclusions have already been reached.⁵⁴ Studies conducted in 1960 in a pulmonary function laboratory revealed that the patients were much more severely affected than was the original clinical impression. In these studies, the patients' incapacity due to shortness of breath became apparent, and their failure to respond to bronchodilators was documented. Starting in 1961, 182 men were studied on three occasions over an 18-month period, and 8 revealed a typical history of "T-Y asthma." Follow-up studies in 1962 on 244 cases who were returned to the United States revealed that 64 percent still had abnormal inflow patterns, and in some, significant emphysema was present. The evidence seems to be increasing that emphysema may occur in susceptible individuals if they stay too long in the Kanto Plain area. A total of 620 patients have been diagnosed as having "T-Y asthma" from 1960 to 1962. All have a negative history of clinical respiratory disease prior to coming to Japan. All but 18 were moderate-to-heavy cigarette smokers.

⁴⁴ Lewis, R., et al: Air Pollution and New Orleans asthma; a preliminary report. *Pub. Health Rep.* 77:947-954 (Nov.) 1962.

⁴⁵ Weill, H., et al: Preliminary report: clinical and allergic study of New Orleans Asthma. Presented at Sixth Air Pollution Medical Research Conference, San Francisco, Calif. Jan. 28-29, 1963.

⁴⁶ Weill, H., et al: Further observations on New Orleans asthma. *Arch. Environ. Health* 10:148-151 (Feb.) 1965.

⁴⁷ Schoettlin, C. E., and Landau, E.: Air Pollution and asthmatic attacks in the Los Angeles area. *Pub. Health Rep.* 76:545-548 (June) 1961.

⁴⁸ Zeldberg, L. D., et al: The Nashville air pollution study: V. Mortality from diseases of the respiratory system in relation to air pollution. Presented at 91st Annual Meeting of the APEA meeting, Kansas City, Nov. 1963.

⁴⁹ Huber, T. E., et al: New environmental respiratory disease (Yokohama asthma). *A.M.A. Arch. Indust. Hyg. & Occupat. Med.* 10:399-408 (Nov.) 1956.

⁵⁰ Phelps, H. W., et al: Air pollution asthma among military personnel in Japan. *J. A.M.A.* 175:990-993 (March 18) 1961.

⁵¹ Phelps, H. W.: Air pollution asthmatic bronchitis among United States personnel in Japan. *Japan Heart J.* 2:180-186 (April) 1961.

⁵² Beard, R. R., et al: Observations on Tokyo-Yokohama asthma and air pollution in Japan. *Pub. Health Rep.* 79:5, 439-444 (May) 1964.

⁵³ Motley, H. L., and Phelps, H. W.: Pulmonary function impairment produced by atmospheric pollution. *Dis. Chest* 45:154-162 (Feb.) 1964.

⁵⁴ Phelps, H. W.: Follow-up studies in Tokyo-Yokohama respiratory disease. *Arch. Environ. Health* 10:143-146 (Feb.) 1965.

THE COMMON COLD AND OTHER RESPIRATORY DISEASES

Common colds and other infections of the upper respiratory tract occur more frequently in areas with high pollution levels. This was indicated in a study in a small Maryland city as long ago as 1950,⁵⁵ and has since been confirmed by studies in Great Britain,⁵⁶ Japan,^{57, 58, 59} and the Soviet Union.⁶⁰ In connection with a study of air pollution in the Detroit-Windsor area by a U.S.-Canada International Joint Commission,⁶¹ responses to a Cornell Medical Index questionnaire indicated that people living in the two high-pollution areas in Detroit reported themselves afflicted with more symptoms of illness than people living in the two low-pollution areas. This was particularly true, and apparently statistically significant, in regard to prevalence of coughing and colds.

An interim analysis of the diaries of homogeneous groups of student nurses in a relatively polluted area, Los Angeles, and a relatively unpolluted one, Santa Barbara, California, showed that the mean frequencies of all respiratory and other symptoms in the former area were equal to or greater than the corresponding symptom frequencies in the latter.⁶² The probability of any one nurse reporting a cough on any one day of the period analyzed was 20 percent in Los Angeles and 6 percent in Santa Barbara. In the same study, a time-associated relationship between daily oxidant levels and the mean daily frequency of eye discomfort in the Los Angeles group was reported.

ALL RESPIRATORY DISEASES

That there is a definite link between air pollution and respiratory disease was further indicated when results were reported in November 1963 from a survey of deaths in and around Nashville, Tennessee, for a 12-year period ending in 1960.⁶³ This would appear to provide evidence that normal city levels of air pollution correlate well with death rates from diseases of the respiratory system. Altogether, data on 38,207 deaths were studied and, even when full allowance was made for differences in age, color, and socio-economic status, the sections of the city subjected to heaviest air pollution were areas of maximum deaths from all respiratory diseases and from such specific respiratory diseases as tuberculosis, influenza, and pneumonia. Although smoking was not included in this study, it is not considered to be of significance for those specific diseases of the respiratory system. What is significant is that mortality ratios were correlated with air pollution levels in the ambient air.

Similar findings were made in a study conducted in the area of Buffalo, New York. A recent report on this study indicated that high levels of air pollution, as measured by suspended particulates, were correlated with elevated mortality from all causes and with mortality due to chronic respiratory diseases. Among white males 50 to 69 years old, the death rate for all causes was 50 percent higher in the area of heaviest particulate pollution than in the area of lowest particulate pollution. A similar mortality pattern was found among women, which supports the hypothesis that a non-occupational environmental factor was responsible. An even more striking relationship was found between particulate levels and mortality from chronic respiratory diseases. In this respect, the

⁵⁵ Helmann, H. et al: Health and air pollution. A study on a limited budget. *A. M. A. Arch. Indust. Hyg. & Occupat. Med.* 3:399-407 (April) 1951.

⁵⁶ Holland, W. W., et al: Influence of the weather on respiration and heart disease. *Lancet* 2:338-341 (Aug. 2) 1961.

⁵⁷ Abe, S.: Air pollution in Sapporo. *Science and Labor* 13:98-108, 1958. (Quoted by Toyama, T. in *Air Pollution and its Health Effects in Japan*. *Arch. Environ. Health* 8:161-181 (Jan.) 1964.)

⁵⁸ Saruta, N.: Effects of air pollution on the health of people of northern Kyushu, Japan. (First Report) *Kyushu J. Med. Sci.* 12:167-176, 1961. (Quoted by Toyama, T. in *Air Pollution and its Health Effects in Japan*. *Arch. Environ. Health* 8:161-181 (Jan.) 1964.)

⁵⁹ Suzuki, T.: Air Pollution and its health effects in Amagasaki City. Report of Air Pollution Control Committee of Amagasaki, 1962. (Quoted by Toyama, T. in *Air Pollution and its Health Effects in Japan*. *Arch. Environ. Health* 8:161-181 (Jan.) 1964.)

⁶⁰ Yansheva, N. Ya.: The effect of air pollution from power and chemical plants on health. *Gigiena i Sanitariya* 8:15, 1957. (Transl. by Levine, B. S. in *U.S.S.R. Literature on Air Pollution and Related Occupational Diseases*, Vol. 1, 1960, U.S. Dept. of Commerce, Office of Technical Services, Wash. 25, D.C.)

⁶¹ Air Pollution in the Detroit-Windsor Area. Report of the Technical Advisory Board to the International Joint Commission United States and Canada. Washington. Ottawa, 1959.

⁶² Hammer, D. I., et al: Los Angeles air pollution and respiratory symptoms. *Arch. Environ. Health* 10: 475-480 (Mar.) 1965.

⁶³ Zeidberg, L. D., et al: The Nashville air pollution study: I. Sulfur Dioxide and bronchial asthma—a preliminary report. *Am. Rev. Resp. Dis.* 84:489-503 (Oct.) 1961.

death rate in the area of highest pollution was nearly twice that in the lowest pollution area. This statistical relationship showed up even when allowance was made for age and socio-economic status of the deceased persons.

EFFECTS OF AEROALLERGENS

(1) *Bronchial asthma*

It is widely recognized that a number of airborne substances cause allergic responses in sensitized individuals. These substances, such as pollen, spores, rusts, and smuts, and known as aeroallergens, present a major public health problem.⁶⁴

Bronchial asthma and allergic rhinitis, and more commonly known as hay fever, are typical human responses to exposure to aeroallergens. Pathological symptoms may be severe,⁶⁵ and the primary complications of bronchial asthma are numerous,⁶⁶ in extreme cases sometimes even leading to death.⁶⁷

Aeroallergens are primary causative agents in inducing bronchial asthma. Estimates of the national incidence of this disease vary widely, but a recent study of the epidemiology of asthma and hay fever in a total community, Tecumseh, Michigan, indicates that 5 percent of the inhabitants had a medical history of asthma.⁶⁸ This and other studies indicate that many millions of persons in this country are or have been affected by this condition. For many of these it is a severe handicap.

Allergic pollens come from trees, grasses, and weeds. Ragweed presents the most serious problem in the pollen allergy in the United States. Although found primarily in the central portion of the continent, infestation is developing in other areas. Other aeroallergens, such as spores from the mold *Alternaria*, are found in every State.

(2) *Allergic rhinitis*

Allergic rhinitis, or hay fever, is even more prevalent than bronchial asthma. Studies of university student populations since 1950 show an incidence of ragweed pollinosis as follows: in Indiana, 18.7 percent; in the State of Washington, 16.7 percent; and in Michigan, 19.2 percent.⁶⁹ The National Health Survey has estimated that about thirteen million persons throughout the country are being adversely affected by hay fever and/or asthma. Hay fever, unlike asthma, is rare in children under 10 years of age. The prevalence figure from the general population must therefore of necessity be smaller than the prevalence figure for selected young adult populations. The study of students mentioned above also shows that many foreign students develop ragweed pollinosis for the first time in their lives after a year or two of exposure to this potent aeroallergen. This fact has obvious public health significance when we consider that the ragweed plant appears to be migrating on this continent.

It might be thought that simple hay fever presents less of a hazard to health. Recent analyses indicate, however, that 5 to 10 percent of persons subject to allergic rhinitis will develop asthma if the disease runs unchecked.⁷⁰ There is therefore ample reason to be seriously concerned about the effects on our national health and well-being of aeroallergens in general and of ragweed pollinosis in particular. There is little doubt that our agricultural, highway construction, and suburban land developments, which leave so much bare soil on which ragweed thrives, are leading to a wider distribution of ragweed pollen and of the asthma which it causes.⁷¹ There are a number of possibilities for controlling ragweed pollen and other aeroallergens. These control measures, however, are

⁶⁴Hewson, E. W.: Atmospheric pollution in relation to microclimatology and micro-meteorology: Some problems. In: Proceedings of the Toronto Meteorological Conference 1953. Royal Meteorological Society, London, 1954, pp. 240-252.

⁶⁵Vaughn, W. T., and Black, J. H.: Practice of Allergy. C. V. Mosby Co., St. Louis, 1954.

⁶⁶Sheldon, J. M., et al: A Manual of Clinical Allergy. W. B. Saunders Co., Philadelphia, 1953.

⁶⁷Rackemann, F. M.: Deaths from asthma. *J. Allergy* 15:249-258 (July) 1944.

⁶⁸Broder, I. et al: The epidemiology of asthma and hay fever in a total community, Tecumseh, Michigan. I. Description of study and general findings. *J. Allergy* 33:513-523 (Nov.-Dec.) 1962.

⁶⁹Maternowski, C. J., and Mathews, K. P.: The prevalence of ragweed pollinosis in foreign and native students at a midwestern university and its implications concerning methods for determining the inheritance of atopy. *J. Allergy* 33: 130-140 (March-April) 1962.

⁷⁰Broder, I., et al: The epidemiology of asthma and hay fever in a total community, Tecumseh, Mich. II. The relationship between asthma and hay fever. *J. Allergy* 33: 524-531 (Nov.-Dec.) 1962.

⁷¹Wagner, W. R., Jr., and Beals, R. F.: Perennial ragweeds (*Ambrosia*) in Michigan with the description of a new intermediate taxon. *Rhodora* 60: 177-204, 1958.

administratively very complex; for example, they involve a change in agricultural practice wherein the farmers would spray the fields after the crop has been harvested. Such control methods should be evaluated and the effective ones adopted for use until such time as adequate immunochemical means of desensitization become available.

EFFECTS ON LABORATORY ANIMALS (EXCLUDING CANCER)

Laboratory research has provided important information concerning the effects of specific pollutants on animals. Mice, rabbits, guinea pigs, rats, and monkeys have been utilized to demonstrate the toxic properties of such air pollutants as sulfur dioxide, sulfuric acid, hydrogen sulfide, ozone, nitrogen dioxide, and some dusts.

In one recent experiment,⁷² the respiratory response of guinea pigs inhaling low concentrations of acrolein was characterized by an increase in total respiratory flow resistance, accompanied by decreased respiratory rates and increased tidal volumes. The changes in respiratory function were reversible when the animals were returned to clean air. In another study of considerable relevance, conducted by Dr. Mary Amdur,⁷³ guinea pigs which had relatively higher initial flow resistance values, corresponding roughly to humans with respiratory disease, were exposed to an irritant aerosol or to an irritant gas. These animals showed a greater resistance than did control animals, particularly at the lower concentrations, at which the latter group had shown only a slight change. Animals which were exposed to both an inert aerosol and an irritant gas showed an enhancement of the effect over that shown by the irritant gas alone.

Other experiments with animals have shown that certain irritants common in polluted air can slow down, and even stop, ciliary activity in the air passages.⁷⁴ This impairment results in less effective cleansing of the mucus carpet of those air passages, and hence greater susceptibility to respiratory infection. A two-hour exposure of mice to as little as 3.5 parts per million of nitrogen dioxide significantly increased their susceptibility to respiratory infection initiated by challenge with an aerosol of *Klebsiella pneumoniae*. Infected animals exposed to 25 ppm of nitrogen dioxide for two hours showed an increased mortality rate and decreased survival time.⁷⁵

Thus, information which has been obtained by artificial exposure of animals is providing some indexes of both human and animal effects to be expected from natural exposure.⁷⁶

On the other hand, knowledge of the toxic potentialities of some air pollutants, such as peroxyacyl nitrates, ketenes, free radicals or radical formers, and air ions, is grossly incomplete and unsatisfactory. Similarly, only a beginning has been made in the more important area of toxicological interactions in which the presence of one air pollutant may, at one extreme, completely abolish the effects of another or, at the other extreme, enhance the effects out of all proportion to the toxicity of either alone.

RADIOACTIVE MATERIALS

In this brief survey of the part played by radioactive materials in the overall contamination of the atmosphere, no attempt will be made to cover the possible wartime use of nuclear devices and resultant civil defense requirements. Our concern here is rather with the increasing peacetime uses of all forms of ionizing radiation, and specifically with radioactive materials which are airborne.

(1) Sources

The sources of radioactive materials which may be present in our environment include: natural sources (radium and thorium in earth and cosmic rays); nuclear weapons testing (fallout); nuclear power production (waste disposal); nuclear fuel processing (waste disposal); and radioisotope use and disposal (industry and research).⁷⁷

⁷² Murphy, S. D., et al: Respiratory response of guinea pigs during acrolein inhalation and its modification by drugs. *J. Pharmacol. and Exp. Therap.* 141: 79-83 (July) 1963.

⁷³ Amdur, M. O.: The effect of high flow-resistance on the response of guinea pigs to irritants. 25:564-568 (Nov.-Dec.) 1964.

⁷⁴ Falk, H. L., and Kofin, P.: Chemical and biological considerations of atmospheric carcinogenic agents. *J. APCA* 7:12-14 (May) 1957.

⁷⁵ Purvis, M. R., and Ehrlich, R.: Effect of atmospheric pollutants on susceptibility to respiratory infection. II. Effect of nitrogen dioxide. *J. Infect. Dis.* 11: 72-76, 1963.

⁷⁶ Catcott, E. J.: Effects of air pollution on animals. In: *Air Pollution, SHO Monograph Series* no. 46, Geneva, 1961, pp. 221-231.

⁷⁷ Terrill, J. G. Jr.: Radiological Health Activities Related to Weapons and Missile Testing. A statement prepared for the Senate Committee on Public Works, Subcommittee on Air and Water, June 30, 1964.

The greatest source is from natural deposits of radioactive materials. The predominant component of radioactivity in air is the noble gas, radon-222, which is formed in the earth from decay of radium-226. A portion escapes to the atmosphere, where further decay results in a series of radioactive atoms which become a part of the normal atmospheric aerosol by attachment to other existing particles.

Great quantities of radioactive debris have been injected into the atmosphere by nuclear testing. Debris injected into the upper atmosphere remains for several months to years during which most of the radionuclides decay to insignificant concentrations, so that only the longer-lived nuclides, such as strontium-90 and cesium-137, enter the lower atmosphere. The debris injected into the lower atmosphere remains airborne long enough for the freshly formed fission products to be transported around the earth, contributing enroute to ground-level contamination. Fortunately, great dilution, washout in precipitation, and decay occur prior to population exposures, so that the probability of inhaling significant amounts has been slight. With the limited test ban treaty, this source has declined significantly. Radiation exposures from such radioactive fallout occur primarily from whole-body exposure from gamma-emitting nuclides deposited on the surface, and from radionuclides deposited in tissues through ingestion.

The processing, manufacturing, and use of nuclear fuels and radioisotopes, and the disposal of associated wastes, have incorporated engineering and procedural controls which have maintained these minimal sources. Several incidents at nuclear installations which have aroused concern appear to have been of the nature of industrial "accidents," and precautions have been taken to minimize the likelihood of their recurrence.

Inhalation has been recognized as a major, if not the most important, route of entry to the body of potentially hazardous materials for occupational exposures. Nonoccupational exposures may occur from external gamma radiation and ingestion, as mentioned above, as well as through inhalation.

(2) Effects

A great deal is known about the effects on human beings of large doses of radiation—such as would be encountered in a nuclear war—but comparatively little about the effects of small doses of radiation, for example, natural background radiation and fallout from nuclear tests.^{78 79}

The biological effects of radiation are either *somatic*, that is, occurring during the lifetime of the exposed organism, or *genetic*, the effects on germ cells. These effects depend on the type and quality of radiation and the quantity absorbed in tissues. Because of the difficulty of detecting effects of very low exposures, it is not known whether or not there is a "threshold" for any of the radiation effects; i.e., a dose below which there is no effect. There is some evidence from studies of experimental animals that suggests there is no "threshold" for genetic effect. If this is true for all effects, any amount of radiation causes damage, and the damage increases with increase in total cumulated exposure.

Somatic Effects.—The time of appearance of somatic effects is dependent on the magnitude of exposure. Following very large acute exposures, effects may appear within a few hours or less. Such early effects include central nervous system disorders, nausea, decrease in formed blood elements, intestinal disorders, and radiation burns. Longterm effects which may appear after many years from acute and chronic exposures, both large and small, include leukemia, bone and other cancers, cataracts, and overall shortening of life span.

Genetic Effects.—Genetic effects result from radiation damage to germ cell chromosomes, i.e., cell constituents responsible for transmitting characteristics from generation to generation. These effects can appear in subsequent generations. The effect may produce undetectable defects in the offspring; some may appear unspecifically as health impairments which may be minor or which may result in premature death or permanent serious illness. Studies with experimental mammals indicate that genetic damage increases with increase in exposure rate as well as total exposure.

Exposure in the U.S. population to fallout is slight compared to natural and other manmade health hazards. However, since the application of radiation-producing machines and materials, such as nuclear reactors, radioactive nuclides, and X-rays, will continue to increase in the future, radiation exposure will also

⁷⁸ United Nations, 1962. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation: New York.

⁷⁹ National Academy of Sciences—National Research Council. The biological Effects of Atomic Radiation. Washington. 1956 and 1960 Reports.

increase. Any risk to the population should be commensurate with the benefit resulting from the use of nuclear energy. Guides have been established to assist in maintaining radiation exposures at reasonable levels.^{80, 81}

(3) Relative importance as air pollutants

To put the various sources of radiation exposure in some perspective, the Federal Radiation Council⁸² estimates the radiation exposures to the U.S. population resulting from all past nuclear tests at 110 millirem (the conventional unit of measurement) for whole body exposure over a 30-year period and at 465 millirem for bone exposure over a 70-year period. These amounts are only 3 percent and 5 percent, respectively, of the corresponding figures (3,000 millirem and 9,000 millirem) for exposure to naturally occurring radioactive materials in the environment. Expressed in another way, the U.S. population having the highest exposure has received an exposure from the radioactive fallout of all past nuclear tests about equal to that from natural radiation in this country in one year. Of course, this exposure is *in addition* to that from natural sources.

1. *Pesticides.*—Airborne hazards from pesticides have largely been related to occupational exposure on the part of persons concerned with their application. There are some instances in which pesticides applied by aircraft have drifted from the intended area to another area, with troublesome consequences, but on the whole, the evidence of adverse effects on members of the general population from the inhalation of airborne pesticides is minimal.⁸³

On the other hand, pesticides not only provide an example of the many new chemicals which in their production and use are potential air pollutants but also constitute a class of products which, by virtue of their toxicity and widespread use, require special consideration in any program to anticipate and ameliorate the harmful effects of atmospheric pollution.

Sales of organic pesticidal chemicals by primary producers increased 15.7 percent in 1961 and another 14.4 percent in 1962, when they amounted to \$346,441,000. In the report cited above, the President's Science Advisory Committee pointed to increasing volume of use, persistence of some chemicals in the environment, observed effects on wildlife, and indications that at least two insecticides are accumulating in man, as evidence of the need to obtain more data on the present levels of pesticides in our environment and to increase our efforts to understand their longterm effects.

SULFUR OXIDES

The sulfur oxides that are of concern as atmospheric pollutants are sulfur dioxide, sulfur trioxide, and their acids and acid salts. Fossil fuels, such as coal and petroleum, contain elemental sulfur, and when the fuel burns, the sulfur is converted to sulfur dioxide and to a lesser degree, sulfur trioxide. Since fossil fuels are burned abundantly in the United States to heat buildings and to generate electric power, pollution of the atmosphere with the oxides of sulfur is widespread and is especially prevalent in cities. Petroleum refineries, smelting plants, coke processing plants, sulfuric acid manufacturing plants, coal refuse banks, and refuse burning activities are also major sources of sulfurous pollution.

Effects of Sulfur Oxides on Man

The evidence is considerable that sulfur oxide pollution aggravates existing respiratory disease in humans and contributes to its development. Sulfur dioxide gas alone irritates the upper respiratory tract; adsorbed on particulate matter, the gas can be carried deep into the respiratory tract to injure lung tissue. Sulfuric acid when inhaled in a certain particle size can also deeply penetrate the lung to damage tissue.

In the documented air pollution disasters—Meuse Valley, Belgium, 1930; Donora, Pennsylvania, 1948; New York City 1953 and 1963; London, 1952 and 1962—large numbers of people became ill and many died. All episodes had common factors; they occurred in heavily industrialized areas during relatively brief

⁸⁰ Federal Radiation Council. Background Material for the Development of Radiation Standards. Washington. Report No. 1, 1960 and Report No. 2, 1961.

⁸¹ Federal Radiation Council. Background for the Development of Radiation Protection Standards. Washington. Report No. 5, 1964.

⁸² Federal Radiation Council. Estimates and Evaluation of Fallout in the United States from Nuclear Weapons Testing Conducted Through 1962. Washington. Report No. 4, 1963.

⁸³ Interagency Coordination in Environmental Hazards (Pesticides): Hearings before the Subcommittee on Reorganization and International Organizations of the Committee on Government Operations, United States Senate, Part I (May, June 1963): U.S. Government Printing Office, Washington, 1964.

periods of anticyclonic weather conditions; and sulfur dioxide levels were excessively high as were levels of other gaseous and particulate pollution. Although the pattern of effects was not perfectly uniform in all these episodes, generally speaking, the elderly, the very young, and those with preexisting cardiorespiratory disease were most affected.

Epidemiological and clinical studies substantiate this evidence that certain portions of the population are more sensitive to sulfur oxide pollution. For examples: prolonged exposure to relatively low levels of sulfur dioxide has been associated with increased cardiovascular morbidity in older persons; prolonged exposures to higher concentrations of sulfur dioxide has been associated with an increase in respiratory disease death rates and an increase in complaints by school children of non-productive cough, mucous membrane irritation, and mucus secretion; the residual air in the lungs of emphysema patients has been significantly reduced when the patients breathed ambient air that had been filtered of pollutants; and the most important single factor to correlate (inversely) with the feeling of well-being in chronic bronchitis patients has been the level of smoke and sulfur dioxide pollution.

Sulfur oxides pollution can also adversely affect the more robust portions of the population. Experiments in which healthy human volunteers were exposed to sulfur dioxide concentrations several times higher than the taste threshold concentration indicate that such exposures will produce pulmonary function changes including increased respiration rates, decreased respiratory flow rates, and increased airway resistance. The impairment of function is greater when the sulfur dioxide gas is administered together with particulate matter.

In other experiments in which healthy human subjects were exposed to sulfur oxides, effects were observed but a complete interpretation of effects could not be made; for examples, concentrations of sulfur dioxide below the taste threshold produced cortical conditioned reflexes, and concentrations at the taste threshold desynchronized the predominant wave in electroencephalograms and increased the sensitivity of the dark adapted eye.

Clinical-epidemiological studies on humans in community atmospheres

Clinical-epidemiological studies on the acute and chronic effects of community atmospheres containing oxides of sulfur at various concentrations have been undertaken by numerous investigators. It should be noted that these atmospheres contained other pollutants as well and, that although sulfur dioxide is the measure of sulfurous pollution in the studies, also present were an undetermined amount of sulfuric acid mist and sulfate salts. It has been shown by numerous investigators that the effects related to a given amount of sulfur dioxide in community air can be expected to be greater than in laboratory experiments in which sulfur dioxide was the only pollutant.

Spicer made daily observations over a period of several weeks of air pollution and pulmonary function of a group of normal individuals and a group of subjects with chronic obstructive airway diseases. In general the airway resistance and other measures of pulmonary function of the two groups changed together from week to week, and persons within either group changed together from day to day. An analysis of individual persons revealed that some responded to changing concentrations of one component of air pollution, others responded to changing concentrations of another component, and still others responded to many things. The data seem to indicate increasing airway resistance in patients with chronic obstructive lung diseases when exposed to as little as 0.05 parts per million (ppm) sulfur dioxide in ambient air. Sulfur dioxide concentrations averaged over 2-hour periods ranged from nearly zero up to 0.5 ppm during the period of the study. Further studies are needed to substantiate these observations.

Lawther and Waller and Pemberton studied groups of patients with chronic bronchitis over several winters. Lawther's group consisted of about 1000 patients with established bronchitis who recorded daily whether they felt better or worse than on the preceding day. The percentage of those who felt worse than on the preceding day was then calculated. Fluctuations in this index followed closely the daily variations in air pollution, and when smoke rose above 300 $\mu\text{g}/\text{m}^3$ and sulfur dioxide above 0.21 ppm the health of the group deteriorated. The authors concluded that air pollution as measured by smoke and sulfur dioxide was the most important factor affecting the day to day well-being of the subjects.

McCarroll, et al studied a large number of families (approximately 1000 people) in New York City and correlated the symptoms of upper respiratory tract and eye irritation with sulfur dioxide concentrations. In two air pollution episodes occurring in the period November through December of 1963, in which the daily average sulfur dioxide concentration exceeded 0.2 ppm for 4 days and reached maximum 1 to 2 hour average concentrations of 0.9 to 1.5 ppm, there were significant increases in the incidence of rhinitis, sore throat, cough, and eye irritation.

Anderson and Ferris found that, after controlling for age, height, sex, and smoking habits, one second forced expiratory volume and Wright peak expiratory flow rates were greater for persons living in a town with less pollution (0.05 mg sulfur trioxide/100 cm²/day; 10 tons/mi²/mo dustfall) than for persons living in a more polluted town (0.4 mg sulfur trioxide/100 cm²/day; 35 tons/mi²/mo dustfall). In both towns air pollution was measured only during August and September, months of generally low pollution in the United States and Canada.

Prindle, et al observed greater airway resistance in persons who lived in the more heavily polluted of two towns where sulfation rates (3.7 mg sulfur trioxide/100 cm²/day) and dustfall (83 tons per square mile per month) were respectively 6.2 and 3.2 times greater in the one town than the other. Gaseous sulfur dioxide averaged 0.09 and 0.01 ppm in the high and low polluted towns respectively. The major source of pollution was a coal fired power plant.

Epidemiologic studies of morbidity within cities

Diseases which seem to be of the most concern from the standpoint of sulfur oxides pollution are chronic bronchitis and/or chronic disabling respiratory diseases, cardiac diseases, and respiratory diseases due to infection.

Martin studied daily hospital admissions in London during the periods 1958 to 1959 and 1959 to 1960. The hospital admissions were separated into three categories: (1) diseases from all causes; (2) cardiac diseases, and (3) respiratory diseases. For each category a daily morbidity index was determined as the deviation in number of admissions from the 15 day moving average. The separate daily morbidity indexes were then correlated with daily measures of smoke and sulfur dioxide. Correlation coefficients of morbidity from all causes with smoke and sulfur dioxide were significant only in 1958 to 1959. Correlation coefficients of respiratory morbidity with smoke and sulfur dioxide were essentially equal—0.25 in 1958 to 1959 and 0.34 in 1959 to 1960. Correlation coefficients of cardiac diseases with smoke were 0.28 in 1958 to 1959 and 0.22 in 1959 to 1960; with sulfur dioxide they were 0.20 in 1958 to 1959 and 0.23 in 1959 to 1960.

Burn and Pemberton observed that up to four times as many bronchitis attacks were reported than were expected during five smog periods in Salford, England during 1958. Daily average sulfur dioxide concentrations during these periods were between 0.5 and 1 ppm, and daily average smoke concentrations were above 1 mg/m³. During the year period, bronchitis attacks ranged from 130 percent of expectation in the most severely polluted area to 60 percent in the least polluted area. Average daily sulfur dioxide concentrations in the more heavily polluted areas were approximately 0.25 ppm; in the less polluted areas average daily sulfur dioxide concentrations were approximately 0.10 ppm. Average daily smoke values were approximately 500 µg/m³ in the more severely polluted areas and 350 µg/m³ in the less polluted areas.

In a Detroit, Michigan/Windsor, Ontario study, greater morbidity was observed in areas with higher pollution than in areas with lower pollution. Sulfur dioxide concentrations were about twice as high in the more polluted areas (0.04 to 0.10 ppm annual average) as in the lesser polluted areas. In the more highly polluted areas suspended particulates were found to be 1.2 to 1.8 times greater (193 to 281 µg/m³ annual average) than in the lesser polluted areas. As absolute differences in pollution between otherwise comparable areas increased, greater increases in sickness rate between the areas were noted.

Zeidberg, et al studied morbidity among 9,313 individuals in 2,833 households in Nashville, Tennessee. The major part of the analysis was confined to the middle socioeconomic class households representing 6,393 individuals. A direct correlation between morbidity and pollution could not be shown with any consistency except for those 55 years of age or older. In this older age group cardiovascular morbidity among the white population progressed as either the soiling index or sulfur dioxide concentration in the residential area increased. Cardiovascular morbidity was approximately twice as high in the

most polluted areas (annual average—Cohs 0.831 or more, sulfur dioxide 0.01 ppm or more) as in the least polluted areas (Cohs 0.330 or less, sulfur dioxide 0.005 ppm or less). The annual averages are geometric means which can be approximately converted to arithmetic means by multiplying by 1.5. Relationships between air pollution and morbidity rates for cancer, respiratory diseases, and gastrointestinal diseases could not be demonstrated.

Epidemiologic studies of morbidity between cities

Dohan studied the incidence of respiratory illnesses lasting more than 7 days in female employees in 5 cities. The results of this study showed a very high correlation (0.964) of the average concentration of suspended sulfate in the air in these cities with the rate of respiratory illnesses. The average sulfate concentrations for the cities ranged from 5 to 20 $\mu\text{g}/\text{m}^3$. During the noninfluenza epidemic years the incidence of respiratory disease was more than twice as great in the city with the highest surface concentration as in the city with the lowest sulfate concentration.

The incidence of total respiratory disease during the 1957 to 1958 Asian influenza epidemic was greater than in the same cities during non-epidemic years. In the city with the lowest concentration of suspended sulfates there was approximately a 20 percent increase in the incidence of respiratory illness during the epidemic year, whereas, in the city with the highest concentration of suspended sulfate there was approximately a 200 percent increase in the incidence of respiratory illness. During the influenza year the incidence of respiratory diseases in the city with the highest pollution was more than 5 times as high as in the city with the least pollution. The author could not demonstrate correlations between respiratory disease rates and the mean concentrations of benzene soluble organic matter, acetone soluble organic matter, nitrates, copper, or zinc. However, the mean concentrations of nickel and vanadium (measured in 4 cities) increased along with increase in incidence of respiratory disease.

Epidemiologic studies of morbidity associated with air pollution episodes

Increased illness rates associated with the acute air pollution episodes which occurred in the Meuse Valley in 1930, Donora in 1941, New York City in 1953 and 1962, and London in 1952 and 1962, and in which high concentrations of sulfur oxides were present have been reported.

In the Meuse Valley, Belgium during a period of anticyclonic weather in December, 1930, a dense fog enveloped the valley. By the third day many of the residents developed throat irritation, hoarseness, productive and non-productive cough, shortness of breath, and sense of chest constriction. Some individuals also developed nausea and vomiting. The most severely affected were elderly people and individuals who had previous cardiorespiratory disease. No measurements of air pollution were made at the time of the episode, but subsequent investigations indicated that the oxides of sulfur were the principle irritant.

In Donora, Pennsylvania in October, 1948 a similar meteorological condition occurred which lasted 4 days. By the third day 42.7 percent of the population (5910 persons) developed mild to severe symptoms of irritation characterized by burning of the eyes, tearing, nasal discharge, sore throat, non-productive cough, nausea, vomiting, and diarrhea. No age group was spared but the incidence rate of illness increased with age. Regardless of age the most sensitive individuals were those with pre-existing heart and lung disease. Retrospective studies indicated that sulfur dioxide levels may have reached 0.5 to 2.0 ppm and that large numbers of other airborne particulates and gases were present.

Ciocco and Thompson restudied the Donora population 10 years after the incident. Among the persons surviving in 1957 who could be questioned (80 percent of the total study group) there was no evidence that those who smoked tobacco in any form prior to October, 1948 became ill during the episode at a higher rate than those who did not smoke. The essential findings were that persons who reported acute illness at the time of the smog episode subsequently demonstrated higher mortality and higher prevalence of illness than the other persons living in the community at that time.

Abercrombie reported that the normal number of weekly applications for emergency bed service during the month of December in London was approximately 1000. In 1952 when a severe smog developed between December 5 and December 9 the weekly total number of applications was more than 2500. The increase in illness was larger in cardiorespiratory disease. The illness rate did not return to the normal statistical rate for approximately 2 to 3 weeks. Sulfur

dioxide measurements during the smog reached peak levels of 1.3 ppm and the general average during the episode was 0.7 ppm.

Greenburg, et al. reported that during the period of high air pollution in New York City in November, 1953 pediatric and adult clinic visits for upper respiratory illnesses and cardiac diseases rose above normal in all of the 4 hospitals studied. Sulfur dioxide ranged between 0.07 ppm and 0.86 ppm from November 12 to November 24, and hospital admissions were clearly elevated by November 16 at which time concentrations had not exceeded 0.25 ppm.

From November 27 through December 4, 1962 a condition of atmospheric stability occurred in New York City during which sulfur dioxide concentrations ranging up to 1.4 ppm and Cohs values ranging up to 9 were observed. Greenburg, et al studied visits during this period for upper respiratory infections, cardiac conditions, and asthma at five emergency clinics in the major city hospitals, four old-age homes, an employee clinic at the Chase National Bank, and visits recorded by the Blue Shield Health Insurance Plan. The average daily visits at each of the installations were compared with the period prior to and subsequent to December 1 through 7. No significant change was found in the records of any of the facilities with the exception of the four old-age homes. A significant rise in upper respiratory illness was found in all 4 of the old-age homes, and the incidence of illness did not return to normal until after December 14.

Acute illnesses then, of epidemic magnitude developed after 24 hour average sulfur dioxide concentrations of approximately 0.5 ppm, during which peak hourly averages of 0.75 ppm or more occurred, and when suspended particulate matter concentrations of 1000 $\mu\text{g}/\text{m}^3$ or higher or when Cohs values of 8 or more were attained. Increased hospitalization and outpatient clinic visits were primarily attributed to cardiorespiratory illnesses. In severe episodes accompanied by fog, nausea and vomiting occurred in addition to the usual symptoms of respiratory irritation. Secondary complications frequently develop in individuals of all age groups, but the elderly individuals and the individuals with preexisting cardiorespiratory disease are especially susceptible. From one study it was determined 10 years after the episode that individuals who became ill during the outbreak had a less favorable morbidity and mortality experience than those who were not so affected.

Epidemiologic studies of deaths among cities

Studies of differences in death rates between different cities of the United States as they relate to air pollution have not been made. However, several such studies have been made in England. Very high correlations have been obtained between various measures of air pollution containing sulfur oxides and respiratory disease deaths. Bronchitis death rates relate strongly to indices of air pollution from domestic coal consumption, lead peroxide candle sulfation rates, and to pH of the precipitation. Pneumonia death rates increase from 40 per 100,000 to 60 per 100,000 as sulfate in the dustfall increases from 1.4 to 7 tons/ mi^2/mo . Bronchitis death rates increase by a factor of about 1.5 as lead peroxide candle sulfation rates increase from 0.75 to 2.25 $\text{mg}/100 \text{ cm}^2/\text{day}$.

Epidemiologic studies of deaths during air pollution episodes

Numerous reports of increased deaths during air pollution episodes exist. In London, annual average sulfur dioxide concentrations are about 0.10 ppm, but fogs are frequent, and air pollution episodes occur in varying degrees almost every year. In the most notable episode, that occurring in 1952, there were 4000 excess deaths. During this episode sulfur dioxide averaged 0.7 ppm during the 4-day period and reached a peak of 1.3 ppm for a "short period". In the United States only a few such incidences have been recorded, but an intensive search for their occurrence has not been made.

In the 4 day air pollution episode at Donora, Pennsylvania in October, 1948, 17 persons died on the third day and 3 other deaths were ascribed to fog. Normally at Donora in the period 1948 to 1948 about 100 persons died per year or 1 person every third day. The ages of the 20 persons who died during the episode ranged from 52 to 84 years. Pre-existing disease of the cardiorespiratory system appeared as a single factor among the fatally ill, although in four cases no history of any chronic disease was obtained. Autopsies of three persons who died during the smog showed acute changes in the lungs characterized by capillary dilation, hemorrhage, oedema, purulent bronchitis, and bronchitis. Chronic cardiovascular disease was a prominent feature in the autopsies.

Only in the degree of severity and in the outcome were fatal cases different clinically from the severely ill persons who did not die.

In the air pollution episode occurring in November, 1953 at New York City the average number of deaths per day in the period November 15 to November 24 was 244, whereas the averages for 6 control years ranged from 218 to 227. The increase was generally distributed over all age groups and all causes of deaths except accidents, homicides, and suicides.

Existing data, then, indicate that excess deaths may occur in United States cities with annual average sulfur dioxide concentrations of 0.05 ppm or more when periods of pollution buildup occur, or during stagnation periods of 3 or more days in which peak instantaneous concentrations of 1 ppm or $\frac{1}{2}$ hour average concentrations of 0.8 ppm occur. Deaths are not limited to any particular group but certain groups, including those with preexisting heart, circulatory, or respiratory diseases, and infants and the elderly are certainly affected.

Selected References

1. A comprehensive listing of references to, and abstracts of, scientific reports on sulfur oxide pollution and its effects on health and welfare is contained in "Sulfur Oxides and Other Sulfur Compounds: A Bibliography with Abstracts," Public Health Service Publication No. 1093, U.S. Department of Health, Education, and Welfare, Washington, D.C., 1965. A selection of important references follows.
2. Greenburg, L., Jacobs, M. B., Field, R., Braveman, M. M. and Drolette, B. M. Air pollution and health. Report of an incident in New York City during November, 1953. Public Health Reports. 77:7-16. Jan. 1962.
3. Firket, J. The cause of the symptoms found in the Meuse Valley during the fog of December, 1930. Bull. Royal Acad. Med. Belgium. 11:683. 1931.
4. Schrenk, H. H., Heimann, H., Clayton, G. D., Gafafer, W. M. and Wexler, H. Air pollution in Donora, Pa. Pub. Health Bull. No. 306. Federal Security Agency. Washington, D.C., 1949.
5. Spicer, W. S. The complexity of the relationship between air pollution and respiratory health. Proceedings of the National Conference on Air Pollution. December 10-12, 1962. PHS Pub. No. 1022.
6. Rohrman, F. A. and Ludwig, J. H. Sources of sulfur dioxide pollution. Presented at the 55th National Meeting Amer. Inst. of Chem. Eng., Houston, Texas, Feb. 7-11, 1965. Session No. 46. Paper No. 46e. pp. 1-16.
7. Greenburg, L. and Jacobs, M. B. Sulfur dioxide in New York City atmosphere. Ind. Eng. Chem. 48:1517-1521. 1956.
8. Heimann, H. Effects of air pollution on human health. In: Air Pollution. WHO Monograph Series No. 46. Col. Univ. Press. 1961. pp. 159-220.
9. Goldsmith, J. R. Effects of air pollution on humans. In: Air Pollution. Vol. I. Stern, A. C., ed. Acad. Press, New York. 1962 pp. 335-386.
10. Lawther, P. J., Martin, A. E. and Wilkins, E. T. Epidemiology of air pollution. WHO Pub. Health Papers, No. 15, Geneva. 1962.
11. Catecott, E. J. Effects of air pollution on animals. In: Air Pollution. WHO Monograph Series No. 46. Col. Univ. Press. 1961 pp. 221-231.
12. Farber, S. M. and Wilson, R. H. L. Air contamination: A respiratory hazard. J. AMA. 180:362-366. May 5, 1962.
13. Goldsmith, J. R. Effects of air pollution on man. Connecticut Medicine. 27:455-464. Aug. 1963.
14. Prindle, R. A. and Landau, E. Health effects from repeated exposure to low concentrations of air pollutants. Public Health Reports. 77:901-909. Oct. 1962.
15. Anderson, R. J. Epidemiologic studies of air pollution. Dis. of the Chest. 42:474-480. Nov. 1962.
16. Spicer, W. S., Jr., Storey, P.B., Morgan, W. K. C., Kern, H. D. and Standiford, N. E. Variation in respiratory function in selected patients and its relation to air pollution. Am. Rev. Resp. Dis. 86:705-712. Nov. 1962.
17. Waler, R. E. and Lawther, P. J. Some observations on London fog. Brit. Med. J. 2:1356. 1955.
18. Pemberton, J. Air pollution as a possible cause of bronchitis and lung cancer. J. Hyg. Epidemiol. Microbiol. Immunol.
19. McCarroll, J. R., Cassell, E. J., Ingram, W. and Wolter, D. Health and the urban environment. Arch. Environ. Health. 10:357-363. Feb. 1965.
20. Motley, H. L., Smart, R. H. and Leftwich, C. I. Effect of polluted Los Angeles air on lung volume measurements. J. AMA. 171:1469-1177. Nov. 1959.

21. Anderson, D. O. and Ferris, B. G. Air pollution levels and chronic respiratory disease. *Arch. Environ. Health.* 10:307-311. Feb. 1965.
22. Prindle, R. A., Wright, G. W., McCaldin, R. O., Marcus, S. C., Lloyd, T. C. and Bye, W. E. Comparison of pulmonary function and other parameters in two communities with widely different air pollution levels. *Am. J. Public Health.* 53:200-218. Feb. 1963.
23. Heiman, H. Air pollution and respiratory disease. PHS Pub. No. 1257. 1964.
24. Phillips, A. M. The influence of environmental factors in chronic bronchitis. *J. Occupat. Med.* 5:468-475. Oct. 1963.
25. Zeidberg, L. D., Prindle, R. A. and Landau, E. The Nashville air pollution. *AM. J. Public Health.* 54:85-97. 1964.
26. Dohan, F. C. Air pollutants and incidence of respiratory disease. *Arch. Environ. Health.* 3:387-395. Oct. 1961.
27. Greenburg, L., Field, F., Reed, J. I. and Ehrhardt, C. L. Air pollution and morbidity in New York City. *J. AMA.* 182:161-164. Oct. 13, 1962.
28. Greenburg, L., Field, F., Erhardt, C. L. and Reed, J. I. Air pollution incidents and morbidity studies. *Arch. Environ. Health.* 10:351-356. Feb. 1965.
29. Zeidberg, L. D., Horton, R. J. M. and Landau, E. The Nashville air pollution study: V. Mortality from diseases of the respiratory system in relation to air pollution. Presented at the Am. Public Health Assoc., 91st Annual Meeting, Kansas City, Missouri. 1963.
30. Wilkins, E. T. Air pollution. Some chemical and physical aspects of its effects on living material. In: *The Effects of Air Pollution on Living Material.* Symposia of Biology. 8:71-80. The Institute of Biology. London. 1959.
31. Wilkins, E. T. Air pollution and the London fog of Dec. 1952. *J. Royal Sanit. Inst.* 47:1-15. 1954.
32. Scott, J. A. The London fog of December, 1962. *Med. Officer (London).* 109:250-252. April, 1963.
33. Prindle, R. A. Notes made during London smog in December, 1962. *Arch. Environ. Health.* 7:493-496. Oct. 1963.

OXIDANTS

Oxidants are a major class of compounds found in photochemical smog—a major air pollution problem arising from atmospheric reactions of gases derived from the combustion of organic fuels. Emissions from motor vehicles are a prime factor in the formation of photochemical smog in virtually all parts of the country. Other factors which contribute to smog formation are the combustion of fuels for heat and electric power, burning of refuse, evaporation of petroleum products, and handling and use of organic solvents. The principal identifiable oxidants in polluted urban air are ozone, the peroxyacyl nitrates (PAN), and the oxides of nitrogen, primarily nitrogen dioxide.

Effects of photochemical smog on man

Eye Irritation.—The most commonly experienced effect of photochemical smog is eye irritation. The components causing eye irritation have not been completely identified, but there is some correlation between the occurrence of eye irritation and overall levels of oxidant in the atmosphere. Eye irritation is generally experienced at community oxidant levels of 0.1 parts per million (ppm) and higher.

Odor.—There is a characteristic pungent odor associated with photochemical smog. Ozone is an acrid component of this odor.

Respiratory Effects.—Studies have shown that it is harder for humans, particularly patients suffering from chronic respiratory disease, to breathe in areas having even a moderate level of photochemical air pollution (0.10 ppm total oxidant or higher). In clinical studies of patients with chronic bronchopulmonary disease exposed to the ambient Los Angeles smog for one week (when compared to the effects on the same patients breathing filtered air for a similar period), the most significant and uniform effect of photochemical smog exposure was an increase in oxygen consumption and a decrease in oxygen content in the blood (decrease in arterial blood oxygen tension levels) during light exercise. Thus, while the patients were consuming more oxygen, less of it was being made available to the body. There also was greater difficulty in breathing (increased pulmonary airway resistance) in the patients when breathing the smoggy air.

Effects of photochemical smog in animals

Short-term Effects.—Studies on guinea pigs exposed over their lifetime to atmospheric photochemical smog showed that the animals experienced greater difficulty in breathing on days of high photochemical air pollution levels. Even more significant increases in breathing resistance, particularly in the older animals, occurred on days having severe smog.

Long-term Effect.—Laboratory mice exposed to community photochemical smog levels over a 16-month period showed an increase in lung tumors (adenomas) in the aging animals when compared to the controls exposed to filtered air.

Several strains of young laboratory mice, 5–8 weeks old, when chronically exposed continuously to low levels of synthetic smog (irradiated auto exhaust cycled within test chambers to simulate the daily oxidant fluctuation pattern occurring in ambient air) showed increased susceptibility to pulmonary infection and chronic disease during the latter half of the animals' lifetime compared to controls exposed only to clean filtered air. Significant decreases in mouse fertility and survival rate of infant mice were also manifested during the 13-month exposure period (through the animals' effective reproductive period).

Effects of ozone on man

Odor.—The characteristic sharp odor of ozone, sometimes described as an "electrical" odor, can be detected instantaneously at very low concentrations (0.02–0.05 ppm), depending on individual acuity. At somewhat higher concentrations (0.05–0.10 ppm) the odor becomes more pronounced and disagreeable.

Respiratory Effects.—Ozone is a severe irritant to all mucus membranes. Significant exposures may cause pulmonary congestion and other complications. The first symptoms of irritation due to ozone, dryness of the upper respiratory passages and initial irritation to the mucous membranes of the nose and throat, occur after brief exposures (13–30 minutes) to low concentrations (0.05–0.10 ppm). At higher concentrations (0.30–1.0 ppm, all within the recorded range of community oxidant levels) and after somewhat longer exposure (15 minutes–2 hours), there is marked respiratory irritation accompanied by respiratory distress (choking, coughing and severe fatigue, particularly at the upper end of this range). At relatively high concentrations, such as found in severe photochemical smog, lung function is impaired for the duration of exposure and beyond. Based on a laboratory study of exposure of normal subjects to 0.6–0.8 ppm ozone for a single 2-hour period, there was a marked change in lung function (highly significant reduction in diffusing capacity and significant reduction in vital capacity and forced expiratory volume) lasting up to 24 hours. Bronchial irritation and substernal soreness also lasted up to 12 hours, while slight coughing lasted up to 24 hours. At still higher concentrations, beyond the highest levels found in community photochemical smog (1.5–2.0 ppm), a single 2-hour exposure to ozone caused general morbidity in a man lasting for approximately two weeks after a single two-hour exposure. His immediate symptoms included impaired lung function, severe chest pains, altered taste sensation, coughing, headache and extreme fatigue. During the period of severe malaise following exposure, the subject also showed a loss of coordinating ability and difficulty in expression and articulation.

Effects on Vision.—Humans exposed to significant levels (0.20–0.50 ppm for 3 hours) showed a considerable decrease in visual acuity and changes in the extra ocular muscle balance, night-vision, lateral phoria, and other visual effects.

Long-term Effects.—Few long-term studies of ozone exposure of humans have been reported. Chronic occupational exposures to intermittently and relatively high concentrations of ozone (0.5–1.2 ppm averages) over a two-week period caused severe recurrent headache, fatigue, chest pains, difficulty in breathing and wheezing.

Effects of ozone on animals

Short-term Effects.—A concentration of 0.10 ppm ozone for 3 hours causes an increase in mortality of test animals over similarly infected animals not exposed to ozone. Concentrations of ozone (comparable to commonly found atmospheric levels) also cause a decreased activity in mice (decreased running ability after exposure to 0.20 ppm for 6 hours), while ozone levels of 0.34 ppm and above for 2 hours caused temporarily impaired lung function. At ozone concentrations well above present community levels (1.50 ppm and above), pathological lung changes occurred after single 4-hour exposures which apparently were reversible after withdrawal from the ozone environment.

Long-term Effects.—Continuous ozone exposure for 3–17 weeks at concentrations of 0.10–0.25 ppm shortened the lives of infected guinea pigs and increased their mortality rate, while discontinuous long-term exposures (0.10–0.20 ppm for 7 hours/day, 5 days/week for 3 weeks) caused an increase in the mortality of new-born mice. Significantly increased mortality and severe chronic lung injury including hemorrhage, fibrosis of the lung parenchyma and constriction of the lung airways occurred in guinea pigs and rats when discontinuously exposed to ozone concentrations of 1.50 ppm for 62 weeks.

Effects of PAN on animals and man

The use of PAN compounds in animals or human exposures is only quite recent and thus little information has been developed. No apparent evidence of pronounced injury to animals exposed to PAN in concentrations approximating atmospheric levels has been observed to date. PAN, however, did cause eye irritation when panels of human volunteers were exposed to pure synthetic PAN at a concentration of 1 ppm for 10–15 minutes; the threshold of detection of PAN is approached at 0.5 ppm for 12 minutes.

PAN appears to have an effect on pulmonary function of humans similar to that reported above for oxidant. In a recent study, it was found that healthy students when performing moderate exercise and breathing 0.30 ppm PAN for 5 minutes showed a statistically significant increase in oxygen uptake compared to an identical period when they were breathing clean filtered air; breathing also was affected.

Selected References

1. Haagen-Smit, A. J.: Chemistry and Physiology of Los Angeles Smog. *Ind. Eng. Chem.* 44: No. 6, 1342, June 1952.
2. Haagen-Smit, A. J.: Photochemistry and Smog. *J. Air Poll. Cont. Assn.* 13: No. 9, 444, September, 1963.
3. Stephens, E. R., Darley, E. F., Taylor, O.C., and Scott, W. E.: Photochemical Reaction Products in Air Pollution. *Int. J. Air Water Poll.* 4: Nos. 1–2, 79, 1961.
4. Mittler, S., King, M., and Burkhardt B.: Toxicity of Ozone. III. Chronic Toxicity. *Arch. Ind. Health.* 15: 191, March 1957.
5. Murphy, S. D., Ulrich, C. E., Frankowitz, S. H., and Xintaras, C.: Altered Function in Animals Inhaling Low Concentrations of Ozone and Nitrogen Dioxide. *Am. Ind. Hyg. J.* 25: 246, May-June 1964.
6. McDonnell, H. B.: Experiments with Ozone on Guinea Pigs. *J. Ass. Off. Agric. Chem.* 13: 19, 1930.
7. Smith, L. E.: Peroxyacetyl Nitrate Inhalation. Cardiorespiratory Effects. *Arch. Envir. Health.* 10:161, February 1965.
8. Scheel, L. D., Dobrogorski, O. J., Mountain, J. T., Svirbely, J. L., and Stokinger, H. E.: Physiologic, Biochemical, Immunologic, and Pathologic Changes Following Ozone Exposure. *J. Appl. Physiol.* 14: No. 1, 67, January 1959.
9. Lagerwerff, J. M.: Prolonged Ozone Inhalation and its Effects on Visual Parameters. *Aerospace Medicine.* 34: No. 6, 479, June, 1963.
10. Brinkman, R., Lamberts, H. B., and Veninga, T. S.: Radiomimetic Toxicity of Ozonised Air. *The Lancet.* 7325:133, January 18, 1964.
11. Balchum, O. J., Buckley, R., Levey, S., Bertolino, J., Swann, H., and Hall, T.: Studies in Experimental Emphysema. *Arch. Envir. Health.* 8: No. 1, 132, January, 1964.
12. Spicer, W. S., Jr.: Relation of Air Pollution to Disease. *Arch. Envir. Health.* 9: No. 5, 600, November, 1964.
13. Remmers, J. E., and Balchum, O. J.: Effects of Los Angeles Urban Pollution Upon Respiratory Function of Emphysematous Patients. Paper No. 65–43. Presented at the 58th Annual Meeting, Air Pollution Control Association, Toronto, Canada, June 1965.
14. Swann, H. E., Brunol, D., Wayne, L. G., and Balchum, O. J.: The Acute Effects of Los Angeles Smog on the Respiration of Guinea Pigs. *Arch. Envir. Health.* In press.
15. Heuter, F. G., Contner, G. L., Busch, K. A. and Hinners, R. G.: Biological Effects of Atmospheres Contaminated by Auto Exhaust. *Arch. Env. Health.* In press.
16. Schoettlin, C., and Landau, E.: Air Pollution and Asthmatic Attacks in the Los Angeles Area. *Public Health Reports.* 76: 545, June 1961.

CARBON MONOXIDE

Carbon monoxide is one of the most common of all urban air pollutants and one of the most harmful to man. Its ability to impede the oxygen-carrying capacity of the blood makes it lethal in high concentrations. In the passenger compartment of motor vehicles in traffic, it may reach levels sufficiently high to interfere with man's driving ability and thus pose a safety hazard in virtually any community, regardless of the extent of ambient air pollution. Though all processes involving combustion of carbonaceous material produce carbon monoxide, the motor vehicle is by far the most important source from which this pollutant gas reaches the atmosphere. The wide use of motor vehicles, coupled with the fact that they discharge pollutants from points close to the ground, makes them the prime contributor to most people's daily exposure to carbon monoxide. Federal standards to control carbon monoxide emissions from new motor vehicles have been established and will be effective beginning with 1968 model cars and light trucks.

Effects of carbon monoxide on man

Carbon monoxide poisoning is a well understood phenomenon. As with many other harmful gases, the degree of damage which man sustains as a result of exposure to carbon monoxide is related to the concentration of the gas in inhaled air and the length of exposure. The hazards of carbon monoxide arise mainly from its strong affinity for hemoglobin, which carries oxygen to body tissues. The effect of carbon monoxide combining with hemoglobin is to deprive the tissues of needed oxygen. At concentrations of slightly more than 1,000 ppm, carbon monoxide kills quickly. Fifty parts per million is now recommended as the upper limit of safety for healthy industrial workers exposed for an eight-hour period. At approximately 100 ppm, most people experience dizziness, headache, lassitude, and other symptoms.

There are many factors which cause a greater susceptibility than the average. Drinker has pointed out that any impairment in circulation, heart disease in any form, anemia, asthma, lung impairment, any condition that speeds metabolism, any increase in activity, high temperature, high humidity, and high altitude are conducive to making certain persons particularly vulnerable to carbon monoxide exposure.

In adopting its "serious" levels of standards for carbon monoxide in 1960, the California Department of Public Health indicated that exposure to 30 ppm of carbon monoxide for eight hours, or exposure to 120 ppm for one hour, may be a serious risk to the health of sensitive people. These levels were based on the assumption that such exposures would result in the inactivation of five percent of the body's hemoglobin. At these levels, there were cognitive and psychomotor capability deficits. The degree of impairment increased with the ambient carbon monoxide level and the carboxyhemoglobin level in the blood become higher if the subject was smoking or was a chronic general smoker.

At high levels of concentration, carbon monoxide, more than any other air pollutant, has been identified as a participant in synergistic reactions. For example, the combined effect of carbon monoxide in the presence of hydrogen sulfide or nitrogen dioxide is more severe than the sum of the effects of each of the gases. At low levels, synergism has not been established; however, carbon monoxide with other pollutants probably has an additive effect.

Clinical-epidemiological studies

A substantial part of existing scientific information on the effects of carbon monoxide has come from clinical studies of healthy adult males. Thus, in 1929, men were exposed in a chamber from 4 to 7 hours daily, for 68 days, to gasoline engine exhaust containing 200, 300, and 400 ppm of carbon monoxide. At 200 ppm, carboxyhemoglobin reached 25 percent in 5 or 6 hours; more than one-half the subjects experienced no symptoms at all, the remainder suffering slight discomfort in 2 hours and frontal headache in 4 hours. At 300 ppm and at 400 ppm, carboxyhemoglobin reached 30 percent, within 5 and 4 hours, respectively. At the higher concentration, more than 90 percent of subjects suffered frontal headache within 4 hours and a few complained of occipital headache. No other adverse effects upon health or well-being were detected, and psychologic examination revealed only a slight tendency to poorer performance in the prolonged steadiness test. A definite increase in hemoglobin and red blood cell count was noted.

More recently, Nichols and Kinsey exposed volunteers during prolonged submarine submergence to from 25 to 100 ppm of carbon monoxide for 22 days. The number of headaches occurring during 6 days at 100 ppm was significantly

greater than the number occurring during 6 days immediately following return to outdoor ventilation; but the level of carboxyhemoglobin was in the range of subjective complaints in only two subjects.

Exposure to even small amounts of carbon monoxide may impair visual discrimination. In experiments on human subjects, Halperin and co-workers showed that visual sensitivity to differences in light intensity may suffer reversible impairment even at carboxyhemoglobin levels as low as 3 percent and that the visual effect depends not only on the absolute blood carboxyhemoglobin level but also on the length of time this substance is present in the blood. Furthermore, about one-third of the carbon monoxide administered over an hour's time appears to diffuse into the tissues and is tightly bound there, so that after carbon monoxide is eliminated from the blood, visual impairment may persist for varying periods of time, depending both on the concentration of carbon monoxide in the blood and the duration of its presence there. It has also been shown that carbon monoxide exposure may affect the auditory and nervous systems.

Carbon monoxide in cars

Recent research has focused attention on the extent to which carbon monoxide in the passenger compartment of motor vehicles in traffic or parked alongside heavily travelled streets may reach concentrations in excess of those in the ambient air. Because of the possible adverse effects on motorists' ability to respond to complex driving situations, this aspect of the carbon monoxide problem is being given increasing attention by the Division of Air Pollution.

Concentrations of carbon monoxide inside automobiles travelling on or parked along routes of high traffic density during rush-hour periods have been measured in the six cities where the Public Health Service conducts air sampling in its Continuous Air Monitoring Program. The concentrations measured represent exposures experienced by commuters, bus drivers, taxicab drivers, policemen, and others travelling on busy routes.

The 30-minute integrated samples collected in this preliminary investigation showed that carbon monoxide concentrations inside motor vehicles in traffic were generally considerably higher than levels recorded simultaneously at Continuous Air Monitoring Program sites. In heavy traffic concentrations inside vehicles were 1.3 to 6.8 times the simultaneous ambient air values. In all likelihood, in-car concentrations were even higher at times; peak values could not be determined from the 30-minute integrated samples.

In each of the six cities, carbon monoxide concentrations exceeded 30 ppm in at least 10 percent of the integrated samples. The averages of all samples collected in each city ranged from 21 to 39 ppm. The range of individual samples was 7 to 77 ppm.

In 1956, the Fuel Research Station in England reported the occurrence of elevated levels of carbon monoxide. In the January 1956 smog episode, carbon monoxide concentrations in the ambient air reached 50 ppm in London and 80 ppm in Salford. Inside automobiles, concentrations were undoubtedly considerably higher. For comparison, the average carbon monoxide level in London during 1955 was 15 ppm.

Concentrations higher than 100 ppm occasionally occur in garages, tunnels, behind automobiles, or in the open atmosphere. For example, maximum concentrations of more than 100 ppm were found during several months of observation in Detroit in 1960. Recent measurements in London suggest that such levels may not be simply sporadic; in Oxford Circus, there were frequent periods of more than 100 ppm.

It is quite possible, then, that the levels of carbon monoxide that are reached in the streets both in vehicles and close to highways are frequently high enough to affect some especially susceptible persons, such as those already suffering from a disease associated with a decrease of oxygen-carrying capacity of the blood (e.g., anemia), or those suffering from cardio-respiratory disease. The extra burden that is placed on the body by the reduction of the oxygen-carrying capacity of the blood induced by carbon monoxide may cause injury to vital organs. People already burdened by the presence in their blood of unusual amounts of carbon monoxide because of tobacco smoking or occupational exposure, may also be adversely affected by the extra amount of carbon monoxide they inhale from contaminated air.

Chronic exposure

Another important aspect of the carbon monoxide problem relates to the occurrence of injury to persons exposed to low levels of the gas over long periods of

time. Some researchers believe that even small amounts of this gas are likely to produce some detectable response.

In many foreign countries, chronic carbon monoxide poisoning has been an accepted clinical entity for some years. It was described in Finland in drivers of motor cars operated by charcoal gas; in Yugoslavia; in Scandinavian countries; and in Canada. In Japan, workers occupationally exposed to carbon monoxide fumes exhibited optic neuritis, hearing impairment, and vestibular disturbance conceivably attributable to the exposure. In Russia, Skvortsova surveyed schoolgirls who had lived from one year to their entire lifespan within a mile or so of steel furnaces, where atmospheric carbon monoxide levels reached concentrations of 106 ppm. Findings included elevated red blood cell counts (with low-normal hemoglobin) in 28 to 46 percent of subjects and a corresponding incidence of headache, fatigability, and poor appetite, all of which were attributed to chronic carbon monoxide exposure.

In 1961, Lindgren reported on a study in which he had examined workers occupationally exposed to carbon monoxide. These workers suffered from an excessive frequency of headache, interpreted by the investigator as a sign of repeated slight acute poisoning, but no other clinical manifestation considered typical of chronic carbon monoxide poisoning was found any more frequently in the exposed than in a control group.

Investigations reported by Von Post-Lingen in 1964 and carried out between 1955 and 1958 at the National Institute of Public Health in Stockholm revealed different results than did Lindgren's study. Observations were made of the reactions of healthy persons to carbon monoxide concentrations which do not generally cause subjective disturbances. The results of these experiments showed that: (1) Daily inhalation of carbon monoxide for four weeks, producing carboxyhemoglobin of 10-11 percent, gave rise to a cumulative effect which was manifest as latent impairment of the ability to distinguish between light flashes in rapid succession; (2) Daily inhalation of carbon monoxide producing 6-7 percent or 10-11 percent carboxyhemoglobin caused increase of sensitivity. In some sensitivity subsided during the following months and disappeared after a year.

Current laboratory studies

An ongoing study by the Division of Air Pollution is providing data that underline the possible hazards of high levels of carbon monoxide in cars and along busy streets. In one phase of the study, rats were exposed to carbon monoxide in concentrations of 30 to 50 parts per million for periods ranging from 15 minutes to two hours. A noise or an odor was used to simulate an environmental stimulus. The animals' brain impulse patterns were recorded and analyzed electronically.

Rats exposed to carbon monoxide showed an abnormal pattern of brain impulses. The abnormality seemed to correspond to reduced alertness and attentiveness, as indicated by the animals' response to noise and odors. Exposed animals were not as prone to investigate the stimulus as were normal animals not exposed to the carbon monoxide.

The findings suggest that exposure of the rats to carbon monoxide interfered with their ability to get along in their environment. Though the carbon monoxide did not seem to impede the animals' ability to receive stimuli or act on them, it may have reduced their ability to integrate such stimuli and thus lay the groundwork for making an appropriate response.

The significance of these findings in terms of human behavior is still uncertain, but the implication is that carbon monoxide in relatively low concentrations may keep man from dealing properly with a complex situation, such as driving in traffic. The effect may be similar to that of alcohol or fatigue; indeed, the effect of carbon monoxide may be doubly dangerous when a driver is tired, has had an alcoholic beverage, or is under treatment with certain drugs, such as tranquilizers.

A preliminary investigation conducted in the summer of 1965 in six major cities indicated that carbon monoxide levels inside cars in heavy traffic are often in the range in which rats' brain impulses are impaired. In the six cities—Cincinnati, St. Louis, Philadelphia, Denver, Chicago, and Washington, D.C.—in-car carbon monoxide concentrations were substantially higher than ambient air levels at the same time. The measurements were made on express-type highways and in downtown streets, mainly during morning and evening rush-hour traffic. Thirty-minute air samples were collected in plastic bags and then analyzed; air was taken through open car windows.

The investigation is being continued on a somewhat more sophisticated scale. A mobile sampling unit has been equipped to measure both carbon monoxide and hydrocarbons on a continuous basis and record the results automatically. The samples are representative of air that enters a car through open windows and air-intake ducts for heating systems.

The mobile unit has made measurements in Cincinnati, Louisville, Atlanta, Baltimore, and New York City. Also scheduled are Chicago and Detroit. Additional cities will be scheduled later. The results thus far are similar to those of the preliminary investigation. This study is being conducted by the Division of Air Pollution of the Public Health Service.

Selected References

1. Sayers, R. R., Yant, W. P., Levy, E., and Fulton, W. B.: Effect of Repeated Daily Exposure of Several Hours to Small Amounts of Automobile Exhaust Gas. U.S. Public Health Bulletin No. 186, Washington, D.C., 1929.
2. Halperin, M. H., McFarland, R. A., Niven, J. L., and Roughton, F. J. W.: *J. Physiol.* 146: 583-593, 1959.
3. Grut, A.: Chronic Carbon Monoxide Poisoning. Ejnar Munksgaard, Copenhagen, 1949.
4. Lindgren, S. A.: *Acta med. scandinav.* 167 (suppl. 356): 1-135, 1961.
5. Nichols, G., Jr., and Kinsey, J. L.: Carbon Monoxide as a Habitability Factor in Prolonged Submarine Submergence. U.S. Naval Medical Laboratory, Report No. 223, New London, Conn., 1953.
6. Grudzinska, B.: Electroencephalographic patterns in cases of chronic exposure to carbon monoxide in air. *Folia Medica Cracoviensia* 3: 493-515, 1963.
7. U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Air Pollution, Motor Vehicles, Air Pollution, and Health—A Report of the Surgeon General to the U.S. Congress in Compliance with Public Law 86-493, The Schenck Act (Government Printing Office, Washington, D.C., 1962).
8. Xintaras, C.: Application of the evoked response technique in air pollution toxicology, *Toxicology and Applied Pharmacology* 8: 77-87, 1966.
9. Moureu, H.: The various aspects of pollution by the exhaust gases of motors of internal combustion. *Rev. Pathol. Gen. Physiol. Clin. (Paris)* 61-915-931, 1961.
10. Chovin, P.: Studies of Atmospheric Pollution in the Department of the Seine, in 1963. Municipal Laboratory Police Headquarters, Paris, France, 1964.
11. Von Post-Lingen, M. L.: The significance of exposure to small concentrations of carbon monoxide. Results of an experimental study on healthy persons. *Proc. Royal Soc. Med.* 57 (Part II): 1021-1029, 1964.
12. Brice, Robert M. and Roesler, Joseph F.: The Exposure to Carbon Monoxide of Occupants of Vehicles Moving in Heavy Traffic. Presented at the Annual Meeting of the Air Pollution Control Association, San Francisco, California, 1966.

PARTICULATES

Particles of solid—and occasionally liquid—matter in the air constitute a relatively small but important portion of polluted community air in most cities and towns in the United States. These so-called particulates may be either so large that they rapidly settle to the ground or they may remain suspended in the air until they are removed by such natural phenomena as rain—or until they are inhaled by people. Particulates may be quite complex in their chemical composition. The organic materials found in airborne particles may contain aliphatic and aromatic hydrocarbons, acids, bases, phenols, and other compounds. Airborne particles may also contain any of a wide range of metallic elements; those most commonly found are silicon, calcium, aluminum, iron, magnesium, lead, copper, zinc, sodium, and manganese. Sources of particulates include such activities as fuel combustion, various manufacturing and processing operations—including production of steel, cement, and petroleum products, and open burning and incineration of refuse.

Effects of particulates

Particulate air pollution is widely regarded as objectionable because it is often esthetically bothersome, it interferes with visibility, and it is associated with

soiling and corrosion of metals, fabrics, and other materials. Its adverse effects on health are far more subtle but are nonetheless significant. In general, concern about the health effects of particulates is related to (1) the ability of the human respiratory system to remove such particulates from inhaled air and retain them in the lung; (2) the presence in such particulates of some mineral substances having toxic or other physiologic effects; (3) the presence in such particulates of polycyclic hydrocarbons having demonstrated carcinogenic (cancer-producing) properties; (4) the demonstrated ability of some fine particles to enhance the harmful physiologic activity of irritant gases when both are simultaneously present in inhaled air; (5) the ability of some mineral particulates to increase the rate at which sulfur dioxide in the atmosphere is converted by oxidation to the far more physiologically active sulfur trioxide.

The size of airborne particles has an important bearing on whether and to what extent they will reach the lungs. Most coarse material—particles about five microns or more in diameter—lodges in the nasal passages. Smaller particles are more likely to penetrate into the lungs; the rate of penetration increases with decreasing particle size. Particles smaller than two to three microns usually reach the deeper structures of the lungs, where there is no protective mucous blanket.

Only limited data are available on the usual size distribution of particulates in polluted urban air. One study has indicated that all but about one percent of airborne particles in city air were below 10 microns in diameter. Based on existing air pollution data, it seems reasonable to estimate that about one-half (by weight) of particulates suspended in the air are of a size that can enter the human respiratory tract. This estimate is for particulates in general. The proportion of respirable material is higher for some types of particulate matter; for example, the great majority of sulfate particles are of a size that permits entrance into the respiratory tract.

The ability of particles to accentuate the adverse physiological effects of simultaneously inhaled gas is one of the most important aspects of the health hazard of particulate air pollution. Combinations of gases and particles have been shown to cause toxicity changes in rodents, resistance to air flow in the respiratory tract, and bactericidal action.

Of particular importance is the evidence that particulates enhance the ability of sulfur oxide gases to penetrate deeply into the respiratory tract and produce serious damage. Because it is highly soluble, sulfur dioxide gas, when inhaled alone, tends to be dissolved in the moist layers of the upper respiratory tract. But polluted urban air almost always contains sulfur oxides in association with solid particles; absorbed on such particles, sulfur oxides can penetrate deeply into the respiratory tract and damage the ill protected tissues of the lungs. Even when such acidic particles are neutralized to sulfates, they remain biologically active. Studies at Harvard University have indicated that two forms of sulfurous particulates—ammonium sulfate and zinc sulfate—alone or in combination, produced increased resistance to breathing in laboratory animals. The greatest degree of increased resistance was produced by sulfate particles in the same size range found in urban air.

Studies in Great Britain have demonstrated that smoke and soot particles aggravate chronic bronchitis. Because of their high porosity, such carbon particles readily adsorb gases and vapors; moreover, the combustion processes that produce these particulates also produce the complex polycyclic hydrocarbons that have been shown to be capable of producing cancer in laboratory animals. The degree to which such materials may reach respiratory organs is indicated by a finding that benzopyrene is tightly bound to soot particles and is not removed by human serum or gastric juice.

As previously noted, airborne particulates commonly contain various metallic elements. One of the most common and potentially most harmful is lead, which reaches the air both from industrial processes and motor vehicles. Available data indicate that most of the lead particles present in polluted urban air are of a size permitting entry into the human respiratory system and retention in the lungs. A study in Los Angeles showed that, with atmospheric lead levels of about 10 micrograms per cubic meter of air 75 percent of the total particle mass consisted of particles smaller than 0.45 microns. Particles of approximately one micron or smaller will probably be retained by the lungs. A detailed discussion of the known and suspected health hazards of lead is contained in the proceedings of the December 1965 Public Health Service Symposium on Environmental Lead Contamination.

A great many other metals are also present in particle form in polluted community air. Among them are many whose toxicity is well documented, mainly as a result of occupational experience, though their potential hazards in the relatively low concentrations in which they are present in the community environment have not been adequately evaluated. One such element is beryllium, whose use as an ingredient in rocket fuels poses community exposure problems. Others which are of increasing concern are cadmium, vanadium, arsenic, nickel, manganese, and chromium.

Selected References

1. American Association for the Advancement of Science: Air Conservation and Public Policy; Publication No. 80 of the AAAS. Washington, D.C., 1965.
2. Motor Vehicles, Air Pollution, and Health—A Report of the Surgeon General to the U.S. Congress. U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Air Pollution, Washington, D.C. 1962.
3. Katz, Morris: Some Aspects of the Physical and Chemical Nature of Air Pollution. In: Air Pollution, World Health Organization, Monograph Series No. 46, Geneva, 1961.
4. Heimann, Harry: Effects of Air Pollution on Human Health. In: Air Pollution, World Health Organization, Monograph Series No. 46, Geneva, 1961.
5. Toyama, Toshio: Air Pollution and its Health Effects in Japan. Archives of Environmental Health, Vol. 8, No. 1, Jan. 1964. pp. 153-173.
6. Gocke, T. M., and Duffy, B. J.: Epidemiology of chronic bronchitis in Jersey City. Arch. Int. Med. 110: 606 (Nov.) 1962.
7. Pemberton, J. and Goldberg, C.: Air pollution and bronchitis. Brit. Med. J. 4887: 567-573 (Sept. 4) 1954.
8. Burn, J. L., and Pemberton, J.: Air pollution, bronchitis, and lung cancer. Int. J. Air & Water Poll. 7: 5-16 (Jan.) 1963.
9. Weill, H. et al: Further observations on New Orleans asthma. Arch. Environmental Health 10: 148-151 (Feb.). 1965.
10. Amdur, M. O., "The effect of aerosols on the response to irritant gases," in Inhaled Particles and Vapours, Proceedings of an International Symposium Organized by the British Occupational Hygiene Society, C. N. Davies, Ed., pp. 281-292 (Pergamon Press, London, 1961).
11. Junge, C. E., Air Chemistry and Radioactivity (Academic Press, New York, 1963).

OXIDES OF NITROGEN

Sources and emissions

Oxides of nitrogen are one of the most important groups of atmospheric contaminants in many communities. They are produced during the high-temperature combustion of coal, oil, gas, or gasoline in power plants and internal combustion engines. The combustion fixes atmospheric nitrogen to produce the oxides. At these temperatures, nitric oxide forms first and in the atmosphere it reacts with oxygen and is converted to nitrogen dioxide. While this oxidation is very rapid at high concentrations, the rate is much slower at low concentrations. In sunlight, especially in the presence of organic material as typified by Los Angeles-type photochemical smog, the conversion of nitric oxide to nitrogen dioxide is greatly accelerated.

Nitrogen dioxide, the most toxic of the oxides of nitrogen, is an important component in the complex of chemicals producing photochemical smog. It does not occur in community air as an isolated contaminant. If its potential harmfulness is to be assessed, it is essential to understand its specific biologic effects. This review is concerned with NO_2 as if it were the single toxicant polluting the air breathed by a community and what standards for community air would be appropriate with this assumption and current knowledge.

This review is not concerned with nitric oxide. There have been no known demonstrable cases of human nitric oxide poisoning. Nitric oxide is one-fourth to one-fifth as toxic as nitrogen dioxide in rats (Gray et al., 1952). Rats inhaling nitric oxide for as long as nine days, at concentrations of 10 ppm, failed to exceed a detectable level of hemoglobin-nitric oxide complex (Sancier et al., 1962). The electronic spin resonance method for detecting such complexes would detect as little as one tenth percent of the complex in whole blood.

Today there is a trend toward higher combustion-chamber temperature and more efficient combustion. The higher temperature results in a further increase in the production of oxides of nitrogen, especially from automobiles.

It is estimated that 0.15 kilogram of nitrogen oxides is produced per person per day. This is a maximum figure, and it reflects a standard of material well-being directly related to the industrial development of the community, the number of automobiles used, and the population density. In less mechanized societies, the figure would be far less.

In recent years Los Angeles County recorded its first instances of nitrogen oxide concentrations that exceeded the first alert (3.00 ppm) level: 3.17 ppm on December 19, 1960 and 3.93 ppm on January 13, 1961. Because of its limited ventilation, there is reason for concern at the increase of oxides of nitrogen in areas such as Los Angeles. If no steps are taken, Los Angeles will become more crowded, the ventilation will become worse because of the greater number of buildings, and the direct adverse effect may become an important factor in community air pollution.

Nitrogen dioxide is unique among the common pollutants in that it absorbs light in the visible region of the spectrum, mostly in the blue region. It is thus a yellow-brown gas. Because it is visible, substantial concentrations reduce visibility even without the presence of aerosol particles. A concentration of 8 to 10 ppm would probably reduce visibility to about 1 mile.

Effects

The hazards associated with nitrogen oxides are (i) a direct noxious effect on the health and well-being of people and (ii) photochemical oxidation of organic material, which is an indirect effect. In the concentrations normally found in community air pollution, by far the most objectionable consequences of the oxides of nitrogen are those that arise from photochemical reactions.

Of the oxides of nitrogen, nitrogen dioxide is considerably more toxic than nitric oxide, acting as an acutely irritating substance. In equal concentrations, it is more injurious than carbon monoxide. Chronic lung disease has been produced experimentally by subjecting animals to nitrogen dioxide, and there is some evidence that exposure to the nitrogen dioxide released during the filling of silos has caused a chronic pulmonary condition. The Cleveland Clinic fire of May 1929 illustrated the insidious nature of nitrogen dioxide as a poison; a large number of people died after inhaling nitrogen dioxide produced by burning x-ray film. However, exposures of this severity are rare. Nitrogen oxides, at levels found in air pollution, are only potentially irritating and potentially related to chronic pulmonary fibrosis.

Nitrogen dioxide has received considerable attention as an air pollutant because it is a hazard in numerous industries. The threshold limit (established by the American Conference of Governmental Industrial Hygienists) for an 8-hour working day has been tentatively set at 5 ppm. However, a report that a 3- to 5-year exposure of Russian workmen to concentrations of nitrogen dioxide generally below 2.8 ppm resulted in chronic changes in the lung has contributed to the belief that 5 ppm of nitrogen dioxide may not be safe for daily exposure.

The proven effects of NO_2 on man and lower animals are confined almost entirely to the respiratory tract. With increasing dosage, acute effects are expressed as odor perception, nasal irritation, discomfort on breathing, acute respiratory distress, pulmonary edema, and death. Nitrogen dioxide's relatively low solubility, however, permits penetration into the lower respiratory tract. Delayed or chronic pulmonary changes may occur from high but sublethal concentrations and repeated or continuous exposures of sufficient magnitude.

Effects on man

Effects on man will be considered first. The odor of nitrogen dioxide is detectable at levels which could occur in atmospheric pollution; 1 to 3 ppm (parts per million) has been demonstrated to be the threshold for this effect. Nasal irritation and eye irritation, however, do not usually occur until levels are reached well above those expected in atmospheric pollution. In one study, even at 13 ppm, only three out of eight volunteers complained of eye irritation, although seven out of eight had nasal irritation. Concentrations which have caused death from acute pulmonary edema in man have been poorly documented, but indirect evidence indicated they were in excess of 100 ppm. The concentrations which lead to delayed effects, such as bronchiolitic fibrosa obliterans, are also far too high for relevance to standards (Lowry & Schuman, 1956). There is little in the literature which verifies pulmonary effects in man other than transient discomfort at concentrations below 50 ppm. The single report suggesting such effects (Vigdortschik et al., 1937) cites not only emphysema but multiple symptoms, signs, and hematologic and biochemical changes in workers

inhaling as little as 2.6 ppm for several years; however, the report does not contain any diagnostic criteria or data that would permit evaluation. Reports which indicate an absence of effects in individuals inhaling up to 20 ppm, or 30-35 ppm, are similarly lacking in data or assurances as to the actual concentrations of NO_2 encountered.

Effects on animals

It is obvious that experimental and epidemiologic data on man are extremely limited in the low concentrations likely to be found in community air. At the present time, therefore, the biological basis for estimating levels at which effects may occur for NO_2 must depend on animal studies. Since the irritant qualities of the gas and the locus of action are the same, cautious application of these data to man is justified despite the quantitative differences known to exist in the responses of several animal species. Concentrations of NO_2 over 200 ppm are fatal to most species even after single brief exposure—for example 5 to 15 minutes. Concentrations of NO_2 between 100 and 200 ppm, continued for 30 to 60 minutes, were also fatal to most species, as were concentrations of 50 ppm or more continued up to 8 hours. Continuous exposures of 25 ppm were fatal to rats, but intermittent exposures (6 hours/day) were not. Even concentrations below 5 ppm, if maintained continuously, have led to increased mortality in rats and mice; while intermittent exposures were not associated with deaths until concentrations reached 35 to 50 ppm. Two facts are obvious in reviewing the data on lethal effects. One is that high concentrations for short periods of time have a greater relative effect in terms of death or acute pulmonary damage than do lower concentrations over longer periods of time (Gray, 1959; Carson et al., 1962; Hine et al., 1964). The second is that intermittent exposures with intervening recovery periods are less harmful to experimental animals than continuous exposures. Of course, neither continuous nor intermittent exposures are directly comparable to the cyclic and variable exposures encountered in community air.

Summarization of the animal studies aimed at demonstrating subtle, chronic, or delayed effects resulting from continued or repeated exposures to low levels of NO_2 is complicated by the great variety of species, exposure patterns, and timing of observations. In general, exposures to between 10 and 20 ppm of NO_2 produces definite and persistent pathologic changes in the lungs. Between 5 and 10 ppm, results are equivocal, with animals continuously exposed sometimes exhibiting changes in bronchial epithelium; but intermittent exposures yielded negative findings. Balchum et al. have shown that exposure of guinea pigs to as little as 5 ppm produces minor pulmonary changes and the development of circulating substances capable of agglutinating normal lung proteins.

Minor changes in the bronchial epithelium have also been described by Freeman and Haydon in rats exposed continuously to 4 ppm for 20 weeks. Although Mitina described distinct pathological changes in rabbits exposed to 2.8 ppm and 1.4 ppm intermittently for 15 to 17 weeks, other competent workers have not reported such changes in animals exposed to similar and higher concentrations. A toxic potential is confirmed by the demonstration by Buell (1965) on the ability of NO_2 to denature what was believed to be collagen and elastin in rabbit exposures *in vivo*, the increase in oxygen consumption of spleen and liver homogenates reported by Buckley and Balchum (1965), and the work of Pace showing effects on tissue cultures. It is impossible to translate these directly into standards at this time.

Since NO_2 is one of many toxicants present in community air, it is important that it remain at or below the lowest level at which one would predict a minimal effect on the health of the most susceptible individuals in the community. The most sensitive indicator so far discovered for a biologic effect of NO_2 is the production of increased susceptibility to infection by certain aerosolized bacteria. By this technique, Ehrlich and Purvis have demonstrated increased mortality in mice from *Klebsiella pneumoniae* (at approximately LD_{50}) following 2 hours of exposure to 3.5 ppm NO_2 , and following 3 months' continuous exposure to 0.5 ppm NO_2 . However, this was not found for all strains of mice and hamsters. Some required over 2 hours exposure at 25 to 30 ppm of NO_2 . Translation of this effect to man and other infectious agents can be only speculative at this time. The experiments cited were deliberately designed to create the most sensitive possible indication. Care was taken not to introduce any direct effect of the gas upon the microorganisms which might reduce the effective dosage. Nevertheless, the work appears important in pointing toward possible interrelationships between air pollutants and altered responses to infectious disease. A changing

and poorly defined group of susceptible individuals would be present in any community, representing those with the critical point of dosage and immunity to still unspecified infectious diseases. In this group a minor alteration in local defensive mechanisms might be critical in determining the course of an infection. The presence or absence of appropriate organisms might well determine the consequences in terms of pneumonia or bronchiolitis which might follow a more severe exposure to an irritant gas such as NO_2 . Thus, on the basis of this preliminary exploration and though the evidence is scanty, the exposure of large populations to continued concentrations of NO_2 exceeding 0.5 ppm could not be justified; nor could intermittent exposures above 3.5 ppm.

The above evaluation is made in full cognizance of the fact that other considerations, such as plant damage, visibility, or combined effects with other air pollutants, may be more critical than the health effects of nitrogen dioxide alone.

The role of particulates which are always present in the atmosphere is worthy of special consideration. Boren has exposed mice to NO_2 absorbed on carbon particles with resultant focal destructive lesions. This work, like the still unpublished work of Tyler using NO_2 on carbon particulates in horses, may alter present views in regard to acceptable concentrations of pollutants when there are concurrent particulates which may concentrate chemical action in vulnerable points of the lung.

Selected references

1. "Air Conservation." The Report of the Air Conservation Commission of the AAAS. Publication No. 80 of the AAAS, 1965.
2. Balchum, O. J., Buckley, R. D., Sherwin, R., and Gardner, M. "Nitrogen Dioxide Inhalation and Lung Antibodies". Archives of Environmental Health, Vol. 10, pp. 274-277, February 1965.
3. Boren, Hollis G. "Carbon as a Carrier Mechanism for Irritant Gases". Archives of Environmental Health, Vol. 8, pp. 119-124, January 1964.
4. Buckley, Ramon D. and Balchum, O. J. "Acute and Chronic Exposures to Nitrogen Dioxide: Effects on Oxygen Consumption and Enzyme Activity on Guinea Pig Tissues". Archives of Environmental Health, Vol. 10, pp. 220-223, February 1965.
5. Carson, T. R., Rosenholtz, M. S., Wilinski, F. T., and Weeks, M. H. "The Responses of Animals Inhaling Nitrogen Dioxide for Single, Short-Term Exposures". American Industrial Hygiene Association Journal, Vol. 23, pp. 457-462, November-December 1962.
6. Gray, Edward LeB. "Oxides of Nitrogen: Their Occurrence, Toxicity Hazard". AMA Archives of Industrial Hygiene, Vol. 19, pp. 479-486, May 1959.
7. Kleinerman, J. And Wright, G. W. "The Reparative Capacity of Animal Lungs after Exposure to Various Single and Multiple Doses of Nitrite". American Review of Respiratory Diseases, Vol. 83, pp. 423-424, March 1961.
8. "Motor Vehicles, Air Pollution, and Health". A report of the Surgeon General to the U.S. Congress, June 1962, U.S. Department of Health, Education, and Welfare.
9. Pace, D. M. et al. "The Effects of NO_2 and Salts of NO_2 upon Established Cell Lines". Canadian Journal of Biochemistry and Physiology, Vol. 39, pp. 1247-1255, August 1961.
10. Public Health Service. "Motor Vehicles, Air Pollution, and Health". A report of the Surgeon General to the U.S. Congress, House Document No. 489, 87th Congress, 2nd Session, June 1962.
11. Purvis, Matthew R. and Ehrlich, Richard. "Effect of Atmospheric Pollutants on Susceptibility to Respiratory Infection". Journal of Infectious Diseases, Vol. 113, pp. 72-76, July-August 1963.

HYDROCARBONS

Among the substances responsible for photochemical air pollution are unsaturated hydrocarbons (faster reactors), saturated hydrocarbons (slower reactors), aromatics, and aldehydes. These are emitted during the incomplete combustion of all fuels (including rubbish and agricultural field wastes), but automobile exhaust is the major source. Hydrocarbons and other organic gases are also expelled during the production, refining, and handling of gasoline and from such manufacturing operations as industrial dryers and ovens, and furnaces used for baking paints, enamels, and printing ink.

Hydrocarbons are a group of substances most of which, normally, are toxic only at concentrations in the order of several hundred parts per million. How-

ever, a number of hydrocarbons can react photochemically at very low concentrations to produce irritation and toxic substances. Because of the large number of hydrocarbons involved, the complexity of the photochemical reactions and the reactivity of other compounds such as nitrogen dioxide and ozone, a complete assessment of the hazards posed by atmospheric pollution by hydrocarbons is not feasible at this time.

During the last 20 years a progressive increase in death rates from lung cancer not entirely attributable to improved diagnostic methods and increased lifespan has been reported in many countries. A remarkable feature in these reports is the observation that the death rate from lung cancer in urban areas is consistently higher than in rural areas, that this difference can be explained only in part by differences in smoking habits, and that benzpyrene may be the carcinogen common to both cigarette smoke and polluted air.

There is no doubt that the atmosphere of many polluted areas contains substances which are experimentally capable of producing cancer in animals. It has been stated that carcinogens may be found in any polluted atmosphere which is analyzed with sufficiently sensitive methods. What is not known is whether these substances are present in sufficient amounts to produce cancer in man through inhalation.

Lung cancer has been produced experimentally by exposing mice simultaneously to ozonized gasoline, a form of simulated smog, and to influenza virus. This work by Wisley and co-workers opens up a new approach to work both on the role of viruses and of air pollutants.

Two classes of carcinogens have been detected in polluted atmospheres: (1) The organic carcinogens, such as benzo(a)pyrene, dibenzanthracene and related compounds. (2) Potentially carcinogenic metals and metal compounds. The magnitude of pollution with benzo(a)pyrene is substantially greater in cities whose pollution sources are primarily the combustion of coal in comparison with those whose pollution is primarily from petroleum combustion.

Recent evidence suggests that benzpyrene and related aromatic hydrocarbons may not be the only carcinogens present in polluted atmospheres.

Their discovery that the concentration of 3, 4-benzpyrene and related aromatic polycyclic hydrocarbons in the atmosphere and in vehicular exhaust did not account for the yield of skin tumors in mice led Kotin and the University of Southern California team to experiment with aliphatic hydrocarbons. Samples of ozonized aliphatic hydrocarbons painted on the interscapular area of mice three times weekly induced papillomas or invasive epidermoid carcinoma after 421 days. Again, in strain A (tumor-susceptible) and in C57BL (tumor-resistant) mice exposed to an atmosphere of unburned ozonized gasoline in an inhalation chamber, in which aromatic polycyclic hydrocarbons were believed to be absent but which contained a variety of oxidants, the occurrence of pulmonary adenomas or alveogenic carcinomas (not true bronchogenic carcinomas) and the incidence of multiple tumors were significantly greater than in control mice breathing washed air.

A cooperative study was recently undertaken by the National Cancer Institute and the University of Southern California. In eight cities studied intensively during a benzpyrene survey, for which morbidity and mortality data were adequate, airborne particulate matter collected by the National Air Sampling Network was extracted to yield four organic fractions: crude benzol, aromatic hydrocarbon, aliphatic hydrocarbon, and oxygenated. Although benzpyrene was present in only the crude benzol fraction and the aromatic subfraction, every fraction proved capable of producing local skin tumors in C57BL mice after subcutaneous injection; but the fractions differed from city to city in their degree of tumor-producing ability. Attempts to relate human mortality in these cities to 3, 4-benzpyrene levels revealed no consistency in pattern from one city to another—hardly surprising, in view of the numerous other variables not accounted for, such as smoking habits, other air pollutants, and occupational exposures. Of great potential significance when levels in ambient air are considered, 12 monthly doses of benzpyrene appeared to be more effective in producing tumors than the same total amount given as a single dose; thus, chronic low-level exposure to these agents may be more injurious than brief heavy exposure. Equally significant in its application to atmospheric exposure was the longer interval that elapsed before tumors made their first appearance after a single injection of the same total amount.

Artificial exposure of laboratory animals has provided some evidence of the effects caused by some of the chemical agents present in this type of smog. The studies of the carcinogenic properties of ozonized hydrocarbons illustrate this

information. Both dermal and pulmonary cancers have been produced in mice artificially exposed to an irradiated mixture of ozone and unsaturated hydrocarbons. Skin painting with aromatic hydrocarbons produced skin tumors in both C57 black and strain-A mice. Skin painting with aliphatic hydrocarbons also produced skin tumors in C57 black mice. Of more interest and probably more significance is the finding that pulmonary tumors were produced in strain-A mice after their exposure to an atmosphere of ozonized gasoline. In these mice tumors developed in 41 percent under washed air conditions and in 80 percent in polluted air. Results on the C57 black mice under similar exposure are reported by Kotin and Falk. The control animals showed a very low percentage of lung tumors, whereas over one-third of those exposed to polluted air produced tumors. Additional biological effects on these mice will be reported in detail. At the moment it has been noted that the mice housed in a polluted atmosphere showed a consistent weight deficit in comparison with the controls.

In the animal experiments in which the various carcinogenic chemicals are used, the target tissue that responds with a malignant cancer growth may be in the respiratory tract or it may be at another site. In connection with the fact that respiratory tract cancer has been experimentally produced by these materials, and the strong current belief that these materials are discharged into the air in larger amounts in recent years as a result of urbanization and industrialization, it is noteworthy that recent epidemiological reports have shown that human lung cancer frequency has been steadily increasing over many areas of the world, especially in urbanized industrialized communities. The possible causal relationship of tobacco smoking to this increase is receiving world-wide attention, as the voluminous literature on the subject attests. The subject of tobacco smoking and its manifold possible health effects, although involving a problem of "personal" air pollution, falls outside the province of our immediate consideration, except in so far as the smoke produced adds to the pollution of the air breathed by bystanders. Of some importance in connection with tobacco smoking is a recent report suggesting that if cigarette smoking does, in fact, contribute to the increased frequency of human lung cancer, it cannot account for all of that increase; urban air pollution, it is argued, also contributes to the frequency of the disease. Thus it would appear that in human cancer, as in other disease, we often deal with conditions that have multiple causation, such as multiplicity being operative both when the disease is considered as a mass human phenomenon and when it occurs in an individual.

The contribution that coexistent disease may play in the development of lung cancer is uncertain. On the one hand, particularly for still active or acute lesions, the host's immunologic defenses may be weakened; on the other, the carcinogen may be better able to make entry into scar tissue. In the case of atmospheric carcinogens, the numerous respiratory irritants that accompany them in community air may promote their biologic activity through both these mechanisms.

Animal experimental work also demonstrates the importance of such biochemical phenomena as synergism and antagonism when applied to the activity of carcinogens. Substances not in themselves carcinogenic, such as croton oil, long-chain fatty acids, higher molecular weight paraffins, various aromatic compounds and phenolic derivatives, have been found capable of promoting or reinforcing the action of carcinogens and are classified as cocarcinogens.

The incidence of spontaneous and induced pulmonary tumors in mice is to an unknown degree a factor of their genetic strain, rendering interpretation of results and comparisons between different sets of experiments hazardous. Further complicating extrapolation to human terms, the tumors induced in mice have been largely adenomas, occasionally adenocarcinomas, and it is not certain that these have any comparative value as far as human cancers are concerned, particularly since it is the epidermoid lung cancer that is usually indicated as bearing a relationship to exogenous influences. The few reported instances of chemically induced epidermoid cancers in mice need to be corroborated by additional experiments, and this will require time and diligence.

Putting their findings together, Falk and his associates postulate a disturbing sequence of events: ciliary activity is inhibited by atmospheric pollutants; soot particles carrying hydrocarbons are abnormally deposited and retained in the lungs, the particles are engulfed by phagocytic cells, and the intracellular proteins elute the adsorbed hydrocarbons; conceivably a high local concentration of eluted aromatic hydrocarbons results, favoring the development of lung cancer.

Selected References

1. Bailar, J.C., III, King, H., and Mason, M.J.: Cancer Rates and Risks. USDHEW, PHSP 1148, U.S. Government Printing Office, Washington, D.C., 1964.
2. Kotin, P., and Falk, H.L.: Atmospheric factors in pathogenesis of lung cancer. *Adv. Cancer Res.* 7:475-514, 1963.
3. Nelson, N.: Carcinogenic implications of inhaled pollutants. *Arch. Environ. Health* 8:100-104 (Jan.) 1964.
4. Shimkin, M.B.: Science and Cancer, PHS Pub. No. 1162, USDHEW, National Cancer Institute, 1964.
5. Dean, G.: Lung cancer in Australia. *Med. J. Australia.* 49 1003-1006 (June 30) 1962.
6. Kotin, P., and Falk, H.L.: Air pollution and lung cancer. In: Proceedings, National Conference on Air Pollution, USDHEW, PHS Pub. No. 1022, U.S. Government Printing Office, Washington, D.C., 1963.
7. Kotin, P., and Falk, H.L.: II. The experimental induction of pulmonary tumors in strain-A mice after their exposure to an atmosphere of ozonized gasoline. *Cancer* 9:910-917 (Sept.-Oct.) 1956.
8. Saffiotti, U. et al.: Experimental studies of the conditions of exposure to carcinogens for lung cancer induction. *J. APCA* 15:23-25 (Jan.) 1965.
9. Kotin, P.: Air pollution with cancerigenic substances. *Acta Union Internationale Contre le Cancer* 19:3-4, 469-471, 1963.
10. Motor Vehicles, Air Pollution and Health. A report from the Surgeon General to the U.S. Congress. Department of Health, Education, and Welfare. June, 1962.
11. Stern, A.C., ed.: Air Pollution, Vol. I, Chapter 9. Academic Press, 1962.

Mr. ROGERS of Florida. Do you feel we are doing enough in providing help for the manpower that will be needed in this area?

Mr. MACKENZIE. We are giving emphasis to this element of our program, Mr. Rogers. In the past several years, we have increased our budget proposals for training of personnel by about threefold and we are doing this in several ways. We are making training grants to a number of universities for training of technical people in this field.

We are supporting fellows in graduate training at other schools and we are conducting short courses within our own laboratory at Cincinnati and from there elsewhere in the field.

Mr. ROGERS of Florida. I visited Cincinnati and was very impressed with what you are doing. As I understand you are sending out teams to areas rather than bringing people to Cincinnati which I would think could be more economical and perhaps reach a wider number of people.

Mr. MACKENZIE. Yes.

Mr. ROGERS of Florida. I wanted to ask one more question, Mr. Chairman. As you know, our committee is not inclined to go along with open-ended authorizations. I would think we would want some substantiation of the figures that the Senate has put in their bill, \$46 million, \$60 million, \$80 million, as to how these funds would be used, where they would be planned for and if you could submit that for the record, I think this could be helpful.

Mr. MACKENZIE. Yes, sir.

(The information requested follows:)

BACKGROUND MATERIAL RELATING TO PROPOSED ANNUAL APPROPRIATION LIMITATIONS FOR FISCAL YEARS 1967, 1968, AND 1969, AS CONTAINED IN S. 3112, AND AIR POLLUTION PROGRAM PROJECTIONS THROUGH PERIOD AUTHORIZED BY H.R. 13199, 1968-72

The Division of Air Pollution of the Public Health Service, Department of Health, Education, and Welfare, in connection with its responsibilities under the Clean Air Act, and in conformance with Executive Branch requirements, prepares long-range plans, generally for five years ahead, on the basis of its best professional judgments as to what is required to fulfill legal requirements in a manner which will most effectively deal with the air pollution problem.

Accordingly, the table below indicates estimates of the cost of the Federal air pollution program for the years 1967-72. These estimates are professional judgment estimates and do not constitute official estimates for future years approved by the Executive Branch. In addition, there follows an explanation of the more significant goals which the program is attempting to achieve and the major program activities proposed to meet these goals.

AIR POLLUTION PROGRAM, FISCAL YEARS 1967-72

Grants

(a) *Research.*—Current experience indicates a continuation of and increase in the wide and active interest by universities in air pollution research. The current and projected existence of backlogs of approved but unfunded grant applications has been used as an experience factor in projecting activity levels through 1972. This program will constitute an important resource to carry out much of the research specifically earmarked for attention in the Clean Air Act.

(b) *Fellowships.*—This program is one phase toward meeting a resource goal of 4,000 additional trained personnel to curtail the current shortage of trained personnel nationally and to meet the increasing demands of expanding State and local control programs.

(c) *Training.*—Increased emphasis in the university grant program will be placed on curricula to develop trained manpower for expanding State and local regulatory control programs. This activity, as in the case of Fellowships, is aimed at assisting in the development of a university-based training structure which will be instrumental in developing the additional trained manpower needed.

(d) *Control programs.*—The goal is an expansion of State and local air pollution regulatory efforts to about 50 percent of the necessary level of activity by 1970 with 100 percent attainable by about 1975. While broadened financial assistance authority, in the form of maintenance or support grants for on-going programs, will be required to meet this goal, good progress has already been made to date through the award of stimulatory control program grants and this progress is expected to continue. It is hoped that the available funds will permit funding of all approved projects. Regional control organizations will be given increased emphasis for assistance.

(e) *Survey and demonstration.*—These grants are directed toward the dual purpose of: a) permitting a State or locality to assess its problem prior to embarking on a specific control program, or assisting in the design of a control program; and b) demonstrating, in a practical field application, new techniques for control of air pollution. Emphasis is currently being given to the survey grant as a preliminary to regulatory control activity, in line with current build-up of programs. In subsequent years, as initial surveys have been completed, the emphasis will shift to demonstration of control techniques which will be of broad significance nationally.

Direct operations

(1) *Research.*—Major emphasis will be in three areas. First, by 1970 it is planned that there will be developed air quality criteria for all major pollutants known to be harmful to man, plants, and materials. This activity will encompass a review and evaluation of all available data and will include clinical, laboratory, and epidemiological research aimed at developing the data necessary for the air quality criteria. This schedule for criteria is geared to the build-up of State and local regulatory programs, which will be the prime users of the criteria.

The second area of research emphasis is with respect to air pollution caused by automotive vehicle emissions. As a result of authority under the Clean Air Act Amendments, it is estimated that by 1970 hydrocarbon and carbon monoxide emissions from about 25 percent of all motor vehicles will meet Federal standards. The FY 1968 research program will be aimed at improvement in techniques, technical developments to permit extension of controls to include oxides of nitrogen, not now controlled, and further efforts to stimulate the development of fundamentally improved means of vehicle propulsion, from the pollution point of view.

The third area of research emphasis is in the control of oxides of sulfur. Toward the end of meeting our goal of having economically feasible means for control of oxides of sulfur emissions by 1970, work will be undertaken to test promising control techniques on a pilot scale, including construction costs, as part of a research contract, cooperatively with TVA, of pilot-scale control apparatus.

These latter areas of research have been specifically singled out for increased emphasis under the 1965 Amendments to the Act.

(2) *Training.*—The direct, short-term technical training offered at the Sanitary Engineering Center, Cincinnati, Ohio, is a necessary and valuable complement to the full-time graduate level training which is principally the type of training funded under the Training Grants and Fellowships activities. This activity is presently under severe pressure to meet demands for intensive training of State and local personnel, as part of the expanding regulatory effort nationally. To maximize the training effort, increased emphasis will be placed on field courses, and on training aids which have a "multiplier effect," such as films and programmed instruction.

Curriculum emphasis will be increasingly on those aspects of air pollution most critically needed by personnel engaged in public regulatory control programs.

(3) *Technical services.*—The basic goal of this activity is to provide adequate technical consultation and related supporting services to State and local control agencies. A major expansion, related to the build-up of State and local regulatory control programs, is contemplated. A major objective is the development of industrial guides to good practice, for all the significant industrial processes in the country. This will be of value to industry, but especially as control guides to State and local agencies. The Air Pollution Technical Information Center will be operational by 1968 and will be a national source of technical information.

(4) *Enforcement and regulations.*—With respect to the Federal automotive regulatory control programs, a 25 percent reduction in pollutant emissions is planned for 1975, with a 40 percent reduction by 1985. These are difficult goals in the face of a rising automobile population, but they are goals which may be considered as "buying time" to permit development and production of "pollution-free" automobiles. Under the provisions of the Act, the automotive manufacturers will request Federal certification for nearly all models, which will mean a substantial amount of direct Federal testing of vehicles in a Federal laboratory. Such a facility is currently planned and being negotiated for. With the model year 1968 automobiles to be the first ones to be Federally regulated, operations will commence in 1967. 1968 will be the first full year of testing under this program.

With respect to Federal abatement authority, apart from motor vehicles, special emphasis will be given to abatement activity in interstate areas of pollution at the initiative of the Secretary. Over 100 areas have been identified as potential problems areas subject to Federal action under the abatement provisions of the Act. By 1968 the level of enforcement activity will be stepped up to at least double that anticipated for 1967. 1967 will be the first full year in which the international and preventive abatement authorities of the Amendments will be implemented. In 1968, there will be expanded activity, under the preventive abatement authority, with primary emphasis on the prevention of potential pollution from electric power generating plants. The projected build-up of power generating plants, with their high pollution potential, will be a major target for application of the new preventive abatement feature.

This activity also includes the program of prevention and abatement of pollution from Federal facilities. By 1970, a significantly substantial reduction in such pollution is anticipated. In 1968 major activity will be on implementing recently issued Executive Order designed to prevent pollution in new Federal construction, and to abate existing pollution.

(5) *Intelligence and surveillance.*—This activity, as a direct Federal operation, is a continuing activity designed to provide basic data on pollution trends and to permit detection of emerging problems. The National Air Sampling Network and the Continuing Air Monitoring Program are the key ingredients of this system at present. By 1972, the intelligence and surveillance program will be increasingly characterized as an input receiving and coordinating mechanism for many State and local monitoring systems which will be funded from air pollution control program grants-in-aid.

(6) *Review and approval of grants.*—This activity is concerned primarily with the legal, administrative, and technical requirements associated with the review, approval, and monitoring of the research grants, the training grants, the fellowships, the control program grants, and the survey and demonstration grant programs. The review and approval program through 1972 is geared to the anticipated levels of the related grant programs through that period.

Air pollution estimates, 1967-72

[In thousands of dollars]

	1967 Presi- dent's budget	Proposed 1967 addi- tional ¹ 1967,	1968 esti- mate ²	1969 esti- mate ²	1970 esti- mate ²	1971 esti- mate ²	1972 esti- mate ²
Activities:							
Grants:							
Research.....	6,958	-----	9,000	10,000	12,000	14,000	16,000
Fellowships.....	468	-----	1,000	1,000	1,000	1,000	1,000
Training.....	2,000	-----	3,000	3,000	3,000	3,000	3,000
Control programs.....	7,000	7,000	21,000	25,000	28,000	31,000	31,000
Survey and demon- stration.....	2,000	-----	3,000	3,000	3,000	3,000	3,000
Total, grants.....	18,426	7,000	37,000	42,000	47,000	52,000	54,000
Direct operations:							
Research.....	11,320	1,850	18,300	20,000	23,000	24,200	25,000
Abatement activities.....	1,652	750	4,632	5,700	6,400	6,900	7,400
Motor vehicle pollution control.....	845	400	1,445	1,670	1,900	2,100	2,300
Technical services.....	2,639	-----	5,208	6,900	7,400	7,900	8,400
Training.....	695	-----	1,600	1,800	2,100	2,400	2,600
Total, direct opera- tions.....	17,151	3,000	31,185	36,070	40,800	43,500	45,700
Grand total.....	35,577	10,000	68,185	78,070	87,800	95,500	99,700

¹ Estimated on the basis of enactment of S. 3112, to include funds for maintenance grants and for required enforcement activities which cannot be funded under existing statutory limitations for 1967.

² Professional judgment estimates, not having official executive branch approval.

Mr. ROGERS of Florida. I am glad to see some emphasis being placed now by the Department and we are going to look to you for increased leadership in the whole area. I think people are very conscious now of the need for pollution control and certainly, I would hope we would have an effort to get greater cooperation from the industry, from the automobile industry, for instance, and with other industry which is contributing to the pollution problem.

Mr. MACKENZIE. May I say that we have had complete and excellent cooperation from the automobile industry in implementing the regulations under title II of the Act.

Mr. ROGERS of Florida. That has been my impression and I think it is commendable.

Mr. MACKENZIE. I appreciate personally, Mr. Rogers, the interest of this committee and hope that this will continue.

Mr. ROGERS of Florida. It will.

Mr. NELSEN. Will the gentleman yield?

Mr. ROGERS of Florida. I yield.

Mr. NELSEN. In listening to the discussion relative to electric engines, being a little bit of a mechanic myself, I know that there are certainly some limitations on an electric automobile because of fuel supply but certainly, we would like to see the Department exciting the automobile industry into action and I think for us to assume that the experimental process would be developed by your Department would be perhaps a fond wish but I think the stimulation would come from there. In the areas of air pollution and other areas, there is where the real effort I think must be and then the stimulation of the automobile industry. I think great advances have been made in the construction of automobiles and even in the crankcase ventilation that now goes through the carburetors again.

We see many old automobiles on the street that are emitting a blue smoke behind. This is something that is a wornout engine of course. I must want to make the point. I think the point is well taken but the great emphasis must be in the automobile industry because they have the facilities of research.

The stimulation must come from your Department and from the Congress.

Mr. ROGERS of Florida. I might say too, that although I agree, a great deal has been done so much more can be done. You get behind one of these buses, even new ones, and I don't think much has been done there. I would hope that you would give a great deal of attention to that as well. It is my understanding that there have been batteries now invented which have long, long life so that it is not a question of a battery running out any more.

I think the possibility of an electric motor might have great promise. So I would hope that this would be encouraged.

Dr. PRINDLE. I think Mr. Nelsen has made the very good point and I think the committee has made the very good point that obviously this is a Federal-industrial relationship that has to be developed and obviously, this is one that does take time and effort on both our sides.

I think we can develop this. I might mention that one of the techniques that we used to try to accomplish the stimulation and cooperation are in the national conferences. We will be holding another one this year in December which we hope will involve all the segments of the public and the industry and attempt to bring out these questions and these problems so that we can bring them into discussion and effect this approach.

Mr. NELSEN. I noted that in your testimony you did refer to the diesel engine. I quite agree. It is very uncomfortable.

Mr. JARMAN. We have had the first bell for a quorum but let me ask one question. Dr. Prindle, in your statement, you made reference to the Federal Government having initiated several interstate abatement actions. What type? What examples?

Dr. PRINDLE. These are under the terms of course of the act. Mr. MacKenzie has the details of these.

Mr. MACKENZIE. The abatement actions to which reference is made, Mr. Chairman, are those which are concerned with interstate pollution, pollution which arises in one State and adversely affects health or welfare of people in another.

Nine such actions have been initiated under the terms of the Clean Air Act since the authority was first enacted. Three of these were at the requests of Governors of the States involved and the other six were

initiated by the Secretary of our Department. I will be glad to put into the record a listing of these if you would like to have them.

(The information requested follows:)

Abatement Actions Initiated Under the Clean Air Act (as of September 29, 1966)

<i>Area</i>	<i>Initiated by—</i>
1. Shelbyville, Del., Bishop, Md.-----	Governor.
2. Shoreham, Vt., Ticonderoga, N.Y.-----	Do.
3. New York-New Jersey metropolitan area-----	Do.
4. Steubenville, Ohio, Weirton and Wheeling, W. Va.-----	Secretary, HEW.
5. Clarkston, Wash., Lewiston, Idaho-----	Do.
6. Parkersburg, W. Va., Marietta, Ohio-----	Do.
7. Kansas City, Mo., Kans-----	Do.
8. Ironton, Ohio, Huntington, W. Va., Ashland, Ky.-----	Do.
9. District of Columbia, Virginia, Maryland metropolitan area-----	Do.

Mr. ROGERS of Florida. Is it not true that the Secretary can call the conference and make some suggestion and then if they are not carried out, can call on injunction procedures?

Mr. MACKENZIE. It is a fairly involved procedure.

Mr. ROGERS of Florida. But anyhow, we have enforcement here. As I recall it was put in the act.

Mr. MACKENZIE. It has to go through essentially three steps, conference, public hearing, and eventually court action if necessary.

Mr. JARMAN. Thank you very much, gentlemen, for an able presentation.

At this time, without objection, I wish to insert in the record a letter from the Department of Health, Education, and Welfare to Mr. Staggers, chairman of the full committee, outlining programs underway and in prospect for reducing sulfur oxide emissions from combustion sources.

(The letter referred to follows:)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
Washington, D.C., July 27, 1966.

HON. HARLEY O. STAGGERS,
*Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in further response to your letter of June 10, 1966, requesting that you be advised as to the steps this Department has taken to implement Sections 103(a) (4) and 103(a) (5) (B) of the Clean Air Act, our plans in this area, and other pertinent information.

Our response, "Programs Under Way and in Prospect for Reducing Sulfur Oxide Emissions from Combustion Sources," is included herewith as Attachment A.

We trust that this information will assist your Committee in carrying out its responsibility in this area, which, as you note, is of such vital concern to the Nation.

Sincerely yours,

WILBUR J. COHEN,
Under Secretary.

ATTACHMENT A

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE PROGRAMS UNDERWAY AND
IN PROSPECT FOR REDUCING SULFUR OXIDE EMISSIONS FROM COMBUSTION
SOURCES

A. INTRODUCTION

The problem of sulfur oxide emissions from the combustion of fossil fuels is one of growing international significance, with which more and more industrial nations are demonstrating serious concern. This problem, with its serious implications for human health, is today a matter of common knowledge. The

Department of Health, Education, and Welfare is taking the lead in research and development designed to reduce these emissions. Although, within the United States, some research is being supported by the fuel, chemical, and utility industries, and the Office of Coal Research of the Department of the Interior, the major effort is being provided by our Department through the Public Health Service's Division of Air Pollution. This involves in-house research, non-Federal and interdepartmental contracts (notably with Interior's Bureau of Mines), and grant programs.

The Department of Health, Education, and Welfare is keenly aware of the broad economic implications of this public health problem and is putting top emphasis on the search for low-cost techniques for dealing with it. The Department's research efforts to control sulfur dioxide emissions are primarily devoted to carrying out two directives from Congress: Removal of Sulfur from Flue Gas, 103(a)(5)(B) in the Clean Air Act, and Removal of Sulfur from Fuels, 103(a)(4) of that Act. These authorities were first specifically reflected in the FY 1965 program, and the additional directives in the 1965 Amendments were programmed for the ensuing Fiscal Year, 1967. Progress in these two areas is covered below, in sections B and C respectively. However, our total program is not limited to these areas; other facets of the problem which are being actively explored by the Department are reported in brief in section D, Other Efforts to Attack the Sulfur Problem. Tentative Cost Estimates are discussed in section E.

B. REMOVAL OF SULFUR FROM FLUE GAS

Section 103(a)(5)(B) of the Clean Air Act is directed toward the development of improved low-cost techniques designed to reduce emissions of oxides of sulfur produced by the combustion of sulfur-containing fuels. Considerable effort has been devoted to this objective, and some progress has been made.

There is available, in the metallurgical and chemical industries, a considerable technology for the removal of relatively high concentrations of sulfur oxides from flue gases. The application of this technology to the relatively low concentrations found in powerplant flue gases has not proved feasible—hence the present worldwide search for applicable processes.

The pioneer full-scale installations of plants for this purpose were in England, where Thames River water was used to wash the sulfur oxides from flue gas. Based upon this and other experience with wet processes, the British now recommend against flue gas washing, with the result that most of the processes now under investigation around the world are dry, or, if wet, involve reversible chemical reactions and do not leave a sulfurous discharge to a stream.

In Germany, the emphasis is on a process that uses activated carbon to absorb the sulfur oxides from the flue gas. In Japan, one process under development first catalytically converts sulfur dioxide to sulfuric acid and then to ammonium sulfate; another process chemically reacts the sulfur oxides into a regenerable manganese sulfate. In Czechoslovakia, an ammoniacal washing process, which yields ammonium sulfate as the end product, is under consideration. In all these countries, as well as in the United States, there is interest in processes that blow alkaline materials into the furnace, because, of all current processes, this is the one most applicable to existing installations.

In the United States, a number of promising processes are now in the proposal stage. There are, however, only two American processes which have reached the pilot-plant stage: the catalytic conversion of sulfur dioxide to sulfuric acid, and the reversible absorption of sulfur dioxide by alkalinized alumina. The former process has been developed by private industry, the latter by DHEW-funded research in the Department of the Interior.

The control method of injecting alkaline materials into furnaces to react with sulfur oxides to produce a solid which subsequently can be removed by electrostatic precipitation or filtration is of immediate application in existing powerplants. Consequently, under a contract with Battelle Memorial Institute, a fundamental study of sulfur fixation by lime and magnesia is under way to elucidate the thermodynamics and kinetics of the reactions involved. Past efforts to remove SO_2 from combustion gases by reacting the SO_2 with alkaline materials such as limestone and dolomite have been handicapped by our inability to inject

these materials into power boiler systems with assurance of good reaction efficiency.

As mentioned above, this Department has transferred funds to the Bureau of Mines of the Department of the Interior for the development of the alkaliized alumina process for scrubbing sulfur dioxide from stack gases and recovering the sulfur in elemental or acid form. Process cost estimates have been developed for the alkaliized alumina, catalytic oxidation, and activated carbon processes for removing sulfur oxides from flue gases.

In-house work has proceeded along more basic lines. Researchers have sought more reactive absorbents for scrubbing stack gases. They have initiated programs to achieve reduction in emissions of pollutants through the use of fuel additives and combustion process modifications.

Engineering evaluations of many removal processes have been made to select candidate methods for early process development and prototype demonstration.

In 1967, the operation of a larger, continuous alkaliized alumina pilot plant will provide more reliable data on the performance and life of the absorbent and will reveal the parameters affecting SO_2 removal over a prolonged, continuous period. Work will begin on the preparation of absorbents which will resist attrition and lead to longer life and cheaper operation. New and more efficient methods of regenerating the absorbent will be investigated. More efficient regeneration leads to smaller equipment designs and results in lower capital plant costs.

Work related to the activated carbon process will be tailored to improve the reaction rate of the sulfur oxides with the carbon, to improve the combustion resistance of the carbon, and to develop improved nonthermal regeneration methods for "spent" carbon. Success in any of these areas will lower operating costs of the process.

In the catalytic oxidation process, the key to economic operation lies in the recovery of the acid in a concentration of commercial value and at a high enough temperature to prevent corrosion of process equipment. We will, therefore, investigate the feasibility of various high-temperature acid recovery systems and also perform related equipment-corrosion testing.

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

The time-temperature-rate relationship of various types of alkaline additives, and the effect of the method of their preparation on their activity, will be determined. Field trials of the most successful activated material are planned in prototype equipment.

The present needs are to move the more promising processes from the proposal to the pilot-plant stage; and to move the more promising pilot-stage processes to the demonstration-plant stage.

In addition to this Federal research on sulfur removal from flue gas, there is a substantial industrial effort which includes several of the processes noted above as being in the proposal stage and the above-noted pilot plant for catalytic conversion of sulfur dioxide to sulfuric acid. Also, the American Petroleum Institute is supporting a literature survey of flue gas desulfurization processes, and the Electrical Research Council and National Coal Association are jointly supporting work on the alkaline injection and alkaliized alumina processes previously described.

C. REMOVAL OF SULFUR FROM FUELS

Section 103(a)(4) of the Clean Air Act relates to the initiation and conduct of programs of research directed toward the development of improved, low-cost techniques for extracting sulfur from fuels.

Residual fuel oil and coal present the major problems in this area. The technology of the removal of sulfur from oil and gas is well known and extensively utilized in producing the almost-sulfur-free gas, gasolines, lubricating oils, and light fuel oils that constitute the bulk of the products of the oil and gas industry the world over.

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

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

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

Studies of the forms and the washability of sulfur in American coal used in powerplants have been undertaken by contract. Analyses of the ability of various commercial processes used in coal preparation to remove sulfur are being examined to determine feasibilities and costs of the processes for particular coals which are utilizable in powerplants. Preliminary studies of new processes have been conducted which may have potential value for use in sulfur removal from coal; these processes include air elutriation, thermomagnetic or electrostatic forces, and corona discharge.

Besides the Federal research effort in this area, there is also an industrial effort. The American Petroleum Institute is supporting a study to determine the estimated cost of desulfurizing Caribbean residual fuel oil and is assembling data on petroleum industry expenditures for fuel oil desulfurization, and the Electric Research Council and the National Coal Association are jointly sponsoring research on the removal of pyritic sulfur from coal.

D. OTHER EFFORTS TO ATTACK THE SULFUR PROBLEM

Basic and necessary though it is to carry out the two specific directives from Congress which are aimed at *controlling* emissions of sulfur compounds to the atmosphere through removal of sulfur from fuels and stack gases, these are by no means the only responsibilities of the Department of Health, Education, and Welfare in connection with sulfurous air pollutants. Other related efforts under way or planned by the Department can be catalogued in four groups: (1) determining overall research needs and priorities; (2) research on alternatives to desulfurization of fuel and flue gas; (3) necessary studies of factors other than control; and (4) supplementary programs which can aid in SO₂ control.

(1) *Determining Overall Research Needs and Priorities.*—This is a continuing study for which the need is obvious if we are to avoid premature and arbitrary

decisions. It involves learning about the gaps in our present knowledge and deciding how best to apply available resources to filling these gaps. A first step was a comprehensive survey of the world's literature; one result has been the publication of a 383-page bibliography of sulfur oxides and other sulfur compounds. Continuing worldwide liaison is maintained on this matter and two representatives of the Department are now in Europe studying sulfur-control methods and related current research in England and Germany. We are also cooperating with the Organization for Economic Cooperation and Development in setting up international air pollution studies. One of the studies recommended for top priority is the sulfur problem. Representatives of this Department have been involved in recent official exchange missions which, among other things, investigated these matters—a Presidential Mission to Germany and a Japanese Natural Resources Mission to the United States.

(2) *Research on Alternatives to Desulfurization of Fuel and Flue Gas.*—This Department attaches utmost importance to its research on the feasibility of means to control atmospheric levels of sulfur oxides by means other than desulfurization of fuels and flue gas. These means include: the use of taller stacks; the location of new fuel-burning sources outside of urban areas; allocating fuel among powerplants so that the better fuels are burned in the plants that are poorly sited or poorly equipped with respect to air pollution and vice versa; separating fuel into better and poorer fractions at the point of production, to permit the allocation suggested above; allocating power load among powerplants so that less load is carried by those that are poorly sited or poorly equipped with respect to air pollution, and vice versa; allocating power load among powerplants so that loading reflects the relative dispersive capacity of the atmosphere at any given time at all plants; and shifting from more to less pollution-producing fuels at individual powerplants when the dispersive capacity of the atmosphere decreases.

(3) *Necessary Studies of Factors Other Than Control.*—As an agency primarily concerned with public health and welfare, the Department must continue and expand its studies of the effects of sulfurous pollutants; and develop Federal criteria as guides to the setting of legal standards—for those and other pollutants—for emissions and for ambient air quality. Reactions which take place after sulfur compounds are emitted to the air must be studied. Surveys must be made in areas of high pollution, and continuing measurements taken throughout the country through the National Air Sampling Network and the Continuous Air Monitoring Program which are operated by the Department.

(4) *Supplementary Programs Which Can Aid in SO₂ Control.*—Certain basic studies are being pursued which are expected eventually to contribute to a reduction in SO₂ emissions. For example, a study is being conducted at Penn State University under the Department's research grant program at a cost of \$20,240 which is concerned with "Interaction of Sulfur Dioxide with Carbon Surfaces." This will help to optimize plant design for minimum operating costs under various flue gas conditions which prevail in the wide variety of existing powerplants.

A major Department program which will importantly affect the overall effort to reduce sulfurous effluents is the Control of Air Pollution From Federal Installations. On May 26 of this year, President Johnson signed Executive Order 11282, which directs the heads of all Federal agencies to lead in the administration's efforts to improve the quality of the Nation's air. In signing the order, the President stated that the most difficult problem encountered in writing the order was the lack of an economically feasible technology for controlling emissions of sulfur. This Department has supplemented the order by issuing standards which set precise limitations on emissions which will be allowed from Federal buildings and facilities. These standards implement the expressed will of Congress that the Federal Government shall be an exemplary "good neighbor" in abating community air pollution. With regard to sulfur oxides, they require that most Federal Installations burn the lowest-sulfur-content fuel that is reasonably available. Among the factors to be considered in determining "reasonable availability" are: price, reliability of supply, and the magnitude of the air pollution problem.

The Federal Government has proposed spending more than \$3 million in 1967 on research to control sulfur emissions. This includes \$1 million for designing four sulfur-removal plants, the construction of which would cost a total of \$8 million. The President has directed the Secretaries of the Interior and Health, Education, and Welfare to explore with the Bureau of the Budget the feasibility of increasing the Federal effort to find a solution to the sulfur emission problem.

E. TENTATIVE COST ESTIMATES

The Department's program for research and development on the control of air pollution by sulfur compounds has been and may continue to be limited by appropriation ceilings. Although the maximum appropriation authorized under the Clean Air Act has increased each year these ceilings have imposed limitations on the effort which could be expended on these as well as other areas of our total program. We have endeavored to utilize available funds most efficiently and to estimate future needs on the basis of current expectations. However, the areas of interest under consideration here are so relatively new, and are developing so rapidly, that even medium range estimates can be considered only as tentative. If maximum progress at least cost is to be achieved, it will be necessary to review at frequent intervals the authorities and resources required. For example, the above programs as currently envisaged would require approximately \$25 million.

(The following information, requested by Congressman Rogers, was subsequently supplied by Mr. Fred Rehm, deputy director, Milwaukee County Department of Air Pollution Control:)

AIR POLLUTION CONTROL ORDINANCE

Department of Air Pollution Control
Milwaukee County

ADOPTED DECEMBER 20, 1961
PUBLISHED JANUARY 4, 1962
and
AMENDED THROUGH JULY 21, 1964
by the
MILWAUKEE COUNTY BOARD OF SUPERVISORS

CHAPTER 89 AIR POLLUTION CONTROL

- 89.01 Creation of department of air pollution control.
- 89.02 Definitions.
- 89.03 Duties of the department of air pollution control.
- 89.04 Establishment of rules and regulations.
- 89.05 Installation permit, operating permit, and certificate of operation.
- 89.06 Sale, use, or consumption of certain fuels.
- 89.07 Fuel shortage emergency.
- 89.08 Reporting of sales and purchases.
- 89.09 Equipment.
- 89.095 Suitable process or control equipment and fuels.
- 89.10 Fees.
- 89.11 Limits of emission and standards of measurement.
- 89.12 Entrance to premises.
- 89.13 Persons liable.
- 89.14 Penalties for violations.
- 89.15 Period of grace.
- 89.16 Maintenance of records.
- 89.17 Appeals to appeal board.
- 89.18 Co-ordination of municipal and county regulations.
- 89.19 Declaration of public purpose of ordinance.

(Created December 21, 1961 J. Proc., p. 1996-2020; published and effective Jan. 4, 1962.)

TO REPEAL CHAPTER 88 OF THE GENERAL ORDINANCES OF THE COUNTY OF MILWAUKEE, AS AMENDED TO AND INCLUDING DECEMBER 20, 1961, AND, PURSUANT TO AUTHORITY OF SEC. 59.07 (85) STATS. AS CREATED BY CHAP. 508, L. 1961, TO CREATE A CHAPTER 89 OF THE GENERAL ORDINANCES OF THE COUNTY OF MILWAUKEE, CREATING A DEPARTMENT OF AIR POLLUTION CONTROL, REGULATING THE EMISSION OF SMOKE AND SOLIDS, LIQUIDS, GASES, FUMES, ACIDS, BURNING EMBERS, SPARKS, PARTICULATE WASTES OR DUSTS, INCLUDING THEIR RADIO-ACTIVE FRACTIONS OR COUNTERPARTS, INTO THE OPEN AIR WITHIN THE TERRITORIAL LIMITS OF MILWAUKEE COUNTY; REGULATING THE CONSTRUCTION, RECONSTRUCTION, REPAIR, USE OF, AND ADDITIONS TO PROCESSES, CONTROL EQUIPMENT AND DEVICES AND THE APPLICATION OF FUELS AND RAW MATERIALS TO EQUIPMENT AND PROCESSES; REQUIRING NOTICE TO THE COUNTY OF MILWAUKEE OF ALL PURCHASES AND SALES OF SUCH EQUIPMENT TO

BE INSTALLED WITHIN THE COUNTY; PROVIDING FOR THE ESTABLISHMENT OF FEES FOR EXAMINATION OF PLANS, INSPECTIONS, TESTS, ISSUANCE OF PERMITS FOR EQUIPMENT AND CERTIFICATES OF OPERATION; ESTABLISHING PROCEDURES REGARDING THE TAKING OF APPEALS; PROVIDING FOR THE DETERMINATION OF A FUEL SHORTAGE EMERGENCY AND THE EFFECT THEREOF; PROVIDING FOR COMMENCEMENT OF ACTIONS TO ENJOIN ACTS, THREATS OF ACTS AND THE PROCURING OR SUFFERING OF ACTS TO BE DONE IN VIOLATION OF THIS ORDINANCE; AND PROVIDING PENALTIES FOR THE VIOLATION OF ANY OF THE PROVISIONS OF THIS ORDINANCE. PURSUANT TO AUTHORITY OF SEC. 59.07 (85) STATS. 1961, CREATED BY CHAPTER 508, L. 1961, NINETEEN NEW SECTIONS OF THE GENERAL ORDINANCES OF THE COUNTY OF MILWAUKEE ARE CREATED TO BE NUMBERED 89.01 TO 89.19, INCLUSIVE, WHICH MAY BE REFERRED TO AS CHAPTER 89 OF THE GENERAL ORDINANCES, AND TO READ AS FOLLOWS:

89.01 Creation of Department of Air Pollution Control. There is hereby created a Department of Air Pollution Control of the County of Milwaukee, which shall consist of the following:

(1) A Director to be appointed by the County Executive under civil service subject to confirmation by the County Board.

(2) A Deputy Director, who shall be appointed under civil service by the Director, and who shall be authorized to perform all powers and duties of the Director in his absence or disability and under his direction.

(3) Such other employees as may, in the opinion of the County Board of Supervisors, be necessary for the proper performance of the work of said department, and who shall be paid such salaries as may be fixed by the County Board, and who shall be appointed under civil service by the Director.

(4)(a) An advisory Board of five persons who shall be graduate engineers representing a cross section of the various phases of air pollution or its control as well as with industrial processes and equipment, and whose experience and training qualifies them to give competent technical advice to the Director or to the County Board.

(b) Three members of the Advisory Board shall constitute a quorum provided that each recommendation of such Board shall be adopted by the affirmative vote of at least three members of the board.

(c) The members first appointed shall be appointed for terms of one, two, three, four and five years respectively and thereafter members shall be appointed for five year terms. Appointments to the Board shall be made by the County Executive subject to confirmation by the County Board. The County Executive shall annually appoint one of the members as chairman. The Advisory Board shall annually elect a secretary. The members of the board shall serve without pay. The terms of each member shall commence on January 1. In the year 1961, the County Executive may appoint an interim Advisory Board to serve until January 1, 1962.

(d) The Advisory Board shall meet at least bi-monthly and at such

additional times as may be called by the chairman. The chairman shall call a meeting upon the written request of at least three members of the Advisory Board. The Advisory Board shall keep minutes of its proceedings which shall clearly show the official actions of the Advisory Board and the vote of any member of the Advisory Board on any question. Such minutes shall be made available to the Director, County Executive, Chairman of the County Board, the Chairman of the County Highway Committee and to the members of the Advisory Board. A copy of such minutes shall be on file in the department office available for public inspection.

(5)(a) An Appeal Board consisting of five members who shall be appointed by the County Executive subject to confirmation by the County Board, for a term of five years, except that of the initially appointed board, one member shall serve for one year, one member for two years, one member for three years, one member for four years and one member for five years, the terms of each member to commence on January 1.

(b) Such members shall be persons of good reputation who have been actively identified with the development and improvement of Milwaukee County or its constituent municipalities and who shall not be interested in the sale of any fuel, process or control equipment or control device. One of such members shall be a practicing attorney and one a professional engineer. A lawyer member of such board shall serve as chairman thereof. The Appeal Board shall annually elect a secretary. Appeal Board members shall serve without compensation.

(c) Such Appeal Board may adopt, amend or repeal from time to time such of its procedural rules and regulations as it may deem necessary to carry into effect its duties as prescribed by this ordinance. When adopted, such rules shall be published once in the official county newspaper.

(d) Meetings of the Appeal Board shall be held at the call of the chairman whenever necessary to process grants of periods of grace as provided in Section 89.15 of this ordinance and when necessary to process appeals as provided in Section 89.17.

(e) The chairman, or the acting chairman in his absence, may compel the attendance of witnesses and may administer oaths.

(f) The Appeal Board shall keep minutes of its proceedings, including records of its hearings or of appeals and other official actions.

(g) Every rule and regulation, every amendment or repeal thereof, and every order, requirement, decision or determination of the Appeal Board shall be filed immediately in the department's office and with the Chairman of the County Board and shall be open for public inspection.

(h) The presence of three members of such Appeal Board at any meeting thereof shall constitute a quorum, and an affirmative vote of a majority of a quorum or of the members present at any meeting in excess of a quorum shall be necessary to any determination by the Appeal Board. The Appeal Board shall keep minutes of its proceedings which shall clearly show the official actions of the Appeal Board and the vote of any member of the Appeal Board on any question.

(i) The County Clerk shall be ex-officio secretary of the Appeal Board in all appeals brought before it.

89.02 Definitions. For the purpose of this ordinance, whenever any of the following words or terms are used herein, they shall have the meaning ascribed to them in this section.

(1) **ADVISORY BOARD**—The board appointed by the County Executive to act as advisors to the Director of the Department of Air Pollution Control of the County of Milwaukee and to the County Board.

(2) **AIR POLLUTANTS**—Smoke, solids, liquids, gases, fumes, acids, burning embers, sparks, particulate wastes or dusts, including their radioactive fractions or counterparts.

(3) **APPROVED**—Approved by the Director.

(4) **APPURTENANCE**—Any structure, device, mechanism or accessory part having any effect upon, or relationship to the operation or performance of any process or control equipment.

(5) **BTU**—British thermal unit.

(6) **BOARD OF APPEALS**—The Board of Appeals as created by Section 89.01 (5).

(7) **BUILDING FIRES**—A "new fire being built" 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.

(8) **CERTIFICATION NUMBER**—A number assigned to a particular solid fuel certified by the Director to distinguish it from any other certified solid fuel.

(9) **CERTIFICATE OF OPERATION**—A certificate issued by the Director authorizing the use of any process or control equipment for the period indicated after it has been found that it can be operated in compliance with the ordinance.

(10) **CERTIFIED SOLID FUEL**—Solid fuel the volatile content of which is 23% or less on a moisture and ash free basis and which has been certified for use as a certified solid fuel by the Director. Provided, however, that a solid fuel which contains volatile matter in excess of 23% on a moisture and ash free basis, shall be accepted as a certified solid fuel upon certification by the Director that such solid fuel meets the same standards in regard to smoke production as that of a solid fuel containing 23% or less of volatile matter on a moisture and ash free basis. To qualify such solid fuel for certification, the solid fuel supplier shall:

(a) Furnish to the Director complete specifications, data and information as the Director may require concerning the solid fuel for which certification is requested.

(b) Furnish to the Director a supply of the fuel for which certification is requested, adequate to conduct whatever tests the Director deems necessary to establish whether it meets the required standards as to smoke production.

(c) Pay to the Director in advance all expenses necessary to make the required tests.

(11) **CLEANING FIRES**—The term "when the fire box is being cleaned out" shall mean the period during which the fuel bed, including ash and clinker, is being completely removed from the grate surface.

This operation may be done by cleaning portions of the grate at different times. This does not mean that the act of shaking the grates to remove ash or individual clinkers from the fuel bed constitutes an act of cleaning the fires as interpreted in this ordinance.

(12) **COMBUSTION EQUIPMENT**—Any equipment, apparatus or device having a chamber or space wherein the combustible portions of any fuel or substance is burned, consumed, oxidized or converted into a gaseous state accompanied by the liberation of heat or power under control, and for which a flue, vent, chimney, stack or exhaust pipe is required to conduct the products of combustion from the equipment to the open air or atmosphere.

(13) **CONTROL EQUIPMENT**—Any equipment whose function is to control a process or process equipment and thus reduce the creation of, or the emission of air pollutants to the atmosphere, or both.

(14) **COUNTY**—The County of Milwaukee, Wisconsin.

(15) **COUNTY BOARD**—The County Board of Supervisors of Milwaukee County.

(16) **COUNTY EXECUTIVE**—The County Executive of the County of Milwaukee.

(17) **DIRECTOR**—The Director of the Department of Air Pollution Control of the County of Milwaukee.

(18) **DUST**—Gas-borne or air-borne particles larger than one micron in mean diameter. (Same for fly ash.)

(19) **DUST-SEPARATING EQUIPMENT**—Any device for separating dust from the gas medium in which it is carried.

(20) **EMISSION**—Emission into the open air.

(21) **FUEL BURNING EQUIPMENT**—Any furnace, incinerator, refuse-burning equipment, dust-separating equipment, boiler, apparatus, device, mechanism, stack, chimney, or structure used in the process of burning fuel or other combustible material.

(22) **FUMES**—Gases, vapors or particulates that are of such character as to create an unclean, destructive, offensive or unhealthful condition.

(23) **HEAT ABSORBING EQUIPMENT**—Mechanical apparatus or component parts thereof, such as the radiant or convection surfaces of a boiler, waterwall, water heater, superheater, reheater, dryer or air heater installed in conjunction with fuel-burning equipment for the purpose of receiving, storing, transmitting, utilizing or converting the heat energy liberated from the burning of fuels.

(24) **INSPECTOR**—Any person who is duly authorized by the Department of Air Pollution Control, County of Milwaukee, to perform duties of inspection.

(25) **INSTALLATION PERMIT**—A permit issued by the Director authorizing the construction, installation, alteration, or repair of any process or control equipment in accordance with plans and specifications approved by the Director.

(26) **INTERNAL COMBUSTION ENGINE**—Any engine in which the combustion of gaseous, liquid or pulverized solid fuel takes place within one or more cylinders.

(27) **MECHANICAL FIRING**—A means of firing through the use of

mechanical equipment such as a burner, stoker, or other approved firing device.

(28) OPACITY—State of a substance which renders it partially or wholly impervious to the rays of light.

(29) OPEN FIRE—Any fire wherein the products of combustion are emitted into the open air and are not directed thereto through a stack or chimney.

(30) OPERATING PERMIT—A permit issued by the Director authorizing the use of any process or control equipment for test purposes to determine whether or not it can be operated in compliance with this ordinance. (See Certificate of Operation.)

(31) ORDINANCE—The whole or part of Chapter 89 of the General Ordinances of the County of Milwaukee.

(32) PERSON—Any owner, tenant, lessee, individual, partnership, association, syndicate, company, firm, trust, corporation, government corporation, department, bureau, agency, or other entity recognized by law as the subject of rights and duties.

(33) PROCESS EQUIPMENT—Any equipment which causes, creates, modifies, handles, conveys, controls, discharges or comes in contact with air pollutants which are subsequently discharged to the atmosphere. Processes and process equipment including, but not limited to, are: fuel burning, combustion, heat absorbing, smelting, roasting, grinding, drying, conveying, baking, batching, melting, sintering, cleaning, pickling, galvanizing, pulverizing, painting, calcining, briquetting and sizing equipment.

(34) RAILROAD LOCOMOTIVE—Any railroad locomotive or railroad vehicle using a liquid, solid, or pulverized solid fuel.

(35) RINGELMANN CHART—The standard by which the shade or density of smoke is to be measured is the Ringelmann Chart published by the United States Bureau of Mines. This chart is incorporated in this ordinance as Exhibit I.

(36) SMOKE—All gaseous products of combustion, together with carbon, dust, fly ash, and all other particulate solids in combustion gases in sufficient density to be observable.

(37) SEAL OR SEALING PROCESS EQUIPMENT OR PREMISES—A device installed by the Director so as to prevent use of the process equipment or premises causing the violation or from which violations originate.

(38) STACK OR CHIMNEY—Stack, chimney, flue, conduit, or opening arranged for the emission into the open air of air pollutants.

(39) VOLATILE—The gaseous constituents of solid fuels as determined by the Standard American Society of Testing Materials D 271 Procedure (1944).

(40) WASTE—The waste products of industrial processes, such as mineral wool, lint, peanut hulls, grain chaff, etc.

(89.02 (37) Amended Sept. 12, 1963 J. Proc., p. 1254-1255, 1257; published and effective September 26, 1963)

89.03 Duties of the Department of Air Pollution Control. (1) The duties of the Director, who shall be responsible for the administration

of air pollution control in the County of Milwaukee, include without limitation because of enumeration:

- (a) The investigation of complaints and the making of inspections

and observations of air pollution conditions.

(b) The issuance of permits, certificates and notices under this ordinance; the keeping of applications, specifications, plans, permits, certificates, violations, complaints, and other records on file for department purposes only.

(c) The examination of so much of the plans or specifications for all new buildings and for the alteration of all existing buildings as may be necessary to assure that they are in accordance with Section 89.05 and the rules and regulations established by this ordinance.

(d) The examination of the application and plans or specifications for the construction, installation or alteration of any process or control equipment or any equipment or device pertaining thereto, and, if found to meet the requirements of the rules and regulations, the issuance of an Installation Permit.

(e) The inspection of the installation of all equipment for which a permit has been issued, and when found that the work is completed in accordance with the rules and regulations, the issuance of an Operating Permit, and thereafter when operation is demonstrated to comply with the provisions of this ordinance, the issuance of a Certificate of Operation.

(f) The publication and dissemination of information on methods of air pollution reduction.

(g) The enlistment of the co-operation of civic, technical, scientific and educational societies.

(h) To institute necessary proceedings to prosecute violations of this ordinance and to compel the prevention and abatement of the emission of air pollutants and nuisances arising therefrom.

(2) The duties of the Advisory Board shall include the following:

(a) To act as advisor to the Director.

(b) To consider and make recommendations as to such rules and regulations as may be presented by the Director.

(c) To consider and make recommendations to the County Board of Supervisors on any matters deemed to be in the best interest of effective air pollution control for Milwaukee County.

(3) The duties of the Board of Appeals shall be as set forth in Section 89.01 (5), 89.15 and 89.17 hereof.

89.04 Establishment of Rules and Regulations. (1) The Director is hereby authorized and directed to prepare, with or without the advice of the Advisory Board, and present to the County Board of Supervisors for consideration, rules and regulations for the installation and operation of process or control equipment and all other devices susceptible for use in such a manner as to violate the provisions of the ordinance; as to the kind of fuel to be used for various types of equipment; and as to necessary auxiliary devices that aid in meeting the requirements of this ordinance. When adopted by the County Board, such rules and regulations shall have the force and effect of an ordinance. The County Board of Supervisors, with or without the recommendation of the Director or the Advisory Board, may from time to time alter, amend, or rescind such rules and regulations and promulgate such additional rules and regulations

as are deemed advisable. Such rules and regulations as may be prepared, revised, amended or rescinded shall be made effective thirty days after their publication in the official newspaper of the County.

(2) Where reference is made in this ordinance to the standards or recommended practices of national technical societies or associations, such rules or regulations shall form and be considered an integral part of the ordinance in the same manner and extent as if fully reproduced therein. Not less than two copies of such standards or recommended practices of national technical societies and associations shall be kept on file at all times in the office of the Department of Air Pollution Control and shall be available for consultation by the public.

89.05 Installation Permit, Operating Permit, and Certificate of Operation. (1) No person shall construct, install, reconstruct or alter any process or control equipment pertaining thereto, for which a fee is required under Section 89.10, for use within the county until an application, including not less than two sets of plans or specifications, or both, of the process or control equipment and structures or buildings used in connection therewith, has been filed by the person or his agent in the office of, and has been approved by, the Director and an Installation Permit issued by him for such construction, installation or alteration. All Applications for Installation Permits shall indicate whether any work has been done prior to securing the Installation Permit.

(2) The above mentioned plans or specifications shall show the form and dimensions of the process or control equipment, together with the description and dimensions of the building or part thereof in which such process or control equipment is to be located, including the means provided for admitting the air for combustion processes, the character of the fuel to be used, the maximum quantity of such fuel to be burned per hour, the kind and amount of raw materials processed, the expected air pollutant emission rate, the operating requirements, and the use to be made of such process or control equipment shall be stated.

(3) Maintenance or repair which does not change the capacity of such process or control equipment and which does not involve any change in the method of processing or affect the emission of air pollutants therefrom, may be made without an Installation Permit.

(4) An emergency repair other than as specified in sub-section (3) of this section may be made prior to the application for an Installation Permit if serious consequences may result if the repair were deferred. When such repair is made, the person concerned shall notify the Director on the first business day after the emergency occurred and file an application for an Installation Permit if directed to do so by the Director.

(5) Where work is begun in violation of Installation Permit requirements, the Director may grant such permit, conditional upon removal of all faulty work. The Installation Permit fee shall be doubled in such cases.

(6) An application shall be approved or rejected within ten days after it is filed in the office of the Director. Upon the approval of the application and upon the payment of the prescribed fees, the Director shall issue a permit for the construction, installation, or alteration of such process or control equipment. Failure to approve the application

within ten days shall be deemed a rejection.

(7) No construction, installation, reconstruction, or alteration shall be made which is not in accordance with the plans, specifications, and other pertinent information upon which the Installation Permit was issued without the written approval of the Director.

(8) Violation of the Installation Permit shall be sufficient cause for the Director to stop all work, and he is hereby authorized to seal the installation. No further work shall be done until the Director is assured that the condition in question will be corrected and that the work will proceed in accordance with the Installation Permit.

(9) No person shall violate the seal on any process or control equipment that has been sealed at the direction of the Director unless authorized by the Director in writing to do so.

(10) If construction, installation, reconstruction or alterations is not started within one year of the date of the Installation Permit, the permit shall become void and all fees shall be forfeited, unless an extension of time is warranted and granted by the Director.

(11) No person shall operate or cause to be operated any new or altered process or control equipment or any equipment pertaining thereto for which an Installation Permit was required or was issued until an inspection has been made by the Director and an Operating Permit is issued. The person responsible for the installation, construction or alteration of any process or control equipment for which Installation Permit is required, shall notify the Director when the work is completed and ready for final inspection. An Operating Permit may be issued in accordance with this sub-section upon payment of fees, as required in Section 89.10 for existing process or control equipment where such equipment, related heat absorbing equipment, appurtenances or class of fuel used or to be used, are found to be at variance with the requirements of Section 89.06 or 89.09. The Director is hereby authorized to seal the equipment in operation for which an Operating Permit was not obtained as required in this ordinance.

(12) After the Operating Permit has been issued and it is demonstrated to the satisfaction of the Director that the process or control equipment can be operated in compliance with this ordinance, a Certificate of Operation shall be issued by the Director. Said Certificate of Operation shall be kept posted on or near the installation for which it was issued. The Certificate of Operation shall properly identify the equipment to which it pertains and shall specify the class of fuel, type of raw materials used, if any, for which the equipment and appurtenances have been designed or which has been successfully used in the operating test. Failure to operate successfully under test within the limitations and requirements of the Ordinance under an Operating Permit shall constitute sufficient grounds for ordering changes in the process or control equipment or appurtenances before a Certificate of Operation can be granted. Responsibility for proof, and all expenses incurred in running the tests under the Operating Permit shall be borne by the person owning, operating or in charge of control of such equipment, or their agents. The Director may, if in his opinion the nature of the process or control equipment and its appurtenances in consideration of the use to which it

is to be put so justifies, waive the demonstration or test operation under the Operating Permit, but such waiver shall in no manner provide immunity from prosecution for violations of the requirements of Section 89.11 of the ordinances. When a Certificate of Operation is refused, the Director is authorized to seal the process or control equipment until the person required to procure the Certificate of Operation shall have complied with the provisions of this ordinance.

(13) The issuance by the Director of any Installation Permit, Operating Permit, or Certificate of Operation shall not be held to exempt the person to whom the permit or certificate was issued or who is in possession of the same, from prosecution for the emission of air pollutants prohibited by this ordinance.

(14) The provisions of this section shall not apply to locomotives or steamships.

89.05 (1) repealed & recreated July 21, 1964 J. Proc., p. 1132-1134, 1139; published & effective July 30, 1964.

89.05 (former section (13)) repealed July 21, 1964 J. Proc., p. 1132-1134, 1139; published & effective July 30, 1964.

89.05 (13), (14) renumbered respectively from sections (14), (15) July 21, 1964 J. Proc., p. 1132-1134, 1139; published & effective July 30, 1964)

89.06 Sale, Use, or Consumption of Certain Fuels. (1) The sale, delivery for use, or use within the County of solid fuel for hand-fired equipment which is not a certified solid fuel is prohibited.

(2) Solid fuel which is not a certified solid fuel can be used only in approved mechanical fuel-burning equipment.

(3) Each person selling volatile solid fuel for use in the County shall furnish the buyer with a bill of sale or delivery slip on which is plainly recorded the date of delivery, the name of the seller, the name of the buyer, the quantity delivered, and, if the fuel is certified solid fuel, a statement to that effect.

(4) The provisions of this section shall not apply to steamships.

89.07 Fuel Shortage Emergency. Whenever the Director shall recommend to the County Board that an emergency situation exists whereby, because of the shortage of certified solid fuel or other fuels, there is likelihood that the provisions of Section 89.06 cannot be complied with by suppliers of and vendors of such fuel in the County during a certain period, or it is not possible to operate within the provisions of Section 89.11, the County Board of Supervisors, upon being satisfied that such emergency does in fact exist, may declare the existence of an emergency period or waive the limitations of Sections 89.06 and 89.11 for the same period.

89.08 Reporting of Sales and Purchases. (1) It shall be the duty of all persons engaged in the business of selling process or control equipment to report to the Director in accordance with rules and regulations adopted the sale of such equipment to be installed within the County of Milwaukee; and it shall be the duty of every person purchasing

any of said equipment to give to the seller a statement in writing signed by such purchaser or his duly authorized agent setting forth the correct street and house number address of the building in which such equipment is to be installed. The report herein required shall be in writing and shall be delivered by the seller to the Director within seven days after such sale, and shall contain the name and address of the purchaser and the location of the building in which such equipment is to be installed or used.

(2) For the purpose of obtaining facts with respect to the compliance with this section, the Director is hereby authorized to demand and shall be furnished with a true and correct report at any time showing in detail the equipment sold, and the names and addresses of the persons purchasing said equipment, together with the addresses of the buildings in which such equipment is to be installed.

(3) Any person violating any of the provisions of this section or making any false statement or report in connection with the sale of any equipment mentioned in this section shall be subject to the fines and penalties hereinafter provided.

(4) The provisions of this section shall not apply to wholesale transactions made for the purpose of resale.

89.09 Equipment. (1) All solid fuel-burning equipment shall be equipped for mechanical firing with a stoker, pulverized fuel burner, or other approved device, or a certified solid fuel shall be used.

(2) All installations, excepting stand-by equipment placed in use in an emergency and used for a period or aggregate of periods of not to exceed 10% of any one year, using pulverized fuel burners, spreader type stokers, or other similar solid fuel suspension-burning type of equipment, shall be provided with approved dust-separating equipment. The Director shall be notified of such emergency within twelve hours after the happening thereof.

(3) The provisions of this section shall not apply to steamships.

(4) Where existing process or control equipment covered by the provisions of the ordinance are found by tests to be incapable of operation within the limitations and requirements specified in Section 89.11, changes shall be made in such equipment, apparatus, devices or structures in accordance with orders issued by the Director, subject to appeal as provided for in Section 89.17.

89.095 Suitable Process or Control Equipment and Fuels. (1) All process or control equipment related heat-absorbing equipment, appurtenances, fuels or raw materials used or to be used shall be suitable under operating conditions for compliance with requirements of Section 89.11.

(2) Where process or control equipment, related heat-absorbing equipment, appurtenances, fuel or raw materials are found to be unsuitable for lawful operation within the limitations prescribed in Section 89.11, the Director may order changes to be made in such equipment, appurtenances, fuel or raw materials as may be necessary to secure, under operating conditions, compliance with requirements of said Section 89.11 irrespective of compliance with the requirements of Section 89.06

and 89.09. The observation of three violations of Section 89.11 in any consecutive twelve-month period shall be deemed sufficient cause for finding such equipment, appurtenances, fuel or raw materials unsuitable as hereinabove specified, and for the making of such order. Any person, upon receipt of an order requiring such changes to be made, shall forthwith notify the Director what period of time is needed to comply with such order and shall submit plans and specifications indicating the work to be done or specifications of the fuel and raw materials to be used. Where required, an Installation Permit, Operating Permit, and Certificate of Operation shall be secured in accordance with Section 89.05.

(89.095(3), (4) repealed July 21, 1964 J. Proc., p. 1132-1134, 1139; published & effective July 30, 1964)

89.10 Fees. (1) The following fee schedule shall apply to all new, reconstructed or altered combustion process equipment installed in Milwaukee County. This is the total fee to be charged for an Installation Permit, Operating Permit and Certificate of Operation as required in Section 89.05.

(See attached air pollution fee schedule)

(2) Upon receipt of a written request for any persons for quantitative and qualitative tests of emissions to the open air from any source for which such person is responsible under the provisions of the ordinance, the Director may authorize and arrange for such tests to be conducted at the expense of such person by qualified employees of the Department of Air Pollution Control. An estimate of cost shall first be submitted to the person making the request, stating the charges per day of the field test party and for other laboratory and office work which may be necessary. Upon written approval of the requesting person to the terms and amount of the estimated costs, the tests may proceed, provided safe and suitable facilities for access to the test location have been provided by the person requesting such test work. Scaffoldings shall conform to the requirements of Chapter 35 - Safety in Construction" of the Industrial Commission Codes of the State of Wisconsin. The charge shall be computed on the basis of actual costs for labor, materials and suitable allowance for depreciation to equipment and apparatus.

(3) The following fee schedule shall apply to all new, reconstructed or altered incinerator equipment installed in Milwaukee County. The total fee to be charged for an Installation Permit, Operating Permit, and Certificate of Operation required by Section 89.05 shall be \$1.00 per sq. ft., or any additional fraction thereof, of combined grate and hearth area with a minimum fee of \$2.00 and a maximum fee of \$100.00.

AIR POLLUTION FEE SCHEDULE FOR COMBUSTION PROCESSES
(Based on Maximum Hourly Fuel Consumption)

REFERENCE TABLE

Pounds of Coal or Coke	Gallons of Oil	Fl. ³ of Natural or LP Gas	Registration or Permit Fee	Boiler Horsepower* (Developed)	Fl. ² Steam Radiation** (EDR)	Btu/Hour x 1000 Input
33 to 50	3 3 to 5.0	501 to 750	\$ 10.00	12.0 to 18.0	1,500 to 2,300	501 to 750
51 to 120	5.1 to 12.0	751 to 1,800	15.00	18.1 to 43.0	2,301 to 5,400	751 to 1,800
121 to 400	12.1 to 40.0	1,801 to 6,000	20.00	43.1 to 140.0	5,401 to 18,000	1,801 to 6,000
401 to 800	40.1 to 80.0	6,001 to 12,000	30.00	141 to 290	18,001 to 36,000	6,001 to 12,000
801 to 1,200	80.1 to 120.0	12,001 to 18,000	35.00	291 to 430	36,001 to 54,000	12,001 to 18,000
1,201 to 4,000	120.1 to 400.0	18,001 to 60,000	40.00	431 to 1,400	54,001 to 180,000	18,001 to 60,000
4,001 to 6,500	400.1 to 650.0	60,001 to 97,500	50.00	1,401 to 2,300	180,001 to 290,000	60,001 to 97,500
6,501 to 12,000	650.1 to 1,200.0	97,501 to 180,000	75.00	2,301 to 4,300	290,001 to 540,000	97,501 to 180,000
12,001 to 40,000	1,200.1 to 4,000.0	180,001 to 600,000	100.00	4,301 to 16,000	540,001 to 1,800,000	180,001 to 600,000
Over 40,000	Over 4,000.0	Over 600,000	150.00	Over 16,000	Over 1,800,000	Over 600,000

* - Approx. 80% Boiler Efficiency

** - Approx. 72% Overall Thermal Efficiency (Boiler and Line Loss)

EXEMPTIONS:

- 1 Dwelling units less than 4-families are exempted.
Combination residential and commercial installations shall be governed by this fee schedule.
2. This fee schedule does not apply to incinerators.

(89.10 Amended July 21, 1964 J. Proc., p. 1132-1134, 1139; published & effective July 30, 1964)

89.11 Limits of Emission and Standards of Measurement. (1) IN GENERAL. (a) *Ordinary Operation.* No person shall cause, suffer, or allow to be emitted into the open air from any stack or chimney, process or control equipment, internal combustion engine, premises, open fire, or any other source, smoke the shade or density of which is equal to or greater than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke of No. 2 Ringelmann density, except that smoke the shade, density or opacity of which is equal to but does not exceed No. 2 of the Ringelmann Chart may be emitted for a period or periods of not to exceed two minutes in any thirty-minute period and except when the fire-box is being cleaned out or a new fire is being built therein, or when a break-down of equipment occurs such as to make it evident that the emission was not

reasonably preventable.

(b) *Clean-Outs; New Fires.* When the fire-box is being cleaned cleaned out or a new fire is being built therein, smoke the shade or density of which is equal to but does not exceed No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree equal to but does not exceed smoke of No. 2 Ringelmann density, may be emitted into the open air for a period or aggregate of periods not exceeding nine minutes in any one hour; or smoke of unlimited shade, density or opacity may be emitted into the open air for a period or aggregate of periods not exceeding five minutes in any one hour. The emission of smoke permitted in this paragraph (b) shall be in the alternative and not cumulative. No person shall cause, suffer, or allow to be emitted into the open air during the cleaning out of a fire-box or the building of a new fire therein, smoke the shade, density or opacity of which exceeds the limits permitted by the provisions of this paragraph (b), nor for a longer period than herein permitted.

(c) *Exceptions.* The provisions of paragraphs (a) and (b) of this subsection (1) shall not apply to railroad locomotives in or ready for service nor to steamships.

(2) **LOCOMOTIVES.** (a) *In or Ready for Service.* Smoke the shade, density or opacity of which is unlimited may be emitted into the open air from any railroad locomotive in or ready for service for a period or aggregate of periods not to exceed forty-five seconds in any three-minute period. During the remainder of such three-minute period, smoke the shade or density of which is equal to but does not exceed No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree equal to but does not exceed smoke of No. 2 Ringelmann density, may be emitted. No person shall cause, suffer or allow to be emitted into the open air from any railroad locomotive in or ready for service, smoke the shade, density or opacity of which exceeds the limits permitted by the provisions of this paragraph (a), nor for a longer period than herein permitted, except when a break-down of equipment occurs such as to make it evident that the emission was not reasonably preventable.

(b) *Clean-Outs; New Fires; Diesel Startup.* When a fire-box is being cleaned out or a diesel locomotive is first started up or a diesel locomotive which has been idling over a period of one shift is put back into use or a new fire is being built in a railroad locomotive, smoke the shade or density of which is equal to but not greater than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree equal to but not greater than smoke of No. 2 Ringelmann density, may be emitted into the open air for a period or aggregate of periods not to exceed nine minutes in any one hour; or smoke the shade, density or opacity of which is unlimited may be emitted into the open air for a period or aggregate of periods not exceeding five minutes in any one hour. Emission of smoke as permitted by the provisions of this paragraph (b) shall be in the alternative and not cumulative. No person shall cause, suffer or allow to be emitted into the open air from any railroad locomotive while the fire-box thereof is being cleaned out or a diesel locomotive is first started up or a diesel locomotive which has

been idling over a period of one shift is put back into use or a new fire is being built therein, smoke the shade, density or opacity of which exceeds the limits permitted by this paragraph (b), nor for longer periods than herein permitted.

(3) STEAMSHIPS. (a) *When Navigating or Maneuvering.* A steamship while navigating or maneuvering in the County inside the Milwaukee Bay breakwater may emit into the open air smoke the shade, density or opacity of which is unlimited for a period or periods aggregating not more than three minutes in any fifteen-minute period. During the remainder of such fifteen-minute period, smoke the shade or density of which is less than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree less than does smoke of No. 2 Ringelmann density, may be emitted. No steamship shall emit and no person shall cause, suffer, or allow to be emitted into the open air from any steamship situated as hereinabove set forth, smoke the shade, density or opacity of which exceeds the limits permitted by this paragraph (a), nor for longer periods than herein permitted.

(b) *Steamships Docked.* When any steamship is docked within the County, except as hereinafter provided in paragraphs (c), (d), and (e) of this subsection (3), it may emit smoke the shade or density of which is less than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree less than does smoke of No. 2 Ringelmann density, except that during the last fifteen minutes before such steamship leaves such dock, such steamship may emit smoke the shade or density of which does not exceed No. 3 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree greater than does smoke of No. 3 Ringelmann density, for a period or aggregate of periods not to exceed three minutes; but provided, further, that such permitted emission shall not be cumulative to the emission permitted by paragraph (d) of this subsection. No steamship shall emit, and no person shall cause, suffer or allow to be emitted into the open air from any steamship situated as hereinabove set forth, smoke the shade, density or opacity of which exceeds the limits permitted by this paragraph (b), nor for longer periods than herein permitted.

(c) *Self-Unloading Steamships.* Steamships equipped with self-unloading machinery which is operated by power from the main power plant of such steamship may, while docked in the County and while such self-unloading machinery is actually and necessarily operating in the discharge of cargo, emit smoke the shade, density or opacity of which is unlimited for three minutes in any twelve-minute period. During the remainder of such twelve-minute period, such steamship so equipped and while so operated may emit smoke the shade or density of which is less than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree less than does smoke of No. 2 Ringelmann density. No steamship so equipped and while so operated shall emit and no person shall cause, suffer or allow to be emitted into the open air from such steamship smoke the shade, density or opacity of which exceeds the limits permitted by the provisions of this paragraph.

(d) *Clean-Outs; New Fires.* When a fire-box is being cleaned out or a new fire is being built therein in a steamship or tug-boat, or such

steamship or tug-boat is undergoing inspection by a Marine Inspector in accordance with regulations of the United States Coast Guard, such steamship or tug-boat may emit into the open air smoke the shade or density of which is equal to No. 2 of the Ringelmann Chart or less, or of such opacity as to obscure an observer's view to a degree equal to or less than does smoke of No. 2 Ringelmann density, for a period or aggregate of periods of not to exceed nine minutes in any one hour, or smoke the shade, density or opacity of which is unlimited for a period or aggregate of periods of not to exceed five minutes in any one hour. The emission of smoke permitted in this paragraph (d) shall be in the alternative and not cumulative. No steamship shall emit and no person shall cause, suffer or allow to be emitted into the open air from any steamship while its fire-box is being cleaned out or a new fire is being built therein, or said marine inspector's inspection is being made, smoke the shade, density or opacity of which exceeds the limits permitted by the provisions of this paragraph, nor for longer periods of time than is herein permitted.

(e) *Exemptions; Distress Operation; First Annual Entry Into Milwaukee Harbor.* The provisions of this subsection (3) shall not apply to a steamship which is navigated or maneuvered in the County for the sole purpose of finding protection from unsafe conditions of navigation, provided that when such unsafe conditions cease, such steamship shall at once become subject to the provisions of said subsection. The provisions of this subsection (3) shall not apply to a steamship making its first call at the Port of Milwaukee in any calendar year.

(4) TUG-BOATS. (a) *When Navigating or Maneuvering Under Own Power.* A tug-boat, while navigating or maneuvering under its own power in the County inside the Milwaukee Bay breakwater and not engaged in towing a steamship may emit into the open air smoke the shade, density or opacity of which is unlimited for a period or periods aggregating not more than three minutes in any fifteen-minute period. During the remainder of such fifteen-minute period, smoke the shade or density of which is less than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree less than does smoke of No. 2 Ringelmann density, may be emitted. No tug-boat shall emit and no persons shall cause, suffer or allow to be emitted into the open air from any tug-boat situated as hereinabove set forth smoke the shade, density or opacity of which exceeds the limits permitted by this paragraph (a), nor for longer periods than herein permitted.

(b) *When Towing Steamships.* When a tug-boat is towing a steamship within the County inside the Milwaukee Bay breakwater, it may emit smoke the shade, density or opacity of which is unlimited for a period or periods not exceeding three minutes in any twelve-minute period, and during the remainder of such twelve-minute period smoke the shade or density of which is less than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree less than does smoke of No. 2 Ringelmann density, may be emitted. No tug-boat shall emit and no person shall cause, suffer or allow to be emitted into the open air from any tug-boat situated as hereinabove set forth

smoke the shade, density or opacity of which exceeds the limits permitted by this paragraph (b), nor for longer periods than herein permitted.

(c) *While Docked.* A tug-boat while docked in the County of Milwaukee inside the Milwaukee Bay breakwater may emit into the open air smoke the shade, density or opacity of which is unlimited for a period or periods aggregating not more than three minutes in any fifteen-minute period. During the remainder of such fifteen-minute period smoke the shade or density of which is less than No. 2 of the Ringelmann Chart, or of such opacity as to obscure an observer's view to a degree less than does smoke of No. 2 Ringelmann density, may be emitted. These permitted emissions shall not be cumulative to the emissions permitted by paragraph (d) of subsection (3) of this ordinance. No tug-boat shall emit and no person shall cause, suffer or allow to be emitted into the open air from any tug-boat situated as hereinabove set forth smoke the shade, density or opacity of which exceeds the limits permitted by this paragraph (c), nor for longer periods than herein permitted.

(5) **LIMITATION ON DUST EMISSION.** No person shall cause or allow to be emitted into the open air from any process or control equipment or to pass any convenient measuring point in the breeching or stack, dust in the gases to exceed 0.85 lb. per 1000 lb. of gases, adjusted to 12% CO₂ content for the products of combustion.

(6) **ASCERTAINMENT OF DUST QUANTITY.** The amount of dust or solids in the gases shall be determined, unless otherwise agreed upon by the Director and the person concerned, according to the Test Code for Dust-Separating Apparatus, 1941, and the Test Code for Determining the Dust Concentration in a Gas Stream (1957) of the American Society of Mechanical Engineers, which are hereby made a part of this ordinance by reference.

(7) **DISPOSAL OF DUST.** Dust from dust-separating equipment and from other sources in the installation which is not to be reclaimed shall be moistened and hauled in an approved manner to a county dump or other approved point of disposal. If the dust is to be reclaimed, it shall be handled in a manner satisfactory to the Director.

(8) **NUISANCES.** No person shall cause or allow to be emitted into the open air from any process or control equipment, internal combustion engine, premises, or open fire, any air pollutants in a manner to cause injury, detriment, nuisance, or annoyance, or to endanger the health or safety of any person, or to cause or have a natural tendency to cause injury or damage to business or property.

(9) **SEALING OF PROCESS EQUIPMENT OR PREMISES.** (a) *Order to Show Cause.* When any person has been notified of three or more observed and recorded violations of the applicable regulations of this section in respect to the emission of air pollutants within any consecutive twelve month period, the Director shall within twenty days thereafter further notify such person to show cause before the Director on a day certain, not less than ten nor more than twenty days from the day of the notice, why the process equipment or premises causing such violation shall not be sealed.

(b) *Notification.* In case the person so notified is not the person liable for the violation in connection with a building, process equipment

or premises, then such notice shall also be given to other persons liable as provided in Section 89.13. The notice herein provided for may be given by registered mail directed to the last known address of the person or or persons to be notified, with return receipt of addressee required, or if the person or persons or their whereabouts are unknown, then by posting a notice on or near the premises at which the violations shall have occurred.

(c) *Hearing; Duty to Seal; Appeal.* Upon such certain day the person notified may appear and be heard. Upon such hearing, if the Director finds that adequate corrective means and methods have not been employed to correct the cause of such condition, then it shall be his duty to seal the process equipment or premises until such time as an Installation Permit and Operating Permit as provided under this ordinance have been applied for and issued for the process equipment or premises. The person may within ten days of such decision appeal the finding to the Appeal Board and the appeal shall stay the sealing pending the appeal. No process equipment or premises shall be sealed until expiration of the time for appeal. (See Section 89.17).

(10) VIOLATION OF SEAL PROHIBITED. No person shall violate the seal on any process equipment or premises that has been sealed at the direction of the Director, unless authorized by the Director in writing to do so.

(89.11 (9) & (10) Amended Sept. 12, 1963 J. Proc., p. 1254-1255, 1257; published and effective September 26, 1963)

89.12 Entrance to Premises. No person shall in any manner hinder, obstruct, delay, resist, prevent, or in any way interfere or attempt to interfere with the Director, the Deputy Director, or department employees in the performance of their duly authorized duties by refusing them entrance to the premises at reasonable hours upon identification.

89.13 Persons Liable. All persons owning, operating, or in charge or control of any equipment or premises who shall cause, suffer, allow, permit or participate in any violation of this ordinance either as proprietors, owners, lessees, tenants, managers, superintendents, constructors, installers, mechanics, repairmen, captains, janitors, engineers, firemen, or otherwise, shall be individually and collectively liable for any penalties imposed by this ordinance.

(89.13 Amended Sept. 12, 1963 J. Proc., p. 1254-1255, 1257; published and effective September 26, 1963)

89.14 Penalties for Violations. (1) Any person who shall violate any of the provisions of this ordinance shall, upon conviction thereof, be sentenced to pay a fine of not less than \$25.00 nor more than \$50.00 for the first violation thereof, and not less than \$50.00 nor more than \$100.00 for each succeeding violation, together with the cost of the action, and in default of payment of said fine, and costs of prosecution, the person shall be imprisoned in the county jail or the House of Correction of Milwaukee County for a period not to exceed thirty days. Each day's violation shall constitute a separate offense.

(2) The unlawful emission of air pollutants from each stack or premise shall constitute a separate offense.

(3) The Director, or the Inspectors, upon instructions of the Director, shall have authority to institute complaints against all persons

violating any provisions of this ordinance.

(4) Whenever any person has been found by the Director or his Inspectors to have repeatedly violated the provisions of Chapter 89 of the General Ordinances and particularly Section 89.11 (8) thereof, the corporation counsel is authorized and directed, upon written request of the Director and when in his opinion the facts warrant, to commence appropriate civil legal action in the name of Milwaukee County to enjoin and restrain further continuance of such violation.

(89.14 (2) Amended Sept. 12, 1963 J. Proc., p. 1254-1255, 1257; published and effective September 26, 1963)

89.15 Period of Grace. (1) When a person violating any of the provisions of this ordinance with respect to the emission of air pollutants, produces evidence satisfactory to the Director that he has taken all steps possible to provide for compliance with the provisions of the ordinance, but that the acquisition of the proper equipment or device cannot be obtained or effected immediately, the Director shall have the discretion in such cases to allow a period not exceeding twelve months from the date of application therefor, within which the necessary equipment or device is to be acquired and installed. In a case where the Director has granted a grace period of up to one year, and notwithstanding that the person has given a bona fide order for the equipment required to comply with the ordinance, it appears probable that such equipment will not be delivered within such grace period, the person may apply to the Board of Appeals for an extension of the grace period, serving notice of such application upon the Director. The Board of Appeals shall consider such request and within twenty days after receipt of same, if it is satisfied that there is good cause for further extension of such grace period, by written order may extend such grace period for any time not to exceed one year from the end of the grace period granted by the Director.

(2) During said period of grace granted by the Director or by the Board of Appeals, the person violating the ordinance shall not be subject to the fines or penalties herein prescribed; provided, however, that where such person fails in the time allowed to conform with the provisions of this ordinance, he shall be subject to all the fines and penalties herein prescribed dating from the date of the beginning of the period of grace permitted him.

89.16 Maintenance of Records. The Director shall keep in the office of the Department of Air Pollution Control all applications made, and a complete record thereof, as well as of all permits and certificates issued. He shall keep a record of all air pollution observations on all stacks and generally of the work done by the department. All such records shall be open for inspection by the public at all reasonable times.

89.17 Appeals to Appeal Board. (1) Any person taking exception to any decision or order of the Director in the interpretation of the Rules and Regulations ~~set forth in Section 89.20 of the General Ordinances~~ affecting such person's property or from any order sealing equipment, may appeal to the Appeal Board. Such appeal shall be taken within ten days after the decision or order complained of, by filing with the County Clerk as ex-officio secretary of the Appeal Board, a notice of appeal specifying the decision or order appealed from, the reasons for such

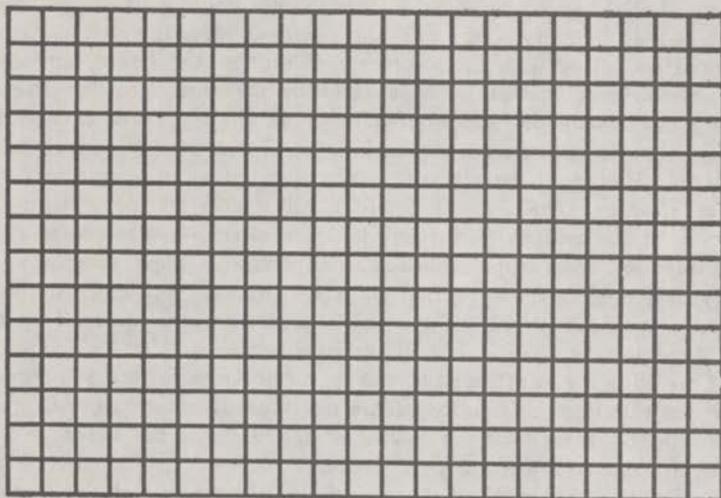
appeal, and the relief sought. At the time of filing such appeal, the appellant shall deposit \$15 with the County Clerk to cover the cost of the hearing. A copy of such notice of appeal shall be served upon the Director and upon receipt thereof he shall promptly furnish to the Appeal Board all the papers relating to the decision or order appealed from. The chairman of the Appeal Board shall set a date for the hearing of such appeal not less than five nor more than ten days after the date on which the appeal was filed with the secretary of the Appeal Board, and shall give notice thereof by mail or by service by the Sheriff to the Director and the party taking the appeal. Such appeal shall operate to stay the decision or order appealed from until the decision of the Appeal Board is rendered. The appellant may prosecute the appeal in person or by an agent or attorney. The Appeal Board shall within ten days after the conclusion of the hearing by written decision affirm, modify or set aside the decision or order appealed from, and cause a copy thereof to be promptly delivered to the appellant and the Director. Such decision shall be binding upon the appellant and the Director unless reversed by the Circuit Court of the County in certiorari proceedings. If the decision or order of the Director is affirmed by the Board of Appeals, the \$15 deposit shall be forfeited to the County. If the decision or order of the Director is modified or reversed by the Board of Appeals and the Director does not within ten days commence certiorari proceedings to review the Board's decision, the costs of the hearing shall be borne by the County, and the \$15 deposit shall be refunded to the appellant. If the Director commences certiorari proceedings, the forfeiture or refunding of the deposit shall abide the result of the court decision.

(2) The Board of Appeals is empowered to grant an extension of the grace period, as provided in Section 89.15. No deposit shall be required in case of application for such extension.

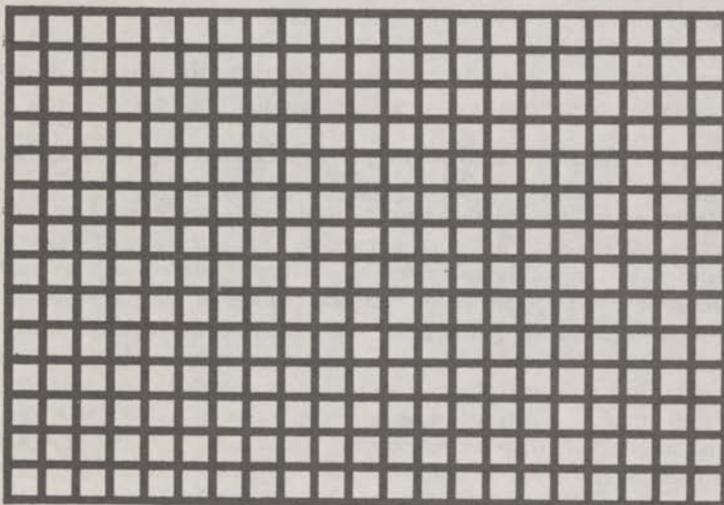
89.18 Co-ordination of Municipal and County Regulations. After, and subject to rules and regulations to be adopted, unless a municipality within Milwaukee County has adopted an air pollution control ordinance at least equally restrictive, no permit for the erection, construction or alteration of any building, plant or structure related in any manner to process or control equipment shall be issued by any department of any of the several municipalities in the County of Milwaukee until the Director has issued a permit covering the property under his jurisdiction to be used in the building, plant or structure as provided in Section 89.05, or has indicated that, in his judgment, the plans submitted will permit the installation of facilities adequate for compliance with the provisions of this ordinance.

89.19 Declaration of Public Purpose of Ordinance. It is declared that this ordinance is enacted in the interests of the public health and welfare of the residents of Milwaukee County. If any part of this ordinance shall be declared to be invalid, such invalidity shall not affect the remaining portions of this ordinance, the County Board of Supervisors hereby declaring that it would have passed such remaining portions of this ordinance notwithstanding such invalidity.

**UNITED STATES DEPARTMENT OF THE
INTERIOR BUREAU OF MINES
R. R. SAYERS, DIRECTOR**



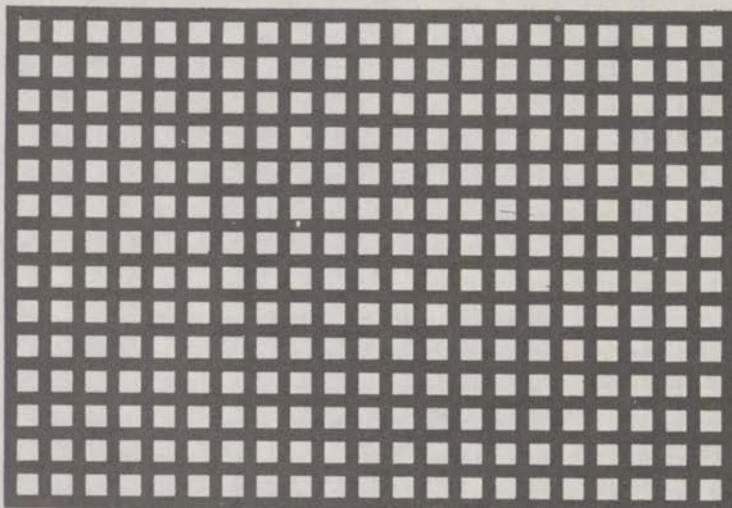
1. EQUIVALENT TO 20 PERCENT BLACK



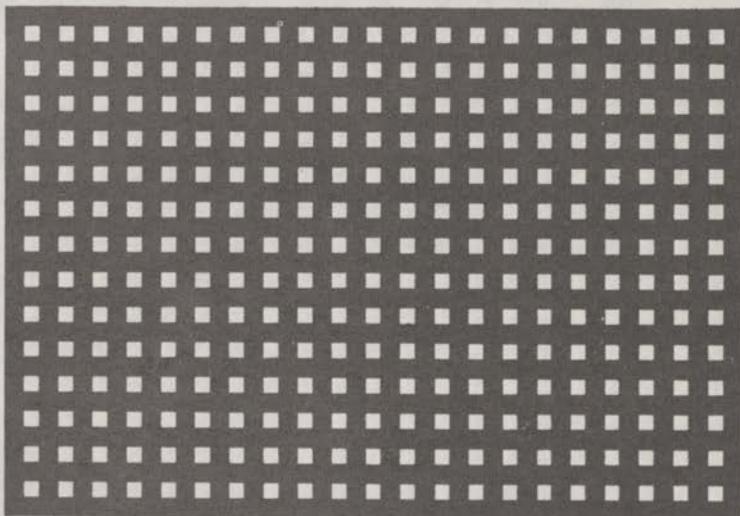
2. EQUIVALENT TO 40 PERCENT BLACK

Ringelmann's Scale for Grading the Density of Smoke

**UNITED STATES DEPARTMENT OF THE
INTERIOR BUREAU OF MINES
R. R. SAYERS, DIRECTOR**



3. EQUIVALENT TO 60 PERCENT BLACK



4. EQUIVALENT TO 80 PERCENT BLACK

**Ringelmann's Scale for Grading the Density of Smoke
EXHIBIT I**

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
WASHINGTON, D. C.

SECTION	TOWNSHIP	RANGE	ACRES	DATE
1	1	1	36	1880
2	1	2	36	1880
3	1	3	36	1880
4	1	4	36	1880
5	1	5	36	1880
6	1	6	36	1880
7	1	7	36	1880
8	1	8	36	1880
9	1	9	36	1880
10	1	10	36	1880
11	1	11	36	1880
12	1	12	36	1880
13	1	13	36	1880
14	1	14	36	1880
15	1	15	36	1880
16	1	16	36	1880
17	1	17	36	1880
18	1	18	36	1880
19	1	19	36	1880
20	1	20	36	1880
21	1	21	36	1880
22	1	22	36	1880
23	1	23	36	1880
24	1	24	36	1880
25	1	25	36	1880
26	1	26	36	1880
27	1	27	36	1880
28	1	28	36	1880
29	1	29	36	1880
30	1	30	36	1880
31	1	31	36	1880
32	1	32	36	1880
33	1	33	36	1880
34	1	34	36	1880
35	1	35	36	1880
36	1	36	36	1880

SECTION	TOWNSHIP	RANGE	ACRES	DATE
37	1	37	36	1880
38	1	38	36	1880
39	1	39	36	1880
40	1	40	36	1880
41	1	41	36	1880
42	1	42	36	1880
43	1	43	36	1880
44	1	44	36	1880
45	1	45	36	1880
46	1	46	36	1880
47	1	47	36	1880
48	1	48	36	1880
49	1	49	36	1880
50	1	50	36	1880
51	1	51	36	1880
52	1	52	36	1880
53	1	53	36	1880
54	1	54	36	1880
55	1	55	36	1880
56	1	56	36	1880
57	1	57	36	1880
58	1	58	36	1880
59	1	59	36	1880
60	1	60	36	1880
61	1	61	36	1880
62	1	62	36	1880
63	1	63	36	1880
64	1	64	36	1880
65	1	65	36	1880
66	1	66	36	1880
67	1	67	36	1880
68	1	68	36	1880
69	1	69	36	1880
70	1	70	36	1880
71	1	71	36	1880
72	1	72	36	1880
73	1	73	36	1880
74	1	74	36	1880
75	1	75	36	1880
76	1	76	36	1880
77	1	77	36	1880
78	1	78	36	1880
79	1	79	36	1880
80	1	80	36	1880
81	1	81	36	1880
82	1	82	36	1880
83	1	83	36	1880
84	1	84	36	1880
85	1	85	36	1880
86	1	86	36	1880
87	1	87	36	1880
88	1	88	36	1880
89	1	89	36	1880
90	1	90	36	1880
91	1	91	36	1880
92	1	92	36	1880
93	1	93	36	1880
94	1	94	36	1880
95	1	95	36	1880
96	1	96	36	1880
97	1	97	36	1880
98	1	98	36	1880
99	1	99	36	1880
100	1	100	36	1880

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
WASHINGTON, D. C.

Air Pollution Control
RULES AND REGULATIONS

SUPPLEMENTING CHAPTER 89
of the
GENERAL ORDINANCE
of
MILWAUKEE COUNTY

**AIR POLLUTION CONTROL
RULES AND REGULATIONS**

(Supplementing Chapter 89 of the
General Ordinances of the County of Milwaukee)

REGULATION I - GENERAL PROVISIONS**RULE 1 - Emissions Permitted**

These rules shall supplement and implement Chapter 89 of the Milwaukee County General Ordinances and apply to all process equipment installations regulated thereby.

RULE 2 - Reporting of Sales and Purchases

All persons engaged in the business of selling process equipment covered by these Rules and Regulations and for which a fee is provided in Section 89.10 - FEES shall report the sale of this type equipment, upon forms provided by the Director, in accordance with Section 89.08 - Reporting of Sales and Purchases.

**REGULATION II - NEW, ALTERED AND RECONSTRUCTED
COMBUSTION PROCESS INSTALLATIONS****RULE 1 - Applicability**

All new, altered and reconstructed combustion process installations for which a fee is provided in Section 89.10 shall be governed by these Rules and Regulations. These Rules and Regulations shall be effective thirty days after passage and publication in the official newspaper of Milwaukee County.

RULE 2 - Gas-Fired Installations

(a) The emission performance of all gas-fired burners shall conform with the requirements of the American Gas Association, Inc., Underwriters' Laboratories, Inc., Factory Mutual Association or the Factory Insurance Association.

(b) Chimney and vent sizes for all gas-fired installations shall conform to the recommendations of the boiler, furnace or burner manufacturer.

(c) All boiler or furnace rooms serving gas-fired installations shall be provided with an outside air intake for combustion that conforms

with Wisconsin Administrative Code section Ind 59.60.

(d) All atmospheric burner equipped gas-fired installations which are required by Wisconsin Administrative Code section Ind 59.67 to be vented to a chimney or flue pipe, shall be equipped with draft hoods, barometric dampers or motorized dampers.

(e) The products of combustion from all gas-fired installations shall be discharged to the atmosphere at such heights and in such manner as to prevent nuisances being created to neighboring occupancies.

RULE 3 - Oil-Fired Installations

(a) The emission performance of all oil-fired burners shall conform with the requirements of Underwriters' Laboratories, Inc., Factory Mutual Association or the Factory Insurance Association.

(b) All oil-fired installations shall be installed in accordance with the recommendations of the manufacturer of the oil-burning equipment.

(c) All oil-fired installations burning heavy No. 5 or No. 6 grade fuel oils shall be equipped with suitable provision for preheating such oils to levels sufficient to give performance within the smoke emission limitations of this ordinance. Recommendations of the burner manufacturer shall be followed in this regard.

(d) Chimneys serving oil-fired installations shall conform in size and height to the recommendations of the boiler, furnace or burner manufacturer.

(e) Where heavy No. 5 or No. 6 oil is used in a boiler having a burner capacity greater than 40 gph, a smoke indicator or smoke alarm shall be provided.

(f) All boiler or furnace rooms serving oil-fired installations shall be provided with an outside air intake for combustion air that conforms with Wisconsin Administrative Code section Ind. 59.60.

(g) The products of combustion from all oil-fired installations shall be discharged to the atmosphere at such heights and in such manner as to prevent nuisances being created to neighboring occupancies.

(h) The owner of the installation may be required to provide suitable test openings at such locations as requested by the Director.

RULE 4 - Solid Fuel-Fired Installations

(a) All suspension solid fuel-burning installations shall be equipped with suitable dust collection equipment to insure performance within the emission limitations of this ordinance.

(b) All stoker-fired installations shall conform to recommendations on setting heights, furnace volumes, heat release, firebox dimensions, stoker size selection, over-fire draft provided by the stoker manufacturer.

(c) All stoker-fired installations serving steam boilers below 15 lbs. /in.² or hot water boilers below 30 lbs. /in.² gauge boiler pressure shall include provision for adequate hold-fire controls.

(d) On all stoker-fired installations, provision shall be made for over-fire, secondary air.

(e) All stoker-fired installations having a feed greater than 400 lbs./hour shall be equipped with a smoke indicator or smoke alarm.

(f) All stoker-fired installations having a feed greater than 400 lb./hour shall be equipped with a fuel-air combustion control system.

(g) Where a pneumatic ash-handling system is installed, provision shall be made to vent this system to the atmosphere through adequate collection devices.

(h) Chimneys serving solid fuel-fired installations shall conform in size and height to the recommendations of the boiler, furnace or burner manufacturer.

(i) The products of combustion from all solid fuel-fired installations shall be discharged to the atmosphere at such heights and in such manner as to prevent nuisances being created to neighboring occupancies.

(k) All boiler or furnace rooms serving solid fuel-fired installations shall be provided with an outside air intake for combustion air that conforms with Wisconsin Administrative Code section Ind 59.60.

REGULATIONS III - INTERNAL COMBUSTION ENGINES

RULE 1 - Immediate Correction

When in the opinion of the Director an air pollution control ordinance violation caused by internal combustion engine equipment requires immediate correction, the person liable for the equipment shall be notified promptly to expedite the appropriate maintenance and repair.

RULE 2 - Public Transportation Terminus Points

Whenever any public transportation automotive power equipment lays over at a terminus point for greater than five (5) minutes, the engine shall be turned off. This rule shall apply when outside air temperatures do not fall below twenty degrees Fahrenheit (20°F) above zero unless the equipment is disabled and it is necessary to continue operation.

REGULATION IV -- SAMPLING AND TESTING

RULE 1 - Authorization

The Director is hereby authorized to conduct, or cause to be conducted, any test or tests of any new or existing process equipment the operation of which, in his opinion, can be expected to result in emissions in excess of the limitations in the Milwaukee County Air Pollution Control Ordinance, or when, in his judgment, there is evidence that any such process equipment is exceeding any emission limitation prescribed in said ordinance. Upon notification by the Director that performance emission tests are considered necessary, a person may elect to conduct such tests himself. In this event, the person shall notify the Director of this decision and of the time and date of such testing. The Director, or his representative, may witness such testing. All tests so conducted shall be in a manner acceptable to the Director and a complete detailed test report of such tests shall be submitted to the Director.

RULE 2 - Departmental Tests

Nothing in these Rules and Regulations concerning tests conducted by and paid for by any person or his authorized agent shall be deemed to abridge the rights of the Director or his representatives to conduct separate or additional tests of any process equipment on behalf of Milwaukee County Department of Air Pollution Control at a time which is mutually agreeable and at the Department's expense, except as in Rule 3 of this Regulation below.

RULE 3 - Test Openings, Scaffolding and Facilities

When tests of existing process equipment are deemed necessary by the Director and the person does not elect to conduct such tests himself, he shall at his expense provide test openings, access scaffolding and other pertinent facilities as requested by the Director. If he refuses to supply the requested test openings, access scaffolding and other pertinent facilities, the Director shall notify such person to show cause before the Director on a day certain, not less than ten nor more than twenty days from the day of notice, why the equipment shall not be sealed. The results of all tests conducted by the Director

shall be furnished to the owner or operator of the process equipment. If the test results establish that the effluents from the process equipment meet the emission limitations of the Milwaukee County Air Pollution Control Ordinance, the Department shall assume the costs for the installation of the test openings, access scaffolding and other pertinent facilities.

(Rules and Regulations adopted July 21, 1964 J. Proc., p. 1135-1139; published Aug. 13, 1964, effective 30 days after publication)

REGULATION V - NEW, ALTERED AND RECONSTRUCTED
INCINERATOR INSTALLATIONS

RULE 1 - Applicability

All new, altered and reconstructed incinerator installations for which a fee is provided in Section 89.10 shall be governed by these Rules and Regulations. These Rules and Regulations with regard to incinerator installations shall be effective thirty days after passage and publication in the official newspaper of Milwaukee County.

RULE 2 - Definitions and Nomenclature

The definitions, nomenclature, classification of wastes and classification of incinerators as proposed and adopted by the Air Pollution Control Association (APCA) Incinerator Committee is herewith adopted and made part of these Rules and Regulations. The nomenclature, definitions and classification of wastes and of incinerators used in these Rules and Regulations and in all communications with the Department of Air Pollution Control relative to incinerators shall conform to this APCA Incinerator Committee's recommended practices.

RULE 3 - Must Meet Performance Emission Requirements

Nothing in these Rules and Regulations will absolve the owner or operator of any incinerator from meeting all of the air pollution performance emission requirements contained in Section 89.11 of the Milwaukee County Air Pollution Control Ordinance. The granting of an Installation Permit, Operating Permit or a Certificate of Operation shall not provide immunity from compliance with, or prosecution for violations of, the provisions of said Ordinance and these Rules and Regulations.

The incinerator supplier shall be solely responsible for the design of all incinerators to insure that any incinerator installed within Milwaukee County is capable of complying with the performance emission requirements of Section 89.11 of the Milwaukee County Air Pollution Control Ordinance when operated in accordance with the manufacturer's instructions at rated burning capacity with all types of wastes which are normal to the owner.

RULE 4 - Incinerator Installations

(a) Air for combustion and ventilation of rooms in which incinerators are located shall be adequate to provide for complete combustion of the refuse, in addition to all other air requirements, at rated burning capacity. All rooms serving incinerator installations shall be provided with an outside air intake for combustion air that conforms with

Wisconsin Administrative Code Section Ind 59.60.

(b) All new, reconstructed and altered incinerator installations having a primary furnace volume greater than 5 cubic feet shall be provided with their own separate high temperature flue of adequate cross-section and height to provide ample draft for capacity operation of the incinerator. No other combustion devices shall be connected to an incinerator flue, except where adequate draft and cross-section exists to insure emission performance of both the incinerator and the other combustion devices within the emission limitations of the Milwaukee County Air Pollution Control Ordinance.

(c) All incinerators shall be equipped with adequate automatic draft regulation.

(d) The products of combustion from all incinerator installations shall be discharged to the atmosphere at such heights and in such manner as to prevent nuisances being created to neighboring occupancies.

(e) When the design of a proposed incinerator installation is such that there is little or no basis to predict the air pollution emission performance of the incinerator, the Director will require that performance emission test data and reports by an approved laboratory or testing group be submitted by the supplier to support any claim that the incinerator will meet the Milwaukee County Air Pollution Control Ordinance performance emission requirements prior to issuance of an Installation Permit. Such supporting tests and report shall be in detail and shall describe the nature of the wastes consumed, the rate of incinerator operation, the frequency of charges, draft and temperature conditions, a description of the test procedures and sampling system, and detailed quantitative and qualitative data and results on the visual, particulate and fume emissions of the unit, plus any other information the Director may request. A listing of those laboratories or test groups who by virtue of equipment, skills and experience are acceptable to the Director shall be maintained in the office of the Department of Air Pollution Control.

When the supplier is unable to supply such data as the Director requires, an Installation Permit and an Operating Permit will be issued only on an experimental basis and the Department shall so notify the owner or operator prior to issuance of the Installation Permit. For all experimental installations, the supplier shall be required to conduct, or have conducted, air pollution performance tests concurrently with capacity burning tests to demonstrate that the incinerator installation is capable of complying with the emission limitations of the Milwaukee County Air Pollution Control Ordinance. The Testing organization shall be one of those laboratories or test groups that have established their qualifications with the Director.

Or, upon written request, as provided by Section 89.10 (2) Fees, the Director is authorized to conduct quantitative and qualitative emission tests using qualified Departmental personnel.

When the emission tests conducted under the Operating Permit fail to show that the incinerator is capable of operation within the emission limitations of the Milwaukee County Air Pollution Control Ordinance, no Certificate of Operation will be issued for this installation and the Director shall issue an order to seal the incinerator from future operation until, after modifications, it can be demonstrated to the Director that the modified incinerator has the capability to operate lawfully under the Milwaukee County Air Pollution Control Ordinance.

(f) Flue-fed incinerators utilizing combined refuse chute and flue shall be prohibited unless equipped with combustion control devices and air pollution control equipment acceptable to the Director. In all flue-fed incinerator installations, performance demonstration tests conducted at the expense of the supplier shall be required under the Operating Permit. Where such tests fail to demonstrate compliance with the emission requirements of the Milwaukee County Air Pollution Control Ordinance, a Certificate of Operation will not be issued and an order to seal this installation shall be issued by the Director until, after modifications, it can be demonstrated to the Director that the modified incinerator has the capability to operate lawfully under the Milwaukee County Air Pollution Control Ordinance.

(g) Refuse burners not connected to a chimney, flue or stack shall be prohibited. No chimney or stack base shall be used as a refuse burner. Refuse burners shall be considered incinerators for purposes of these Rules and Regulations.

(h) Only approved domestic incinerators shall be installed. An approved domestic incinerator is one which has been tested by an acceptable and recognized national laboratory or test group and certified as conforming to the emission limitations of the latest Approval Requirements for Domestic Gas-Fired Incinerators of the American Standards Association.

(i) Whenever an incinerator is found to be in a state of disrepair such that it cannot be operated within the performance emission requirements, the owner or operator shall be so notified. If after 30 days the obvious defects in the incinerator have not been remedied, the Director shall order the incinerator to be sealed. Any person who shall break a seal or who shall use an incinerator sealed by order of the Director shall be in violation of Section 89.11 (10), and upon conviction thereof, shall be subject to the penalties provided in Section 89.14 of the Milwaukee County Air Pollution Control Ordinance.

(j) An order of the Director to seal an incinerator under provisions

of this Regulation is subject to appeal in accordance with provisions of Section 89.17 of the Milwaukee County Air Pollution Control Ordinance.

(Rules and Regulations adopted June 16, 1965 J. Proc., p. 1171-1176; published July 1, 1965, effective August 1, 1965)

MR. JARMAN. The committee will accept in the record letters from the U.S. Conference of Mayors and from the National Coal Association.

(The letters referred to follow :)

U.S. CONFERENCE OF MAYORS,
Washington, D.C., September 27, 1966.

HON. HARLEY O. STAGGERS
Chairman, Interstate and Foreign Commerce Committee,
House of Representatives,
Washington, D.C.

DEAR CONGRESSMAN STAGGERS: The United States Conference of Mayors supports the provisions of H.R. 13199, a bill to amend the Clean Air Act.

Air pollution in our urban areas continues to be a serious threat to community health and welfare. The many factors contributing to the air pollution problem are increasing, and the challenge facing our control agencies is becoming more critical each day.

The United States Conference of Mayors believes that the provisions of the Clean Air Act are designed to assist the cities of this nation in carrying out the front-line responsibility for the control of air pollution. Since the passage of the act, many cities have received financial and technical assistance under the program. Many others have submitted requests for financial assistance and are presently awaiting the availability of additional Federal funds.

This assistance has provided a real stimulus to the initiation and improvement of local control programs. However, the short-term financial assistance now provided by the Clean Air Act does not satisfy the need for the continuing, longer-range effort required for the prevention and abatement of growing air pollution problems. We believe that the provision of grant support for the maintenance of effective control programs, as contained in H.R. 13199, will contribute directly to the effort needed now and in the future.

The United States Conference of Mayors believes, however, that the provision contained in the third sentence of subsection (b) of Section 104 of the Clean Air Act, should not apply to maintenance grants authorized by H.R. 13199. This provision, a narrow maintenance of effort concept, while logical in relation to the existing short-term stimulatory grant program, should not be applied to grants in support of long-range control programs. Over a period of years, control program costs may fluctuate, due to non-recurring costs, without substantially affecting overall program effectiveness. Within the matching requirements prescribed in H.R. 13199, we believe that this grant authority should be flexible enough to allow Federal supplementary financial assistance for the maintenance of the level of effort required for an effective control program regardless of the availability of local matching funds.

We strongly support, too, the provision of H.R. 13199 that would delete that portion of Section 104(a) of the Clean Air Act which limits the total of grants for support of control programs to 20 percent of the total appropriation for any year. In order to control air pollution, it is essential that greater emphasis be placed upon the application of current technology. Larger amounts of grant funds will be needed to assist control agencies in this regard, and the removal of the 20 percent limitation would provide budgetary flexibility in meeting this need.

Sincerely yours,

JOHN J. GUNTHER,
Executive Director.

NATIONAL COAL ASSOCIATION,
Washington, D.C., September 27, 1966.

HON. JOHN JARMAN,
Chairman, Subcommittee on Public Health and Welfare, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: It is our pleasure to comment on S. 3112 and H.R. 13199, which are the subject of a public hearing today by the Subcommittee on Public Health and Welfare.

We believe that this legislation would be strengthened by the adoption of H.R. 15481 which would amend Section 107 of the Clean Air Act to allow public hearings on any changes proposed in air pollution standards for Federal installations.

As you are aware, on June 2, pursuant to Section 5 of Executive Order No. 11282, the Secretary of Health, Education and Welfare published in the Federal Register performance standards for the prevention, control and abatement of air pollution from Federal facilities and buildings. They became effective thirty days later.

While Executive Order 11282 requires publication in the Federal Register of any modification or changes in the standards before they become effective, there is no provision made for a public hearing on such changes. H.R. 15481 would correct this situation by allowing any person affected by the proposed changes to make a request, within ninety days of their publication, for a public hearing.

This would be a constructive move. While the Secretary will maintain complete responsibility for the promulgation of any Federal air pollution standard, there may be times when the full impact of proposed standards may not be understood unless there is an opportunity for affected parties to be heard. The time to resolve the problems which can result from this lack of understanding is prior to the effective date of the standard, not after!

Indeed, without the benefit of a public forum at which all facets of a problem can be considered, there is real danger that an action program may be based on erroneous assumptions. That is why we believe it of utmost importance to provide for public hearings on any proposed change in the existing standards governing air pollution from Federal facilities.

We would also like to see the sense of H.R. 15481 applied to any air pollution control criteria for which the Secretary of HEW is responsible under Section 103(c)(2) of the Clean Air Act. While these criteria are required to reflect the "latest scientific knowledge" the present law in essence says that they require only the latest scientific knowledge of the Secretary of HEW. We do not believe that the true state of any art, or that any scientific knowledge, can be complete without the full and free opportunity for all interested parties to participate in a discussion of what is knowledge and what may be false assumption.

While it may be argued that criteria are not the same as standards, in this case they come very close to being standards. In effect, the Secretary of HEW controls the purse strings of many air pollution control agencies in that he may make grants to such agencies upon his terms and conditions. The net effect must certainly be that state air pollution control agencies will consider any criteria advanced by the Secretary of HEW as a minimum and act accordingly. Nowhere along the line is there any provision at present that calls for a public forum at which all opinions on proposed criteria, or a change in criteria, can be heard. We do not believe that such is the intent of Congress, and urge that any legislation to amend the Clean Air Act include language to correct this situation.

Sincerely,

STEPHEN F. DUNN,
President.

Mr. JARMAN. This concludes our hearings and the committee stands adjourned.

(The following material was submitted for the record:)

STATEMENT SUBMITTED BY ALEX RADIN, GENERAL MANAGER, AMERICAN PUBLIC POWER ASSOCIATION

The motor vehicle commonly is described as a major source of air pollution. A report by the Department of Health, Education and Welfare, published last November, estimated that about half of the total air pollution problem in the United States is caused by cars, trucks and buses. A report published in June in St. Louis, Mo., indicated that 63% of the hydrocarbons discharged into the atmosphere in that city during a 1963 test period were attributed to automobiles.

Efforts are being made to control the exhausting of hydrocarbons and carbon monoxide by vehicles, but even the best of these provide something less than 100% control. For example, 1966 auto models for sale in California, where a stringent exhaust control law is in effect, are equipped with exhaust control systems that reduce hydrocarbon emissions by about 65% and carbon monoxide emissions by about 50%, according to the HEW report.

A PERMANENT SOLUTION POSSIBLE

On this basis, even the adoption of California-type legislation by all of the other states would not solve the vehicular pollution problem; it would merely permit a doubling of the number of automotive vehicles without any increase in

the present level of pollution, admittedly too high. Population projections indicate that a doubling of the number of vehicles can be anticipated within a relatively few years, and automotive pollution will rise accordingly.

Members of the American Public Power Association are deeply interested in what appears to offer a solution to a major part of the automotive pollution problem—the electric battery-powered vehicle. Although it is not likely that battery-powered automobiles would completely replace combustion-powered vehicles, the air pollution problem would be materially alleviated by the widespread use of battery-powered automobiles and trucks.

Development of new types of batteries which are lighter in weight and more long-lasting than earlier types has stimulated much interest in the battery-operated vehicle. Our Association has established a new committee to promote the electric auto. Battery-powered fork-lift vehicles, golf carts, delivery trucks and other specialized vehicles are beginning to catch on, particularly in Great Britain.

The early development of the automobile proceeded along three principal routes—the gasoline-powered engine, the steam engine, and battery-driven electric vehicle. Some of the early manufacturers switched from one type to the other; all types had certain advantages.

SIMPLICITY AND RELIABILITY NOTED

A description of the battery-powered automobile of the turn of the century indicates that it had reached an enviable position. "Evolution of the American Automobile" by Daniel D. Gage and Anne C. Garrison in *Business Topics*, published by Michigan State University, Autumn, 1965 notes that:

"It was the ultimate in simplicity and reliability, starting immediately with the turn of a switch, moving silently, increasing speed with utmost smoothness. Anyone could learn to drive it with finesse in five minutes. Consequently, it became identified with lady drivers and older people who were not concerned with dash and dreams of glory. Like its upholstery, its public image was dove gray. Its top speed did not exceed 25 miles an hour, and its range was limited by the need for recharging the storage batteries every 60 miles, either at a public garage or by means of expensive home equipment. As a passenger car, the electric car held on until the first World War, but the electric truck for street or in-factory use was revived 25 years later."

The same article notes that after the gasoline internal combustion power plant won out over steam and electricity, "for over half a century engineering ingenuity has been devoted to improving the piston engine, which is basically an over-elaborate and unsatisfactory source of power. It may have been that the challenge of perfecting this imperfect machine attracted designing talent to it rather than to the steam or electric car."

RESEARCH EFFORT NEEDED

Whatever its merits as a source of automotive propulsion, the gasoline engine is choking our civilization with its fumes. While continuing to perfect this "over-elaborate and unsatisfactory source of power" to diminish its contribution to our air pollution, it would be desirable, also, to devote engineering talent to the battery-driven vehicle, which appears to have many uses in our urbanized society today.

A study by the Cornell Aeronautical Laboratory, Inc., at Buffalo, N.Y., last year, made for the Commerce Department, suggested the desirability of two distinct types of vehicles, one for urban use and one for interurban highway travel. The Cornell group predicted that a major market for electric automobiles, primarily for urban use, will appear by 1980, pointing out that the electrically powered car creates no air pollution and, perhaps more persuasive to potential buyers, has operating costs which are considerably less than those with internal combustion engines for stop-and-go driving.

Just recently, an interesting suggestion was made by columnist Howard K. Smith in the June, 1966, issue of *Washingtonian* magazine. Declaring that there are dozens of things which we can do about city traffic "when the moment of total paralysis and the incidence of lung and throat ailments finally prove that something must be done."

One of these could be to provide inner city drivers with a fleet of drive-yourself electric, two-seater carts, which could be driven for a mile, at a speed of 20 miles per hour, for each coin put in a slot. "There would be no fumes,

no important accidents, and no traffic jams caused by a mere 40 or 50 people scattered one-apiece in limousines big enough for eight."

CADILLACS VERSUS HORSES

It is certainly true, as Mr. Smith says in the same column, that there are few inner cities today where distances were not covered faster half a century ago in horse-drawn vehicles than they are today in Cadillacs.

So one arm of the research effort into the electric vehicle can be directed toward designing, specifically for urban use, a vehicle which can transport people from place to place at relatively low speed, with ease of stopping and starting in dense traffic. The design of the vehicle itself requires an investment of talent and imagination.

Since there remain a good number of one-car families in America, and since the automobile represents both a convenience and a pleasure vehicle, a great deal of work must be done to increase the speed at which a battery-driven auto can travel, and to increase the distance which can be traveled without recharging the batteries.

A recent article by Edmund K. Faltermayer, appearing in the November, 1965 issue of *Fortune* magazine, reported that Yardney Electric Corp. of New York City has fitted up a special Renault Dauphine with lightweight batteries that can propel it at speeds up to 55 miles an hour, and up to 80 miles on a charge. "The catch is that these are military-type silver-zinc batteries costing \$3,000." Nevertheless, Mr. Faltermayer added, several companies, including Yardney and General Dynamics Corp. are pushing ahead in the search for batteries that would cost only a fraction of this.

Mr. Faltermayer concludes that while a battery-operated car suitable for long journeys is a long way off, a smaller version might be available in a few years. Perhaps he was overly pessimistic, in view of progress which could be made if an all-out research effort were launched to develop smaller, lighter, and more powerful batteries. The fuel cell may offer an even more promising field for further research.

FUEL CELLS HOLD PROMISE

William T. Reid, of Battelle Memorial Institute, who is serving as coordinator of a broad research program on fuel cells, declared in a recent article that the greatest promise in providing electrical power for an automobile comes from the fuel cell. Although fuel cells are not being used commercially, Mr. Reid reported that they are being used experimentally for powering fork-lift trucks, golf carts, and the like.

From the standpoint of electric utilities, Mr. Reid noted that the hydrogen-oxygen fuel cell, which presently has reached the highest level of development of any type of fuel cell, would run on the products of electrolyzed water, thus opening up the possibility of an electrolyzer in each home garage, or in service stations in residential areas.

Batteries presently available cannot be used effectively in automobiles because they are too heavy and too costly, Mr. Reid said in the same article. But he suggested that improvements can be attained in lead-acid batteries—improvements which battery manufacturers have not been forced to make in the past because their present product meets the requirements of the present market. "Here is one area where research might make a major contribution," Mr. Reid declared. "Another would be research and development leading to a wholly new secondary battery based on one of the light metals such as lithium, sodium, magnesium, or calcium with a nonaqueous electrolyte." He added that this would be no easy task but, if successful, it would pay great dividends for other electrical storage systems as well as for electric automobiles.

Mr. Reid's article concluded that regenerative braking, traction motors specially designed for automobiles, controls, and auxiliaries all will need considerable development. In each of these areas, research could be justified leading to a final, practical prototype of an electric automobile.

NEW BATTERIES DEVELOPED

Within the past year, two new types of electric storage batteries have been announced. In December, 1965, the Edison Electric Institute and General Dynamics announced a prototype zinc-air battery expected to be ready for testing soon. In February of this year Gulton Industries, Inc., announced the successful

demonstration of a lithium battery that will be subjected to further development work. During the past decade, the traditional lead-acid battery found in every automobile and the industrial nickel-iron battery developed by Edison have been joined by the nickel-cadmium, nickel-silver, silver-zinc, silver-cadmium and mercury batteries. Developmental work also is going forward on sodium batteries.

An article on developments in electrochemical energy-conversion devices, batteries and fuel cells, by Dr. M. Barak of Chloride Technical Services Ltd., Swinton, Manchester, England, summarized recent progress in England, where battery powered delivery trucks are extensively used, and where passenger vehicles are being designed for battery operation.

Dr. Barak concludes that development work must continue in the direction of lightweight fuel cells with higher outputs, lightweight traction motors, and possibly high-speed transmission before fuel-battery electric cars can become a practical reality.

He reported that over 100,000 electrically propelled vehicles are in operation in Great Britain, including industrial trucks used to transport materials and products in factories, commercial vehicles, mining locomotives, and so on.

A MILLION ELECTRIC CARS PREDICTED

The Electricity Council in Britain more recently predicted that within 10 years a million battery-driven automobiles will be in operation. There are four small electric cars being tested on London streets as a result of the Council's campaign to promote the electric vehicle—two British Motor Corporation "Mini" cars, with the gasoline engine replaced by batteries and an electric motor, and two which are specially designed for electric operation by Scottish Aviation and Peel Engineering, according to a dispatch from London which appeared recently in the *Chicago Tribune*.

The Scottish Aviation model, called the Scamp, and the Peel car, called the Trident, are expected to cost less than \$1,000 when mass-produced. They can go only about 30 miles between recharging, at a top speed of about 40 miles an hour. Batteries weigh about 700 pounds in the two-passenger models.

The Electricity Council predicted that eventually parking meters will be wired to recharge batteries, although recharging would be done in garage sockets during night, using off-peak electric rates, in most cases.

It seems highly important to pursue the design of vehicles specifically for battery operation, as the British are doing. This approach may result in vehicles which are most suitable for specific uses, e.g., commuter travel to and from large cities, as well as in vehicles which make the most efficient use of battery power. Obviously the breakthrough to wide-scale use of electric vehicles will not come as a result only of fitting up standard model cars for battery operation. And a real breakthrough in terms of consumer acceptance must come if the battery-operate vehicle is to have an impact on the air pollution problem.

FEDERAL FUNDS FOR BATTERY RESEARCH

There are about 15 Federal agencies funding a total of 86 projects in battery research. Of these, 21 are being performed in government laboratories, 14 are being performed by 10 universities, and 51 by 24 industrial companies. Manufacturing corporations also are conducting research.

The Tennessee Valley Authority purchased a battery-operated electric car in 1961 for study and evaluation of the possible electric utility load buildup that could occur from public acceptance of such a vehicle. The car is a Renault Dauphine, with electric motor and batteries substituted for the gasoline engine.

After a series of tests on the car, which is called the Henney Kilowatt, it was concluded that commercial feasibility of the electric car "must await a substantial improvement in performance capability, particularly in the capacity to travel longer distances." A need for "major advances in storage battery technology" was noted in TVA's report on the Henney Kilowatt, but it was pointed out that research being carried out in connection with the national space program could make such advances possible.

In 1961, the Lead Industries Association of New York launched a campaign to increase the use of storage batteries as a source of electric power for industrial trucks, personnel carriers and other vehicles. The Association estimated that the electricity consumption of a single electric industrial truck would be 7,500 kilo-

watt hours per year, or more than five times as much as is used by a window air-conditioner. This gives an indication of the importance of the electric vehicle to an operating utility, particularly when we consider that the bulk of the re-charging load would come during the night, when other loads would be very low. Several electric utilities have launched sales promotion campaigns to sell electric trucks, according to an article in the Aug. 23, 1965 issue of *Electrical World* magazine.

R. & D. SUPPORT REQUIRED

A leading proponent of electric autos to combat air pollution has been the Electric Storage Battery Company. The president of this firm, M. G. Smith, has called upon the President to "make recommendations for research and development of all kinds of non-polluting devices and spell out what both the Federal government and private industry should do to get those devices built and used—universally and in the least possible time."

Mr. Smith declared that non-polluting, battery-powered vehicles for low-speed, low-mileage urban transportation are feasible right now.

This brief summary of developments is not intended to be comprehensive, but merely to indicate that there is widespread interest in the electric vehicle and a recognition that it can substantially reduce the air pollution problem, if it is used as an alternative to the gasoline-powered car in urban areas.

Widespread use of electric vehicles would require increased generation of electric power in order to re-charge the batteries of electric vehicles. In this connection, the question of air pollution from electric generating plants will be raised, and should be raised, in assessing the total impact of the use of electric vehicles on the pollution problem.

Unlike gasoline burning automobile engines, modern electric generating station do not produce carbon monoxide, and the gas from stations is discharged into the upper atmosphere, not at street level where it directly contaminates the air people breathe. Furthermore, utilities now have very sophisticated equipment for controlling pollution.

In general, it would seem easier to regulate the discharge from a few hundred large generating plants than from millions of automobiles. The trend toward construction of larger plants, in more remote locations, will facilitate the regulation of generating plant pollution. Increasing use of nuclear fuel also will reduce the potential pollution from generating plants.

The members of our Association are fully aware of the pollution problem, as it is affected by the burning of fuels to produce electricity, and I am confident that they will cooperate in any reasonable plan to reduce or eliminate such pollution.

In addition to establishing a special committee to promote greater research which will lead to a "breakthrough" in mass markets and mass production of electric automobiles, our Association, at its annual Conference in Boston earlier this year adopted the following resolution by unanimous vote on May 12, 1966:

"ELECTRIC VEHICLES

"Whereas battery-powered passenger and other vehicles offer an alternative to vehicles powered by combustion engines, which create severe air pollution problems; and

"Whereas research currently under way indicates that economically feasible battery-powered vehicles can be developed within the near future if the electric industry and manufacturers push forward with an aggressive program of research and development; and

"Whereas the electric vehicle promises to provide an excellent off-peak load for electric utilities: Now, therefore, be it

Resolved, That the American Public Power Association urges a large-scale research and development effort to bring the electric vehicle to the market."

APPA hopes that your Committee, in attacking the most pervasive source of air pollution, will recommend the kind of large-scale research and development effort necessary to make available a pollution-free means of transportation for our urban areas.

Our Association urges the committee's support for a two-pronged research and development effort. Such an effort would include both design of new vehicles suited for battery operation and development of lighter, longer-lasting, and less expensive batteries which can power the vehicles of the future.

COMMONWEALTH OF PENNSYLVANIA,
DEPARTMENT OF HEALTH,
Harrisburg, Pa., August 18, 1966.

HOB. HARLEY O. STAGGERS,
Chairman, House Committee on Interstate and Foreign Commerce, Rayburn
House Office Building, Washington, D.C.

DEAR MR. STAGGERS: I have been informed that your Committee will soon hold hearings on H.R. 13199. The proposed amendments to the "Clean Air Act", provided for in this bill, can have a significant effect on governmental air pollution control efforts throughout the Nation. At a recent meeting of the American Industrial Hygiene Association, the Director of the Pennsylvania Department of Health's Division of Air Pollution Control made the following comments with respect to this proposed legislation.

"A bill introduced at this Session of Congress (H.R. 13199, introduced by Mr. Staggers on March 2, 1966) would permit grants to state and municipal agencies 'up to one-half of the cost of maintaining programs for the prevention and control of air pollution.' The enactment of this bill would alleviate some of the inequities of the present grant program. It would be important, though, that the Public Health Service regulations, developed for awarding grants for maintaining programs, not interfere with the autonomy of these programs. 'Maintenance grants' should not be awarded on a 'project' basis. The individual development of state and municipal programs should not be inhibited by regulations which would have the Federal Government specify how these programs should be operated.

"Maintenance grants' should be awarded on a 'formula' basis. The amount of Federal support to be given to a state or municipal program should be based upon the judicious application of criteria which are related to the extent and nature of the air pollution problems under the jurisdiction of the grantee agency.

"At the present time air pollution control concepts, both technical and administrative, are rapidly changing. It is a time to 'let a hundred flowers bloom'. No single agency has sufficient ability or knowledge to prescribe the administrative techniques which should be used by various state and local air pollution agencies in controlling the many and varied problems they face."

The Pennsylvania Air Pollution Control Act of 1960 authorized the creation of one of the first state level programs in the Nation. This program is administered by the Pennsylvania Department of Health. The Department first became involved in air pollution control in 1949 when this activity was established in our Division of Occupational Health. After the passage of the 1960 Act, a Division of Air Pollution Control was created in the Department. During our relatively long experience in this activity we have worked closely with the Federal program and other state and local programs. It has been our experience and it is our firm belief that, to be effective, governmental air pollution control programs must be operated by an agency which is not physically, politically or socially distant from day-to-day contacts with local air pollution problems. We believe that the Federal Government should develop broad National goals and a program of technical support. It is also important that Federal activities insure that—

- (1) The importance and effectiveness of local control programs is recognized.
- (2) Real support is given to encourage the development of local programs.
- (3) The ability of local officials to operate a program to the full extent of their competence, resources and local needs and desires, is not interfered with.

The program grant provisions of the "Clean Air Act" were designed to provide real support to local and state agencies. The implementation of these provisions has had a significant effect on the development and expansion of local and state efforts. We believe, though, that the regulations developed by the Public Health Service for the administration of this program were, in some areas, unfair and to a degree interfered with local autonomy. Specifically we object to the provisions of the regulations which require "new money" to match Federal funds and the awarding of grants on a "project basis".

As indicated in the above statement, the "maintenance grants" provisions of H.R. 13199 "would alleviate some of the inequities of the present grant program". To insure that the administration of the maintenance grant program is carried out on an equitable basis, we believe that it should be clearly stated that the

legislative intent of the bill is to permit full local autonomy in program development. The awarding of maintenance grants on a "project basis" by the Public Health Service should be discouraged.

I request that a copy of this letter be included in the record of the Committee hearings.

Very truly yours,

C. L. WILBAR, Jr., M.D.,
Secretary of Health.

(Whereupon, at 11:20 a.m., the subcommittee recessed, to reconvene subject to the call of the Chair.)

○

