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Maintenance of Air Quality Through Performance Standards

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THE PRIMARY OBJECT of air quality standards is to reduce the day-to-day pollution of the urban atmosphere. To the extent that they accomplish that aim they are good and practical. To the extent that they fail to reduce pollution and any possible hazard they are inadequate or impractical.

There would appear to be universal agreement that uncontrolled air pollution is bad for many reasons, including possible resultant human illness, economic loss, plant damage, and soiling. After that general statement, universal agreement ends. As is so often the case, disagreement is based on the lack of evidence or its disputability.

No matter how conventional air quality standards are defined[1] or to what purpose they may be put, they require numbers. These numbers must not only be correct and derived from reliable experience, they must be relevant to the actual situation. The economic and other consequences of enforcing standards which were found ultimately to be unjustified would be considerable. That economics is considered does not imply that dollars are more important than human lives but is merely recognition that the health of a modern society is a frail and complex matter and not solely related to human health.

In this paper the term "conventional air quality standard" refers to environmental exposure standards as exemplified by the California air quality standards.[2] Several problems have arisen in the derivation of conventional air quality standards which are difficult enough to stand in the way of the acceptability or practicality of these standards in at least the immediate future. These problems are true not only of air pollution but of the other environmental hazards of urban life. But the hazards are real and immediate and their control is necessary before such numbers may be available, and thus the control may have to be achieved in some other manner. One such alternative is the use of environmental performance standards in combination with land zoning.

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Deficiencies of Conventional Quality Standards

Much skepticism has developed concerning conventional air quality standards. The following discussion deals with some of the origins of this dissatisfaction. While the examples used come from the area of human health, the experience reported (at the Michgan Seminar on Air Quality Standards[3]) would appear to justify similar arguments in other areas of air pollution effects.

The difficulties in obtaining evidence on which to base air quality standards derive both from the nature of the hazard and the nature of the supposed effects.[4]

Air pollution is ubiquitous. It may be present throughout the lifetime of the individual but it is not constant in duration or degree. The noxious agents themselves may have many parts which coexist in varying degrees and may interact with variable result. Therefore, determining the exact nature of the exposure of an individual is, at best, difficult, and without knowing the exposure it is difficult to relate illness to the exposure in more than a general way. Such general correlations would be of little use in producing the exact numbers necessary for establishing air quality standards. Experimental exposures have produced much of the present information on the health effects of air pollution. Almost always, the effects found in the laboratory have required amounts of pollutants far in excess of those found in ordinary urban air.

Aside from the quantitative differences between the experimental situation and urban air, the complex interactions occurring in the natural situation are not taken into account. In only one situation has the naturally occurring problem lent itself to the establishment of numbers that could be used to formulate a conventional air quality standard—that is, of course, the oxidant mixture occurring in the Los Angeles type of "smog." There, eye irritation can be directly correlated with certain levels of oxidant, as can impaired visibility. However, the measurement of "oxidant" is a recognition of the complex interactions occurring in the natural setting and gives some indication that it may be futile to set standards for individual pollutants in other situations.

Other than this case of "oxidant" and eye irritation in Los Angeles, no situation exists where a readily identifiable symptom can be correlated directly with a pollutant in its natural occurrence.

It is conceded generally that the difficulties in deriving numbers suitable for use as conventional standards are considerable and will continue to be considerable for some time to come. So difficult in fact, that even the California standards, which represent the best attempt thus far, are more remarkable for the paucity of numbers than for their presence. Would there be California standards if it were not for the somewhat special Los Angeles situation? The setting of standards is always difficult initially and if the paucity of evidence were the only problem with the present standards then we would have to be content with what is possible, and strive for further evidence.

But the lack of available evidence is not the only problem; another is the *effect* of conventional air quality standards. When the standard is exceeded one concludes that a menace exists and that remedial action is required. In essence it is a statement of a danger that has already occurred and, as such, can do nothing directly to reduce the already present danger. Action, brought about because the standard was exceeded, may prevent an increase in the hazard and may indeed bring a reduction to lesser levels but cannot directly prevent the hazard in the first place. Such conventional standards are statements of things past. I am aware, of course, that the repetitive occurrence of adverse or other levels as defined in the standards will cause indirect preventive action through aroused public opinion and legislation, but such action is like the proverbial closing of the barn door after the horse is out. In areas where levels can reach those set by the standards, a bad situation already exists. The fact that the standards are exceeded attests to the seriousness of the situation.

To insure that the levels set are not exceeded, constant monitoring of the atmosphere is necessary. It is not sufficient, as in the case of water, to determine from time to time whether the allowable levels have been exceeded. Since in air standards the dimension of time has been added, monitoring must be such as to take into account the time factor. Monitoring stations are complex and expensive. They must be operated 24 hr. a day, 7 days a week. They are subject to considerable technical failure and obsolescence.

There is another, and more crucial, problem involving monitoring of the atmosphere. The level of pollutant determined at the monitoring station is not necessarily the level present at *any* point removed from the station. Levels a few thousand feet removed may be significantly higher or lower than at the monitoring station. In other words, the standards may be exceeded without anyone's knowledge for a number of major technical reasons. Recently, in one of the largest cities of the United States, California "adverse" levels were detected intermittently by an experimental monitoring station for almost 2 weeks before the municipal stations detected the same degree of pollution.

When localities adopt standards, they tend to adopt those set by other areas. Particularly in air pollution, these standards may not be adequate to the industrial or agricultural needs of the new locality.

While the technical problems can be solved, the inherent difficulties in air quality standards, as exemplified by the California standards, remain.

Summarized, the problems of these conventional standards are as follows.

1. They are difficult to set because of the difficulty in obtaining evidence relating specific pollutants to specific hazards.

2. They attempt to define in individual terms a chemically dynamic situation.

3. They define a hazard that has already occurred rather than prevent the occurrence.

4. They are subject to numerous and considerable technical difficulties.

5. They are difficult to adapt from one geographic region to another.

It appears reasonable to explore other methods of air pollution control.

Environmental Performance Standards

The major advance in air pollution control in recent times has been the almost universal acceptance that the air, just as water and wood, is a resource—that it is a resource with limits in its ability to contain wastes and to transport wastes from areas of high contamination to areas of low contamination. Unlike water, air is not subject to storage and it cannot be piped in as the need exists. In addition, the individual does not have much option in the air he uses. But there are other concepts of the air resource that are necessary to air pollution control.

I think that it can be shown that the concept of performance standards is applicable to air. A performance standard is a predictive guide to the ability of the object in question to tolerate a load without failing in its performance. For example, instead of specifying that a floor shall be built of so many members of such and such dimension, it is sufficient to specify that the floor must be able to withstand a stated load. The means of accomplishing the performance is left open.

An example of an environmental performance standard would be the ability of a body of water to disperse a stated load of waste. Such a standard implies that any amount of waste below that load will not build up a progressive concentration in the water.

While the capacity of the air to handle pollutants dumped into it is limited, the capacity varies widely from one area to another. Just as water may flow rapidly or slowly in high or low volume, similarly the turnover of the air varies from place to place. The dynamics of air turbulence describe the ability of the air to cleanse an area by describing its ability to carry off pollutants. Just as turbulence usually provides greater volume for the dispersal of pollutants, so does the trapping of air reduce the volume for carrying off airborne waste. The phenomenon of inversion, with which we have all become familiar, provides the most marked example of a trapped atmosphere with low pollution dispersal.

Prediction of Pollution Dispersability by Air

The dynamics of air movement have been studied in considerable detail for many years by meteorologists as part of weather prediction. For this reason there exists a large body of information describing air movement over various regions of the United States, permitting a fairly reliable estimate of the air pollution potential of these regions. In addition, these dynamics of air motion are generally characteristic of a region much as its terrain and thus can be taken into account in planning for the best use of the air resource for an area.

Of great importance in this conception of the air resource is the fact that changes in mass air flow (and therefore waste dispersal ability) are generally grossly predictable. There are estimates of how often during a given time period an area is liable to experience stagnant air conditions. Such predictability has made possible the successful inversion warning systems which are in use in areas like Donora, Pa., to prevent recurrences of the famous disaster.

The over-all regional meteorologic pattern is influenced by variations in local terrain, whether the terrain be natural or the result of the building activities of man. Although less is known about the micrometeorology of cities, progress is being made and the technology is available for detailed surveys of their microclimate.[5]

Discussed earlier in this paper and well known is the fact that pollutants dispersed into the atmosphere interact among themselves to form new products and even different physical forms. These reactions do not stop with the production of "oxidant" but continue as long as reactants are available. It is not possible, therefore, to see the air resources as a pot of limited capacity that is becoming progressively more full of sulfur dioxide, (for example) and which will eventually become so full that the highest standard will be exceeded everywhere.

While these interactions provide a major barrier to establishing conventional air quality standards they provide a cleansing effect in the over-all air mass. The cleansing effect is not noticeable in the stagnant atmosphere of inversion but is apparently applicable to the huge over-all air resource.

Therefore, it is possible to look at the air resource as made up of dynamic and variable parts which differ from area to area but which are reasonably constant in pattern for any particular area. In addition, the air resource has certain self-cleansing aspects.

Finally, changes in the ability of local air mass to disperse airborne pollutants can be predicted sufficiently in advance to prevent the build-up of pollution by shutdown of the sources.

From the foregoing it can be seen that the ability of the air to ventilate an area can be described and predicted and can fit the concept of performance standards.

Prediction of Pollution by Source

It is necessary next to show that the amount of pollutant produced by any industrial process can also be predicted.

It is possible and common to determine the amount of pollutant that will be emitted from industrial processes operated at different efficiencies. This can and has been done for sources as varied as home heating, automobiles, and blast furnaces. It is possible to identify prior to installation what forms of pollutants can be expected to emerge from the process contemplated.

Air pollution is a by-product of industrialization and urbanization but it is not the only undesirable by-product. Noise, vibration, noxious odors, traffic, crowding, and transportation difficulties are all concomitants of the growth of cities.

Any attempt to control air pollution should take into account the relationship of these other problems to air pollution. For example, when a major housing development is planned, it is usual to consider the increased burdens on school, transportation, traffic, and other facilities. Now, in addition, it should be necessary to consider the previous status of air pollution in the area and the ability of the local air mass to handle the changes in the load imposed by the concomitant changes in automobile traffic, heating, and supporting pollutant-producing activities, as well as changes in the terrain.

Historically, the principle of zoning has been used to control many of these problems. While originally categorical in their statements of desirability and undesirability, recently zoning ordinances have been developed with greater flexibility. It appears reasonable that the principle of zoning can be extended to include the control of urban pollution. The additional designation of the air performance standard for the zone would determine, in addition to the other deciding factors, what load of airborne pollutants could be tolerated under varying conditions. The number and type of pollutant-emitting activities is irrelevant as long as the total load is not exceeded.

Air pollution control therefore should be a part of the other controls that guide the use of land and the changes and growth of cities and industries.

The place of zoning in air pollution control has also been described by Ingram, who said:

> Studies which establish the behavior of pollutants in the atmosphere could be used most effectively to establish zoning districts which would be favorably located to provide a minimum of effect on air of a neighborhood and maximum of pollutant dispersal. Zoning regulations could be used to establish patterns of building configuration and bulk to reduce adverse effects in the immediate area.[6]

Conclusion

This paper has described the background necessary to a concept of the control of air pollution through zoning and the formulation and use of air performance standards.

In general the purpose of such zoning would be to prevent the build-up of levels of air pollution in any area. The essential elements are:

1. The degree of cleanliness of air that is desired (It is not necessary that each area have the same requirements for pollution concentration. For example, where orchid raising is an industry, levels of ethylene lower than might generally be tolerated are necessary.)
2. The knowledge of the ability of the air mass of an area to disperse pollutants
3. An ability to predict changes in this rate of dispersal
4. An acceptance of the necessity to alter operations in an area when the rate of dispersal falls
5. A knowledge of the emission rates of the contemplated pollution-producing activity
6. An acceptance of the fact that industry is not the only source of pollution and that all activities that disperse waste into the air must be taken into account—including, for example, allowable traffic density
7. Recognition that confluent air masses for zoning purposes do not follow city, state, or even national boundaries and that, therefore, cooperation across these boundaries is essential

The mass of evidence and technology necessary for control of air pollution on this basis is already present. The acquisition of further evidence and technology is considerably less difficult than the acquisition of the evidence necessary for conventional standards.

No new problems are created by air performance zoning, and the major difficulties inherent in this method are present in any air pollution control method—namely, the necessity for interagency cooperation and the necessity for cooperation across political boundaries. The technical advantages are great, but the other advantages are more important. It is a method of control inherently and directly related to the prevention of pollution build-up and not merely one indicating past error, as in conventional standards. It is inherently more enforceable since it is directly keyed to emission rates.

Zoned air pollution control is fairer to industry for several reasons. For new industry it allows choice of production methods and location based on calculable economic variables, including the approximate amount of expected shutdown time due to changed meteorologic conditions. For established industry it provides defense against expensive changes in methods necessitated by the appearance of new and unexpected sources of pollution in the same area.

For the inhabitant it is better because the control of air pollution is related to the control of the other noxious by-products of his urban existence.

That this method of control requires extensive and difficult interagency cooperation is a problem which must be solved for many reasons besides air pollution.

Summary

The difficulties inherent in conventional air quality standards as exemplified by the California standards have been discussed. They are: (1) Present evidence relating specific pollutant levels to specific effects is inadequate. (2) They indicate a problem already present rather than prevent the problem. (3) A number of major technical problems are associated with their use. (4) They attempt to define in individual terms a chemically dynamic situation. (5) They are not related to the other interrelated problems of industrialization and urbanization.

The concepts of the air resource, air performance standards, process emission rates, and zoning principles necessary to air pollution control are presented. The arguments in favor of air pollution zoning are advanced.

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