

AIR POLLUTION IN MINNESOTA

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As an industrial hygiene engineer I am concerned with dust, fumes and gases and other environmental factors in places of employment that might have an adverse effect on the health of industrial workers. Because of this knowledge about air contaminants I am also the end man on many of the problems related to the outside air that come to the attention of our Department. From my vantage point, usually on one end of the telephone, there isn't much doubt that the people of this State are becoming increasingly aware of and concerned about contaminants in the air around them.

My desk is also the repository for the reams of printed matter on the problem in other parts of the country that come to our Department. As I go through the material, I sometimes wonder whether I'm being brainwashed by the deluge into believing that we must have a problem here, too. However, the material does illustrate the variable nature of the problem and makes the point that the air resources in many parts of the country are being severely taxed.

It is our hope today to abstract the information presently available on the nature of our air resources, how we abuse it and the consequences of such abuse. My role as lead-off man is to outline our knowledge of the problem in Minnesota. We can't start without discussing some terms and concepts.

In man's efforts to live with his neighbors it became necessary to spell out the rights of man and his property. The nuisance laws evolved from these rights. Our nuisance laws had their origin in the territorial days before Minnesota became a state. The present Minnesota Statutes say "Anything which is injurious to health, or indecent or offensive to the senses, or an obstruction to free use of property, so as to interfere with the comfortable enjoyment of life or property, is a nuisance." They go on to say that "An action may be brought by any person whose property is injuriously affected or whose personal enjoyment is lessened by the nuisance, and by the judgment the nuisance may be enjoined or abated, as well as damages recovered."

The laws which define the powers and duties of cities and villages say that the "Council shall have power by ordinance to define nuisances and provide for their prevention and abatement." In interpreting the law, a distinction is made between private and public nuisances but the line of distinction is not always clear. If a nuisance has public health implications, the local health officer can take action. These laws sound straightforward until you try to apply them to a specific situation. The nuisance laws need to be rewritten.

Air pollution might be considered a special nuisance condition. It has been defined as "the presence in the outside air of contaminants in such quantities and of such duration which are or may tend to be injurious to human, plant or animal life or property, or which unreasonably interfere with the comfortable enjoyment of life or property, or the conduct of business."

Air pollution may be what I call "localized" or "generalized" for want of better words. An example of localized air pollution would be the emissions from an asphalt road-mix plant soiling the Monday morning wash at the homes down the street, a direct cause and effect relationship.

Generalized air pollution is that which results from multiple sources discharging into a limited air reservoir. The air reservoir might be limited by topography or by meteorological conditions such as a temperature inversion or a combination of both. Our multiple sources might be backyard trash burners, space heating units, automobiles and a variety of industrial sources. Under these circumstances, it is impossible to tell which source is responsible for the effect we find objectionable. Studies in Los Angeles tell us that the substances put into the air are not necessarily the ones that cause the problem - that chemical reactions take place in the air that produce intermediate or end products that cause eye irritation or plant damage or other effects, effects which are frequently out of proportion to that expected from the concentration of the original contaminants. Problems that arise from generalized air pollution do not lend themselves easily to control by the application of the nuisance laws.

I'd like to make a point that relates to the words "of such quantity and of such duration" in the definition of air pollution. Obviously, the level of contamination in the air is not constant day after day or even throughout any one day. Long-termed average concentrations may have significance but generally we are concerned with the condition that exists over the worst ten percent or five percent or even one percent of the time. We might be concerned as to whether the screens on our houses are going to last two years or ten years, but more commonly we are concerned with the damage that sulfur dioxide can do to alfalfa in thirty minutes or the period over which eye irritation occurs or the length of a period of adverse weather. All air samples represent average air concentrations over some unit of time. In examining air quality data, it is important to note the time over which the sample was taken. Knowing this, one can make some valid judgments as to the average maximum concentration over a longer or shorter period of time.

Traditionally, a concern about air pollution was a concern about smoke and control action was aimed at smoke abatement. In this country agitation to control smoke started in the early 1900's. In Minnesota the legislative sessions in 1913, 1917 and 1921 gave cities of different classes authority to control dense smoke. Duluth, Minneapolis and St. Paul had smoke abatement officers in the 1930's. The efforts of such officers across the country were quite futile. It wasn't until 1940 when St. Louis combined the law with public and political support that the first effective smoke abatement ordinance was enforced. St. Louis reduced its smoke density by 73 percent between 1939 and 1946. The results were so dramatic that other large coal-burning cities soon followed suit. In our Twin Cities area the control officers were given a big assist when natural gas became available just prior to World War II and another assist just after the war when our railroads changed from steam to diesel locomotives. Today there is no longer a technical reason to tolerate dense smoke from fuel burning sources but the problem won't go away by itself. Someone estimated that our society produces solid wastes at the rate of 4 to 5 pounds per capita per day and that this will increase to 6 or 7 pounds per capita per day in the near future. Half of this waste is burned in incinerators, back yards and at open dumps. In one out-state community where the burning dump was just beyond the cemetery, I was told that the smoke and odor didn't create a problem in town but it did make it difficult to sell cemetery lots.

As dense smoke came under control it soon became obvious that other contaminants in the air posed serious problems. The Donora, Pennsylvania, episode in October of 1948 demonstrated to this nation that air pollution can kill. Twenty people died during a period when only two deaths were expected. The episode is important to us because the subsequent investigation led to the ultimate involvement of the Federal Government in a progressively increasing program of research into the many facets of the nation's air resources and its use as a receptor for the wastes of society.

About the same time Los Angeles started having periods of severe eye irritation. They had one of their worst periods early last month. The amazing thing is that while their population has doubled over the last twenty years and the number of automobiles has increased threefold, they have been able to stay close to even with the problem. To do this they embarked on a research and control program that cost the citizens of Los Angeles about \$1.20 per capita per year. Up until this year Minneapolis and St. Paul budgeted about 2 cents per capita per year for air pollution control and no other Minnesota community had a control program. Much of what we know today about air pollution stems from the efforts made to resolve the problem in Los Angeles. The continuing documentation of problems in other communities across the nation serves to warn us that we, too, can expect our problems to be intensified.

Between October 1959 and July 1960 a state-wide survey was made in Minnesota to determine the nature and extent of air pollution and to judge the adequacy of control authority and capability at the levels of State and local government. Information was collected through questionnaires to all local health officers, clerks of municipalities and county agricultural agents, through interviews, direct observation, limited air sampling and review of existing sources of data. A report, entitled "An Appraisal of Air Pollution in Minnesota," was released in 1961. Much of what I have to say is based on this report.

First, let me talk about some of our plus factors; factors which lessen the potential for air pollution in Minnesota.

Our weather is determined to a considerable extent by our location in the middle of the North American continent. It is dominated by a permanent polar high pressure area to the north of us. As a result, we average about a dozen weather systems moving through our State each month in the winter and a few less in the summer. In contrast, the southeastern states come under the influence of what is known as the "Bermuda High." This permanent high pressure area tends to stagnate over large areas of the east and south, creating periods of low wind speed and inversion conditions that may last for days. The Donora episode occurred during one of these periods. Likewise, southern California is influenced by the "Pacific High" that extends all the way to Hawaii.

In Minnesota our topography in general is favorable for the dispersion of air contaminants. We don't have mountain ranges that block the flow of air nor oceans that can cause sea-land, land-sea wind reversals that tend to build up pollution loads.

Further, Minnesota does not have fossil fuel resources of its own, at least the peat resources of the north have not as yet been exploited. As a high fuel-cost state, natural gas came early to our Twin Cities area and is gradually extending to other parts of the State.

Lastly, we are just on the edge of the heartland of industrial America. We don't have the concentrations of heavy industry that can contribute so seriously to the air pollution problem. Instead, much of our industry processes agricultural products or produces high value items such that transportation costs are minimized.

To offset these advantages we do have nocturnal or night-time temperature inversion conditions about 40 percent of the time in some parts of the State. On almost any night when the sky is clear and the wind speed is low, the ground loses heat by radiation to the open sky. As the ground cools, the air next to it also cools. In the early evening during leaf-burning time, one can see the smoke rise to a level of 10 or 12 feet and then level out. As the night progresses the depth of the inversion becomes greater. Any pollutant released below the top of the inversion is held in

this mass of air and the concentration tends to build up with time. An intolerable situation may result. Some time after the sun comes up in the morning, the temperature of the ground starts to rise, convection currents are created, the inversion breaks up and the accumulated pollution is dispersed. In some cases under inversion conditions a plume from a tall stack will form a ribbon of pollution in the very stable air and travel for miles. As the inversion breaks, segments of this ribbon may be brought down to the earth's surface creating ground-level fumigations. People in the Highland Park area of St. Paul complained about this condition twice last month.

We have a number of communities in Minnesota that have a greater-than-average vulnerability to a pollution build-up. We would like to know more about the possible effect of Duluth's topography with its 800-foot bluff on one side and the lake on the other. When Northern States Power Company's Pathfinder plant was planned for Sioux Falls, South Dakota, a year-long weather study was made at the plant site in the valley of the Big Sioux River. This valley is about 150 feet deep and a mile wide. It was found that while the average wind speed at the top of the surrounding hills was 10 mph, down in the valley it was only 6 mph. Intense temperature inversions also developed especially in the winter months. One cold morning the temperature was 19° F. colder in the valley than at the hilltop. Many communities along the Minnesota River have valley locations not too different from that on the Big Sioux. On the lower Mississippi River the valley is even deeper. Certainly, this topography is not conducive to the dispersion of pollution. Some of these communities might well be approaching unacceptable levels of generalized air pollution at certain times or their location may place a limitation on the amount of new pollution that can be tolerated. Even the Red River poses some problems. Here the land slopes gently for a distance of 20 or more miles to heights that are 200-300 feet above the valley floor. At night cold air drains down this slope and accumulates in the valley. I've come into Fergus Falls and into Mankato in the morning hours when their respective valleys were filled with haze. I also stayed in Duluth for a month in the fall of the year and could never tell what kind of a day it was going to be by looking out of the hotel window in the morning. From the proper vantage points it is not difficult to see the pollution build up in the morning in the Twin Cities. I've thought that part of the problem here in Minnesota is that our Scandinavian population can't make a good visual appraisal of the situation until they've had their morning coffee and by that time the inversion has broken up and the pollution dispersed.

Further, some of our weather advantage is offset by our winter space heating requirement. Few states challenge this leadership. If southern California had our annual space heating requirement of 8000 degree days, there probably wouldn't be a Los Angeles metropolitan area as we know it today.

We also have a changing economy in the State. Almost all of our recent growth has been in urban areas. During the last census period our Twin Cities grew by 28 percent, that's faster than any of the other 13 metropolitan areas of equal or greater size, except Los Angeles and Washington, D. C. Along with this growth comes an even greater growth in power requirements, industrial and commercial development, and transportation needs. This growth is taking place outside of the political boundaries of the central cities.

On visiting communities throughout the State, I've been impressed with the efforts being made to attract new industry. Industrial parks have been laid out, buildings provided, and other special concessions made. For a community to survive it must grow, it needs payroll and it needs a broadened tax base. Some of the industries being solicited are not going to be an asset to the community. In some cases it would be most desirable to evaluate the air pollution potential of the new industry

and to spell out necessary measures for control before construction is authorized. A few communities have sought our advice in anticipation of a problem but more have come to us after the problem has developed.

In response to a survey questionnaire, fifty percent of the communities with a population of over 1000 (1950 census) reported sources of air pollution and half of these were manufacturing plants. Thirty-three percent stated that complaints were received and 17 percent that there had been damage to property or vegetation. The question of what is air pollution comes up. For example, South St. Paul officials didn't report any sources of air pollution. Further, 210 of the 240 communities with a population greater than 1000 used dumps for either garbage or refuse or both. One hundred eight-three permitted burning at the dump. Still only 24 communities reported complaints from this source. Only 29 communities prohibited backyard burning and this was chiefly a fire control measure in the northern forest area.

Much of our out-state manufacturing industry is related to agriculture. Many creameries have outmoded heating plants and create smoke problems. There were many complaints about milk-drying plants - milk solids are hard to remove from automobiles and from plate glass store windows. Fertilizer plants emit dust that is hard on TV antennae and other household hardware and occasionally there is a loss of ammonia gas to the neighborhood. This past summer we had numerous complaints about the new aqueous ammonia fertilizer storage tanks. Canning plants frequently have odor sources such as lagoons. Alfalfa dehydrating plants release both dust and gases which pose a real problem to some people with asthma or respiratory disease and a housekeeping problem to others. You will note that the things I mentioned are all point sources of air contamination, sources that can be related directly to an effect. These are the things people complain about. There are many other point sources in the State not related to agriculture.

The survey questionnaires gave little or no information on the problem of generalized air pollution, the pollution that results from multiple sources discharging into a limited air space. Information on the trend toward urbanization and the associated growth patterns and projections give some clues to the generalized air pollution potential in some local areas of the State. Limited air sampling during the winter months of the survey in Duluth, Fergus Falls, Minneapolis, St. Paul and on the roof of the State Board of Health showed comparable levels of generalized air pollution in these communities although the levels tended to be highest in Duluth and Fergus Falls. Duluth, St. Paul and our State Board of Health station have been part of the National Air Sampling Network for a number of years. This provides an opportunity to compare Minnesota findings with those in about 200 other communities across the nation. Moorhead joined the network last year. Samples were also collected in Grand Marais as a non-urban station for three years. At the State Board of Health station measurements are also made for soiling effect and for the gaseous contaminants, sulfur dioxide and nitrogen dioxide. More air quality data are available from the Asthma-Grain Dust study being conducted by the University of Minnesota and more will be available from the recently expanded control programs in Minneapolis and St. Paul. Although the air quality findings in Minnesota are limited, they do not justify a sense of complacency about our situation.

Regardless of whatever other effects may result from contaminants in our air, the ultimate concern is with the possible effect on human health. It is known that air pollution has caused acute illness and even death, especially during periods of adverse weather conditions. While these episodes are dramatic they don't tell us very much about the long-termed effect on health. However, there is a growing body of information tending to establish a relationship between air pollution and chronic illness. It is suggested that air pollution may account in part for the "urban

factor" in morbidity and mortality statistics. As communicable diseases are brought under control, more and more people are dying of chronic illness. Last year heart disease accounted for 38 percent of the deaths in Minnesota. The problem may be how much added stress does air pollution create for the person with heart disease. The same might be true of emphysema, bronchitis, lung cancer and asthma. It is possible that in some cases air pollution is the major causative factor. The British believe this is true for their high incidence of chronic bronchitis. Polycyclic hydrocarbons which have a capability of causing lung cancer have been found in air samples collected in Minnesota. A study committee of the City Council of New York City recently concluded that the presence of one of these compounds (3, 4 benz pyrene) was such that breathing that city's air was equivalent to smoking two packages of cigarettes per day. A comparable number for the air of Minneapolis would be seven cigarettes per day. Since 1960 the University of Minnesota has been involved in a study of the relationship between grain industry pollutants and asthmatic response in University students. Someone suggested that living on the University Campus for four years might be just long enough for some individuals to become sensitized to grain dust. It would be dangerous to wait until we have uncontested proof of the effect of air pollution on health before taking remedial action.

The survey revealed some political aspects that complicate the picture. First, most communities are limited by law to controlling air pollution that is judged to be dense smoke or to act under an authority to control nuisances. While the nuisance laws are broad, they are not designed to cope with problems of any complexity. Secondly, air pollution problems tend not to recognize political boundaries and the laws governing interjurisdictional problems are vague at best. Thirdly, metropolitan areas need some special consideration to aid them in solving area-wide air pollution problems. And lastly, the recognition, evaluation and control of many air pollution problems call for a competence that doesn't exist in most communities. There is a need for technical leadership and specialized equipment resources at the State level to assist in the solution of problems at the level of local government.

It was my purpose this morning to give a quick over-all look at what's happening to the air resources of Minnesota. Subsequent speakers will enlarge upon the State and national picture and delve into the technical aspects of the problem in more detail.