# Polluted Air, a Growing Community Problem

By HENRY N. DOYLE

**Can we achieve that to which every citizen is entitled: an atmosphere of reasonable cleanliness? This review of some of the constructive efforts which communities in the United States are making to study and control the ever-increasing problems of air pollution gives hope that we can learn to manage the great sewer that is the atmosphere.**

AIR POLLUTION, the most complex problem facing the environmental hygienist, has been with us ever since man began to use coal as fuel. As technology advances, the problem becomes more acute. In the past, the hygienist hesitated to tackle it because he lacked the necessary equipment to measure the effects on man or to measure the microquantities of contaminants in the atmosphere. Nor was there any general demand for action since the public had customarily associated industrial stack discharge with prosperity.

In recent years, however, the 1948 smog disaster in Donora, Pa., and the growing significance of the Los Angeles air pollution problem have changed the public's attitude from apathy to anxiety. Some measure of this change has been evident in the requests the Public Health Service receives for information on air pollution, a negligible number prior to 1940. Each year sees a significant increase in their volume. In addition, during the past 5 years, 25 cities have requested investigations similar to the one made in Donora by the Public Health Service.

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Industry, as well as government, is keenly aware of the growing interest of the public in atmospheric pollution and its health and economic implications. Many millions of dollars are being spent by both for research and correction. Industry itself is spending an estimated $120 million a year to control air pollution. Even so, few experts believe that in the foreseeable future our cities will have "country fresh" air. Air pollution is a penalty of our modern way of life, and, unless we wish to pay exorbitant prices for certain commodities, we may have to tolerate a certain degree of atmospheric pollution for years to come.

The public in general fails to realize that the atmosphere is the world's greatest sewer. All organic waste, industrial or otherwise, must finally be discharged into the air either directly, through combustion, or by disintegration. Technology, however, in many cases can alter the chemical composition of industrial and domestic organic compounds so as to make them innocuous. In the past, we have used the atmosphere to disperse much of our inorganic waste over large areas. This type of pollution can be prevented with modern dust collection systems and electrical precipitators. Such control measures are costly, however, and they cannot be expected to be put in general use in the absence of either restrictions or economic advantages.

The effects of atmospheric pollution on people may be arbitrarily divided into four major categories: effects on human health and comfort, toxic effects on animals and vegetation, economic damage, and loss of natural resources.

### Health Effects

The effect on health of chemical air pollution has been a controversial subject ever since the use of coal was banned in England during the thirteenth century because of the alleged injurious effects of coal smoke. Current scientific literature is replete with allegations concerning the harmful effects of chemical air pollution. Investigators have attempted to correlate an increasing incidence of respiratory and chronic diseases and an ever-rising rate of lung cancer with the increased severity of pollution. However, in many cases the investigator has been able only to implicate air pollution because of other corresponding and determining factors such as housing, income, nutritional status, and intelligence levels.

A study of the possible relationship of smoke to increased mortality is now under way in England in connection with the recent record fog. Following the 4 days, December 5 to 9, 1952, in which the greater part of metropolitan London was continuously enveloped by a smoke-laden fog, a spectacular rise in deaths occurred.

During this period, abnormally large numbers of persons of all ages died from causes associated with respiratory difficulty. This was similar to what had happened immediately after a comparable fog in 1873, but the death rate in 1952 was much greater and was, in fact, as great as that during the worst week of the last cholera epidemic. Exceptionally high concentrations of smoke and sulfur dioxide were recorded. The highest average concentration was 4.46 mg. of smoke per cubic meter of air and 1.339 parts of sulfur dioxide per million parts of air (*1*).

Although there are no large metropolitan areas in the United States which suffer extended periods of smoke-laden fogs, significant smogs do occur in certain industrial areas. Largely because of the enormous difficulties in obtaining reliable data, epidemiological investigations have not been made in these communities. The field of the chronic effects of smog on health thus remains relatively unexplored. Nonetheless, despite the absence of any clear-cut etiology, it is difficult to ignore the vast mass of indirect evidence on chronic effects.

The acute effects of air pollution have been easier to substantiate. Conclusive proof has been afforded by three recorded episodes in which large masses of people were affected. These involved the Meuse Valley, Belgium (*2*), Donora, Pa. (*3*), and Poza Rica, Mexico (*4*). In the Meuse Valley (1930), 60 persons died and several thousands were made ill. In Donora (1948), 20 persons died and some 5,000 were affected in varying degrees. In neither case was the causative agent specifically identified. Most authorities agreed that a combination of contaminants was responsible. A large concentration of industry in a narrow valley and the occurrence of unfavorable weather conditions were circumstances common to both episodes.

The Poza Rica incident (1950), in which 22 persons were killed and 320 were hospitalized, was due to the accidental release of hydrogen sulfide to the atmosphere, which resulted from the failure of mechanical equipment in a sulfur recovery plant. This incident, however, should be classed as an accident since similar possibilities exist wherever large volumes of toxic gases are being processed or transported.

Other isolated incidents affecting numbers of people have also been reported. In one small industrial city, a beryllium manufacturing plant had since 1943 been discharging into the community atmosphere certain beryllium particulates that by 1951 gave rise to 16 cases of chronic beryllium poisoning. Five of the persons so affected have died. Because of the radial distribution of the cases, the source of the poisoning was unmistakably traced to the beryllium plant (*5*).

To our knowledge, such occurrences are rare. When detected they can be controlled through education, or, in the instance of a recalcitrant industry, by means of local law. Unfortunately, however, health authorities do not always have complete information regarding the location of plants manufacturing or processing dangerous and toxic chemicals.

In contrast to infrequent acute health effects, sensory discomforts are well recognized by all persons who have had any contact with air pollution in major metropolitan centers. Obnoxious contaminants include those substances which irritate the eyes or nasal passages and those which have a distinct and often irritating odor. The atmosphere in Los Angeles has been particularly affected by lachrymators which cause frequent sensory disturbances. Although these materials have never been proved to be injurious to health, they certainly do not contribute to a sense of well-being.

## Toxic Effects

While some of the alleged chronic effects of air pollution on human beings may be difficult to prove conclusively, there is unmistakable evidence that pollutants influence the growth and development of animals and plants. Animals have become sick from eating vegetation which has been contaminated with fluorides from the stack discharges of certain industrial plants. As a result, the teeth of grazing animals in fluorine-polluted districts have been known to deteriorate so much that the animals were unable to feed. Advanced fluorosis in these animals has been associated with such symptoms as lameness resulting from bone lesions, reduced feed consumption, emaciation, diarrhea, decrease in production, and lowered breeding efficiency (*6*).

The Public Health Service's investigation of the Donora smog incident, which was characterized by a combination of pollutants, revealed that an appreciable number of domestic animals became ill, and some died. Dogs appeared to be the most susceptible, both as to morbidity and mortality.

Air contaminants may also harm plant life. They may discolor crops and reduce yield. Acid gases in the atmosphere may scorch leaves and young plants beyond recovery and may sour the soil. In some industrial areas, there are no crops, gardens, or vegetation because of the harmful effects of air pollutants.

Sulfur dioxide from smelting and other industrial operations adjacent to forest regions has had a pronounced detrimental effect on tree growth. Continued absorption of atmospheric sulfur dioxide has been known to reduce conifers, which normally maintain their needles for 3 years or longer, to only the current year's growth of needles. Other important atmospheric contaminants which can cause injury to vegetation include hydrogen fluoride, sulfuric acid aerosols, and certain unidentified organic compounds.

## Economic Damage

Annual direct losses from air pollution in the United States are estimated as amounting to at least $1.5 billion, or about $10 per capita (*7*). A large part of this loss obviously is caused by damage to or destruction of vegetation. In 1950, for example, approximately $300,000 worth of leafy vegetable crops alone were damaged by smog in the Los Angeles area (*8*). Contributing to the total expense is damage to property, including the discoloration and disfiguration of buildings. Corrosive acid gases in the atmosphere eat away stone, mortar, and metals. It has been reported that sheets of galvanized iron had a life span of 3–6 years in Pittsburgh as compared with 7–14 years in a smoke-free community and that copper would last only 10–20 years in Pittsburgh, whereas it would last indefinitely where there is relatively little atmospheric pollution.

The interiors of buildings are also subject to soiling and corrosive action on walls, rugs, draperies, linens, and clothes. Replacements must be made frequently. Soap, laundry, and dry cleaning bills are increased, adding to the household living costs. The Mellon Institute of Industrial Research estimated that in 1913 over $2 million was spent in Pittsburgh on extra laundry and dry cleaning of clothing soiled by soot; another $75 million was spent on cleaning and renewal of wallpaper and curtains.

There is a loss of merchandise in stores. Polluted atmospheres also cut down the normal amount of sunlight. More artificial lighting is needed, thus increasing the cost of illumination. Air contaminants may even force people to move to another community, thus causing a drop in real estate values.

**Loss of Natural Resources**

A further loss by air pollution lies in the large tonnage of valuable materials emitted into the atmosphere. The Mellon Institute estimated that in 1926 about 160,000 tons of nitrogen were lost in smoke from soft coal used in American households. This amount was equal to nearly half the inorganic nitrogen used that year in the United States. Although this nitrogen would not be recoverable, it serves to illustrate the magnitude of losses by industrial processes.

According to the United States Bureau of Mines, 700,000 tons of manganese, representing approximately 50 percent of our yearly requirements of this critical commodity, could be recovered annually from processing losses. Among the rare metals, germanium, gallium, rhenium, and selenium are being lost in flue dusts and smelter discharges; recovery processes are yet to be developed. Great Britain is reported to be dissipating yearly in coal ash 1,000 tons of gallium and 2,000 tons of germanium into the air (*9*).

The economic value of reclaiming substances previously discharged into the atmosphere may be illustrated by the experience of the Canadian smelter which formerly caused crop damage in the State of Washington. The smelter now uses its sulfur dioxide in the manufacture of fertilizer. As a result, the returns to the smelter from this operation exceed the value of its smelting operations.

**Major Studies**

Until relatively recently, measurements of the degree of air pollution consisted of fall-out studies in which concentrations were expressed as tons per square mile of surface. Such studies were helpful in demonstrating that, in many highly industrialized areas, the dust-fall amounts to hundreds of tons per square mile per year. This system of measurement, however, failed to identify the contaminant and gave no index of the diurnal variation. Consequently, it had critical shortcomings as an aid to effective abatement and control of air pollution. With recent progress in instrument development, the chemist is now able to evaluate both quantitatively and qualitatively the atmospheric particulate matter and certain of the gases. Concentrated research, though, remains to be done on the isolation and identification of certain materials, particularly the hydrocarbons and other organic compounds, which exist in the atmosphere in trace amounts.

**Table 1. Concentration of metallic elements in urban atmospheres in micrograms per cubic meter of air**

| Element | Average values | | |
|---|---|---|---|
| | Detroit | Windsor | Charleston |
| Silicon | 3. 5 | 6. 4 | 8. 7 |
| Aluminum | 3. 2 | 3. 0 | 2. 3 |
| Iron | 3. 0 | 2. 8 | . 8 |
| Calcium | 2. 5 | 7. 8 | 1. 4 |
| Magnesium | . 6 | . 9 | . 4 |
| Lead | . 4 | . 7 | . 2 |
| Zinc | . 4 | . 3 | Absent |
| Manganese | . 2 | . 3 | . 13 |
| Copper | . 05 | . 4 | . 11 |
| Titanium | . 05 | . 1 | . 01 |
| Tin | . 04 | . 06 | . 01 |
| Molybdenum | . 03 | . 05 | . 01 |
| Barium | . 01 | . 07 | . 03 |
| Cadmium | . 01 | . 006 | . 002 |
| Chromium | . 008 | . 02 | Trace |
| Nickel | . 006 | . 03 | Trace |
| Antimony | . 005 | Absent | Absent |
| Vanadium | . 002 | . 009 | Trace |
| Cobalt | . 001 | Trace | Absent |
| Beryllium | . 001 | . 002 | . 001 |

A number of studies of various air pollutants have been made in major industrial areas. Table 1 shows an analysis of the metallic constituents of the atmosphere in three cities: Detroit, Windsor (Ontario), and Charleston, W. Va. (*10*). In each instance, the same methods of sampling and spectrographic analysis were used. It is evident that certain elements such as iron, calcium, magnesium, and silicon constitute the bulk of the metallic elements (80 to 90 percent). It will be seen in table 1 that the elements below manganese generally occur in amounts less than 0.1 microgram per cubic meter. In comparison with the predominant metals, those of lower concentrations—manganese and below—are commonly considered the more toxic. This uniformity of findings, if substantiated by further study, is of great importance in that it indicates a common problem in large and diversified industrial areas.

An interesting comparison of the area distribution of certain elements in Detroit and

Cincinnati is shown in table 2. As might be expected, there is an increase in the total particulate atmospheric load as one moves from the residential section to the center of the industrial area (*11*). Organic matter constitutes the major portion of air contaminants, since the metallic elements comprise only from 5 to 11 percent of the total weight. According to some authorities, the bulk of the organic matter is considered to be gasoline combustion products, organic chlorides, ketones, aldehydes, and organic acids.

Table 3 illustrates the concentration of some organic constituents found in the Los Angeles area (*8*). Insufficient work has been done to determine whether or not a common pattern of organic constituents exists in other areas.

In an air pollution study conducted in Salt Lake City in 1951, the contaminants were collected by electrostatic precipitation rather than by filtration, were accumulated for the duration of the study, and were chemically analyzed. Table 4 illustrates the inorganic constituents according to their relative proportions. Here again is evidenced the same general order of the metallic elements as was found in Detroit and Charleston. The only exception is silicon, which, in this case, dropped from 1st to 6th place. Despite the fact that Salt Lake City is a nonferrous smelting center, the order of the metallic elements is almost identical to that for the Detroit area where the industries are primarily ferrous in nature.

The accumulated material from the Salt Lake City study was split into benzene soluble and insoluble fractions. The benzene soluble and combustible fraction constituted 22 percent of the sample and was assumed to consist of tars and hydrocarbons; the benzene insoluble and combustible fraction (48 percent of the sample) was assumed to be soot and insoluble tars. The difference (30 percent of the sample) was ash or inorganic matter. Comparable data on the organic fractions for other areas are not available. Photomicrographs of the particulate matter collected during the Salt Lake City smog of November 28, 1950, are shown in figure 1.

Weather conditions greatly affect the concentration of atmospheric contaminants. In the Cincinnati study (*11*), it was found that the concentration of the particulate matter was greater in the winter months by a ratio of almost 2 to 1; whereas the number of particles present in the atmosphere increased by a ratio of almost 4 to 1. As is evident in table 3, the degree of contamination by the gaseous material in Los Angeles is much greater on days of reduced visibility than on days of good visibility. The same observation may be made for the particulate matter. For instance, the concentration of all the contaminants, except formaldehyde, shown in table 3 increased by a factor between 5 and 6; the formaldehyde concentration was only doubled. Other studies done in Los Angeles have proved that days of

**Table 2. Concentration of certain elemental constituents in the atmosphere of Detroit and Cincinnati, according to district**

| Element | Average values in micrograms per cubic meter of air | | | | | |
|---|---|---|---|---|---|---|
| | Residential | | Semi-industrial | | Industrial | |
| | Detroit | Cincinnati | Detroit | Cincinnati | Detroit | Cincinnati |
| Iron | 3. 0 | 6. 0 | 5. 4 | 7. 7 | 7. 4 | 12. 7 |
| Aluminum | 3. 8 | 2. 2 | 4. 6 | 4. 0 | 5. 0 | 5. 3 |
| Silicon | 2. 6 | ---------- | 3. 7 | ---------- | 4. 1 | 17. 7 |
| Calcium | 4. 3 | ---------- | 4. 3 | ---------- | 3. 6 | 5. 2 |
| Lead | . 6 | 1. 0 | 1. 0 | 2. 0 | . 9 | 3. 7 |
| Zinc | . 2 | 1. 6 | . 4 | 1. 3 | . 7 | 2. 0 |
| Manganese | . 18 | . 2 | . 23 | . 4 | . 3 | . 4 |
| Copper | . 11 | 2. 0 | . 13 | . 8 | . 2 | 1. 2 |
| Tin | . 03 | . 1 | . 04 | . 1 | . 04 | . 1 |
| Total concentration of all pollutants | 184 | 191 | 279 | 344 | 381 | 472 |

**Table 3. Concentration of pollutants in the Los Angeles atmosphere; maximum values as measured over downtown Los Angeles on various days**

| Pollutant | Concentrations (in ppm) by volume | |
|---|---|---|
| | Day of good visibility | Day of reduced visibility |
| Acrolein | (1) | Present |
| Lower aldehydes | 0. 07 | 0. 4 |
| Carbon monoxide | 3. 5 | 23. 0 |
| Formaldehyde | . 04 | . 09 |
| Hydrocarbons | . 2 | 1. 1 |
| Oxidant | . 1 | . 5 |
| Oxides of nitrogen | . 08 | . 4 |
| Ozone | . 06 | . 3 |
| Sulfur dioxide | . 05 | . 3 |

[1] No quantitative method is known for measuring low concentrations of acrolein.

reduced visibility correspond with certain meteorologic conditions, especially temperature inversions.

Figure 2 illustrates the effect of inversions on the intensity of the Salt Lake City smog. On February 8, 1951 the atmosphere was thermally normal or unstable whereas on February 15, an inversion existed, resulting in atmospheric stability. On both days the wet bulb temperature and wind velocity and direction were of the same order of magnitude. Relative humidity was 55 percent on February 8 and 80 percent on February 15.

From the foregoing, several conclusions may be drawn:

The atmosphere is a great receiver and diluter of civilization's waste products.

It is suspected that there is a relationship between air pollution and certain chronic illnesses in humans although this has never been definitely proved. There is no doubt, however, that under certain combined topographic and meteorologic conditions, acute illness and death in man may occur.

Certain atmospheric pollutants when present in sufficient concentration have definite toxic effects on animals and vegetation.

Atmospheric pollution causes great economic waste and a loss of valuable mineral resources.

There appears to be a remarkable similarity in the qualitative pattern of the inorganic pollutants in large industrial areas which have climatic and industrial resemblances.

Contaminants are largely organic in nature, but insufficient information is available on the organic constituents to conclude that there is a similarity in the organic contaminants in industrial areas.

The degree of pollution in any area is affected by seasonal and meteorologic variations.

### Governmental Activities

There is no legislation governing air pollution on the Federal level although several bills have been introduced into Congress to give Federal agencies, chiefly the Bureau of Mines and the Public Health Service, authority to engage in certain research aspects of the problem. Major Federal activity in the field of air pollution in recent years has been confined to a comprehensive investigation of the Donora disaster by the Public Health Service. Currently, at the request of the International Joint Commission of the United States and Canada, a study transcending international borders is being conducted in the Detroit-Windsor area by the Public Health Service and the Canadian Government (*12*).

At present, almost every State and local in-

**Table 4. Metallic elements in Salt Lake City smog**

| Element | Percent of total sample |
|---|---|
| Aluminum | 2. 5 |
| Calcium | 2. 0 |
| Iron | 2. 0 |
| Magnesium | 1. 0 |
| Lead | . 7 |
| Silicon | . 4 |
| Copper | . 4 |
| Zinc | . 2 |
| Manganese | . 1 |
| Tin | . 06 |
| Titanium | . 04 |
| Molybdenum | . 03 |
| Nickel | . 02 |
| Chromium | . 01 |
| Antimony | . 01 |
| Arsenic | . 01 |
| Barium | . 01 |
| Cobalt | . 01 |
| Vanadium | . 01 |

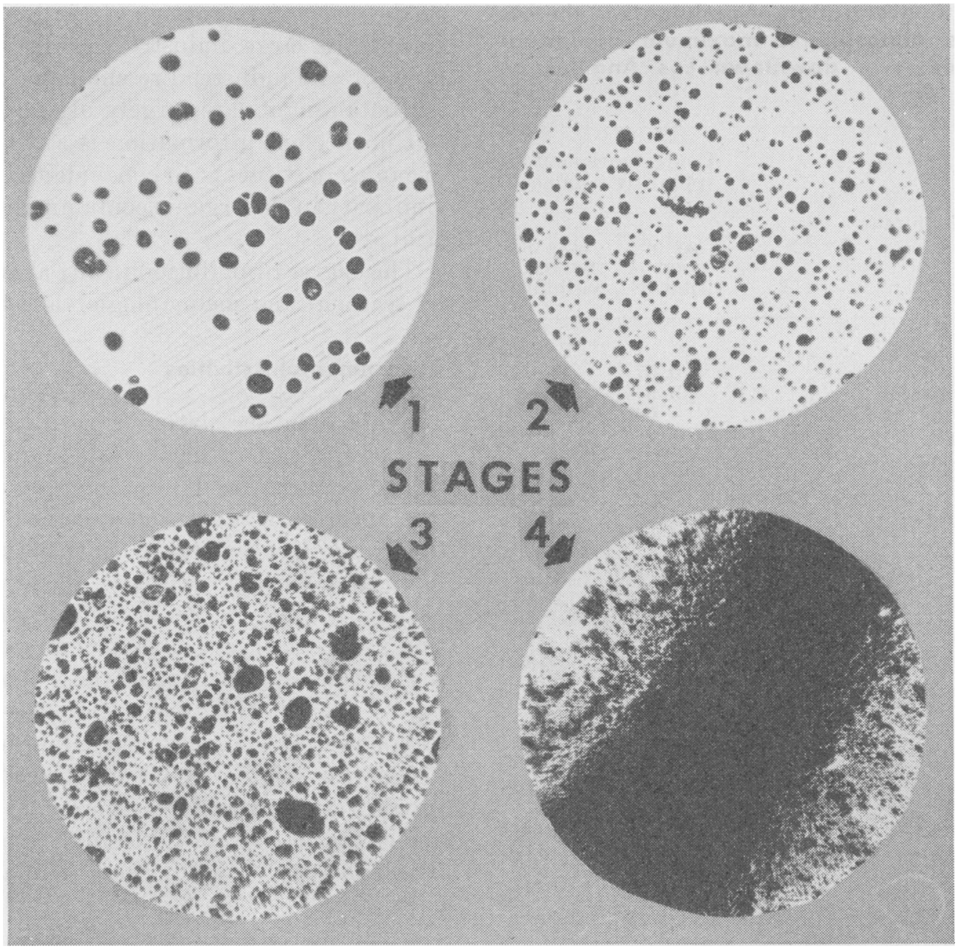


**Figure 1. Photomicrographs (magnification 100×) show the particulate matter collected by a cascade impactor in the fall of 1950 during a Salt Lake City smog. The impactor separates and collects atmospheric particles according to size. Stage 1 shows the larger particles. Stages 2 and 3 show the intermediate size particles—the larger ones visible are probably due to impaction and coalescence. Stage 4 shows the smaller particles.**

dustrial hygiene agency is engaged to some extent in air pollution studies. Industrial hygiene agencies are well qualified for such activities because of their experience and knowledge in dealing with a wide range of airborne contaminants. In many instances, they have had to assume this responsibility at the expense of their regular activities.

Pennsylvania is among the States with a full-scale air pollution program. Since early in 1949, when the Pennsylvania General Assembly authorized funds for the study of the problem, an air pollution unit has been operating within the bureau of industrial hygiene of the Pennsylvania Department of Health. The staff studies technical phases of air pollution problems, conducts investigations wherever necessary, and assists communities in the evaluation of local problems. The air pollution unit is fully equipped with testing apparatus and meteorologic equipment and has a mobile laboratory and apparatus for the determination of atmospheric sulfur dioxide concentrations.

In Maryland, air pollution control constitutes an important activity in the divisions of industrial hygiene of the State Department of Public Health and the Baltimore City Health Department. While specific air pollution legislation has not been passed, the State legislature has appropriated moneys for this work for the past 3 years. Activities of the State unit have generally been confined to investigating local problems created by specific industries. To facilitate its work, the State has available a mobile laboratory and testing equipment. Requests for assistance with air pollution problems have been particularly numerous in Baltimore. During the 1952–53 fiscal year, 70 percent of the 230 complaints received by the Baltimore industrial hygiene unit dealt with community air pollution.

In New Jersey, too, the bureau of adult and industrial health devotes much of its time to air pollution problems. The bureau not only investigates complaints, but also engages in research on methods of sampling. At the same time, it is attempting to bring about a better understanding of the problem by the general public. The bureau is presently conducting a study of the highly industrialized Perth Amboy area. This study is an excellent example of how a State can plan and initiate an air pollution study and maintain the confidence and support of both the public and industry.

The West Virginia division of industrial hygiene recently completed a study in the Greater Kanawha Valley industrial area, which was requested by an industry and citizens' advisory committee, and industrial groups contributed $25,000 to help defray a large part of the cost. The Kettering Laboratory and Institute of Industrial Health assisted in the technical study, and the Public Health Service gave consultant services. The study clearly defined a need for continuing studies and for a long-range plan based on technical principles that would enable the best control possible within the limits of sound economy. The report also emphasized a need for uniform, accurate, and continuing records of emissions to the atmosphere by industry.

The Oregon Legislature in 1951 established an Air Pollution Authority as a part of the State health department. The authority is directed to investigate the extent and magnitude of air pollution in the State and to develop a comprehensive program for the prevention and control of all sources of air pollution.

Air pollution activities are more prevalent on the local level. Many large cities, including Los Angeles, New York, Cleveland, Detroit, and St. Louis, have recognized that smoke control is but one aspect of the air pollution problem and, in addition to previously existing smoke abatement units, have established air pollution control units. Most of these city units are policing agencies, which base their actions on sound technical studies and reasonable standards.

The activities reviewed above are but a few examples of the air pollution work being conducted by various States and municipalities. They are intended only to depict the diversity of activities and illustrate different methods of approach.

Various private agencies have also been active in the field of air pollution. Particularly noteworthy is the fine work being done by the Kettering Laboratory and Institute, the Battelle Memorial Institute, the Industrial Hygiene Foundation, the Lake Carriers' Association, the Manufacturing Chemists' Association, and many universities as well as numerous other organizations. We look to these agencies to develop better equipment for air pollution control and to bring about a better understanding of the problem on the part of industry and the public.

## The Job Ahead

Air pollution is not an insolvable problem. However, its solution is going to require patience, persistence, research, and a mutual understanding among the public, government, and industry. Each can and must play a definite part in bringing about cleaner air for our towns, cities, and metropolitan areas.

The public must realize that it is a part of a modern technologic society and that its continued high standards of living call for full industrial production. The average man must further realize that he too is a contributor to air pollution because of his automobile, his backyard incinerator, and often, because his home heating system is inefficient. The impact of chemical air pollution on our health and resources has been manifested for only a relatively short period. Given sufficient time, the problem can and will be solved. It is not meant to imply, however, that in the meantime a citizen should stand idly by and possibly have his

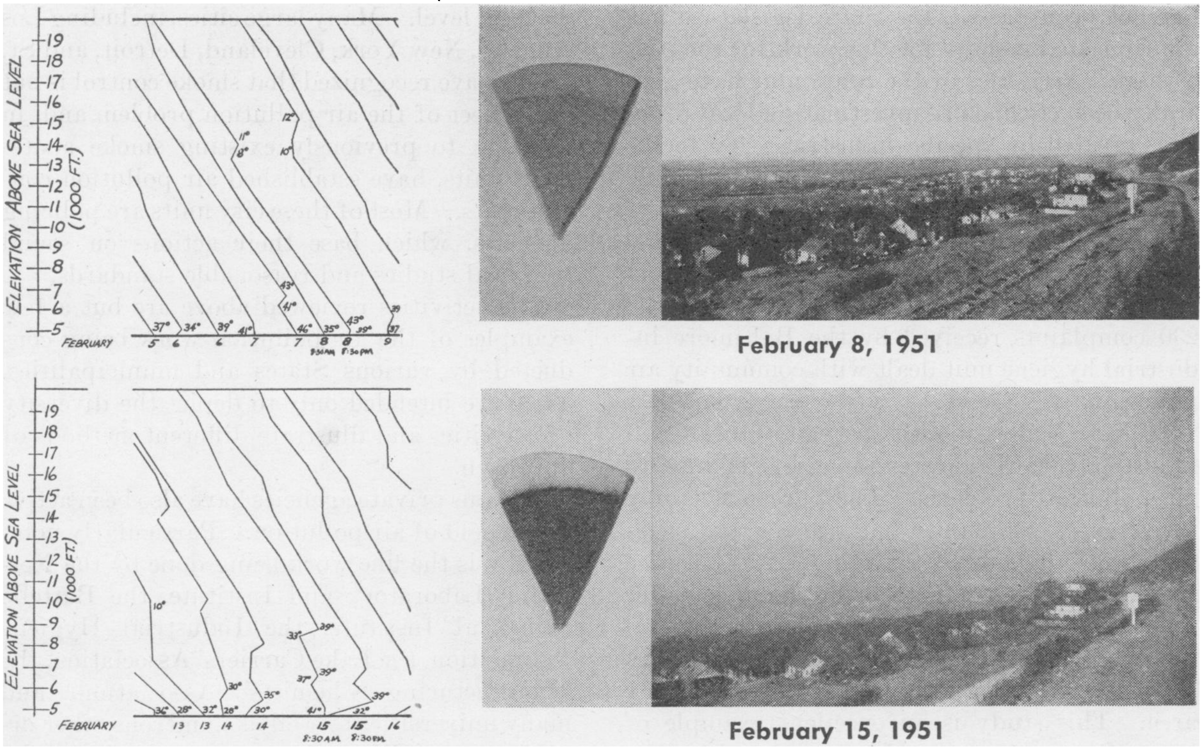


**Figure 2. Illustrations of effect of inversion on smog intensity in Salt Lake City, February 8 (top row) and February 15 (lower row). The graphs show aerological soundings—note inversion on February 15. Next are filter paper samples (volume 450 cubic feet) of smog stain—the February 15 sample is almost black. The difference in visibility on the two days is emphasized by the identical views overlooking the Salt Lake Valley.**

health impaired and his property damaged by an obvious offender.

The municipal and State governments have an important part to play in the solution of this problem. Legislation seems to be inevitable. However, extreme caution should be used at this time in drawing up rules and regulations, particularly regulations placing maximum allowable limits on the amount of a contaminant which could be liberated by an industry or which may be tolerated in the atmosphere. Such regulations may tend to curtail production and are unjustified in the light of present limited knowledge.

Much research is still needed on the health effect of pollutants, particularly combinations of pollutants. In the meantime, studies should be undertaken by cities and towns to define the extent of the air pollution problem and to determine the major sources of contaminants. Necessary steps should then be taken to correct obvious deficiencies. Municipalities need to review critically their zoning laws. It is folly to permit the development of real estate tracts immediately adjacent to industrial areas. Studies should also be made by the community to determine the prevailing weather conditions, particularly wind direction and velocity; community expansion can then be planned so that new developments are not on the downwind side of heavy industrial areas. Likewise, if the processes of proposed new industries are of such a nature that toxic gases and dust are to be discharged to the atmosphere, every effort should be made to place these industries outside the inhabited area and downwind from major population centers.

There is also need for careful analysis of local topographic and meteorologic peculiarities. Communities located in relatively narrow valleys subject to frequent atmospheric inversions are simply inviting disaster when they encourage new industry or industrial expansion. Those industries which are already in the community should be expected to abide by reasonable rules and regulations which have been found to be effective in other areas. Persuasive methods should be used to secure self-initiated corrections on the part of industry. At the same time, the community should realize that it too is quite often a violator of good municipal air pollution standards by virtue of burning trash heaps, allowing the operation of inefficient boiler plants in municipal power generating plants, and permitting inadequate regulations controlling the type of fuel and combustion plants for private homes, apartments, and office buildings.

Industry must adopt the good neighbor policy. A community cannot tolerate a dominant industry. For an industry to be successful, it must learn to live in complete accord with the inhabitants of the community. In selecting locations for future industrial sites, industry must not only consider such items as transportation, availability of raw materials and labor, but it must also add new criteria: topography and meteorology. If toxic chemicals are to be discharged into the atmosphere, it must locate where meteorologic conditions are conducive to the favorable dissemination of smoke and other contaminants unless adequate control of pollutants is assured. Industry must also appraise its stack effluents. It must assure that highly toxic compounds such as beryllium are controlled within narrow limits. This may in some cases necessitate studies to determine the toxicity of new compounds and those metals which have recently gained industrial significance.

Because of the magnitude and complexity of the air pollution problem, the solution must obviously lie in concerted action. An individual industry can rarely afford to engage in specialized toxicologic studies of suspected harmful contaminants. It must therefore draw upon the resources of universities, research foundations and other private organizations, and government. Furthermore, it must accept the community as a partner in a jointly recognized and accepted effort to cleanse the atmosphere of excessive and harmful contaminants. With such a spirit of mutual confidence and unity, we shall be able to cope with the problem before a threatened saturation impels desperate action as in water pollution. Indeed, there is every hope and reason that we can achieve what every citizen is entitled to: an atmosphere reasonably free from chemical pollutants.

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