

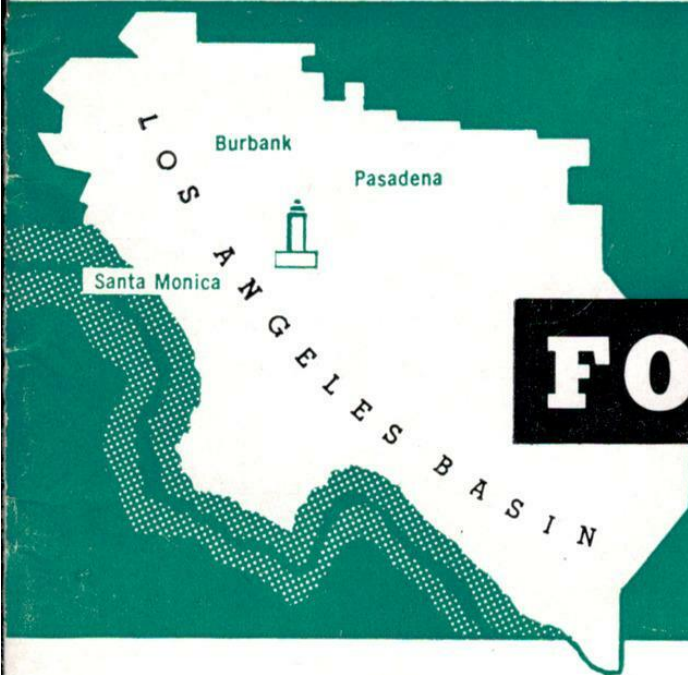
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AIR POLLUTION FOUNDATION

FINANCIAL CENTER BLDG.
704 SOUTH SPRING ST.
LOS ANGELES 14. CALIF.



Air Pollution

FOUNDATION

704 SOUTH SPRING STREET
LOS ANGELES 14, CALIFORNIA

1955

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President's Report

1955

Delivered to the Trustees and Supporters of the Foundation at the Second Annual Meeting, Hotel Ambassador, November 10, 1955, held jointly with the Southern California Conference on Elimination of Air Pollution arranged by the California State Chamber of Commerce.

by Lauren B. Hitchcock

WHAT THE AIR POLLUTION FOUNDATION IS DOING

One year ago, at our first annual meeting here, I told you of the formation of this Foundation as an independent, nonpolitical, nonprofit, fact-finding organization dedicated to establishing clearly the nature and causes of smog, thereupon to develop or encourage others to develop appropriate and workable remedies. Since at that time our staff had been organized and at work only a few months, my report was necessarily limited to a statement of what we were doing and what our plans were. Today we can report what we have done. I wish to acknowledge the help of my associates in preparing this report.

In the Statement of Policy adopted by the Board of Trustees of the Air Pollution Foundation there are eight objectives. One of these is to assemble a competent technical staff to organize and direct a broad program of cooperation, research, and public information. A second is to maintain a library of materials pertinent to the subject of air pollution. The accomplishment of both objectives was reported to you last year.

On the other six objectives we can report very substantial progress, primarily because of the hard and able work of the Foundation's scientific team and public service staff, as well as the help we have received from industry, business, government, and university leaders in air pollution work. It is from the very fact that all these men are joining in the attack, that the community is giving increasing support to this cause, that we know the job will be done.

The first of these remaining objectives is "*to determine, record, and publish what has been accomplished to date by all agencies dealing with air pollution.*" The significance of our results can only be brought into proper focus by concurrent consideration of the work of many other agencies dedicated to the solution of the air pollution problem. Accordingly, we take into account the progress of others in this report and evaluate the Foundation's results in the light of the other findings. Both the progress attained in the last year and the questions remaining to be answered are presented under four headings in our Second Technical Progress Report, No. 12 in our series of technical reports on air pollution. This report is just off the press and copies are available at this conference.

The four basic questions discussed in this report are:

1. What is smog?
2. How is smog formed?
3. What are the sources?
4. How may smog be abated?

In Report No. 12 we summarize in 143 pages all information available at the end of September, 1955 which bears on these questions. Since we are communicating with other air pollution workers on a scientific subject, much of this report is technical. However, our findings in each chapter are set forth in what seems to me to be plain English. In my report here to you today I shall only give you the high spots of this and other progress.

A second objective: *"To determine what remains to be done and to employ experts through the device of research or service contracts, who will provide information and advice for the shaping of future policies and action."* First of all we have conducted a fact-finding program consisting of crucial research investigations through contracts placed with leading research centers extending across the nation (Figure 1). Out of these has already come important evaluation of the feasibility

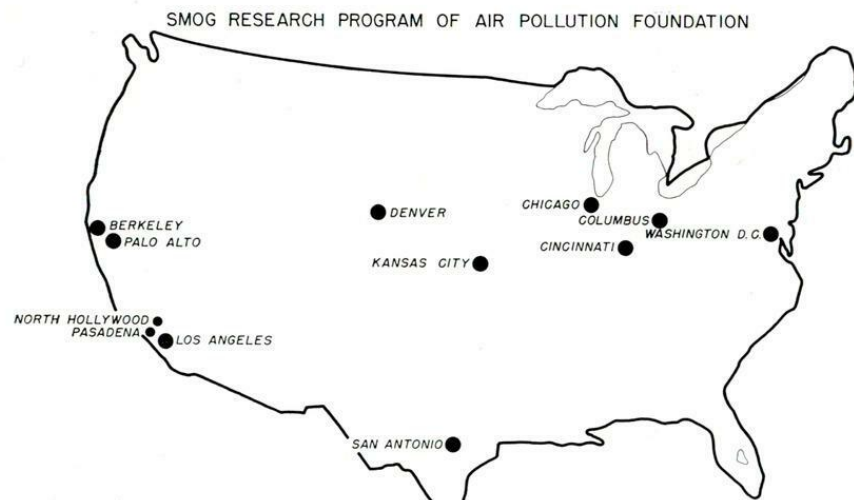


Fig. 1

Projects have been placed at Battelle Memorial Institute, (Columbus, Ohio); Armour Research Foundation, (Chicago, Illinois); Bureau of Standards, (Washington, D. C.); Midwest Research Institute, (Kansas City, Missouri); University of Denver, (Denver, Colorado); Stanford Research Institute, (Palo Alto and Pasadena, California); Berkeley Research Products, (Berkeley, California); Borman Engineering Company, (North Hollywood, California); Southwest Research Institute, (San Antonio, Texas); California Institute of Technology, (Pasadena, California) and others.

of proposed air pollution remedies. For example, we have investigated alternate motor fuels not containing tetraethyl lead, as well as alcohol-gasoline blends; the former, because it was thought that a catalytic muffler using unleaded gasoline might be easier to perfect; the latter, because of persistent reports that alcohol blends might reduce motor vehicle exhaust pollution. For reasons set forth in Report No. 12, neither offers promise.

Devices have been evaluated for the control in automobile exhaust of unburned motor fuel, broadly known to the chemist as hydrocarbons and their derivatives. These devices seek to reduce such emissions or to treat the exhaust gases after they have left the engine. We find that some of these look very hopeful.

Burning of rubbish has been identified as an important source of pollution, and the economic, workable, and nonpolluting method of collection and sanitary landfill is recommended. I believe the Foundation's clear-cut recommendations have materially advanced the program of action now underway. It cannot for practical reasons be done overnight. The Air Pollution Control District is doing everything possible to press forward on this campaign.

By development of new and continuous measuring tools for smog, the Foundation in its first year has increased man's knowledge of the problem and developed sound methods of attack.

Out of this first year of fact finding the Foundation has substantially advanced understanding and diagnosis of the air pollution problem and is now actively participating in the development and evaluation of workable remedies. Valuable suggestions are being received from some of the best minds in industrial, governmental, and university laboratories.

A third objective: *"To collect information as to what other municipal areas have done and are doing under similar circumstances; to consult with, exchange information with, and to suggest to governmental and private agencies those research activities, enforcement methods, or other matters, which have not yet been conducted or tried and which seem to offer promise of air pollution abatement, so that the efforts of all groups and individuals may be coordinated properly."* By frequent meetings with these agencies and by exchange of information and literature, the Foundation is helping to unite efforts of industry, government, and the public here and elsewhere in the struggle for cleaner air. This increases the manpower on our problem, a problem we are sharing with a growing list of cities, a problem which is still elusive. One important conclusion is the need for constant measuring of pollutants in metropolitan areas, in order that we may know definitely with what we have to contend.

A fourth objective: *"To hold technical conferences with experts and specialists working in this country or abroad on selected phases of the air pollution problem in order to facilitate and accelerate the process of finding solutions."* The Foundation has sponsored technical conferences here in Los Angeles, which has brought the help of national authorities to bear on important phases of our air pollution problem. These include conferences on motor vehicle exhaust, sanitary rubbish disposal, formation and analysis of aerosols, smog-forming chemical reactions, and relation of our weather to smog. The Foundation has accepted invitations from leading

scientific societies to conduct conferences at their meetings, at which our problem could be described and discussed. Out of such meetings comes greater help from others in this country and abroad.

The large-scale entry of the automobile industry into our problem, with all its resources of laboratories and engineering and scientific experts, is one of the most encouraging developments I can report. The decision of this great industry to come to our help was perhaps influenced to some small extent by the efforts of the Foundation to present the problem to it.

Other critical phases continue to be pushed forward by the oil industry and the steel industry. The cooperation we are receiving from these groups and their technical leaders is invaluable.

This summer, at the request of the Board of Trustees, seven authorities on various aspects of the Los Angeles smog problem agreed to serve as a Technical Advisory Committee on the Foundation's research program. The assistance of these outstanding scientists and engineers is very welcome. A list of members of this committee appears on p. 4.

Another important objective is "to publish current information by the most appropriate means on all phases of air pollution and its abatement." The twelve technical reports published to date constitute in total 1,120 pages of basic information dealing with primary aspects of modern urban air pollution in the Los Angeles area. Many of the findings will inevitably have application in other communities. Copies of all reports have been furnished not only to you, our trustees and contributors, but to all leading air pollution workers in this country and abroad, to scientific societies, and to the principal libraries in this country. These reports have been favorably reviewed in national magazines. Requests for them are being received not only from people in Los Angeles County but from municipal and state officials in California and from others over the country. Over 8,000 copies of these reports have been printed.

At the same time the Foundation has been aware of its obligation to accurately inform the public. Valid information has been supplied through all media, including the press, radio, and television. We publish a monthly newsletter. We have sound motion pictures and color slide collections as visual aids. In response to invitations from many civic and neighborhood organizations in Los Angeles County, we set up a speakers' bureau to provide competent speakers. Trustees and supporters of the Foundation have been most cooperative in providing able men from their own organizations for this bureau.

At the request of the local Public Affairs Committee of Kiwanis International with 110 clubs in the Los Angeles Basin, the Foundation has cooperated in their public-spirited effort to inform the public accurately and impartially about the nature and causes of smog and the progress which is being made in developing remedies. We stand ready to assist other groups if called upon. We are cooperating with the Air Pollution Control District and the State Chamber of Commerce in this meeting today.

Purposes to Which Funds Have Been Allocated

Despite the generosity of the contributors who are supporting us in this pioneering attack, the magnitude of the problem has required severe rationing of funds among a few of the most urgent projects, particularly those not being done elsewhere or done adequately. Figure 2 shows where our dollar went. Note that 74 cents goes for direct research expenses. General and administrative expenses amount to only 16 cents or 22 per cent of direct research as compared with 80 to 120 per cent typical of most industrial research.

Our Finance Committee, assisted by many civic leaders, serve without compensation in voluntary fund raising for the Foundation.

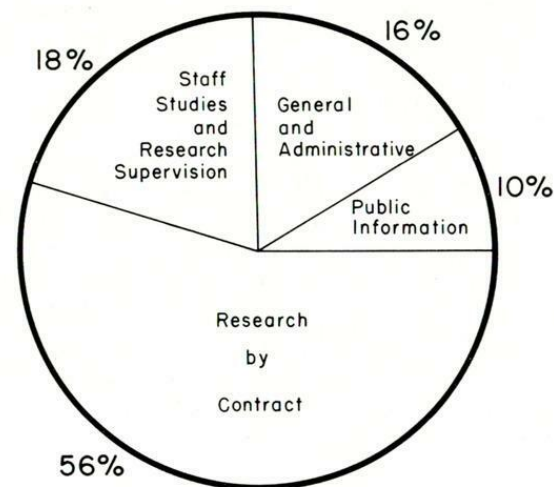


Fig. 2
Allocation of the Budget

Our research dollar has been divided among the main purposes shown in Figure 3. These subjects are most closely concerned with our smog problem and we believe the way in which our research dollar is divided among these purposes is roughly equivalent to their relative importance. Our 1956 goal is \$750,000. Many of our contributors have already renewed their annual subscriptions. Remaining renewals are anticipated, based on the experience of last year. Even so, \$200,000 of new money must be raised, primarily from sources which have not yet contributed. Favorable consideration is now being given by some of these groups. It is most important that our goal be reached.

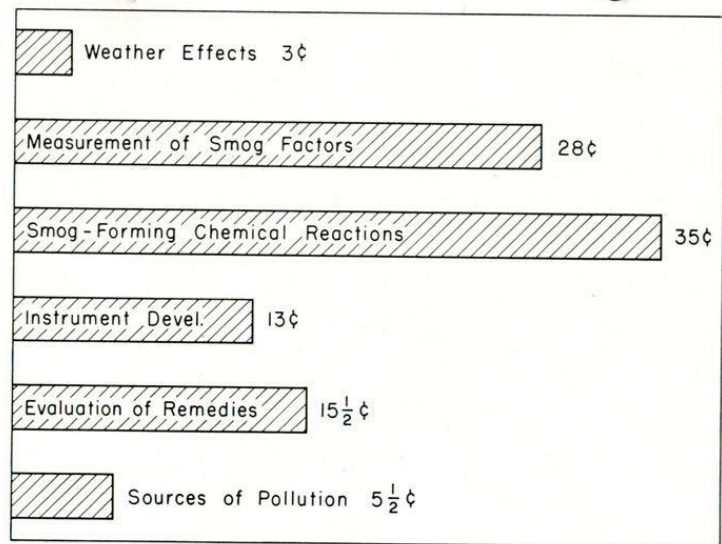


Fig. 3

Where our Research Dollar Goes

Summary of the Los Angeles Smog Problem

I have touched on some of our principal accomplishments and cited a very few examples. I know that you want to hear answers to such questions as "What have we found out?" and "Are we any nearer to solving the smog problem?" The answer to the second question is "yes" and I shall do my best in this brief report to tell you why.

First, I will tell you what we have found out as a result of the work described above; second, why we are nearer to a solution; and third, the nature of the solution as it is now taking shape.

It is inevitable that in bringing the definition of the Los Angeles smog problem up to date some of the conclusions will seem familiar, particularly to those who have followed air pollution work in Los Angeles for several years. Many of these conclusions derive from the work of the Air Pollution Control District, Professor Haagen-Smit at California Institute of Technology, Stanford Research Institute, and others. This definition is the result of critical selection of facts and evaluation of many differing theories which characterized the vague understanding of the problem as of two years ago. Those of you who have followed this battle more closely may recognize a firming up of certain points, and the absence of other theories and supposed remedies.

The Los Angeles smog problem is a direct consequence of air pollutants arising from man's activities. Operation of motor vehicles, factories, and rubbish burners,

to name three principal categories, contribute a great variety of pollutants in gas, liquid, or solid form. Some of these are visible at the point of origin, and some are not. None of these pollutants at the point of origin possess the characteristics of smog, which we will define shortly.

While our smog problem is a direct consequence of man-made pollution, meteorological and topographical influences contribute to the undesirable effects, although they do not of themselves cause these effects. Los Angeles did not have a smog problem of any moment prior to around 1940, yet the meteorology and topography of this area have undergone no significant change as far back as there is any record. The quantity and variety of pollutants, being a direct consequence of man's activities, increase with the number of motor vehicles, factories, and tonnage of refuse burned.

About the beginning of World War II man's activities in the Los Angeles Basin resulted in a daily production of pollution which began to exceed the natural dissipating capacity of the environment, particularly on those days when the inversion was low and the winds were low. Man's activities had always produced pollution, but up until then, while we had had the same cycles of low inversions and low winds, objectionable concentrations did not arise because the emissions were not excessive. The same opportunities for escape of pollution exist today as existed then, no worse or no better, but the daily production of pollutants has increased enormously so that their concentrations are much higher than they used to be.

Methods of Attack

Two obvious approaches to the problem have received a vast amount of speculative consideration by both scientists and laymen. The first approach is to find some way of changing our meteorological or topographical features. The second is to reduce our pollutants at their points of origin. Another way is treatment of the atmosphere, as by neutralization or dilution.

Profound studies by properly qualified meteorologists and physicists have failed thus far to reveal any likelihood that man can economically change either meteorological or topographical features sufficiently to have any significant effect on our air pollution problem. The quantities of energy associated with these natural influences appear to be far beyond any resources of man of which we have knowledge at present.

The second approach, to reduce pollutants at their sources, is the only approach which has resulted in any progress in abating air pollution here or elsewhere. Beginning about eight years ago, various control devices were installed. These controls include, for example, sulfur recovery systems, electrostatic precipitators, bag filters and other devices for collecting some of the dusts, floating roofs on gasoline storage tanks, closed recovery systems in oil refineries, and many others. These installations have been made either voluntarily by the parties concerned or as a direct consequence of regulations of the Air Pollution Control District, which estimates that in total these devices are keeping out of our air today about 1,100 tons per day of pollutants.

In metropolitan areas with better natural ventilation, this achievement would undoubtedly have been far more significant. One can only speculate on what our smog problem here would be like today if this progress had not been made. That it is inadequate is due to the tremendous continuing growth here in man's activities, a growth unequalled elsewhere in this country. The continuation of severe smog attacks shows that either the pollutants which have been controlled are not the ones which contribute substantially to our smog effects, or if they are, that they have not been reduced sufficiently.

Are Some Pollutants More Harmful?

This brings up a third approach to a solution of our smog problem, which is really a special case under the second method of reducing pollutants at their points of origin. In this third approach it is assumed that some pollutants are much worse than others. By the same token it is assumed that there are some pollutants which are relatively innocuous. This, of course, has been the traditional approach to development of our sanitary water supplies, which contain innocuous contaminants but in which the harmful agents are controlled to levels which have been carefully determined to be tolerable.

This third approach has in its favor the possibility that the control of only harmful air pollutants would be considerably less expensive to the community; for to attempt to solve our problem by reducing *all* pollutants to, let us say, 1940 levels would require the development and installation of a vastly greater amount of equipment, hence take more time and money. The third approach assumes that the harmful pollutants can be identified and that devices can be developed and installed specifically for these pollutants in less time and at less expense.

There is evidence that some of our numerous pollutants here are more harmful than others. It therefore becomes apparent upon brief reflection that we must have some yardstick of harmfulness. We know of no single pollutant entering our atmosphere which is known to be harmful to man at the highest concentrations found here. Ozone, which has come to be the index of our smog intensity, does not originate in any of man's activities but forms in our atmosphere as a consequence of complex photochemical reactions involving certain of our pollutants. Neither has anyone been able to find among our myriad pollution sources any compounds which, as emitted, produce the specific forms of eye irritation or plant damage characteristic of Los Angeles smog in the concentrations measured in the atmosphere. Again, therefore, these agents are formed in our atmosphere subsequent to the point of escape.

Pursuing this third approach then, one wishes to know which pollutants take part in the reactions which produce the harmful or undesirable effects.

Let us at this point offer a definition of Los Angeles smog: it is an atmospheric condition which can be defined so far only in terms of its identifiable effects. These are (1) eye irritation; (2) reduced visibility; (3) oxidant formation, including ozone; and (4) plant damage. This is admittedly a loose and arbitrary definition, but we know of no better one at present. It distinguishes between gross air pollution

on the one hand and the condition which develops objectionable effects. It is useful only to the extent that it provides some basis for selecting harmful or undesirable pollutants from the great variety we have. To put it another way, if by removing certain pollutants we could prevent the above-named effects, we would say that we had found the smog formers.

Principal Pollutants

In pursuing the third approach, it seems logical to begin with an inventory of our atmosphere. An inventory of pollutants at their points of origin is also pertinent. Both inventories are needed in taking either the second or third approach. Much work has been done in an effort to develop these data. While much more remains to be done, estimates of the composition and quantities of sources, reinforced by extensive air sampling, indicate that the principal initial pollutants arising from man's activities include these:

- Carbon monoxide
- Organic Compounds
 - Hydrocarbons
 - Partially oxidized hydrocarbons
 - Miscellaneous organics from partial combustion of rubbish
 - Miscellaneous solvents (dry cleaning, paint thinners)
- Oxides of nitrogen
- Oxides of sulfur
- Particulate matter
 - Carbon (soot)
 - Dust (silicates, carbonates, sulfates, etc.)
 - Ash (great variety of metallic oxides)
 - High molecular weight organic polymers, tars, finely divided particles from the abrasion of tires, etc.
- Water vapor
- Carbon dioxide

In some of these categories there are a great variety of compounds. Water and carbon dioxide are considered to be innocuous. Carbon monoxide is not found in our atmosphere at concentrations remotely approaching toxic levels published by public health authorities, nor has it been shown yet to take part in atmospheric reactions. Accordingly, it is set aside tentatively as harmless under presently known conditions prevailing here.

Particulate Matter

Particulate matter is suspect not only because of its more obvious role in forming aerosols and reducing visibility, but because of the growing evidence that sub-micron* particles may collect gaseous and liquid pollutants existing at nontoxic

*A micron is about 1/25,000 of an inch; the average human hair is about 70 microns thick.

levels, concentrate them, and transport them into the deeper portions of the respiratory system. Some metallic oxides existing normally in our particulate matter are also capable of catalyzing oxidation reactions, including the oxidation of sulfur dioxide to sulfur trioxide.

Analyses of our particulate matter by the U. S. Public Health Service, as reported by Chambers, are preliminary but indicate that the sulfate and nitrate content here is higher than in any of thirty other American cities sampled. Because of the obvious contribution to grime and smoke, let alone the unproven but suspected effects, it is generally conceded that particulate matter should be the object of more complete control. Despite the efforts of the Air Pollution Control District (APCD) and others, one important source of particulate matter, namely the burning of rubbish, remains largely uncontrolled mainly because of political factors. APCD regulations exist, the purpose of which is to limit the rate at which the particulate matter may be emitted as defined either by grains per cubic foot of stack gases or by opacity as estimated by the Ringelmann chart. Burning of refuse has been estimated by APCD to account for as much as 65 per cent of the "smoke" in Los Angeles.

The control of particulate matter is subject to the same approach as air pollution in general, in that one may strive to control *all* particulate matter at the source, or to identify harmful particulates and seek to control these selectively. Again, we are in need of much more information. Except for the reduction of visibility, there is inadequate evidence so far that particulate matter contributes to smog as defined by its manifestations.

Sulfur

Sulfur dioxide itself is found in our atmosphere normally at lower levels than found in some other large cities. Plant damage due to smog is definitely distinguishable from that due to oxides of sulfur and sulfuric acid. Data on the concentration of sulfur trioxide and sulfuric acid in our atmosphere are virtually nonexistent. There is no evidence that sulfur dioxide in the maximum concentrations ever reported here causes any eye irritation. There is no evidence that oxides of sulfur or sulfuric acid increase measurements of oxidants or ozone. Sulfur dioxide reduces the oxidant reading by potassium iodide. In short, at the concentrations found in our atmosphere in Los Angeles, there is no evidence that sulfur dioxide exerts any harmful effects despite the popular impression that "sulfur is a culprit," a view traceable to incidents in other cities where at times sulfur oxides or hydrogen sulfide have been found at higher concentrations and associated with acute air pollution effects. The extent to which sulfur compounds in the Los Angeles atmosphere are harmful is yet to be established.

Organic Compounds

Among the so-called principal pollutants listed above, there remain organic compounds and oxides of nitrogen. These include all the hydrocarbons* found in natural

*Hydrocarbons are compounds of hydrogen and carbon and are the principal substances in petroleum and petroleum products, such as gasoline and oil.

gas, and petroleum and petroleum products, beginning with methane. Such compounds and their derivatives enter our atmosphere from gas distribution systems; from the production, refining, and marketing of petroleum products; and from the incomplete combustion of these products; also, from the vaporization and/or atomization of heavier products such as lubricating oils; and by evaporation from carburetors and motor vehicle fuel tanks. Depending upon air-fuel ratios and upon normal operating temperatures and design characteristics of the great multitude of combustion devices which man operates today, both unburned and partially oxidized fuel escapes to the atmosphere.

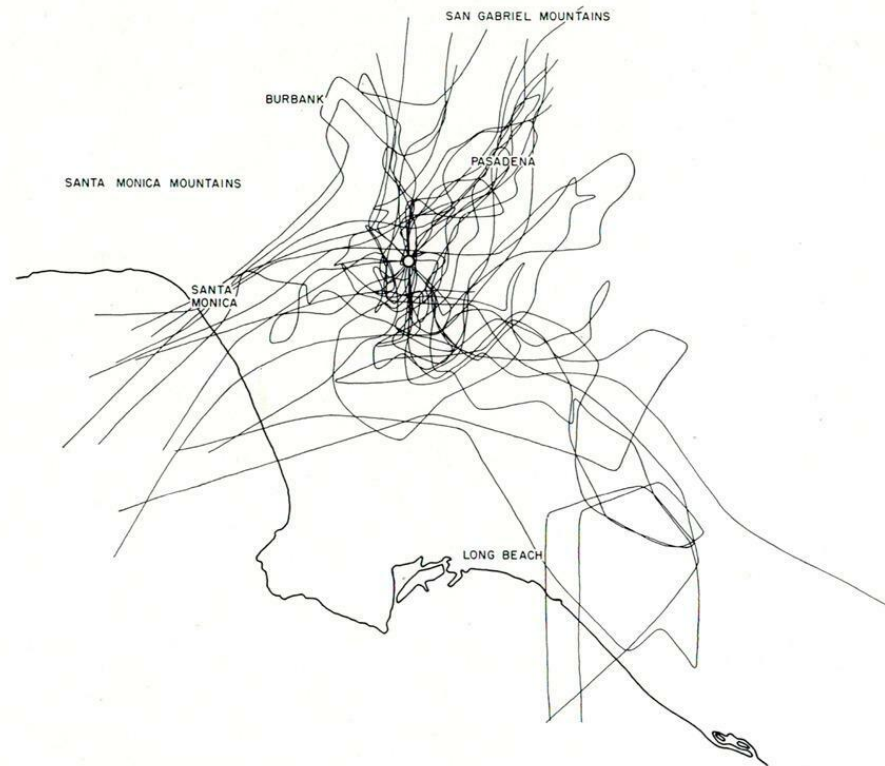


Fig. 4

Paths taken by polluted air to downtown Los Angeles on thirty-two smoggy days when hydrocarbon concentrations downtown exceeded 0.5 parts per million of air. This confused jumble of "spaghetti" is clarified by the schematic representation in Figure 5.

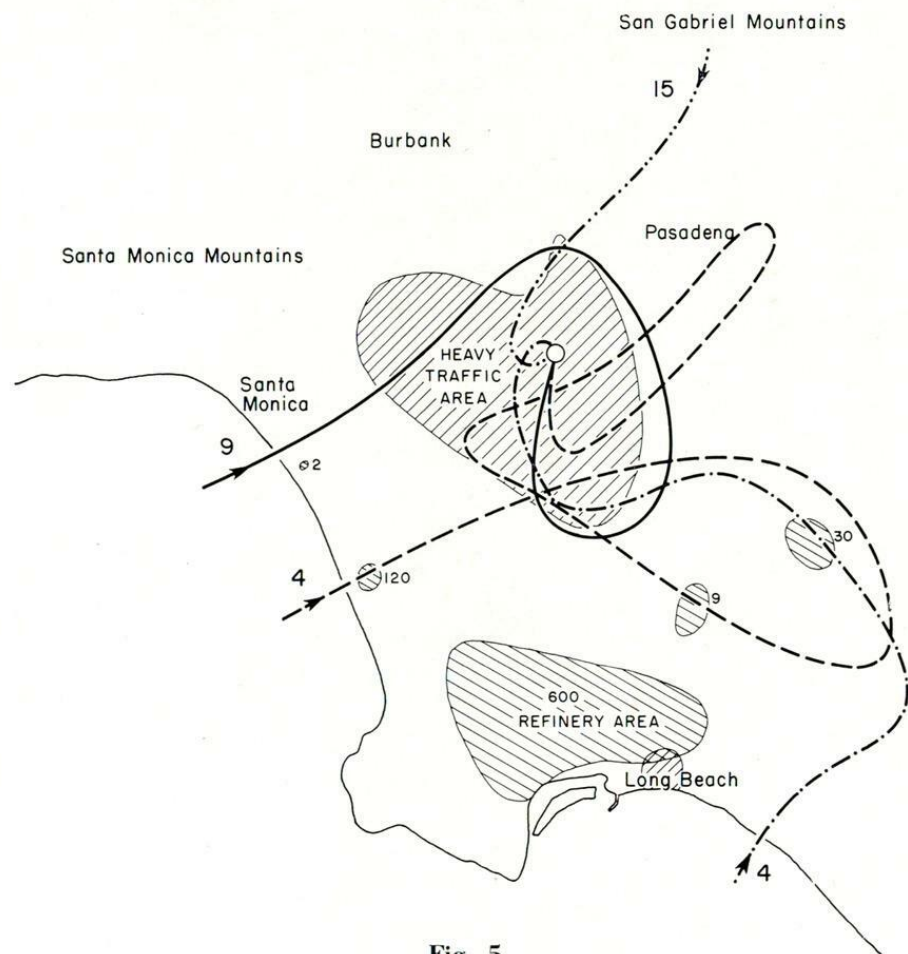


Fig. 5

Schematic summary of thirty-two wind paths from Figure 4, with number of individual trajectories represented shown by a numeral near beginning of each of the four representative paths shown. Note that on fifteen days hydrocarbons in downtown Los Angeles were picked up by air moving in from the San Gabriel Mountains and on nine other days from the coast near Santa Monica, a total of twenty-four, or 75 per cent of the thirty-two smog days when the air traversed heavy traffic areas and no refinery areas; on the other eight days the paths led near enough to refineries to be influenced by them, although none passed directly over the area of concentrated refineries in the south. In all thirty-two cases wind paths traversed heavy traffic areas in arriving at the downtown test station at Fifth and Spring Streets. Details of these findings are included in Report No. 13 now in preparation.

In addition to the galaxy of hydrocarbons and hydrocarbon derivatives connected with the production and use of commercial fuels, there are organic compounds resulting from the incomplete combustion of miscellaneous refuse. While but a few of these organic compounds have been identified, it is known that they include phenols, acetone, methanol, organic acids and tars, somewhat analogous to the products of wood distillation.

The consumption of miscellaneous solvents, as in dry cleaning or in paint thinners in the Los Angeles area, must closely approximate the input of these compounds to our atmosphere. Among such solvents would be found carbon tetrachloride, trichloroethylene, tetrachloroethylene, benzene, monochloro benzene, solvent naphthas, and turpentine.

Haagen-Smit originally, and now several other workers, have produced oxidant and/or ozone by irradiating mixtures of single organic compounds with nitrogen dioxide and oxygen, in which the organic compound has been any one of a number of different saturated hydrocarbons, olefins, diolefins, straight chain or branched molecules, aldehydes, alcohols, ketones, and complex mixtures of organic compounds such as commercial gasoline as well as auto exhaust. The capacity for oxidant or ozone formation may vary widely from one organic molecule to another. The amount of oxidant and/or ozone formed is also dependent upon the starting concentration of nitrogen dioxide and upon the intensity and time of radiation.

Reduction of Selected Organic Compounds

In the light of these experiments and others carried out along similar lines, observed oxidant and ozone values in the Los Angeles atmosphere can be accounted for qualitatively in terms of observed concentrations of organic compounds and nitrogen dioxide, even though we do not yet understand the complex reaction mechanisms. We cannot yet say that the reduction or the elimination of certain classes of organic compounds, such as gasoline hydrocarbons, would cause a proportionate, or any, reduction in ozone, because it is entirely possible in our present state of knowledge that the remaining organic matter plus the unchanged nitrogen dioxide would still produce as much ozone as before. Conceivably, reduction of nitrogen oxides might have a more significant effect in reducing smog than reduction of organic compounds, particularly if the latter reduction were confined to certain classes of compounds.

So far we have been discussing one smog effect, namely oxidant-ozone. The experimental production of eye irritation, plant damage, and reduced visibility by irradiation of organic compounds and nitrogen oxides at experienced concentrations is far less extensively reported in the literature.

There are indications that auto exhaust blended from all four operating cycles, and hydrocarbons at concentrations close to those estimated for the Los Angeles atmosphere during heavy smog periods, when irradiated, will produce both eye irritation and plant damage. There are indications that the same may be true of gasoline vapors themselves. We do not know what the compounds are which irritate

eyes or damage plants, nor do we know from which hydrocarbons or other organic compounds they are formed. Ozonated olefins produce typical smog damage to plants in controlled laboratory tests. Consequently, we cannot say that reducing the hydrocarbon content of auto exhaust by 50 per cent or any other fraction will or will not reduce eye irritation and plant damage. If what might be termed "gasoline-economizer" devices are developed, which would reduce the hydrocarbon content in auto exhaust on an over-all average by 50 per cent for example, at the present time we can only say that this would effect fuel savings of about 3 per cent, based on the total fuel consumption of the average motor vehicle. Based on an average consumption of two gallons per day, this should represent a savings of about 20 gallons per car per year, or about \$6. Some people feel that the cost of a control device would be justified by fuel economy alone. Multiplied by over two million vehicles, this would amount to keeping out of our air something like 500 tons of gasoline vapors per day. With respect to smog effects, however, without control of oxides of nitrogen at the same time and without control of the very substantial remainder of the organic compounds, we can see little basis at present for the conclusion that a significant reduction in smog is to be expected by the use of a device which will reduce hydrocarbons from automobile exhaust by 50 per cent.

This statement will doubtless seem unreasonable to some people and disappointing to a great many. It is a statement based on lack of data rather than on the basis of facts in hand. This is why we feel that "chamber" experiments (see page 22) are urgently needed in order that the smog-forming potential of actual sources, singly and in combination, may be tested, as well as the effects of proposed control devices for these sources. Experimentation in this way could forestall the premature adoption of devices which might cost the community many millions of dollars without commensurate gains.

Other Data Needed

We believe that additional information is essential as to the variation of various pollutants with respect to both time and place. We have no data showing the concentrations of organic compounds and oxides of nitrogen, for example, in the immediate proximity of heavy traffic arteries. Our data so far are limited to a few scattered monitoring stations where in all likelihood we have measured residual values after both chemical reaction and dispersion have taken place. Similar comments may be made with respect to composition and concentrations of other pollution sources, such as industrial stacks. Considerable progress has been made in developing methods of analysis, particularly in the direction which will permit continuous automatic recording for monitoring purposes. Much, however, remains to be done. Without sufficiently accurate and dependable methods of analysis and monitoring, we cannot know with what we have to contend.

The many uncertainties on what seem to us crucial questions, indicated throughout the foregoing discussion, are the basis of the numerous research projects we propose. Any practical estimate of the cost of such research now in sight far exceeds our own financial resources. We hope that other agencies will recognize the importance of these research projects so that more rapid progress may be made.

How Much Progress Has Been Made?

Because the nature and causes of smog are now more clearly understood and more generally agreed to, and because, therefore, the types of remedies are beginning to take shape at least in a general way, important progress has been made and is being made despite the fact that smog is still with us and may be getting worse. We know now what our principal targets are. We are building an arsenal of weapons in the form of scientific instruments and methods of analysis. We can begin to call our shots. Those of you who were close to the situation two years ago I think will agree that progress has been made. The Foundation has been a part, but only a part, of this progress.

What is the Shape of Remedies to Come?

Recognizing that predictions are hazardous, certain probabilities stand out with respect to the types of remedies likely to prove successful. These are:

1. There is little likelihood that any practical changes in the meteorology or topography of the Los Angeles Basin would be effective in reducing smog. The quantities of energy required to transform or modify these natural influences appear to be far beyond any resources of man of which we have knowledge at present.
2. Control of the effluents from the burning of rubbish can well be accomplished by banning this archaic practice. Cut-and-fill disposal may offer effective relief for some years, but eventually improved designs for municipal large-scale incinerators will probably have to be developed. Adequate designs await further research.
3. The reduction of air-borne particles from industrial stacks will have to be attacked from two different standpoints. Improved efficiency of combustion could eliminate organic aerosols, but inorganic materials will have to be removed from the stack gases by physical or chemical means. Both approaches require further research.
4. If sulfur dioxide emissions are found to require further reduction, the most effective attack may well be elimination of sulfur from the fuel. Suitable methods, particularly for residual fuel oil, are not currently available.
5. Further abatement of hydrocarbon and solvent losses by evaporation means an extension of vapor recovery or combustion systems. More engineering research will be required to develop economic equipment for this purpose.
6. Reduction of the hydrocarbon emissions from the exhaust of internal-combustion engines awaits an effective method. In the case of spark-ignited engines, four areas show promise: fuel cutoff devices operating during deceleration, exhaust converters (either catalytic or noncatalytic), fuel injection, and improved maintenance. It may well be that ultimately some combination of the above may be most suitable. In the first three areas adequate devices are not yet developed, although automobiles using fuel injection could well appear in 1957. Such designs would obviate the need for a fuel cutoff device. Even so, exhaust converters would still be needed.

The quantitative value of improved maintenance has not yet been determined. Whether governmental action in this regard will be desirable depends on the magnitude of hydrocarbon reduction that could be achieved and the nature of other devices to be used.

Slightly different problems are presented by the diesel engine, but these should be amenable to further research. Such work should be initiated at once. If the gas turbine engine becomes a reality for automobiles, other problems may develop. It is assumed that the automobile manufacturers will anticipate this possibility.

7. The one area in which it is difficult to envision an effective reduction device is for oxides of nitrogen, whether they are emitted from automobiles, diesels, or industrial stacks. Obviously, a concerted research study is badly needed.

Implicit in this picture of remedies to come is the need for stepped-up engineering and development. Above all, Los Angeles needs an air resource test facility. Plans are now being drawn up by the Department of Engineering at the University of California at Los Angeles with the cooperation of the Air Pollution Control District and the Air Pollution Foundation. Such a facility is intended to provide accurate and reliable information as to the importance of various atmospheric pollutants and the consequences of reducing or eliminating any one or more of them. Of great importance to us would be our ability to test in this facility the various remedies that have been and will be suggested. In this way the public would be assured that any remedy recommended to it or required of it was workable, worthwhile, and economical. **Among all the jobs that lie ahead of us on the road toward victory over smog, the construction of this air resource facility we consider foremost.**

Can the Smog Problem be Solved?

We are asked many times by our friends, by the Foundation's supporters, and the public in general if we really believe that the smog problem can and will be solved. If the staff of the Air Pollution Foundation believed that the answer to this question were anything but "Yes!" they would shut up shop and change jobs. No reputable scientist willingly associates himself with any project that he believes will result in failure.

But to say that the solution will be easy and quick is another matter. There are two technical factors involved in solving the Los Angeles smog problem. These are (1) lack of information, and (2) lack of adequate abatement methods. To solve these problems, we must (1) establish limits for the important pollutants and (2) develop control mechanisms based on these facts. We are currently engaged in finding and assembling the necessary factual information. With this as a base, we can develop abatement procedures just as surely as scientific men can develop jet aircraft or man-made satellites.

But there is a third problem — one not under the control of the scientists. This is the willingness of the community — which includes business, industry, the public, and government — to spend the necessary money and to accept the necessary controls. Nothing worthwhile is ever free.

Now let's get specific! Evidence is piling up that two major smog sources not now controlled are incinerator effluents and the hydrocarbons from automobile exhaust. We, along with others, are developing solutions. We *know* what to do about the incinerator problem; now it is up to the community to accept the solution.

Work on the development of a device to reduce hydrocarbons in automobile exhaust is underway in many laboratories. A device to reduce oxides of nitrogen may also have to be developed. Industry will have to tool up to manufacture these. But, will industry supply the money if it is not certain that the products will be effective and will sell? We are developing the means to test these devices so that we can assure industry and the public that they will be effective.

Let us assume these tests are affirmative. Then comes community action. The devices will cost money—perhaps \$15, perhaps \$150, for each car owner. The devices may have to be inspected twice a year. This means an inspection system, which means higher taxes and further inconvenience to the motorist. So, in this hypothetical but highly probable case, the alleviation of smog will mean that the community must accept direct costs for installation and maintenance, the indirect cost of inspection, and a measure of inconvenience. But again, if we did not believe the community wants to get rid of smog badly enough to do these things, we wouldn't be here.

Likewise, industry may have to develop and install additional devices for the reduction of hydrocarbons, nitrogen oxides, and possibly other pollutants. We think the willingness of this part of our community to spend the necessary money and to accept the necessary procedures has been demonstrated and may be relied upon in the future.

But even if remedies which have been suggested do not completely solve the problem, the remaining difficulties are amenable to the same tactics:

Get the facts.

Develop and test abatement devices and methods.

Get public acceptance.

This is the Foundation's program; we believe it will be effective.

"The scientist should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favorite hypothesis; be of no school; in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature."

... Michael Faraday

Statement of Policy

Purpose of the Foundation

An independent, nonprofit corporation has been established for the following purposes:

1. To cooperate with and to assist in coordinating the efforts of governmental agencies, educational institutions, specialized research groups, and medical, legal, and other technologists, so that every phase of air pollution shall be the object of careful study and constructive, remedial action.
2. To provide for research on those phases of the problem not already undertaken or completed by other agencies.
3. To inform the public periodically concerning the nature and extent of air pollution, progress made in its elimination, and obstacles to such elimination.

Organization of the Foundation

The Board of Trustees of the Foundation is composed of business, professional, and industrial leaders with records of conspicuous public service. About one-third are representatives of industrial enterprises which are or may be contributors in some degree to air pollution. The principal reason for their membership on the Board, in addition to their recognized standing in the community, is to make certain that they will be parties to all facts and evidence brought to light on the problem, so that they and their colleagues in like enterprises can continue to devote their best efforts toward the abatement of air pollution.

As a matter of policy, not more than one representative of a given industry serves on the Board at a time. Trustees serve without compensation, nor do they contribute financially to the Foundation. Less than half of the Trustees represent companies or organizations which are providing financial support, and most of these do not contribute to air pollution.

The funds of the Foundation are donated by about 150 different enterprises, trade associations, banks, insurance companies, and industries, representing a cross section of the community. Few of the donors are or may be contributing to air pollution, and less than one-half of total funds received come from all such sources combined.

Financial contributions are unrestricted as to purpose and convey no rights to the donors other than to receive copies of reports, findings, and recommendations. Neither membership on the Board of Trustees nor donation of funds can in any way obtain privileged treatment in connection with responsibility for air pollution or its abatement. The work of the Foundation will be conducted with complete objectivity at all times and its findings are made impartially.

A Managing Director and a limited staff of experts will conduct the day-to-day activities of the Foundation under the general supervision of the Board of Trustees.

What the Foundation Proposes to Do

1. To assemble a competent technical staff to organize and direct a broad program of cooperation, research, and public information.
2. To determine, record, and publish what has been accomplished to date by all agencies dealing with air pollution.
3. To determine what remains to be done and to employ experts through the device of research or service contracts, who will provide information and advice for the shaping of future policies and action.
4. To collect information as to what other municipal areas have done and are doing under similar circumstances.
5. To maintain a library of materials pertinent to the subject of air pollution.
6. To consult with, exchange information with, and to suggest to governmental and private agencies those research activities, enforcement methods, or other matters, which have not yet been conducted or tried and which seem to offer promise of air pollution abatement, so that the efforts of all groups and individuals may be coordinated properly.
7. To hold technical conferences with experts and specialists working in this country or abroad on selected phases of the air pollution problem in order to facilitate and accelerate the process of finding solutions.
8. To publish current information by the most appropriate means on all phases of air pollution and its abatement.

What the Foundation Does Not Propose to Do

1. It will not duplicate services already rendered by governmental or private agencies.
2. It will not conduct research activities directly, unless it appears clear that no existing agency can conduct them as advantageously.
3. It will not expend funds entrusted to it for the construction or equipping of Foundation laboratories that will duplicate facilities already available.
4. It will not hold public hearings for the purpose of receiving complaints, or in any way substitute for governmental agencies now charged with responsibility for certain phases of the air pollution problem.
5. It will not offer any immediate or ready solution for a very complicated, long-range problem.

How the Work of the Foundation May Be Assisted

Those who believe that the proposed activities of this independent Foundation can be of help may assist in this work by making contributions payable to the AIR POLLUTION FOUNDATION, addressed to its headquarters at 704 South Spring Street, Los Angeles 14, California.

Contributions from governmental organizations, business or industrial enterprises, and from private citizens will be welcomed by those in charge of its program.

A Word of Caution . . . and an Invitation

The smog-free skies of an earlier day in California cannot be brought back immediately by any endeavor, however resolute the attempt, or through any quick expenditure of funds; they can be restored over a reasonable time by diligent and honest fact finding, by wise and effective action.

Air pollution is now recognized as a national problem. The fundamental contributions which the Foundation is making toward the solution of urban air pollution are attracting increasing national attention.

Assumptions Made by the Foundation

1. That the problem of air pollution is one of the most serious confronting urban areas in California and elsewhere; that it is worthy of the best efforts of everyone concerned; and that it calls for the expenditure of whatever funds are needed for its solution.
2. That the air pollution problem is not new and is generally increasing.
3. That geographical and meteorological features often contribute materially to the air pollution problem, especially in the Southern California area.
4. That every additional person or industrial enterprise locating in this area potentially adds to the problem.
5. That much excellent work has been done by governmental and private agencies to reduce air pollution, and by the press to keep the public informed; that the public should be informed of all significant phases of the problem.
6. That further information must be obtained and additional action taken before the air pollution problem can be brought under proper control.
7. That there is no quick or easy solution to the problem, no matter what funds should be spent immediately or what laws should be invoked. There is an understandable tendency to oversimplify this problem and to insist that its obvious seriousness and urgency somehow must expedite its solution.
8. That the control of emission of particular gases, fumes, or dusts may not alone solve the problem. (Some of these pollutants, believed to be harmless or of minor importance individually, may in combination undergo photochemical reactions in a manner not completely understood at present.)
9. That while the solution of the urban air pollution problem is long range, short-range steps should be taken to alleviate it further, as soon as reliable facts are available and policy decisions have been made.
10. That many of the findings of the Foundation, including methods of attacking the air pollution problem as well as remedies, are applicable to all metropolitan areas and should be widely disseminated.

TECHNICAL REPORTS

published by the

AIR POLLUTION FOUNDATION

| | | |
|---------------|---|----------------|
| Report No. 1 | "Meteorology of the Los Angeles Basin" M. Neiburger and J. C. Edinger, 99 pp., April, 1954..... | \$ 3.00 |
| Report No. 2 | "Combustion and Smog" W. L. Faith, 63 pp., September, 1954..... | \$ 3.00* |
| Report No. 3 | "Conference on Incineration, Rubbish Disposal, and Air Pollution" Francis R. Bowerman, Editor, 52 pp., January, 1955..... | \$ 3.00 |
| Report No. 4 | "First Technical Progress Report" W. L. Faith, L. B. Hitchcock, M. Neiburger, N. A. Renzetti, L. H. Rogers, 89 pp., March, 1955..... | \$ 4.00 |
| Report No. 5 | "Hydrocarbon Losses from the Petroleum Industry in Los Angeles County" Southwest Research Institute, 22 pp., November, 1954..... | \$ 1.50 |
| Report No. 6 | "Basic Statistics of the Los Angeles Area" Neil Goedhard, 74 pp., January, 1955..... | \$ 3.50 |
| Report No. 7 | "Tracer Tests of Trajectories Computed from Observed Winds" M. Neiburger, 59 pp., April, 1955..... | \$ 3.00 |
| Report No. 8 | "Field Evaluation of Houdry Catalytic Exhaust Converters" Southwest Research Institute, 77 pp., June, 1955..... | \$ 3.00 |
| Report No. 9 | "An Aerometric Survey of the Los Angeles Basin, August-November, 1954" N. A. Renzetti, Editor, 334 pp., July, 1955..... | \$10.00 |
| Report No. 10 | "Feasibility of Control Methods for Automobile Exhaust" Southwest Research Institute, 63 pp., August, 1955..... | \$ 2.50 |
| Report No. 11 | "Visibility Trend in Los Angeles" M. Neiburger, 45 pp., September, 1955..... | \$ 1.50 |
| Report No. 12 | "Second Technical Progress Report" W. L. Faith, L. B. Hitchcock, M. Neiburger, N. A. Renzetti, L. H. Rogers, 143 pp., November, 1955..... | \$ 3.00 |
| Report No. 13 | "Wind Trajectory Studies of the Movement of Pollutants in the Los Angeles Basin" M. Neiburger, N. A. Renzetti, R. Tice..... | in preparation |
| Report No. 14 | "Photochemical Processes in Polluted Air" P. A. Leighton and W. A. Perkins..... | in preparation |

*Out of print. Essential information of Report No. 2 now brought up to date and included in Report No. 12.

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