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STEPS TOWARD CLEAN AIR

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TO THE

COMMITTEE ON PUBLIC WORKS
UNITED STATES SENATE

FROM THE

SPECIAL SUBCOMMITTEE ON
AIR AND WATER POLLUTION

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STEPS TOWARD CLEAN AIR

Introduction

Last December, the Congress enacted major legislation revamping the role of the Federal Government in air pollution control. The Clean Air Act of 1963 represents a sharp departure from prior legislation in that it created within the Federal Establishment a mechanism for greatly stimulating the national effort to abate and control air pollution. Its provisions were broad, and they ranged into fields which the Federal air pollution effort had not previously entered—abatement authority and financial aid to control programs, to mention only two. Nevertheless, enactment of the Clean Air Act is not in itself the end, but rather a fresh beginning. For there remain several important aspects of the national air pollution problem which require additional attention on the part of the Congress, the executive branch, the cities and States, industrial and other sources of community air pollution, and the American people. This report represents the assessment of a subcommittee which has devoted major attention to surveying the remaining unmet challenges of air pollution and the opportunities that exist to meet and overcome them.

The Special Subcommittee on Air and Water Pollution was created on April 30, 1963, by its parent committee, the Senate Committee on Public Works. At that time, several legislative proposals dealing with air pollution had been referred to the Committee on Public Works and were awaiting consideration. The chairman of the Public Works Committee instructed the subcommittee to "extensively explore" the problem of air pollution in all its ramifications—sources, nature, effects, and control—and to determine the most beneficial legislative remedies. The subcommittee was empowered to hold hearings, to conduct studies, to recommend amendments to existing legislation, to develop new legislative proposals, and to prepare reports of its findings and conclusions.

Initially, it was the subcommittee's plan to hold extensive hearings across the Nation prior to the consideration of any legislation so that the members of the subcommittee could explore the air pollution problem in the greatest possible depth, greater in fact than that dictated by the scope of the several bills pending before the subcommittee. The members wished to acquire a fund of information sufficient to enable them to consider wisely not only the merits of the pending bills but also the need for legislation that would be possibly much more responsive to the problems than that already introduced. As a first factfinding step, the subcommittee instructed its staff to prepare a report on the problems of air pollution, its causes and effects, the history of Federal, State, and local governmental control activity, and the specific areas which seemed most urgently to demand attention. This report, "A Study of Pollution—Air," was issued in September 1963.

This staff study documented the magnitude of the national air pollution problem and made clear the fact that immediate consideration of the pending legislation was highly desirable. It was obvious that early action was called for if Congress was to enact legislation to cope with the problem within that year.

The subcommittee therefore decided to divide its work into two phases: (1) immediate consideration of the pending legislative proposals; and (2) after completing action on that legislation, investigation of those aspects of the air pollution problem not fully covered by the pending bills. In September 1963, legislative hearings were held; a bill was subsequently reported out and passed by the Senate. Differences between Senate and House versions were resolved, and on December 17, 1963, the President signed Public Law 88–206—the Clean Air Act.

Major provisions of the Clean Air Act are described in appendix I of this report. Briefly, the act authorized continuation and substantial augmentation of the Federal air pollution program, carried on by the Department of Health, Education, and Welfare since 1955. The act, however, went far beyond prior legislative authority by assigning to the Department several new responsibilities in the area of air pollution control. It granted the Secretary of Health, Education, and Welfare specific abatement powers, similar to those he already had in the area of water pollution control. It established, for the first time, a program of grant assistance to State, regional, and municipal air pollution control agencies to stimulate State and municipal governments to assume fully their responsibility for the control of air pollution at its source, a responsibility which the subcommittee staff report showed the cities and States of the country were not adequately meeting.

Other provisions of the Clean Air Act directed the Secretary of Health, Education, and Welfare to develop and promulgate criteria of air quality for the guidance of control agencies and other governmental bodies desiring to establish enforcible standards of air quality and air pollution emission limitations; to form a joint industry-Government technical committee to explore the problem of motor vehicle air pollution and recommend steps toward its solution; to conduct studies and investigations leading to the development of practical, low-cost methods of removing sulfur from fuels in order to reduce the amount of atmospheric sulfurous pollution caused by the burning of sulfur-containing coal and oil; to develop prototype devices and procedures for air pollution control; and to establish a procedure for the regulation of air pollution discharged from buildings and other facilities under Federal jurisdiction.

Following adoption of the Clean Air Act, the subcommittee turned to a more detailed inquiry into the complexities of the national air pollution problem, devoting its attention chiefly to facets such as vehicular pollution and the development of effective regional approaches to control, which evidently presented the greatest impediments to comprehensive air pollution control throughout the Nation. On January 27, 1964, the subcommittee initiated in Los Angeles a series of field hearings to gather as much on-the-spot information as possible. In addition to Los Angeles, hearings were held in Denver, Chicago, Boston, New York, and Tampa to gather, at first hand, a fund of information on the kinds of problems typically affecting

representative communities in various parts of the country. Witnesses who provided testimony at these hearings included governmental air pollution control officials, Governors, mayors, municipal and State health officers, representatives of industry, and spokesmen for citizens' organizations active in the effort to control air pollution. This series of hearings was concluded in late February. In June, the subcommittee again held hearings in Washington, taking testimony over a 5-day period on several specific aspects of the air pollution problem—motor vehicles, pollution control equipment, solid waste disposal, emissions from jet aircraft engines and from the testing of missile and rocket fuels, the control of sulfur emissions associated with the burning of coal and oil, and the need for new Federal research and development facilities to carry out the expanded programs authorized under the Clean Air Act. Testimony was received from Federal officials, from representatives of the several industrial fields directly concerned, and from a number of expert witnesses, consultants, and members of university faculties.

This report is based on the conclusions formed by subcommittee members growing out of an analysis of more than 1,400 printed pages of testimony and supporting documents. The members of the subcommittee have arrived at a set of recommendations which they feel are amply supported by the massive fund of information developed over the past year. Following is a brief summary of the subcommittee's findings and its specific recommendations. The bulk of this report consists of more detailed dicussions of the seven specific areas for which recommendations have been offered.

Summary

In all of the hearings held since the adoption of the Clean Air Act of 1963, automotive exhaust was cited as responsible for some 50 percent of the national air pollution problem. It is, in many respects, the most important and critical source of air pollution, and it is, beyond question, increasing in seriousness despite preliminary and isolated efforts to control it. One reason for the automobile's extreme importance in the overall national air pollution problem is its omnipresence. Automobiles are found in every populated area, whether industrialized or recreational, urban or suburban. The Division of Air Pollution of the Public Health Service has estimated that any place inhabited by 50,000 or more persons will have enough motor vehicles to create the potential for an air pollution problem. But motor vehicles, increasing though they are as a presently uncontrolled source of air pollution, have not far outstripped industry and waste disposal as the foremost contributors to the burden of pollution in the air. In major metropolitan areas with their confounding array of air pollution sources and in small mill towns dominated by a single, overwhelming air pollution source, the factory, powerplant, or incinerator smokestack is still the dominant landmark on the air pollution horizon.

The Nation is adding new and more complex air pollution sources to its highways and landscape faster than it is bringing them under control. This is true despite the fact that equipment and technological skills capable of controlling most of the major sources of air pollution, moving and stationary, are available today. This is not meant to imply that additional research is not vital. On the contrary, research

is urgently needed to find ways of controlling or preventing those sources of air pollution which now defy solution, and it is also needed to make improvements upon the sometimes crude means we rely on today to reduce emissions of solid and gaseous pollutants from industrial and other sources. Research, furthermore, cannot be confined to a quest for ways to plug up existing sources; it can as fruitfully or even more fruitfully be focused on the discovery or development of preventive measures.

The mandate in the Clean Air Act to seek practical, low-cost methods of removing sulfur from fuels before they are burned is an example of research in this important area. The cities and States cannot be expected to assume the major responsibility for this research and development activity. Excepting only California and Los Angeles County, they have not equipped themselves for such effort but have instead logically looked to the Federal Government for leadership, for new information, and for the maintenance of a truly national research and development program. This the Division of Air Pollution of the Public Health Service has provided for the past 9 years and will be able to continue in the years to come under the authority of the Clean Air Act. Within the Department of Health, Education, and Welfare the act places new and expanded responsibilities on the Division's research and development capabilities, and it is evident that the Division will have to be provided additional facilities, resources, and manpower if it is to meet the increased demands that the Clean Air Act places upon it.

Hand in hand with research must go the application of available and proven technology for the abatement and control of air pollution. No more obvious and disgraceful illustration of the need for applied technology can be found than the appalling state in which the Nation's waste disposal practices exist. Municipal, domestic, and industrial solid wastes are adding needlessly to the national air pollution problem simply because well-recognized methods of disposing of them cleanly and safely are all but totally neglected. To be sure, the aggregate cost of solid waste disposal is enormous, but the blight, the illness, the property destruction, and the environmental degradation produced by a smoldering garbage dump or a billowing, foul-smelling incinerator are far more costly to society. The Federal Government has both an opportunity and an obligation to help remedy this situation by employing its technical and financial resources to aid communities in the acquisition of proper disposal facilities.

In the control of air pollution, as indeed in most areas of human endeavor where social and technological problems merge, society is faced with the sometimes difficult task of balancing the rewards of progress with its penalties. The great industrial expansion of the last century has been achieved not without its price, and the unwanted and sometimes devastating effects of air pollution are a part of that price. We have reaped a huge harvest from the mineral resources of the earth, from its iron, coal, and petroleum; but we have also harvested vast quantities of potentially dangerous by-products. In the case of fossil fuels, we have had to take, and burn, the sulfur with the coal or oil. And in so doing, we have dumped into our air resource the sulfur compounds which endanger our health and destroy our property. Decades passed before serious attention was given to the proposition that sulfurous air pollution might be an unnecessarily

high price to pay for the riches that coal and oil had helped produce. Now, finally, there is reason to believe that we are ready to give the problem the attention it has long deserved, and indeed needed to solve it. Methods of taking sulfur out of fuel have been developed; methods of trapping sulfur gases from the emissions of electric generating stations have been developed, even to the point where the sulfur can be transformed into marketable sulfuric acid. The need now is to further perfect such techniques and to put them to use.

Collaboration between government and industry can be as beneficial to mankind, whether applied to an old problem or to a new one, such as the emissions from jet aircraft and the testing of missile and rocket fuels. Small by comparison, this quite new area of concern in air pollution presents an opportunity to conquer a problem before it grows to major proportions. The Federal Government and the segments of industry which are closely associated with Federal activities in the missile and rocket field, especially defense and space contractors, should pool their knowledge in the interest of minimizing or eliminating entirely the hazardous emissions being produced by the combustion of novel chemical fuels. Similarly, the operators of jet aircraft, aircraft engine manufacturers, and Federal aviation authorities have a compelling opportunity to correct now an air pollution problem which must be expected to grow as we move into the second decade of the expanding jet age.

These illustrations of the great benefits that would accrue to joint industry-government efforts in the area of air pollution point to a continuing responsibility of the Federal air pollution program. This is the obligation to provide technical aid to industry to help in planning and implementing measures for the abatement and control of air pollution.

Finally, it should be pointed out that the subcommittee is aware of the need for uniformity in the legal basis for air pollution control throughout the country. It is patently unjust for a government on one side of a political boundary line to permit levels of air pollution in its airspace far greater than those tolerated on the other side. Conversely, it is impractical for one jurisdiction to strive for the attainment of high standards of air quality if its adjoining neighbor, which will inevitably share the same air supply, does little or nothing to prevent wholesale pollution of the atmosphere. What is needed is a set of uniform laws and ordinances, which can be developed by the Department of Health, Education, and Welare and recommended to the States and cities of the Nation, so that they can at least have the benefit of the best judgment on matters pertaining to regional air resource management.

These are the areas in which the subcommittee feels additional action is required and makes the following recommendations:

Recommendations

That consideration be given to—

1. Legislation which would provide a minimum national standard limiting exhaust emissions of air pollutants from gasoline-powered motor vehicles.

2. Legislation which would require the Secretary of Health, Education, and Welfare to establish criteria for allowable exhaust emissions from diesel-powered vehicles.

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3. Legislation which would authorize the establishment of a program of grants for the construction of community solid waste disposal facilities.

4. Legislation which would authorize the establishment of a Federal Air Pollution Control Laboratory.

5. Legislation which would authorize the establishment of a technical committee, composed of representatives of the Department of Health, Education, and Welfare, the coal and petroleum industries, and the electric power industry, and the Federal Power Commission to effect a program of development of improved, low-cost techniques leading to the reduction of the emissions of oxides of sulfur produced by the combustion of sulfur-containing fuels.

It is further recommended that—

6. The Secretary of Health, Education, and Welfare prepare suggested State laws and regulations and municipal ordinances and codes which would encourage uniform control of air pollution within "air sheds," particularly where the problems are interstate in nature.

7. The President call a conference, made up of representatives of the Department of Health, Education, and Welfare, the Department of Defense, FAA, NASA, the Atomic Energy Commission, the Department of Commerce, and affected industries, to review rules, regulations and efforts to avoid air pollution resulting from jet aircraft, rocket and missile testing, and experimental fuel use. The conference should devise an effective means of coordination and mutual support to eliminate and avoid air pollution in these areas and should meet periodically to review Government activity.

Automobiles

Emissions of automobile exhaust constitute a major proportion of the community air pollution problem in all large cities in the Nation. Equipment and engineering modifications have been developed and tested which will reduce substantially the amounts of two major components of automotive exhaust-hydrocarbons and carbon monoxide. The automotive industry has agreed to produce cars beginning with the 1966 model year for sale in California which will be equipped with exhaust pollution control devices capable of reducing emissions to the levels set by California law. The industry does not plan, however, to make such vehicles available for sale other than in California, despite the documented fact that vehicular pollution is a serious and growing problem in all other parts of the country.

It is therefore recommended that legislation be considered which would require that, on or before 1 year after passage of such legislation, all gasoline-powered motor vehicles manufactured and introduced into interstate commerce or imported into the United States be required to meet standards where emissions of hydrocarbons and carbon monoxide are no greater than those the industry has agreed to meet in California and that rules and regulations be promulgated to insure proper operation and maintenance of the exhaust control equipment installed on such vehicles.

Because oxides of nitrogen may be increased in automotive exhaust as certain other components are reduced, it is recommended that the Secretary of Health, Education, and Welfare initiate or expand

research efforts aimed at developing methods and equipment for the control of oxides of nitrogen.

In view of the fact that about 15 percent of the hydrocarbon losses from motor vehicles come from the carburetor and fuel tank, and that effective means of preventing such losses are not available, it is further recommended that the Secretary of Health, Education, and Welfare undertake, with the assistance of the technical committee authorized under section 6 of Public Law 88–206, a study of ways and means of correcting this source of pollution and report his findings to Congress by one year after passage of this legislation.

Automobiles manufactured for sale in the United States, beginning with the 1963 model year have been factory-equipped with crankcase ventilation devices to prevent so-called blowby emissions. It is recommended that foreign cars imported into the United States be required to include similar equipment and that the Secretary of Health, Education, and Welfare develop and promulgate rules and regulations for the performance and maintenance of such devices.

Of primary importance to the subcommittee was the problem of automotive air pollution. The hearings demonstrated that the potential exists for a dramatic reduction in the air pollution problem created by motor vehicles. Industrial spokesmen and others advised the subcommittee that techniques for the control of motor vehicle exhaust and, specifically, for the reduction in the amount of pollutants which lead to the formation of photochemical smog, have passed the research stage and are now capable of large scale application on new, and potentially on used, automobiles in this country.

Since the industry has stated it can meet the standards set by California, and since California, with its severe problem, has standards which will materially improve conditions, it would seem that the same standards could be reasonably applied nationwide. Since the industry, in testimony as cited herein, advised it would not voluntarily provide automobiles meeting California's standards on a nationwide basis it is up to Congress to act.

Automobiles, trucks, and buses, which number approximately 82,500,000 in the United States, are the most numerous and widespread contributors to the national air pollution problems. In testimony and other information presented to the subcommittee by industrial representatives, governmental officials, and research workers, the major importance of motor vehicles as a vast, uncontrolled source of air pollution has been clearly demonstrated. At hearings in Los Angeles in January 1964, the subcommittee accumulated information both on the magnitude of the automobile air pollution, or smog problem, in Los Angeles and on the efforts being made in the State of California to deal effectively with this problem.

Gov. Edmund G. Brown of California reported to the subcommittee that—

> automobiles in the Los Angeles basin burn up some 7 million gallons of gasoline every day. And in the combustion process they pollute the air with 1,625 tons of hydrocarbons—the principal source of smog; 485 tons of oxides of nitrogen; and another 8,115 tons of carbon monoxide.

When these figures based on the Los Angeles experience are projected for the entire Nation—where some 65 billion gallons of fuel are burned each year—the quantities of pollutants produced annually by motor

vehicles is seen to be enormous—more than 14 million tons of hydrocarbons, more than 4 million tons of oxides of nitrogen; and over 75 million tons of carbon monoxide.

The State of California and particularly Los Angeles are seriously plagued by automotive smog, but the subcommittee has reached the inescapable conclusion that this problem is not confined to one city or State. Governor Brown expressed the view that automotive smog is a national problem. And Warren M. Dorn, member of the Air Pollution Control Board, Los Angeles County Board of Supervisors, stated:

> The automobile, which is responsible for the emission to the Los Angeles atmosphere of 80 percent of the smog-causing hydrocarbons and 50 percent of the smog-causing oxides of nitrogen, is uniquely a creature of interstate commerce. Its raw materials, its subassemblies, its finished products move in interstate commerce. Upon the well-being of the industry that produces it rests a good portion of the well-being of our economy. Its use has remade the appearance and the social structure of the United States. The waste products arising from its use now threaten the health, welfare, and comfort of people in communities from coast to coast.

The air pollution control officer for Los Angeles County, Mr. S. Smith Griswold, also attested to the national significance of the smog problem.

> Evidence now available would indicate that this community is not alone in this plight. Although we apparently were the first to reach and pass the "smog threshold," other communities now also are beginning to suffer acutely from this problem. Our problem, therefore, may no longer be viewed as unique, but rather as one shared in common with all other urban areas of the Nation, areas which presently contain more than 70 percent of our total national population.

This point of view was reiterated and substantiated in testimony presented in Washington by Vernon G. MacKenzie, Chief of the Division of Air Pollution, Public Health Service, U.S. Department of Health, Education, and Welfare. Mr. MacKenzie explained that the factors which combine to produce smog in Los Angeles are present to a degree in virtually every populated part of the country. These factors are motor vehicles, meteorological conditions which restrict the dilution of pollutants, and photochemical reactions which convert hydrocarbons and oxides of nitrogen into eye-irritating and plant-damaging secondary pollutants. Mr. MacKenzie pointed out that, with respect to concentration of motor vehicles, Los Angeles is surpassed by many other communities. The density of automobiles per square mile in Los Angeles in 1962 was 1,350. The corresponding figures for other major American cities were: Chicago, 1,541; Detroit, 1,580; New York City, 2,220; Philadelphia, 3,730; and Washington, D.C., 4,100. Mr. MacKenzie also presented data demonstrating that meteorological conditions which tend to entrap pollutants, and photochemical reactions which convert automotive exhausts into smog have been reported in many parts of the country and are, in fact, the rule rather than the exception. Mr. MacKenzie quoted the following from the Yearbook of Agriculture, published in 1963 by the U.S. Department of Agriculture:

> Los Angeles no longer has, if it ever had, a monopoly on photochemical smog. The characteristic symptoms on plants have been found in almost every metropolitan area of the country * * * the entire coastal area from roughly Washington, D.C., to Boston has come to rival southern California for extent, severity, and economic loss to agriculture because of photochemical smog. The occasional appearance of smog symptoms on vegetation of other sections is reason for serious concern.

During the hearings in Denver, the subcommittee was advised by Mayor Thomas G. Currigan that—

> The rate of increase of car and truck registration has been greater than the population growth, and is expected to increase from over 400,000 in 1960, to over 800,000 in 1970 * * * these growth factors will add to the air pollutants to be dissipated by the already overburdened air over the metropolitan area.

The matter of air pollution from automotive sources, it was further brought out in discussions between Senator Muskie and Robert Haver, chairman, Colorado Air Pollution Advisory Committee and Dr. Richard Reese, another committee member, follows:

> Senator MUSKIE. You say about 40 percent of your air pollution is due to industrial sources and 40 percent from motor vehicles?
>
> Mr. HAVER. That is correct.
>
> Dr. REESE. We have done an inventory in Denver which showed roughly 40 percent due to automobile, maybe about 30 to industries, and 30 to domestic sources—heating, backyard incinerators, dumps, and so forth.

Dr. Alfred E. Frechette, commissioner, Massachusetts Department of Public Health, touched on the problem of air pollution when he stated:

> While we have no specific data as yet on the relative contribution of automobiles to air pollution in the Boston area, we do know that gasoline consumption and vehicle density in the Boston area is comparable to other metropolitan areas in the county and we, therefore, must assume that the automobile constitutes a very important source of air pollution. The provision of the Clean Air Act supporting further research in this area is most welcome.

Mr. Genairo G. Constantino, chief, Division of Air Pollution Control and Mechanical Equipment and Installations, city of Providence, R.I., also indicated the presence of pollutants which emit from automobiles when he said:

> For example, the U.S. Public Health Service pilot study showed evidence of the occurrence in Providence of the Los Angeles-type smog—especially during the summer when the oxidant levels rose to as high as 0.3 parts per million. Accordingly, in addition to continuing participation in the National Air Sampling Network the Public Health Service report recommended a long-term air pollution monitoring program in order to define not only the potential danger to public health, but also to delineate the problem of the gaseous pollutants more fully, to assess the need for effecting various other control activities, and to follow trends in air pollution levels—all being necessary if we are to carry out this responsibility to the citizens of Providence.

Mayor Robert Wagner, of New York, in discussing the air pollution problem originating from all sources indicated the contributions from automobiles and buses when he said:

> Our problem here in the New York metropolitan area can be divided into two categories: First, there is pollution from smokestacks and chimneys, from coal and fuel oil used to produce heat and power, and from incinerators. Second, there are traffic fumes.
>
> Every day, 2 million automobiles and about 6,500 diesel buses use the streets of New York. While the diesels may be more offensive, and may cause headaches and nausea, the deadlier gases come from the gasoline engines. We have required the use of fume-repressing devices on all city-owned vehicles since 1961, and the automobile industry is now installing them on all new cars.
>
> This, however, does not check the fumes from the older cars, those manufactured before 1963, which are operated in the city; nor does it check the diesel fumes from trucks and buses, since diesel engines are not adaptable to fume-repressing devices; nor have we or anyone else been able to solve the problem of what to do about tailpipe exhaust from automobiles, since the device that I have referred to only checks emissions from the crankcase and not from the exhaust pipes.

In his statement before the subcommittee in New York City, Dr. Leonard Greenburg, professor of preventive and environmental medi-

cine, Albert Einstein College of Medicine, and the first commissioner of air pollution control in New York City and now a member of the New York State Board of Air Pollution Control, stated:

> It is well known that at this very moment we do not possess approved control devices for the automobile exhaust tailpipe. True, the Los Angeles Control District, the State of California, and the U.S. Public Health Service have been working on this problem for a long time and at great cost; nevertheless, we still do not have an approved device for controlling the hydrocarbon vapors discharged in the automobile exhaust gas stream. Hopefully this will be achieved in the not too distant future. Then, and only then, will it be possible to control one important portion of the total problem.

In view of the evidence indicating that automotive air pollution is a problem of national concern and scope, it might seem surprising that California is the only State which has undertaken a program aimed at solving this problem. The explanation may be found in the fact that Los Angeles was the first community to recognize the role of motor vehicles in producing smog and that adverse meteorological and topographical conditions there tended to make the problem acute and alarming several years before other cities had any indication of their burgeoning smog problems.

Los Angeles County has undertaken the most comprehensive and effective air pollution control program in history, and its efforts have led to the imposition of stringent controls on stationary sources of pollutants, both industrial and domestic. Yet despite the dramatic reduction in the quantities of pollutants being discharged into the air of Los Angeles, the smog problem persisted because its primary source—the automobile—remained uncontrolled. It is still uncontrolled, but the State of California, through its motor vehicle pollution control board, has undertaken a program aimed at developing and imposing control techniques on virtually all automobiles registered in the State.

The California program was described to the subcommittee during its hearings in Los Angeles by several State officials, including Governor Brown and Mr. J. B. Askew, chairman of the California Motor Vehicle Pollution Control Board. These witnesses, as well as industrial representatives who testified in Washington, explained that since 1961 new cars registered in California have been required by law to be equipped with any of a number of State-approved "blowby" devices which control the release of pollutants from the crankcase by returning these fumes to the engine for reburning. Five such devices are available for installation on used cars back to the 1950 model year. By the end of 1965 California authorities expect to have crankcase devices on 85 percent of registered vehicles in the State of California.

In speaking of the "blowby" control, Mr. Harry A. Williams of the Automobile Manufacturers Association, stated:

> It was learned in 1959 that unburned fuel mixtures which escape downward past the piston rings into the crankcase were resulting in hydrocarbon emissions to the atmosphere through the road draft tube in amounts in the order of 30 to 40 percent of the total emissions from a given vehicle * * *. On its own initiative, the industry introduced these (blowby) devices on vehicles offered in California at the beginning of 1961 model sales. After a year's experience with these in the hands of a relatively large number of California users, the industry announced in December of 1961 that crankcase ventilation systems would be installed on all 1963 models of American-made automobiles sold in the United States.

Mr. George A. Delaney, smog consultant of the Automobile Manufacturers Association, under questioning by Senator Muskie with respect to the crankcase control, stated:

> Starting in January 1 of this year (1964), any used car in California which changes ownership, in other words, is reregistered under another owner, must be equipped with a crankcase emission control device. Starting January 1 of 1965, all used vehicles in California except a few that are specifically exempted by the board, must be equipped on a progressive monthly basis which runs until October 1965.

Mr. John D. Caplan of General Motors Corp. then stated:

> I would like to clarify a couple of points that Mr. Delaney made, so it is clear. He mentioned earlier that California law provides for local option basis. On used car installation of the crankcase ventilation devices, this comes specifically into play so that in many of the nonurban areas of California, the used cars will not be equipped with crankcase control systems. * * * The other thing is that the crankcase—the principal emissions that they put out are hydrocarbons, and again when we talk about this 30 to 40 percent, and you can discuss this at length, this refers only to the hydrocarbon emissions.

Installation of blowby devices represents a step toward controlling some 25 to 40 percent of the hydrocarbons released to the atmosphere by an automobile. The subcommittee notes, however, that although such devices have been installed since 1963 on American-made automobiles there still is the unresolved question of what is being done with respect to imported automobiles. There is also the need to establish, on a national basis, criteria for the installation of such devices on used cars within a reasonable period of time.

During the course of the field hearings in Los Angeles the subcommittee heard, in addition to testimony on the programs for the installation of blowby devices, the actions and results of actions by the Los Angeles County Air Pollution Control District in the installation of devices to control exhaust pollution from automobiles. Warren M. Dorn, chairman, Los Angeles County Air Pollution Control Board speaking of the "Chrysler kit" which has been developed by the Chrysler Corporation said:

> It seems to me that our experience here has proven that the average hydrocarbons emitted from other motor vehicles are around 800 parts per million; this is the Chevrolet or the Ford, or other car makes, and in the Chrysler kit is less than 300 parts per million. So you can see there is quite a difference in the emissions of hydrocarbons, and because of this great difference we here in this county have now specified only Chrysler products to be purchased in our motor fleet here.

During questioning by Senator Muskie, the following information was elicited from Mr. S. Smith Griswold, air pollution control officer, county of Los Angeles:

> Senator MUSKIE. What is your impression, if you have one, Mr. Griswold, of the capability of the automobile manufacturers to develop effective exhaust control devices?
>
> Mr. GRISWOLD. Well, Senator, I think we have seen effective exhaust controls developed by an industry, the Chrysler industry.
>
> You have heard members of the board of supervisors discuss these. These devices are not exactly devices in the sense of the word that they are like an afterburner on a muffler.
>
> It is actually an engineering change. It is refinement in the carburetor setting. It is a change in the distributor and a few other very minor things which are on 160 police cars which were bought for the sheriff. The cars are Plymouths, and the devices on them are costing the county less than $10 per car.
>
> When our motor vehicle population doubles, as we estimate it will in 1980—from 3½ to 7 million cars—this device (the Chrysler kit) will not be sufficiently

effective. Instead of a device that will reduce emissions by 60, 70, or 80 percent, we may have to reduce the emissions 90 to 95 percent or develop an entirely new type of engine.

The subcommittee has not obtained enough information to determine the effectiveness of the "Chrysler kit" on other makes of automobiles.

The exhaust system itself is the major source of motor vehicle pollutants, and the State of California has been engaged in a development and testing program specifically intended to achieve control of automobile exhaust pollution throughout the State. The subcommittee has gathered considerable information on the California program, both from the legal and technical standpoints. Essentially, it consists of evaluation of proposed devices and techniques for the reduction of two of the chief constituents of automotive exhaust, hydrocarbons and carbon monoxide. State law requires that after the approval of two or more devices or techniques which reduce the emission of these pollutants to the level of 275 parts per million of hydrocarbons and 1.5 percent of carbon monoxide, and when such devices or techniques have been shown to be durable and economical according to State requirements, their use will be mandatory on all new cars of the model year which begins not less than 1 year after approval. Four such control devices were certified by the State motor vehicle pollution control board on June 17, 1964, which means that new cars registered in California beginning with the 1966 model year (fall of 1965) will have to be so equipped. In addition, all used cars must be equipped with exhaust control devices when two or more such devices are approved for installation on used cars. Installation of devices on used cars is to be accomplished through motor vehicle registration under California law; by the end of the year after certification of at least two devices, no motor vehicle may be registered nor reregistered unless it is properly equipped.

During its hearings in Washington, the subcommittee heard testi-testimony by representatives of the firms whose smog control devices have been approved in California. Each of the devices is a replacement for elements of the exhaust system; the principal component is a specifically designed and constructed muffler in which exhaust gases are burned either in the presence of a catalyst or by a direct flame to convert hydrocarbons and carbon monoxide into harmless materials. The results of tests by the California Motor Vehicle Pollution Control Board shows that the normalized emissions over 12,000 miles of device service ranged from 186 to 273 parts per million of hydrocarbons and from 0.62 to 1.36 parts per million of carbon monoxide. It has been indicated that the devices approved by California would likely withstand about 24,000 miles of use before deterioration caused them to fail to meet the specified standards. The cost of the devices is estimated at between $26 and $70, and an annual upkeep cost to the motorist of between $15 and $39.

In the subcommittee view, the action taken thus far in developing exhaust control devices is a major step forward in seeking a solution to the smog problem. However, it should be pointed out that the benefits of such developments may only be enjoyed by the State of California, since no other State has adopted legislation like that in force in California.

While testifying before the subcommittee, representatives of the Automobile Manufacturers Association and the individual automobile makers described their efforts to reduce the exhaust emission of carbon monoxide and hydrocarbons by design changes and additions to automobile engines.

In discussing the progress being made and plans for control of exhaust emissions through design changes and additions to automobile engines, Mr. Harry A. Williams of the Automobile Manufacturers Association stated:

> The main benefits resulting from nearly 12 years of research and development were demonstrated, first, by the automobile industry action in supplying crankcase blowby control devices starting in 1960. Secondly, the benefits were demonstrated when the automobile industry was able to announce on March 10 of this year that the engineers in the industry believe it is feasible, by applying the basic knowledge acquired in this research, to make design changes and additions to engines to automobiles to correct the problem by reducing the emissions under the level of the California standards for exhaust both in terms of hydrocarbon emissions and carbon monoxide.

Later in this presentation, Mr. Williams stated:

> * * * The board of directors of the Automobile Manufacturers Association recommended that each of the member companies immediately initiate major engineering programs to achieve the product goal on nearly 175 engine-transmission designs currently offered, to be ready for production by the fall of 1966 with automobiles that will meet the California standard.
>
> On March 9 we met with the chairman of the California Motor Vehicle Pollution Control Board and on March 10 with the Governor of California and we then publicly announced this 1966 target date. The board and the Governor commended the industry for its announcement. The industry is gratified by the fact that the announced program of design changes will produce effective control of hydrocarbon and carbon monoxide emissions, with durability and life of the control measures comparable with the life of the rest of the vehicle, and with the minimum economic penalty to motorists in the form of costs for equipment and costs of maintenance.

During the course of questioning of the Automobile Manufacturers Association witnesses with respect to the ability of the automobile industry to meet the requirements of the limitation of emissions from automobiles, the following testimony was developed:

> Senator MUSKIE. * * * We know that we are never going to be able to eliminate motor vehicle emissions completely. I assume that is accurate. At best, we are working toward control of harmful ingredients in those emissions, and I take it that the harmful ingredients are likely to be harmful wherever they appear, maybe in different degree, but at least to some degree. What is necessary is, as you suggest, first the accumulation of as much knowledge as we can, but I think that the objective in terms of public policy ought to be what it always is: that the achievement of a compromise as to the requirements that will ultimately be laid down in the various areas of the country. Otherwise, we face the prospect not only of 50 different control devices in 50 different States but, if California is a pattern, even more than that, different control devices in different areas of different States. It is a most frustrating prospect.
>
> Mr. DELANEY. I think we agree entirely with you, Senator. The thing we are cautioning against is the tendency that has arisen in many quarters to take the California specifications and apply them nationally. We are pointing out, and we are, I think, just as anxious as anybody of being able to produce something that has nationwide application, but as the present state of knowledge it is very unwise, it seems to us, to adopt the California specifications and say that that is good for the rest of the United States.
>
> Senator MUSKIE. Let me ask you this. You told the Governor of California that your 1967 model can incorporate some design changes which will effectively control exhaust emissions, as I understand your statement?
>
> Mr. DELANEY. It will meet their specifications.

Senator MUSKIE. Of control of exhaust from the machines?

Mr. DELANEY. Of control which they say is specifically applicable to their State.

Senator MUSKIE. It control exhaust emissions in accordance with California's standard?

Mr. DELANEY. Right.

Senator MUSKIE. Now what harm does it do to control the same emissions in 49 other States?

Mr. DELANEY. There would be no harm, but it is an economic burden on the—it may be an economic burden on the rest of the country.

The subcommittee is greatly concerned by the fact that automobiles designed and built to curb exhaust emission, when they are available, will, under the present situation, be shipped for sale only in California. Other parts of the country will be denied the benefit of this development, industry spokesmen testified, because no other States have adopted laws regulating automobile exhaust emissions. Furthermore, they contend, in States other than California, the role of the automobile in the air pollution problem has not been defined with sufficient precision to permit the development of emission standards or procedures to meet them through engine modifications. It was also suggested that building exhaust pollution control features into all cars would impose an economic burden on purchasers outside California. The subcommittee agrees that these reasons are logical in a narrow sense, but when the interests of the American people are considered and the scientific information confirming the presence of automotive smog in all parts of the country is evaluated, the argument that smog control should be restricted to California seems ill advised. Furthermore, the high rate of mobility of automobiles in the Nation strongly suggests that anything less than nationwide control would be inadequate to meet the automotive pollution problem.

The contribution of the automobile to the national air pollution problem can be reduced. The technological skills and equipment needed to do the job have passed the research stage. The subcommittee can see no valid reason to delay further the adoption of control measures as an integral part of every new automobile manufactured in the United States. If the industry can, as it does, make major changes in the appearance of automobiles almost annually, and if it can, as it does, announce advances in performance with impressive regularity, it certainly can also incorporate promptly the adjustments and equipment necessary to reduce exhaust emissions.

No one can seriously question the fact that reduced automotive pollution will be beneficial in every part of the country, variability in the degree of benefit notwithstanding. As the subcommittee has learned, the effects of smog, particularly its destructive effects on marketable crops and other vegetation, have been seen in 27 States. In a report to Congress presented in June 1962, the Surgeon General of the Public Health Service reported scientific observations indicating that automotive pollution was causing $8 million in crop losses in California each year, and as much as $18 million annually in crop losses in the northeastern coastal States. Information on the economic damage produced by motor vehicle exhaust is quite limited; nevertheless, admittedly fragmentary evidence strongly suggests that the actual cost of vehicular air pollution damage is many millions of dollars a year. If this is the case, the argument that nationwide application of control technology would be an economic burden appears unjusti-

fied. On the contrary, uncontrolled motor vehicle pollution is more likely to be an economic burden borne by the citizens of the entire Nation.

Obviously, the effects of motor vehicle pollution on human health and comfort cannot be reduced to monetary terms. The subcommittee can only conclude that the unnecessary hazard to health created by automotive air pollution should not be permitted to continue any longer than necessary.

It is of great interest to the subcommittee that the industry's announced plans did not dissuade the State of California from approving control devices whose installation on new motor cars would have been mandatory at least 1 full year before factory-modified cars are available in California, had the industry not subsequently accelerated its exhaust control efforts. The subcommittee commends California's action. The smog problem there demands that corrective measures be taken at the earliest possible time. This is not to imply that the State has acted in haste—far from it. The California program has been carefully conceived and executed, and it promises a significant measure of improvement in that State's smog problem within a year. Now the Congress faces the responsibility for seeing that the benefits of this important development are made available to people throughout the entire Nation.

Diesel-powered vehicles

In view of the fact that the number of diesel-powered vehicles operating on our streets and highways and railway system is likely to increase, action must be taken now to control the emission of pollutants from their powerplants. The enforcement of rigid standards is not practical at this stage of technological development. However, a start toward that objective should be made now. It is recommended that legislation be considered which would authorize and direct the Secretary of Health, Education, and Welfare to establish criteria for allowable emissions from diesel-powered vehicles manufactured and intruduced into interstate commerce or imported into the United States.

The Secretary should encourage and support further research into the means of developing and improving control measures for diesel vehicles.

Because of the limited number of diesel-powered vehicles as compared with gasoline powered vehicles, the degree of concern as to their contribution to air pollution is less than that for gasoline powered units. However, a number of factors indicate that diesel emissions should be of concern.

Dr. P. H. Schweitzer, a recognized authority on the diesel engine, made the following comments in his appearance before the subcommittee:

> * * * I point out three significant differences between diesel and gasoline engine emissions, all favoring the diesel:
>
> 1. A well-designed engine, properly maintained, burning suitable fuels, does not emit objectionable smoke.
>
> 2. Diesel exhaust smoke and other emissions are not toxic by current California State motor vehicle emissions standards.
>
> 3. There are so few diesel vehicles—about 1 for every 300 gasoline vehicles—that their contribution to air pollution is minor by any standards.

These three statements are generally valid, but they represented utmost simplifications and require explanations and qualifications.

While spark ignition (gasoline) engines generally burn mixtures that contain more fuel than what corresponds to the chemically correct air-fuel ratio (approximately 14.5:1 by weight), diesel engines invariably have an excess of air for combustion. The result is that in the exhaust the concentrations of the toxic carbon monoxide and unburnt hydrocarbons are below the tolerable concentration.

This refers to the California standards of 275 parts per million of hydrocarbons and 1.5 percent of carbon monoxide.

Dr. Schweitzer, however, suggested that presently used testing methods record only the gaseous hydrocarbons and leave the liquid hydrocarbons that are in droplet form unrecorded. He further stated:

* * * so many parts per million does not truthfully represent the polluting effect of an exhaust constituent, because the exhaust gas discharged is always more and sometimes many times more in a diesel than in a gasoline engine.

Dr. Schweitzer pointed out other factors which are pertinent to the question of degree of pollution emitted from diesels when he stated, "Now only these two exhaust constituents, CO and hydrocarbons, are recognized as air pollutants by the State of California though others are being studied. The diesel engine has thus been declared blameless, and the State of California does not require exhaust cleaning devices for diesel engines.

But let us go over the other potential pollutants:

Aldehydes, such as formaldehyde, and acrolein, are present in somewhat great quantity in the diesel exhaust but are not considered a health hazard. They contribute, however, to its unpleasant odor.

Oxides of nitrogen might be emitted in greater amount from diesel than from gasoline engines. However, the California Department of Public Health holds that these compounds are not harmful at the concentrations currently found in the atmosphere of California cities.

Diesel engines emit more sulfur dioxide than gasoline engines, but if the sulfur content of the fuel itself is below 1 percent, as is generally the case, the atmospheric contamination of this constituent is negligible. It contributes, though, to the unpleasant odor and eye irritation.

Diesel exhaust smoke, so conspicuous on our streets and highways, consists mostly of solid particles of carbon. It is probably more a nuisance than a health hazard but it would be a mistake to dismiss it on this basis * * *.

Dr. Schweitzer told the subcommittee:

There is almost unanimous agreement among the experts that a well-designed engine, in good repair, using the proper fuel, will not emit visible smoke. It is similarly accepted that when overfueled (overloaded) any diesel engine will smoke. In fact, overfueling is the most frequent cause of the diesel exhaust smoke.

Dr. Schweitzer stated that:

As our passenger automobiles are overpowered, our trucks are generally underpowered. They do not have big enough engines in their vehicles.

The result appears to be that truck operators attempt to increase the power of their engines by increasing the amount of fuel fed to them. According to Dr. Schweitzer's testimony, a relatively minor increase in the amount of fuel above that for which the engine was designed, leads to the production of visible smoke which would not otherwise be produced.

In discussing control of emissions from automotive sources Dr. Schweitzer made the following observation,

* * * no government regulation should discriminate in favor of diesel engines because, with the appearance of hybrid engines the delineation between the spark

ignition (gasoline) and compression ignition (diesel) engines is becoming less and less distinct. Laws on vehicular engine emissions should cover all engines but the enforcement agencies could accept it as a prima facie evidence that toxic emissions from a true diesel engine do not exceed the mandatory limits.

Although it has been reasoned that the diesel is not likely to see widespread use in passenger cars, there is a considerable and increasing number of diesel-powered utility vehicles, as well as trucks and buses, in use today. And there is apparently no coordinated national effort to control their present and future contribution to the air pollution problem.

The problem, in the opinion of the subcommittee, is of sufficient importance to warrant the same relative degree of attention as that needed for the gasoline-powered engines, the difference being that much more study has been made of gasoline-powered engines, their emissions, their effect and means of accomplishing controls.

The gasoline engine problem can be dealt with as a single unit because of the uniformity in procedures by the manufacturers of these engines in design and also because of the uniformity of fuels. Diesels, however, cover a wide range of design and use. They are not only used on highways, but on rails, waterways, and at construction sites.

The means of controlling diesel emissions through design and manufacturing changes are not as readily accessible as in the case with gasoline-powered engines. Likewise, it would be difficult to establish a single national standard. However, it is the belief of the subcommittee that criteria can be established for groups of diesel-powered vehicles. The subcommittee strongly urges that the joint industry-government technical committee authorized by the Clean Air Act make a concerted effort to determine the extent, effect, and ways and means of controlling detrimental and offensive emissions from diesel-powered vehicles. In the meantime, however, action is called for which will provide a basis for accomplishing the objective of diesel emission control.

In view of the need for action, the subcommittee recommends that there be legislation enacted which would authorize the Secretary of Health, Education, and Welfare to establish general criteria for allowable emissions from diesel-powered vehicles manufactured and introduced into interstate commerce or imported into the United States.

Solid waste disposal program

Air pollution produced by the disposal of municipal refuse is intolerable because it is totally unnecessary. The subcommittee has learned from expert testimony that proper and sanitary means of disposing of solid wastes are known and are in limited use. Solution of this ubiquitous problem, like so many other aspects of the total air pollution problem, will require considerable expenditure of funds. But in the case of municipal solid wastes, the financial burden rests not primarily with industry but with the public which must authorize the use of public funds to acquire adequate waste disposal facilities.

It would appear that this is an area in which the Federal Government has a great opportunity to assist local and State governments in meeting the problem of air pollution.

It is recommended that legislation be considered which would authorize the establishment of a program of assistance to municipalities in the form of grants for the construction of facilities which will

eliminate air pollution resulting from the disposal of solid wastes. Such grants should be predicated upon local ordinances banning open burning and enforcement procedures to insure that the disposal facilities will have a beneficial effect on reducing air pollution.

One of the concomitants of our increasing population and our rising living standards is the increasing quantities of solid wastes—garbage and refuse—generated in the course of our daily activities. Current methods used for the disposal of such refuse commonly constitute a significant source of air pollution in most of our urban communities. In addition, improper disposal practices are sources of disease-bearing flies and rodents and of pollution to ground and surface waters.

Waste materials come from domestic activities in our households, from food handling and other commercial establishments, from industrial operations, from debris produced incident to building demolition, and the construction of highways, buildings, and other structures. The current per capita production of refuse is estimated to be about 4 pounds per day. Based on an urban population of 130 million people, 520 million pounds of refuse in our urban areas must be disposed of every day of the year. Increased standards of living and economic activity, involving ever-increasing consumption of goods and materials, have resulted in a 40-percent increase in per capita refuse production since 1920. Such continued increases in per capita production combined with an anticipated doubling of our population by the year 2000 clearly indicates the need to give greater attention to the development and application of improved methods and systems for the economical and sanitary disposal of solid wastes.

Several methods are presently utilized for waste disposal. The failure of many communities to maintain adequate collection systems virtually forces householders and businesses to resort to backyard burning of refuse, creating for themselves and their neighbors smoke and odor nuisances and, collectively, contributing importantly to communitywide air pollution problems. On-site disposal by industrial and commercial concerns or in apartment houses may take place in small, inefficiently designed and operated incinerators which, insofar as air pollution is concerned, may be little better than open burning. In all of such on-site disposal methods, the unburned and noncombustible residue must be hauled away from time to time. In many areas, private or public collection services may be available, but the disposal method may be the burning of the refuse in open dumps or in overloaded or improperly designed, municipally operated incinerators.

Another method for central disposal is the sanitary landfill whereby the refuse is dumped in reserved open areas, compacted, and covered with fill dirt. When properly maintained and operated, this method can be quite satisfactory; in some cases it can be a means of reclaiming open "wasteland" areas for future recreational areas or construction sites. The major problem with sanitary landfills, however, is the large quantity of land required. A survey of sanitary landfill practices in the United States in 1961, by the American Society of Civil Engineers, indicated that a typical city of 500,000 population, for example, would use at least 15 acres per year for landfill operations. In the most populated areas the lack of such quantities of suitable land, reasonably close so as to avoid excessive hauling distances, will limit the continued use of sanitary landfill.

As existing landfill sites are used up, the ever-increasing land and hauling costs often force larger communities to resort to incineration. One of the major factors relating to incineration has been the cost associated with it. The average capital investment is $3,500 for each ton of refuse burned in a 24-hour period, and operation and maintenance costs average $6 per ton per day. Ashes, along with other furnace residue, must still be hauled to a disposal site. Other common objections are air pollution, unsightly appearance, noise, odors, and traffic congestion caused by the movement of collection vehicles in the area.

Expert witnesses appearing before the committee were of the opinion that the objections to both landfilling and incineration can be overcome by the use of proper technical methodology. At the same time, however, it was also felt to be important that intensification of efforts be undertaken to improve the effectiveness of these and other methods of disposal.

As indicated in the following excerpts and summaries, testimony presented to the subcommittee clearly establishes solid waste disposal as a serious and costly problem of widespread concern.

Los Angeles.—The burning of rubbish in open dumps, inefficient incinerators, and open fires are banned; refuse collection and disposal costs exceed $30 million per year.

Denver.—Dr. Roy L. Cleere, director, Colorado State Department of Public Health:

* * * the problem related to open incineration is serious. We know it is going to cost more money. We know that Denver, and not only Denver but other local jurisdictions, need to do more with respect to maintaining adequate sanitary landfill procedures for disposing of refuse, which also has increased in amount in recent years. We know that is a problem from the viewpoint of cities growing into fringe areas when the land values have increased tremendously in recent years but, nevertheless, it must be done if we are to correct 25 percent, approximately, of the air pollution problem, the problem related to backyard incineration, the tremendous amount of additional money that will be required on the part of the city to make the necessary improvements in pickup service, to say nothing of the problem related to acquiring the necessary land for landfill methods for disposing of garbage and refuse.

Mrs. Chester W. Rose, General Federation of Women's Clubs:

Part of the air pollution in our neighborhood must come from industry which is located west and south of us, but the very apparent causes are the automobiles and the backyard incinerators. Something can and must be done about all these factors before we all become enervated to the point of nonproductivity—let us who live in this beautiful city demand that there be an end to backyard incineration and that the city government assume complete responsibility for collecting and destroying trash.

Chicago. Mayor Richard J. Daley:

One of the important amendments (to the Chicago air pollution control law) that may come to pass by1968 will be complete prohibition of all improper burning of combustible refuse within the city of Chicago. This could specifically involve leaf burning in the fall and the continual burning of refuse in coal-fired boilers in some 30,000 Chicago apartment houses.

Mrs. Chauncey D. Harris, Cleaner Air Committee of Hyde Park-Kenwood-Woodlawn:

Garbage is burned in heating plants because Chicago does not provide city collection of garbage for any dwelling larger than three flats. As long as we tolerate the burning of garbage in residential areas, we will have air pollution.

Boston.—Gov. Endicott Peabody, of Massachusetts:

* * * The same factors that operate to increase atmospheric pollution—namely, increasing population, urbanization, energy consumption, waste production, and industrial development—serve, in this land-short region, to increase the problems of solid waste disposal. Many of the presently employed methods of waste disposal, which contribute substantially to environmental contamination through employment of methods which simplify and reduce the cost of disposal, are implicated.

New York.—Dr. Leonard Greenburg, professor of preventive and environmental medicine, Albert Einstein College of Medicine, formerly New York City commissioner of air pollution control:

The annual weight of the refuse of New York City is slightly less than 5 million tons, a weight approximately equivalent to 1,000 to 1,200 pounds per person per year. To this must be added about 600,000 tons of combustible construction waste per year * * *. New York is one of the largest cities of the world and * * * one might argue that this is an example of extreme size. But this problem is also true of smaller communities. At the moment, a group of citizens of Northport, Long Island, are aroused because of the nuisance created by the Huntington, Long Island, town dump and incinerator which is located on the dividing line separating the two towns. And the New York Times of 1 week ago (February 9, 1964) tells the story of the strife which is taking place because the town of North Hempstead, Long Island, desires to build an incinerator at Hempstead Harbor. The residents opposed to the construction of the incinerator say it "would saturate the area with odors, smoke, and soot, etc." These are but two examples. But this is not the whole story. In accordance with a New York City local ordinance, certain apartment houses must be provided with incinerators for refuse destruction. And every new apartment house is so provided. There are probably no less than 15,000 such apartment house incinerators in the city at the present time. Most, if not all, of these devices are not properly designed for the purpose intended, and they serve to add a tremendous burden of pollution to the city's air.

New Jersey.—Dr. Roscoe P. Kandle, commissioner, New Jersey Department of Health:

We are faced in New Jersey with an immediate need for improved methods for solid waste disposal in densely populated and industralized areas. Practical solutions have not yet been developed. We would hope to obtain Federal support for applied research and for the establishment of demonstration projects * * *. The problems * * * concerning these large sanitary landfills and what to do with solid waste is a very enormous problem. It has to go somewhere, you know; it just doesn't disappear.

During the hearings in Washington, D.C., Mr. Ross E. McKinney, chairman, department of civil engineering and director, C. L. Burt Environmental Health Research Laboratory, University of Kansas, discussed the problem of waste disposal rather extensively; his most significant and disturbing statement was as follows:

Open dumps have been extensively used for refuse disposal because they are low in cost. The refuse is merely discharged onto the ground and left. The putrescible organics create an extensive air pollution problem that prevents anyone from living close to a municipal dump. Most dumps attempt to burn the combustible materials to reduce the land volume required for refuse disposal. The nature of refuse prevents proper burning so that incomplete combustion results. Large quantities of organics are allowed to pass into the atmosphere as are large quantities of solid particles that have not been completely burned. New Orleans is the classic case of how poor combustion at refuse dumps can create an air pollution situation where the health of the people in the surrounding area is endangered. Atmospheric conditions combined with particles carried into the atmosphere from incomplete combustion of refuse at nearby dumps created increased attacks of asthma and contributed to several deaths. In addition to the air pollution problem, open dumps act as vectors for rats and other rodents and act as potential reservoirs of disease carriers.

There is no excuse for the open dump. They are a menace to health and an eyesore to the area around them. The cost of conversion of open dumps into sanitary landfills is a small investment in the health and welfare of the community which it serves.

The storage, collection, and disposal of solid wastes is one of the major expenditures in urban areas. The American Public Works Association recently pointed out:

> The annual outlay for refuse collection and disposal services—over $1.5 billion—is exceeded only by expenditures for schools and roads.

In addition to these expenditures by local governmental agencies, the Refuse Removal Journal estimated that the annual expenditures for private refuse collection and disposal are over $1.3 billion.

The problem of solid wastes collection and disposal is undoubtedly one of the neglected areas in environmental health. Studies conducted by the American Public Works Association and the Public Health Service show that less than half of the cities and towns in the United States with populations over 2,500 have approved sanitary methods of disposing of the estimated 90 million tons of refuse they produce each year. Although municipalities generally have ample legal authority to regulate solid waste handling within their corporate limits, few States have enacted laws which enable other local governmental units in metropolitan areas to deal effectively with solid wastes problems. Municipalities can exercise the power of eminent domain within their corporate limits, but the land available for refuse disposal is frequently insufficient to meet their needs. Even when a city finds land to purchase in a neighboring community or an unincorporated area, political boundaries are formidable obstacles which may prevent the site from being used for refuse disposal facilities.

State legal authority to provide refuse services on an areawide basis is urgently needed in most metropolitan areas. A few cities are currently sharing disposal facilities on a fee or prorated cost basis, and some counties have countywide refuse disposal systems, but State statutes often do not provide the legal authority for establishing and financing refuse disposal services on an areawide basis. Only nine States—California, Connecticut, Kentucky, Michigan, New Jersey, Ohio, South Carolina, Tennessee, and Washington—have provisions for the formation of districts or authorities to organize and operate such areawide systems. However, Kansas and Wisconsin do have general authority.

State programs to stimulate local improvements in solid wastes storage, collection, and disposal are similarly lacking. In 1964, only 12 States reported to the Public Health Service that they had identifiable solid waste activities, while 31 indicted no program at all. The strengthening of State programs is a serious need at this time.

At the Federal level, activities have been meager in relation to the size and scope of the problem. The Public Health Service's total expenditure in fiscal year 1964 in this field was about $430,000, of which $360,000 was used to support research projects carried out by non-Federal institutions. A report of a group of nationally known experts, convened in 1957 by the Public Health Service to review the status of the problem and to formulate recommendations, highlighted the failure of the public, as well as public officials, to recognize the importance of adequate collection and disposal of solid wastes, with

the resulting nonacceptance of responsibility by some communities. The committee urged the Public Health Service to undertake a national program to improve solid waste disposal practices.

Although the Public Health Service has for many years encouraged and supported research on solid waste problems, its efforts would appear to fall far short of meeting research needs. A 1961 report on research needs in the field of solid wastes, prepared by the American Public Works Association at the request of the Public Health Serivce, indicated that, in addition to the current Federal program for research on liquid and gaseous wastes, a comprehensive research program is definitely needed in the solid wastes field. Its suggests many needed projects and points out that "the annual expenditure in this field—using industry standards as a guide—justify the annual investment of at least $7.5 million in research."

Although the national solid waste disposal construction needs are not precisely known, general information on rates of refuse production, expected changes in the character of solid wastes, and population increases can be used to develop some very broad estimates of national needs.

For example, even if existing deficiencies and normal replacement of existing incinerators are not considered, at least 290 new incinerators will have to be constructed at an estimated cost of $506 million before 1985 to serve only the predicted increase in population of 77 million. This estimate assumes that 75 percent of the increase in population will occur in urban areas, that all of the urban solid wastes would be disposed of by incineration, and that current average costs ($3,500 per ton of rated capacity) would have to be increased by 25 percent to supply more advanced and approved performance which would be required to meet air pollution requirements. If the refuse from only half of the predicted increase in population is incinerated, at least 195 new incinerators would have to be constructed at a cost of $337 million before 1985.

The subcommittee is greatly concerned about the scope and magnitude of the solid waste disposal problem in our Nation. It is of particular concern when it is realized that in our country we must dispose of 520 million pounds daily of refuse which must be removed and disposed of either through burning, burial, or conversion into forms of organic matter for final disposition, or put to useful purposes.

The subcommittee is very much concerned about the effect of improper burning and disposition of solid wastes and of the air pollution and health problem which these practices create. The subcommittee recommends that legislation be enacted which would authorize the establishment of a program of assistance to municipalities in the form of grants for the acquisition of facilities which will eliminate air pollution resulting from the disposal of solid waste. Such grants should be predicated on local ordinances banning open burning and enforcement procedures to insure that construction of the disposal facilities will have a beneficial effect on reducing air pollution.

The grant program can be used as an inducement to communities and States to face up to the problem of disposal of solid waste. This same type program in the water pollution field is responsible to a substantial degree for reducing the sewage discharges into our water supplies.

Certainly the perfect answer is not now available. Institution of such a program will not automatically solve the problem of how best to dispose of solid waste. But it will help in protecting and preserving the Nation's health and economic well-being.

Federal Air Pollution Research Laboratory

Equipment and techniques are available for application to the control of most of the major sources of air pollution. However, a need exists for much additional research and development in the control field and for further studies of pollutional effects on life and property. This need can reasonably be expected to increase as the Clean Air Act stimulates increased control activity throughout the Nation and as new air pollution challenges emerge from our expanding technology. It is therefore recommended that legislation be considered which would authorize the establishment of an Air Pollution Research Laboratory within the Department of Health, Education, and Welfare, and that this Laboratory be equipped and staffed to conduct investigations in the full range of research and development areas relating to the problem of air pollution.[1]

Testimony before the subcommittee indicated that in spite of the studies made in the air pollution field much remains to be done. It is doubtful, in the opinion of Mr. Robert L. Chase, director of engineering, Los Angeles County Air Pollution Control District, that local control agencies can carry the burden. He said:

> Both technical and financial support must be forthcoming from the Federal Government. Even though Los Angeles County has shown its willingness over the years to expend nearly $40 million to support the necessary research and engineering, it does not follow that all other communities can or will do the same.
>
> Now that Congress has passed the Clean Air Act, it is most important that the Federal program be examined now to determine whether past expenditures have been effective in furthering the control of air pollution and whether the program can be made more effective in the years ahead.
>
> The Federal program can be examined, of course, from many different points of view. I believe that it should be examined in relation to local community problems and how the Federal Government can assist local agencies in combating these problems.

The Clean Air Act directs the Secretary of Health, Education, and Welfare, under section 3(b)(8) to "develop effective and practical processes, methods and prototype devices for the prevention or control of air pollution." The act also, under section 6, directs the Secretary to place emphasis on the special problem of automotive vehicle and fuel pollution and provides, as one approach to the problem, for the formation of a technical committee, with industry and Government representation, to evaluate progress, to make recommendations, and to report semiannually to the Congress.

It is clear that the new statutory provisions will require a substantial new effort in the research and developmental aspects of control devices to the prototype stage, and also careful evaluation and com-

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[1] Senator Miller believes that prior to considering legislation which would establish a fully equipped and staffed laboratory (with regional or field centers) within the Department of Health, Education, and Welfare, an all-out effort should be made by the Secretary to obtain the necessary research and laboratory services through contracts with appropriate universities, business, and research organizations. There is, according to Senator Miller, a serious problem of competition between the Federal Government and educational, business, and research organizations for technical and scientific talent, and legislation to staff such a Federal laboratory would tend to aggravate the problem. It is his view that a program of contracts with universities, business, and research organizations, monitored by a small, efficient control group within the Department should be tried first before concluding that the "in-house" laboratory is the only or the best approach to the problem.

parative assessments of new and alternative techniques for control of automotive pollution as well as other types of industrial and domestic pollution.

The Department of Health, Education, and Welfare is concerned that it may be hindered by the lack of adequate and appropriately designed facilities to carry out this special type of work. The Department is planning this aspect of its program to utilize as best and as efficiently as it can suitable facilities which exist outside of the Public Health Service. This can be partially accomplished through research contracts with public and private research organizations, including key Federal agencies such as the Bureau of Mines. It is clear, however, that expanded and improved facilities in the Public Health Service are highly desirable and actually necessary for the best and efficient implementation of the act.

Mr. Vernon G. MacKenzie, Chief, Division of Air Pollution, Public Health Service, had this to say about the need for additional Federal research facilities:

> We should have, to implement all aspects of the Clean Air Act in the most efficient and expeditious way, a permanent suitable facility, desirably in a single location, to house all of the Division of Air Pollution's operating activities, with appropriate regional or field centers as may be needed.
>
> Unfortunately, we do not have this now, and there are no definite, fully approved plans for achieving this goal. The subcommittee members may know the Division of Air Pollution is housed in two separate Washington locations and at four separate locations in Cincinnati, Ohio. The great proportion of our technical facilities in Cincinnati have been acquired through short-term leases. Leased facilities at separate locations, with attendant uncertainties for longer range studies and programs, are poorly calculated to carry out a program which calls for a high degree of coordination and exchange of this information.
>
> This assessment of the facilities available to the Division of Air Pollution is essentially the same as contained in the report of the Committee on Environmental Health Problems (Gross committee, November 1, 1961), which concluded that the facilities available for the air pollution research program were grossly inadequate. Since the issuance of this report, of course, the Division of Air Pollution has been broadly increased by the responsibilities of the Clean Air Act.

The subcommittee is seriously concerned that the accelerated and expanded Federal air pollution control program might be hampered by the lack of adequate facilities to perform the essential functions as provided for in the Clean Air Act. The subcommittee therefore recommends the establishment of a permanent research facility in a suitable location in order better to implement the Clean Air Act.

The subcommittee is aware of the fact there there is existing authority under the Public Health Service Act for the establishment of such additional institutions, hospitals, and stations as are necessary to enable the Service to discharge its functions and duties. However, in the discharge of his responsibility under the Clean Air Act the Secretary of Health, Education, and Welfare must be equipped to provide the assistance called for in facilities that are properly located, constructed, equipped, and staffed to provide the specialized services called for in establishing criteria, testing of engines, testing of air pollution control devices, and conducting research into methods and processes for reducing air pollution. The subcommittee, consequently, is convinced that specific authorization and directives from Congress are essential in this instance.

Reduction of oxides of sulfur

Pollution of the atmosphere by sulfur gases released in the process of fuel combustion is well recognized as a major environmental health and economic hazard. Until quite recently, there was little attention paid to this problem because it was considered technically too difficult or too expensive to correct. However, the subcommittee has learned that great opportunities now exist to make strides toward solution of this problem. Methods of removing sulfur compounds from fuels before they are burned are being developed. In addition, practical pilot studies have shown that sulfur gases produced in large coal-burning powerplants can be converted into marketable sulfuric acid, thereby virtually eliminating both the air pollution hazard and the economic obstacle that has previously frustrated control efforts.

These approaches demand increased exploration and application wherever possible, and the subcommittee feels that joint Government-Industry efforts promise the most prompt and beneficial results. The subcommittee therefore recommends the consideration of legislation what would authorize and direct the Secretary of Health, Education, and Welfare to establish a technical committee composed of representatives of the Department of Health, Education, and Welfare, the coal and petroleum producing industries, and the electric power industry, and also including representatives of the Bureau of Mines of the Department of Interior and the Federal Power Commission to investigate efforts being made toward control of sulfurous air pollution resulting from the use of sulfur-containing fuels. The Secretary of Health, Education, and Welfare should be directed to report to Congress the findings and conclusions of the technical committee, together with his recommendations for such legislation as he may deem necessary to achieve prompt application of effective control procedures.

The problems of sulfurous air pollution, especially that produced by the burning of sulfur-bearing fuels, like the automobile is a national problem. Information presented to the subcommittee concerning sulfurous air pollution and its control does not suggest that the problem is amenable to prompt remedial action; however, there seems to be a firm basis on which to build toward effective control of this type of pollution.

And the need for control to the fullest possible extent is unchallengeable. Sulfurous air contaminants are among the major contributors to the health injury and property destruction associated with community air pollution.

To meet the Nation's sharply rising demands for heat and power, enormous quantities of coal and fuel oil are burned annually in homes, electric powerplants, and factories. The energy derived from these fuels is essential to our highly mechanized and urbanized society, but it is being purchased at the cost of substantial risk to human health and damage to property and vegetation.

In each of the series of hearings the subcommittee has held since passage of the Clean Air Act in December 1963, Government officials, health experts, and industrial spokesmen have testified on various

aspects of the problem of sulfurous air pollution. In the six cities the subcommittee visited during its field hearings, municipal and State officials testified that sulfurous emissions are a major factor in community air pollution problems. And in the hearings held in Washington in June and July 1964, expert witnesses from Federal agencies and industry described the adverse effects of sulfurous air pollution and testified that methods of controlling it have not been developed to the stage at which their application is technically feasible.

The information presented to the subcommittee demonstrates that sulfurous air pollution is a problem in all areas of the United States but that in spite of its known health and welfare hazards and the availability of methods of reducing it, practical control measures are not being taken. Moreover, the hearings elicited little assurance that producers and large users of coal and fuel oil are planning to institute such measures in the near future. In view of these findings, the subcommittee has concluded that increased Federal activity, under the sponsorship of the Secretary of Health, Education, and Welfare, is essential to insure that the available means of controlling sulfurous discharges are applied as promptly and widely as possible and that continued efforts are made to develop improved control methods.

The significance of sulfurous emissions in the national problem of air pollution was emphasized by several witnesses. In Los Angeles, Warren M. Dorn, member of the Board of Supervisors of Los Angeles County, equated the sulfur problem with that of air pollution from motor vehicles:

> Our air pollution problem continues here at greatly excessive levels, and it continues because of our legal and technologic inability to cope with two important sources of air contamination—the gasoline-powered motor vehicle and the fuel oil-burning industrial facility.

In Boston, Dr. Alfred L. Frechette, commissioner of public health for the State of Massachusetts, undoubtedly spoke the truth when he said that the problem of sulfurous air pollution will grow more serious as the Nation's population and per capita consumption of energy increase.

In Los Angeles, the subcommittee also learned that sulfurous contaminants contribute to one of the most widespread and troublesome aspects of community air pollution; namely, the asmospheric reaction which produces photochemical smog. In his testimony, S. Smith Griswold, Los Angeles County air pollution control officer, provided this information:

> Aiding and abetting certain aspects of this reaction are the sulfur compounds present in the atmosphere and which are currently derived principally from the burning of sulfur-bearing fuel oils in our steam-electric generating plants, our petroleum refineries, and in other large industrial facilities. To solve the photochemical smog problem in all its aspects, we must therefore provide for a proper level of control over each of these substances: hydrocarbons, oxides of nitrogen, and sulfur oxides.

Although sulfurous contaminants are a byproduct of such other activities as production of sulfuric acid, refining of sulfur-containing ores, and processing of woodpulp for the manufacture of paper, it is clear from the information given to the subcommittee that the problem of sulfurous air pollution results chiefly from the combustion of sulfur-bearing coal and residual fuel oil. During combustion of those

fuels, most of the sulfur they contain is released in the form of gaseous sulfur oxides. Harry Perry, Director of Coal Research for the Bureau of Mines, U.S. Department of the Interior, testified that in the burning of coal, 60 to 95 percent of its sulfur content is liberated in stack gases, while in the burning of fuel oil, virtually 100 percent is liberated. Mr. Perry noted that according to an estimate made in 1960, as much as 21 million tons of sulfur dioxide are released into the Nation's atmosphere every year as a direct result of the burning of coal and fuel oil.

An indication of the probable future magnitude of the sulfurous air pollution problem can be found in "A Study of Pollution—Air." The report states that the output of electric powerplants, which are the principal users of high-sulfur fuels, is expected to increase fourfold by 1980. During the same period, fuel oil consumption is expected to rise from 3.4 billion barrels annually to 5.7 billion, and coal consumption from 400 million tons per year to twice that much. There is in these statistics an unmistakable indication that sulfurous emissions into the atmosphere will climb steadily toward acutely dangerous levels unless prompt and effective remedial action is taken.

The urgent need for effective control of sulfurous air pollution is underscored by evidence of its threat to public health and welfare. In his testimony, Vernon G. MacKenzie, Chief of the Division of Air Pollution, Public Health Service, U.S. Department of Health, Education, and Welfare, pointed out that high concentrations of sulfurous materials were a factor in the severe air pollution episodes which caused widespread sickness and death in Donora, Pa., and London, England. Hopefully, similar episodes will not strike other cities, but this possibility cannot be ruled out in the absence of effective control of sulfurous emissions. Numerous witnesses have reminded the subcommittee that the types of meteorological conditions which brought on the Donora and London disasters and which are conducive to potentially dangerous accumulations of pollutants of all kinds occur frequently in all parts of the United States.

While a repetition of such disasters would indeed have tragic consequences, it is probable that in the long run the effects of more or less continued exposure to the low levels of sulfurous air pollution common in American cities will produce still greater tragedy. As Mr. MacKenzie pointed out, "sulfur dioxide itself is toxic to man, and to plants. It is corrosive to metal structures, and the sulfuric acid into which it becomes oxidized in the open atmosphere is even more toxic, corrosive, and troublesome." Mr. MacKenzie noted that epidemiologic studies have shown "differences in the prevalance of respiratory disease in various cities among comparable groups of population, depending in direct ratio to the levels of sulfur pollution in the respective cities."

In contrast to the concern expressed by Mr. MacKenzie and other witnesses, some testimony was given which suggests that present urban levels of sulfurous pollutants are not a health problem and that without additional evidence it would be premature to impose restrictions on sulfurous emissions. This point of view was advanced by Peter N. Gammelgard, representing the American Petroleum Institute, who said that—

> medical data suggest that much more investigative work must be done to establish, to a reasonable certainty, the concentration levels and atmospheric conditions at which harmful effects may occur.

The subcommittee would not dispute the need for continued research into the health effects of sulfurous air contaminants, but a review of the testimony leads to the conclusion that evidence sufficient to dictate prompt control measures is already on hand. To delay is to run the risk of a needless sacrifice of human life and health.

Testimony heard by the subcommittee indicated that a number of methods of reducing sulfurous emissions have been developed and proved effective. Furthermore, some of them are not only effective but economically self-sustaining.

Joseph W. Mullen, representing Bituminous Coal Research, Inc., the research affiliate of the National Coal Association, advised the subcommittee that some progress is being made in a project which the coal industry is sponsoring to develop methods of desulfurizing coal.

With respect to fuel oil, methods for desulfurization have already been developed.

Mr. Gammelgard testified that in order to increase their economic return, American refineries have steadily reduced both the sulfur content of their higher grades of fuel and their output of residual fuel. He said that technically feasible methods of desulfurizing residual fuel oil are available but are not being applied because of the low value of the product relative to the costs of using the existing methods of desulfurization.

The question of cost may yet prove academic, however, for the second approach to reduction of sulfurous emissions—removal of the contaminant materials from stack gases—shows promise of yielding an economic return instead of imposing an additional expense. As Mr. MacKenzie testified, several methods of desulfurizing stack gases are being studied in the United States. Three of these methods are not only technically feasible but result in the recovery of useful, marketable sulfur, and sulfuric acid.

The Bureau of Mines has developed a process in which sulfur dioxide is adsorbed on pellets of alkalized alumina. Bituminous Coal Research, Inc., in collaboration with the electric power industry, is investigating a procedure by which sulfur dioxide in stack gases is converted to sulfur trioxide, which is then condensed and removed as sulfuric acid. A similar process has been developed by the Pennsylvania Electric Co.; it differs from the one developed by Bituminous Coal Research primarily in the means used to recover the sulfuric acid. All of these processes are highly efficient. Mr. MacKenzie noted that a report on the Pennsylvania Electric Co.'s method, for example, indicates that it removes about 90 percent of the sulfur dioxide from stack gas. The testimony indicates, in short, that there is no longer any technical barrier to control of sulfurous air pollution, but it appears that the prospects for application of the available control techniques are not good in the absence of a coordinated national effort to hasten their use.

It seems clear in the subcommittee's view that action to reduce the nationwide problem of sulfurous air pollution can best be achieved if the Secretary of Health, Education, and Welfare takes the initiative by coordinating joint industry-government efforts along this line. The progress that has been made thus far is impressive, though limited. If additional progress is to be made and if the isolated achievements reported to the subcommittee are to be expanded to the benefit of all regions of the country, the Department of Health,

Education, and Welfare will have to coordinate a greatly augmented research and development effort. Should this fail to yield the results desired, the Congress should be prepared to consider the appropriateness of Federal legislation regulating the emission of sulfurous pollutants caused by the use of sulfur-containing fuels. The subcommittee would welcome the recommendations of the Secretary of Health, Education, and Welfare with respect to the need for, and form of, such legislation.

Uniform laws and regional action

The committee recommends that the Secretary of Health, Education, and Welfare prepare suggested uniform State laws and municipal ordinances which would result in abatement and control of air pollution within "air sheds," particularly where the problems are interstate in nature. It is the committee's view that in making Federal grants for support of air pollution control programs the Secretary of Health, Education, and Welfare should take into consideration the existence of State and local rules and regulations which insure uniformity of control measures in "air sheds," and that he should take steps to insure that funds are allocated to that agency which has the major authority and responsibility for air pollution control in a particular "air shed."

During field hearings in the cities of Los Angeles, New York, Denver, and Chicago, it was made abundantly obvious that since the area of pollution sources and effects frequently overlaps the boundaries of local political subdivisions, air pollution control activities should be performed by an agency with jurisdiction coextensive with the area air basin. Mayor Thomas G. Carrigan of Denver has aptly observed in his testimony that—

> Since air pollution recognizes no political or physical barriers, we must also ignore these barriers in seeking a solution.

Generally, those witnesses expressing thoughts on control problems in multijurisdictional areas concede that interlocal cooperation of some description is required of all governmental units within an air shed. However, the nature and mechanism of cooperation envisioned varies. With respect to intrastate air sheds, the regional approach ranges from the situation in Denver to that of the Bay Area Air Pollution Control District at San Francisco. The Denver area at present has no organized regional approach while the bay area counties have a thoroughly consolidated air shed. The southern California counties represent still another approach. These five counties deal with their common problem on a purely voluntary basis, although provision is made in State legislation for the formation of a district similar to that of the San Francisco area.

During hearings in Los Angeles, the subcommittee was informed by Paul J. Young, chairman, Southern California Air Pollution Coordinating Council, that—

> although the five counties have individual problems in air pollution and its control, they are a part of the Los Angeles Basin, or more particularly, are geographically situated within a southern California "air shed" and as a means of working toward a solution of their mutual problems, in early 1958, formed the Southern California Air Pollution Coordinating Council.

This council has quasi-official status emanating from the fact that delegates are officially named by the boards of supervisors of Los

Angeles, San Bernardino, Riverside, Orange, and San Diego Counties. Mr Young testified that—

functionally, the council has sought and continues to develop a regional approach on—

1. Uniform local laws.
2. Application of the motor vehicle pollution control laws.
3. Development of responsibility and cooperation in emergencies precipitated by air quality exceeding the State standards.
4. Expansion of U.S. Weather Bureau stations, to encompass more southern California counties.
5. Standardization of air monitoring data.
6. Radiological monitoring.
7. Visibility and the validity of the ambient air quality standards for particulate matter based on visibility.
8. Background levels of contaminants.

Mr. Young testified that the member counties discuss mutual problems which are not too different—

excepting, of course, that Los Angeles has the greater problem because of the tremendous amount of people * * * and the industry and the automobile. But, by and large, it is all the same problem, just the matter of the extent of the problem so that we know we must work together because if we don't, we will have a regional approach enforced by the State government.

In Chicago, Albert J. Mullins, administrator, Cook County Air Pollution Control Bureau, and James V. Fitzpatrick, director, City of Chicago Department of Air Pollution Control, discussed regional problems. Mr. Mullins informed the subcommittee that—

Even if every suburban village were to adopt an ordinance, Cook County's assault on air pollution could be severely hampered by the failure of adjoining counties, including the nearby counties in Indiana and Wisconsin, to control air pollution.

As for securing enactment of a uniform law by each individual municipality in Cook County, Mr. Mullins estimated that of 125 municipalities, about half a dozen have acted. There is, of course, no assurance that uniform enforcement could be had, even if uniform laws were enacted by each of these jurisdictions.

The difficulties found in Cook County are also found to exist on a large scale for the Chicago bystate metropolitan area as a whole. Mr. Fitzpatrick testified that in the 6-county area, 2 in Indiana, 6 in Illinois, over 1,000 independent political jurisdictions exist. These figures are clearly indicative of the need for a regional approach which will insure an effective control program. The subcommittee has been advised that such a prospect is being explored by Illinois and Indiana.

During the subcommittee's hearings in New York City, Mayor Robert Wagner also addressed himself to the need for a regional approach. Among the mayor's comments are the following:

Our prevailing winds are northwesterly, which means that even if our local pollution control measures were 100 percent effective for pollution from local sources, we would still have a very major problem. That problem is growing all the time. We must regard it from a regional point of view, rather than from a city point of view. * * * We ought to have increased Federal interest and leadership in stimulating coordinated regional action against pollution in areas which cover several jurisdictions.

The mayor informed the subcommittee that within the New York City metropolitan region there are a number of agencies which oversee the regional aspects of pollution control. Among them are: the Interstate Sanitation Commission, the New York State Air Pollution Control Board, the New York City Department of Air Pollution Con-

trol, the New Jersey Air Pollution Control Commission, the New Jersey Department of Health, and the Metropolitan Regional Council. In addition these groups have formed a coordinating body, the New York-New Jersey Cooperative Committee on Interstate Air Pollution. This is a voluntary organization providing intergovernmental contact similar to that achieved by the counties of southern California.

While the subcommittee recognizes the primary responsibility of State and local governments in controlling air pollution, it cannot concur in the concept that each individual entity within an air shed should attempt to control its own problem with regional development of standards and coordination of enforcement efforts confined to limited problems. Air pollution is a "local" problem within the air basin afflicted. The primary responsibility for development of standards and coordination of enforcement efforts rests with that level of government, city, county, regional, State, interstate, or Federal, which is best calculated to deal most effectively with the problem in its totality. Frequently a city or county will constitute the most appropriate level, but in metropolitan areas having a common air shed the best approach is on a regional basis. Only those areas which have established an air pollution control program encompassing their entire air sheds are in a position to reach and regulate every source discharging into the air of the basin. Not only does a uniform law necessarily result, but uniform enforcement is an added advantage. Those air sheds not having regional programs operate at a decided disadvantage; even in the unlikely event that a uniform law is attained by each jurisdiction enacting identical ordinances, uniform enforcement still cannot be assured. Furthermore, hard realities compel consideration of the advantages which accrue when the financial burden of control rests on a population and economic base capable of supporting an adequate staff and required services.

Under the Clean Air Act, Congress has encouraged interstate compacts to deal with air pollution and provides financial incentive for regional control programs. Nevertheless, Federal emphasis on the regional approach should be intensified. The Secretary of Health, Education, and Welfare in carrying out the various provisions of the Clean Air Act should seek to encourage the formation of regional air pollution control agencies by giving special emphasis to those portions of the Federal air pollution program which can best be employed to meet this objective, such as control agency grants, technical assistance, and consultation.

Finally, the subcommittee is not unmindful of administrative and other difficulties that establishment of regional control programs would entail in areas where several agencies have been functioning previously. But such problems are not insurmountable and cannot be allowed to prevail over the need for regional action. Such adjustments as may be required by merger of heretofore separate agencies would have to be endured in the public and national interest.

Jet and rocket fuel conference

The Federal Government should engage in exemplary practices in the control of air pollutant emissions from sources under its jurisdiction. Two categories of such sources merit special consideration: operations associated with the fueling, testing, and flight of guided missiles are attendant by potentially hazardous conditions in which

accidental or planned release of atmospheric contaminants may endanger the health or welfare of persons living or working near the site of missile testing and launching.

Also, the operation of jet aircraft, especially during takeoff and landing, can result in the release of substantial amounts of particulate and gaseous air pollutants.

In order to adequately cope with the air pollution problems associated with rocket and missile testing and jet aircraft operation, it is recommended that the President establish a basis for formalized action by calling a conference of the Federal agencies and representatives of industries concerned with these activities and establish definite goals and the basis upon which coordinated and concerted efforts to prevent or control adverse effects shall proceed.

In a nation whose technology is constantly evolving in response to demands for new, improved, and more abundant products and services, new types of air pollution sources are inevitably created with painful frequency. To prevent new source categories from achieving the status of major national problems, it is necessary to keep them under close surveillance and apply suitable controls when action seems warranted. It was to call attention to, and gather information about, two such relatively new categories of air pollution sources that the subcommittee received testimony on the subject of emissions into the atmosphere resulting from the operation of jet aircraft and the testing of space vehicles and rockets.

Testimony was given by several qualified witnesses representing the Department of Defense, the National Aeronautics and Space Administration, the Atomic Energy Commission, the Federal Aviation Agency, the Department of Health, Education, and Welfare, and the Air Transport Association. In general, the testimony indicated that at present emissions from jet engines and rocket propulsion and weapons systems are not a major threat to health and welfare nationally. However, with continued growth and technological change likely to occur in these fields, the possibility that they will one day become significant contributors to community air pollution problems cannot be ruled out. To be prepared to cope with such an eventuality, Federal agencies with responsibilities in the fields of aviation, space exploration, and weapons development must continue their present efforts to determine the harmful effects of jet and rocket emissions and develop increasingly effective techniques for controlling them.

In contrast to discharges from such sources as motor vehicles refuse disposal facilities, and industrial operations, emissions from jet engines are not a major factor in community air pollution and are receiving relatively little attention from air pollution control agencies. But in spite of their apparent insignificance to the overall national problems of air pollution, jet emissions do appear to pose a problem to people and property located in the immediate vicinity of jet airports.

Vernon G. MacKenzie, Chief of the Division of Air Pollution, Public Health Service, U.S. Department of Health, Education, and Welfare, testified in Washington that people living in the immediate vicinity of jet airports in various parts of the United States have complained to municipal, State, and Federal agencies about jet

smoke emissions and odors as well as soiling homes and personal property by soot and oil discharges from jet engines.

Concern with this problem was expressed also by Massachusetts Governor Endicott Peabody when he testified before the subcommittee in Boston. The Governor stated:

> The pollution of our ambient airspace by solids, gases, and noise from jet aircraft is of growing concern to many of our citizens, and economical means of abating such pollution should receive prompt and serious attention by the Federal Government.

This testimony suggests that the operation of jet aircraft does add to the total contamination of the air in the vicinity of jet airports, many of which are surrounded by heavily populated residential areas. There is, however, considerable question as to the extent of the problem. This uncertainty, which was reflected in witnesses' conflicting interpretations of information presented to the subcommittee, evidently results from a lack of sufficient information on the magnitude and effects of jet engine emissions.

The subcommittee learned that the only published data on the contribution of jet emissions to community air pollution are contained in the report of a study conducted in 1960 by the Los Angeles County Air Pollution Control District. At the time the study was conducted, commercial jet traffic was well below present levels, and to develop the power needed for take-offs, the engines then in use generally required the added thrust provided by water injection, a procedure which contributes substantially to smoke emissions. The principal finding of the study was that jet emissions were "insufficient to produce any generalized deteriorization of air quality in the vicinity of Los Angeles International Airport."

In discussing the Los Angeles study, Mr. MacKenzie noted that increases in commercial jet traffic since 1960 cast substantial doubt on the present validity of the conclusion reached 4 years ago. He also stated that while the replacement of engines requiring water injection with newer turbofan engines would be expected to bring about a reduction in smoke emissions, it would not affect other types of discharges, which are related to fuel composition, engine design and condition, and airline operating procedures. But John E. Stephen, general counsel of the Air Transport Association, testified that new, as yet unpublished data show that in spite of increased jet traffic at the Los Angeles airport, jet emissions have diminished. He testified that the introduction of turbofan engines has eliminated—

> the source of what little air pollution there was with the operation of jet aircraft.

It is obvious from this difference of opinion among expert witnesses that a great deal of additional information is needed in order to make possible an accurate appraisal of the extent and hazards of jet emissions.

In their current efforts to develop increasingly powerful rocket fuels for purposes of national defense and space exploration, Federal agencies and industrial contractors are testing a number of highly toxic materials, the release of which into the atmosphere could seriously endanger human health and welfare.

In discussing air pollution control program in the Department of Defense, Col. Alvin F. Meyer, Jr., U.S. Air Force Medical Service Corps, discussed the hazardous properties of propellants, in part, as follows:

> The propellants for the Titan II (nitrogen tetroxide and aerozone 50) are hypergolic and will spontaneously ignite when brought into contact with each other. Both possess properties which are hazardous to health if improperly handled. Their use is not new and experience in industry has indicated that they can be handled safely.

Colonel Meyers further said:

> * * * The requirement for improved chemical propulsion performance had resulted in the use of a large variety of materials which are known to be of a varying degree of toxicity. The urgency of the propulsion problem has resulted in technical applications of these materials at an accelerated rate and has necessitated research and development projects either in advance of or concurrent with toxic hazards evaluations. One of these materials is beryllium. The attention of the U.S. Air Force was first directed to beryllium because of its potential use in the structures of air and spacecraft. Questions as to the degree of hazard during production, manipulation, and fabrication of this metal and its compounds have been a matter of some controversy among industrial health specialists in the past. A considerable amount of investigative work was accomplished by the Health and Safety Laboratory, U.S. Atomic Energy Commission, during the period 1947–57. Some cases of beryllosis terminating in death had occurred in beryllium production plants, as well as illness of a chronic nature. Although there has been a sharp drop in cases since 1949, due to the application of engineering controls of exposure and a reduction in the use of the materials, the potential hazard still is a matter of major concern.

Mr. Vernon G. MacKenzie discussed another potential source of air pollution—fluorine compounds—stating:

> A second high-energy fuel component, fluorine, has long been considered by rocket designers because of its excellent thrust potentialities. Fluorine oxidizers, though difficult to handle, can be used to create one of the most energetic combinations for rocket fuels. Thus it has been reported that an Atlas fueled with fluorine as a partial oxidizer could lift 600 pounds of additional weight into orbit without change otherwise in the rocket design.
>
> Atmosphere fluorine compounds present a problem to both plant and animal life, as well as to man. Plants especially are very susceptible to injury from gaseous fluorine compounds. More so, in fact, than man.

Mr. John L. Sloop, of the National Aeronautics and Space Administration advised the subcommittee that:

> We do have the toxicity problem with certain rocket propellants which I will mention as I go along.
>
> The toxicity of unsymmetrical dimethylhydrazine has been previously mentioned by Colonel Meyer. The quantity used in the Apollo spacecraft is small compared to that used by the Saturn boosters. Of the approximately 5 million pounds of propellant aboard the Apollo space vehicle, less than 50,000 pounds is the nitrogen tetroxide and hydrazine mixture, and this is not used until the Apollo is well into space under normal operations. The propulsion systems must be tested on the ground but these operations consume propellants in about the same proportion as carried abaord the space vehicle. Thus, we can say that, in the Apollo program, for every 100 pounds of propellant consumed in testing, less than 1 is the nitrogen tetroxide-hydrazine mixture combination. The major testing of Apollo spacecraft propulsion will be done at a remote site at the White Sands Missile Range in New Mexico.

Mr. Sloop further indicated NASA interest in other propellants.

> We are interested in a number of liquid propellants, including fluorine, oxygen diflouride, diborane, and hydrazine compounds, all of which are toxic. The largest investigation is of the feasibility of adding 30 percent by weight of fluorine to the oxygen of the Atlas booster for use in increasing the payload capability

of the Atlas Centaur. The present work involves material compatibility, component tests, engine tests, vehicle systems compatibility tests, and ground handling procedures.

Colonel Meyers advised the subcommittee that:

A number of elements of the military services are concerned with research on air pollution, surveillance over installations, and other control procedures. The medical service have a major responsibility as part of their health protection functions. Those responsible for installation construction and operation (Corps of Engineers, U.S. Army; Bureau of Yards and Docks, U.S. Navy; and Directorate of Civil Engineering, U.S. Air Force); Meteorology (such as the Cambridge Research Laboratory and the Air Weather Service, U.S. Air Force); and many other activities (such as the U.S. Naval Research Laboratory; the Chemical Research and Development Laboratory, U.S. Army, and the Rocket Propulsion Laboratory, U.S. Air Force Systems Command) are also involved in air pollution control measures.

Colonel Meyers indicated:

"* * * there is, as indicated, an extensive formal and informal coordination effort among the military services and the Public Health Service."

But he stated:

The current absence of uniformly acceptable air quality standards is a matter of some concern and is a subject to have special consultation and discussion between the Department of Defense and the Department of Health, Education, and Welfare, with special reference to the implementation of section 7 of the Clean Air Act. Further meetings are scheduled between professional representatives of the two departments on the matter of the issuance of permits and related air quality requirements.

In general, the information on this subject presented to the subcommittee indicates that at present air pollution from testing and other uses of rocket fuels is more a potential than an actual hazard to public health and welfare. Though the materials being used are indeed toxic to man and are liable to escape into the atmosphere either during routine operations or by accident, the testimony indicates that the relatively small quantities used in launch-site testing and the remote locations of such sites tend to minimize the potential hazard to the public welfare.

The subcommittee was reassured to learn that Federal agencies engaged in development of rocket fuels are cognizant of the possible dangers and generally try to plan their operation to avoid contamination of community air supplies. It appears, however, that industrial use of such fuels has occasionally been planned with less care. It is the subcommittee's opinion that since most, if not all, industrial effort in this field is undertaken for the Federal Government, Federal agencies have a responsibility to insure that contractors exercise a high degree of caution in handling toxic materials.

Witnesses concerned with missile and rocket fuels testing and development agreed on the need for continued vigilance to prevent contamination of the Nation's air by toxic chemicals, and indicated that they are individually trying to evaluate the potential hazards and guard against them.

The subcommittee notes that there is a considerable amount of activity among departments and within departments with respect to the air pollution control problem but there seems to be lacking the complete coordination among the various agencies as was intended by section 7 of the Clean Air Act. In June of 1964 there was an exchange of correspondence between the Secretaries of Health, Education, and Welfare and the Department of Defense and the Administrator of the National Aeronautics and Space Administration which indicated that

no formalized arrangements had been perfected to accomplish the objectives of section 7, and that essentially all that is occurring is an interchange of information.

The subcommittee is concerned about the informal arrangements now utilized between those agencies concerned with the testing and operation of rockets and missiles and the testing of experimental fuels. Based on testimony received, it is apparent that the intent of the Clean Air Act with respect to Federal agency coordination is only loosely being complied with.

It is the recommendation of the subcommittee that a formalized and specific procedure be established to evaluate the degree of air pollution potential and methods of preventing or controlling pollution from jet aircraft, rockets, and missiles. In order to accomplish the desired objective of complete coordination it is the subcommittee's recommendation that action be originated at the Presidential level to establish procedures, rules, regulations, and methods for arriving at means of attaining mutual support between the various Federal agencies and affected industries.

APPENDIXES

Appendix I

AIR POLLUTION CONTROL LEGISLATION

a. Prior legislation

The prior authoritv of the Department of Health, Education, and Welfare with respect to air pollution is derived primarily from the Air Pollution Control Act, Public Law 159, 84th Congress, approved July 14, 1955, as amended.

This act authorized a program of research and technical assistance to obtain data and to devise and develop methods for control and abatement of air pollution by the Secretary of Health, Education, and Welfare and the Surgeon General of the Public Health Service. The act recognized the primary responsibilities and rights of the States and local governments in controlling air pollution, but authorized Federal grants-in-aid to air pollution control agencies to assist them in the formulation and execution of their research programs directed toward abatement of air pollution.

Under the provisions of the act, the Surgeon General was authorized to prepare or recommend research programs; encourage cooperative activities by State and local governments; conduct studies and research and make recommendations with respect to any specific problems of air pollution, if requested; conduct research and make grants for research, training, and demonstration projects; and to make available to all agencies the results of surveys, studies, investigations, research, and experiments relating to air pollution and abatement.

Public Law 86–493, approved June 8, 1960, directed the Surgeon General of the Public Health Service to conduct a thorough study of motor vehicle exhaust as it affects human health through the pollution of air. A report on this study was published as House Document 489. In 1962, the Air Pollution Control Act was amended by Public Law 87–761 so as to make permanent the requirement that the Surgeon General conduct studies relating to motor vehicle exhaust. The act was further amended so as to authorize appropriations to carry out the act until June 30, 1966.

Although the Air Pollution Control Act, as amended, constituted the basic authority for the Department's activities in the field of air pollution, sections 301 and 311 of the Public Health Service Act have also been utilized as a basis for appropriations to support these activities. Section 301 is the basic section of the Public Health Service Act with respect to the Surgeon General's authority relative to research, research training, and related functions; section 311 is the basic section authorizing Federal-State cooperation and technical assistance. In addition, section 314(c) of the Public Health Service Act authorizes grants to States, counties, etc., to assist in establishing and maintaining adequate public health services, including grants for demonstrations and for training of personnel for State and local health work.

The program that developed under authority of the 1955 air pollution legislation was primarily focused on research and technical assistance. In shaping this program, it was felt that effective control would depend upon greatly increased knowledge of the types and amounts of pollutants being discharged to the atmosphere; better understanding of the meteorological and climatological factors that influence the dispersion of pollutants in the atmosphere; more sophisticated knowledge of the physical and biological effects of pollutants, especially in the relatively low concentrations in which they are usually encountered in community air; a fuller awareness of the importance of certain specific air pollution problems, such as the motor vehicle; and improved information on the administrative, legal, social, and economic factors involved in the control of air pollution.

The technical assistance aspect of the program was primarily centered on efforts to define and characterize the air pollution problems existing in various cities and States, and some interstate metropolitan areas. The goal of this tech-

nical assistance activity was to help in the establishment or strengthening of State or local control programs by helping to identify and clarify the air pollution problems in certain areas and to plan effective programs to achieve better control of these problems.

Two other major areas in which the Federal program has been active relate to (1) the training of technical personnel, and (2) the dissemination of information. Training activities were undertaken in recognition of the fact that there are not enough trained personnel to staff the control programs that are needed now in cities and States throughout the country.

Providing authoritative and comprehensive information about air pollution to the many official groups, professional organizations, and other segments of the population who have a direct interest in the problem has been a major element of the Federal air pollution program since its inception.

The information accumulated in the years 1955–63, concerning the magnitude of the air pollution problem and the general inadequacy of State and local control programs, contributed to the recent reshaping of Federal policy in this field. The committee became convinced, that "control programs must be accelerated" and that "the nationwide character of the air pollution problem requires an adequate Federal program to lend assistance, support, and stimulus to State and community programs."

b. The Clean Air Act of 1963

With the adoption of the Clean Air Act in December 1963, Federal policy in the field of air pollution control underwent significant evolution. Although there was no change in the view that responsibility for the control of air pollution rests primarily with State and local governments, the Federal Government responded to a very real need by equipping itself to aid State and local control programs more effectively and to stimulate them to the increased level of activity considered necessary. Thus, the preamble adds a new dimension to the Federal role when it states 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 preamble points out that most of the Nation's people now live in urban areas, including metropolises which sprawl across municipal, county, and State boundary lines, and it specifically mentions motor vehicles as one of the major contributors to the mounting air pollution problem.

The Congress has instructed the Federal Government to assume the responsibility for directly aiding in the development of State, regional, and local control programs sufficiently equipped and empowered to reverse the trend toward ever more polluted air. To begin with, the act continues and expands the authority for the ongoing research, development, and technical assistance programs of the Division of Air Pollution. It places considerable emphasis on the fact that there is still much to be learned in the technical and scientific spheres and that the Federal Government has a responsibility for seeing that this knowledge is developed. The same is true of the need for additional trained personnel to work in the fields of air pollution research and control.

Among the important new authorities provided by the Clean Air Act is that for program grants. Briefly, these grant funds may be made available to State and local agencies for the purpose of developing, establishing, or improving air pollution control programs. Federal funds will be available on a matching basis—$2 for every $1 for single jurisdictional programs, and $3 for every $1 for programs operating on a regional basis. The objective of this provision is not to participate in the maintenance cost of ongoing air pollution control programs throughout the Nation, but rather to stimulate State and local agencies to develop new programs or to expand existing control efforts.

The new Clean Air Act also includes for the first time a limited legal regulatory authority on the Federal level for abatement of specific air pollution problems. This limited regulatory power is clearly intended to supplement the abatement powers of State and local governments with respect to two types of situations:

First, with respect to an interstate problem in which pollution arising in one State may be endangering the health or welfare of persons in another State, the Secretary of Health, Education, and Welfare, may, on his own initiative or on official request as specified in the act, initiate formal proceedings for the abatement of the pollution as found to be necessary;

Second, with respect to a similar air pollution problem, but which is purely intrastate in nature, the Secretary may invoke such formal abatement proceedings only on official request from designated officials in the State involved.

These Federal regulatory powers are intended to supplement the State and local authorities (1) by providing a means of dealing with interstate problems which

are not easy and sometimes are impossible to reach by the remedies available to a single State, and (2) providing technical and other assistance from the Federal Government in cases with which, although intrastate in character, it is difficult for State or local authorities to deal.

The regulatory abatement procedures authorized in the act are very similar to those in use for several years under the provisions of the Water Pollution Control Act—involving the steps of conference with the cognizant official agencies, public hearing, and finally court action. The procedure may, of course, terminate at the initial or second step of the process if the problem is resolved.

Several other provisions of the Clean Air Act reflect the new and evolving Federal air pollution control policy. For example, the act directs the Department of Health, Education, and Welfare to develop and promulgate criteria of air quality for the guidance of State and local authorities in establishing standards for source emissions and ambient air. In addition, specific directives are included to give particular research attention to the removal of sulfur from fuels and to the development of effective and practical devices for controlling air pollution. The act also calls for the formation of a technical committee on motor vehicle pollution, composed of representatives from the Department of Health, Education, and Welfare and the automotive industry, the manufacturers of motor vehicle pollution control devices, and the producers of motor fuels. This committee will review progress toward effective control of vehicular pollution and indicate specific areas in which additional research and development are needed. The Secretary of Health, Education, and Welfare is required to report to Congress periodically on this aspect of the air pollution problem and recommend any new legislation that he determines is warranted. Thus, the Congress has initiated a process of almost continuous review of the motor vehicle pollution problem.

Finally, the act retains the previous directive that Federal facilities should, to the fullest extent possible, seek to minimize or eliminate air pollution for which they are responsible. In addition, the new act authorizes the Secretary of Health, Education, and Welfare to designate classes of potential pollution—sources for which Federal agencies would be directed to obtain permits from him, subject to such conditions as he may prescribe. The Secretary is required to report to the Congress each January on the status of these permits and the compliance with their terms.

APPENDIX II

Source and effect of pollutants

Pollutant	Major sources	Principal effects
Sulfur dioxide	Fuel combustion (coal, oil, cellulosic material), industrial processes.	Sensory and respiratory irritation, plant damage, corrosion, possible adverse effects on health.
Oxidants	Atmospheric photochemical reactions involving nitrogen oxides, organic gases, vapors, and solar radiation.	Sensory and respiratory irritation, plant damage. Provides, indirectly, an index of visibility reduction due to photochemical aerosols. Possible adverse effects on health.
Carbon monoxide	Gasoline-powered vehicles, fuel combustion, industrial processes.	Reduction in the oxygen-carrying capacity of blood.
Total gaseous hydrocarbons.	Fuel combustion, industrial processes, evaporation of hydrocarbons.	Visibility reduction, plant damage, and sensory irritation are effects produced in photochemical reactions involving reactive hydrocarbons; ethylene itself causes plant damage.
Nitrogen oxides (nitric oxide and nitrogenic dioxide).	Fuel combustion, industrial processes	Visibility reduction, plant damage, and sensory irritation are produced in photochemical reactions involving nitrogen oxides; these gases may also cause adverse health effects, and nitrogen dioxide can cause decreased visibility.
Total aliphatic aldehydes, formaldehydes, and acrolein.	Fuel combustion, incineration of wastes, atmospheric photochemical reactions.	Sensory irritation, plant damage, visibility reduction, and possible adverse effects on health.
Carbon dioxide	Combustion processes	Used as an index of pollution from combustion operations.
Suspended-particulate matter.	Combustion, and industrial and natural processes.	Visibility reduction, soiling.
Hydrogen sulfide	Coke, distillation of tar, petroleum and natural gas refining, manufacture of viscose rayon, and in certain chemical processes.	Odor nuisances, caused deaths in Poza Rica, Mexico, when large quantity escaped from units of a natural gas refining plant.

Source and effect of pollutants—Continued

Pollutant	Major sources	Principal effects
Hydrogen fluoride	Heating to high temperatures of ores, clays or fluxes containing fluorine. Generally from steel mills, ceramic works, aluminum reduction plants and superphosphate factories.	Damage to citrus and certain other agriculture plants, flowers; affects teeth and bones of cattle when forage crops have been consumed.
Lead	Internal combustion engines industrial emissions, open burning of lead paint coated wood.	Lead poisoning.

APPENDIX III

Sources and Control of Emissions

I. Automotive:
  A. Emissions:
    1. Automobile: Hydrocarbons, carbon monoxide, and oxides of nitrogen.
    2. Diesels: Smoke, odor, oxides of nitrogen and benzopyrene.
  B. Controls:
    1. Automobiles: Blowby, exhaust control devices, and engine modification.
    2. Diesels: Better operational control, improved fuel, and possibly exhaust control device.

II. Stationary:
  A. Dust, smoke, and mist:
    1. Emissions: Fly ash, soot, smoke, iron oxides, particles suspended in moisture, particles suspended in gaseous substances, etc.
    2. Controls: Settling chambers, separators, packed beds, collectors (such as bag houses), scrubbers, precipitators, and air filters.
  B. Gas and vapor:
    1. Emissions: Sulfur dioxide, oxides of nitrogen, fluorides, hydrocarbons, and hydrogen sulfide.
    2. Controls: Stacks (for dispersion), absorbers or scrubbers, incinerators, catalytic combustion, and absorption.
  C. Odor:
    1. Emissions: General offensive odors from chemical plants, pulp and papermills, stockyards, slaughterhouses, etc.
    2. Controls: Dispersal or dilution, combustion, absorption, and modification.

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