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PERFORMANCE STANDARDS IN INDUSTRIAL ZONING*

The expression "performance standard" is taken from building code terminology. Modern building codes are written more in terms of what materials and methods of construction will do - their performance under stated conditions - rather than in specific descriptions of materials and building methods. This change has been forced on building commissioners because of the great number of new materials and designs that have been brought out in the past ten or twenty years.

The situation in zoning is similar. Zoning administrators are asked to rule on new land uses, and on new - and improved - forms of old uses. Our factories are making new products, are using new production processes, and are taking on a new appearance. The buildings are kept to a single story. They are placed well back from the property lines. Factory grounds have neat lawns and beds of flowers. The buildings are windowless and air-conditioned. Many modern industrial plants would be an asset to many residential districts. Our zoning ordinances need re-working to catch up with our industrial techniques.

Our building codes have passed through three stages. In the first, or primitive, stage, for example, the code said that a party wall should be made of brick or stone. It was soon found that there are brick walls and brick walls. Some of them withstand burning and some do not. It was necessary to state how you wanted the wall constructed and how thick it should be. This was the second stage, the specification code. Then along came builders with new materials: monolithic concrete, cinder block, and so on. They were faster and cheaper to build, and the proponents claimed they would furnish all the protection we sought.

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*This paper by Dennis O'Harrow, who has been serving as Director of Planning, Youngstown Comprehensive Plan, and who returned to the ASPO office November 1st, was one of the major highlights of the recent National Planning Conference in Pittsburgh. With a table added, it is being published as a PLANNING ADVISORY SERVICE bulletin. The editor believes this to be one of the most important contributions to zoning in a number of years. (WHB)

When we stopped to think, we found that we actually didn't care what the wall is made of - brick, concrete, steel or tissue paper - so long as it is fireproof. So we established a performance code. The party wall must be able to retain its strength and block off a fire produced under laboratory conditions. The fire reaches a temperature of 2,000° Farenheit in two hours. If the material holds up in this test, it is permissible to use it in building a party wall.

Some parts of our zoning ordinances have reached the specification stage - side yards, for example. We don't say "side yards must be furnished," which would be the primitive stage. Instead, we say "there will be two side yards, each of which will be not less than five feet in width." This is a specification standard, because we have specified a minimum acceptable width. It is not yet a performance standard. We haven't said what we want the house to do, which is to assure adequate light and air to its neighbor, nor have we set up an accurate definition of "adequate light and air."

While parts of our zoning ordinance have progressed to specification standards, there are still parts that are back in the primitive stage. Especially is this true of our method of handling industrial zoning. The clause that is best evidence of this primitive stage is probably somewhere in 99 per cent of existing zoning ordinances. It goes

> "...and any other use that is not objectionable because of the emission of dust, odor, noise, excessive vibration or other nuisances."

It is not necessary to go into detail on the weaknesses of such clauses. All of us have recognized the weaknesses and we want to overcome them. Almost universally we have tried to overcome them by setting up groups of uses that we think have about equal powers of nuisance generation. We have outlined districts for "light" and "heavy" industry, but, for the life of us, we can't give a clear definition of "light" and "heavy." In some cases, we have limited the horsepower of individual machines - on what justification it has never been clear, except that someone else had done it before. Sometimes we have limited the number of employees, saying that a laundry employing five persons is a business and will be permitted in a business district, but that a laundry employing six persons is an industry and we cannot allow it.

In some places we have improved upon our primitive standards by granting conditional use permits. We shall permit the industry to locate in the district it requests if it fulfills certain conditions regarding the handling of dirty materials, off-street loading, paint spraying, sandblasting, and so on. Where discretion is vested in a zoning administrator, as it is in Los Angeles, we have been able to liberalize the unyielding provisions of our zoning ordinances in this manner.

It is not intended to leave the impression that our attempts to change from a primitive ordinance to a specification ordinance are without value. Although we

can go a long way in writing performance standards into our zoning code, there are several fields in which we will have to continue specification standards for many years to come. Again we parallel the modern building code, which uses performance standards as often as possible, but still carries a list of specifications for items on which performance standards are either not available or not practical.

However, we can move out of the primitive stage at many points in our zoning regulations. This discussion will be confined to zoning for industrial uses, but industrial zoning is only one part of zoning control. We can do much to advance zoning by a critical re-examination of all parts of the ordinance.

We need a more complete definition of performance standard. The ideal zoning performance standard will substitute a quantitative measurement of an effect for the qualitative description of that effect that we have used in the past. It will not use the terms "limited," "substantial," "objectionable," "offensive." Instead, it will establish definite measurements, taken by standardized methods with standardized instruments, to determine whether the effect of a particular use is within predetermined limits, and therefore is permissible in a particular zone.

This paper will review briefly the outlook for standards in those important fields in which they are lacking; state briefly what the performance zoning ordinance may do, and finally, suggest how we may advance toward making these performance standards available for our zoning ordinance revisions.

There are eleven fields in which we need to look for performance standards for industrial zoning. These are:

(1) Noise
(2) Smoke
(3) Odor
(4) Dust and dirt
(5) Noxious gases
(6) Glare and heat
(7) Fire hazards
(8) Industrial wastes
(9) Transportation and Traffic
(10) Aesthetics
(11) Psychological effects

(1) Noise. The possibility of setting up performance standards for noise appears both hopeful and difficult. It is hopeful because acoustical research has in the past few years come up with some new techniques for measuring noise, and with a new unit of noise called the "sone." Many of you have heard of the older unit, the "decibel." This is primarily a measure of the pressure created by sound waves, and will not be superseded in the measurement of the strength of individual tones. But the technical difference between "sound" and "noise" - particularly the difference between the decibel measurement of sound and the loudness of noise - is a subject that you want to approach only when you are in the pink of mental condition. The outlook is hopeful because of the work that is now being completed in Chicago by Professor G. L. Bonvallet of Armour Research Foundation. Professor Bonvallet has taken enough measurements of the kind of noise that

we are interested in - street and traffic noise, industrial noise, transportation noise - so that he will soon be in a position to give us limiting spectra for noise.

The control of factory noise through zoning is also hopeful because the most effective means for the muffling of noise is a tool that we have used in zoning for some thirty-five years - setback. Noise is decreased approximately as the square of the distance. If the noise of a factory is a certain figure when you stand at the property line, move the factory twice as far away and the noise will be down to one-fourth the former intensity. (Don't be too quick to believe that objectionable noise at ten feet has dropped to a whisper at twenty feet. Common sense tells us that isn't true. Noise measurements are on a logarithmic scale, and loudness drops slowly in the upper brackets.) But setbacks from property lines give us an extremely useful control for noise. And noise gives us another excellent excuse for setbacks.

The discouraging aspect of performance standards for industrial noise is that factory noise - the noise from industrial processes - is not the objectionable part of industrial noises in 95 per cent of our factories. This was first brought out in the famous New York City noise survey of 1930, in which factory noise was considered objectionable in only 1 per cent of the cases. This finding has been reaffirmed several times, most recently in the Chicago noise survey. Objectionable industrial noise is overwhelmingly due to traffic and transportation noises - trucks coming from and going to the plant, steam locomotives puffing and diesel engines thundering, box cars switching and gondolas banging, thousands of self-propelled employees changing shift. The chance of controlling this type of noise through a performance standard on noise generation is not good.

Nevertheless, we are going to have to approach our problem from all angles, and one of these angles is noise. At least 5 per cent of our factories do create objectionable production noise in addition to the traffic noise they spawn. Any factory noise adds to the overall noise pattern. It appears that we are ready to set up definite standards in this field.

(2) Smoke. The second in the list of needed performance standards is a limit on smoke emission. Here we are in unusually good shape. Because of the strenuous work that has been done in smoke control over the past decade, we have excellent standards and simple methods of measurement.

There are two instruments for measuring smoke: the Ringelman chart and the umbrascope. The simplest and most popular is the Ringelman chart. On this chart are five designs, each representing a degree of smoke density. When you are far enough away from the chart, the designs merge into shades of gray, all except No. 5, which is solid black. The shades are numbered from 1 to 5. Multiply the number by 20 and you get the percentage density of the design. Thus, No. 1 is 20 per cent, No. 2 is 40 per cent, No. 3 is 60 per cent.

The model smoke control ordinance forbids the emission of dense smoke, and dense smoke is defined as equal to Ringelman No. 2 or darker. Afew ordinances set the limit at Ringelman No. 3 or darker. We thus have our performance standard on smoke emission already worked out for us. All we have to do is to apply it.

There are, of course, some problems in bringing the smoke standards over into the zoning ordinance. For example, if our city smoke control ordinance forbids smoke more dense than Ringelman No. 2, we may want also an area in which we set No. 1 as the limit, or an area in which we specify no smoke whatsoever, requiring gas, oil or electricity as a fuel. However, there is no doubt that we are ready to drop smoke from the ubiquitous list of undefined nuisances and substitute the clear definition that we have available.

(3) Odor. Thus far, there have been readily at hand some well-tested standards of measurement. In the field of olfactory offenses, we have to proceed cautiously.

Smell (and its concomitant, taste) is perhaps the most subjective of our sensations. You just can't measure odor. You can't even describe it, except to say that it smells like some other odor, or that it is pleasant, indifferent, or horrible. Odors have been classified in dozens of different ways. Numerous tries have been made to determine odor profiles, but none of them has quite come off. There are now some experiments under way to place odors in the electromagnetic spectrum. These experiments show promise, but results thus far are not usable.

One approach to odors is through measurements of the threshold of smell, which are available for a considerable list of compounds. These measurements show the minimum concentration to give the first sensation of odor. Measurements are made in ounces of the substance per thousand cubic feet of air. For example: .0011 ounces of hydrogen sulfide, the familiar "rotten egg" gas, in a thousand cubic feet of air, is the minimum concentration that can be smelled. Less than this concentration we cannot perceive. There is a wide variation in the amount of different substances needed for the threshold of smell. It takes .05 ounces of butylene beta, which is the warning odor used in illuminating gas. It takes only 18 millionths of an ounce of ethyl seleno mercaptan, which seems to hold some sort of position as the foulest of all smells.

A great many substances have had this odor threshold determined. A list of several hundred, mostly for polysyllabic organic compounds, included, however, only one of the compounds that constitute the peculiar odor that arises from a fish-processing plant. This investigation of odors has not exhausted current knowledge on the subject. At any rate, the list is too long to include, except by reference, in the ordinary zoning ordinance. Even if accurate measurement of odor is not now possible, it is only a question of time before it will be. In the meantime, we have some empirical methods open to us.

There are very few industrial activities in which offensive odor cannot be prevented from escaping. The odor from our old friends the glue factory, the

slaughterhouse, and the fish cannery can be completely eliminated - at least as far as escape into the atomosphere is concerned. On the other hand, there seems to be no prospect, present or future, for the elimination of the odor nuisance from a stockyards. In the doubtful list we would also have to put petroleum refining, artificial gas manufacture, and rubber manufacture. Probably, our best approach to the odor problem is to bar no industry by name, because of its odor nuisance. Instead, we would specify that in a certain district, we shall permit no industry to locate that commits an odor nuisance. Then perhaps we should have a check-list of industries that have traditionally smelled bad. We would specify that these industries must present detailed plans to prove that they are going to eliminate the odor, or we won't let them operate in this district. Of course, we must not forget that if there are some industries not yet able to eliminate odors, they must be located somewhere. We must have a district permitting them to be erected in some, if not all, of our cities.

(4) Dust and dirt. The fourth in the list of needed standards is one for dust and dirt. The most frequent source of dirt from our industrial sections is the smoke-stack, blowing cinders and fly ash into the air. Here again, we have the work of the smoke-abatement pioneers. They have definitely stated that they would not tolerate fly ash in excess of "0.3 grains per cubic foot of flue gas at a stack temperature of 500° Fahrenheit." This standard would not be difficult to incorporate into our zoning regulations. Again, we may wish to set different limits - such as .2 grain or .1 grain.

As for other kinds of dust and dirt, there are at present no standards to determine a permissible amount of pollution. Here, the solution may be the same as that suggested for odors. We would not list any industry by name. In those districts that we wish to keep free of dirt, we would require satisfactory proof that an industry will be able to keep all dust and dirt confined within the walls of the building. If there be any industry which cannot keep its dirt to itself, we'll need to find a district for it somewhere - down-wind. However, there is probably no industry conducted within a building that nowadays needs to pollute the air with dirt.

(5) Noxious gases. By noxious gases is meant those gases which are relatively odorless, but which can, in sufficient concentration, be dangerous to plant and animal life. Hydrogen sulfide, the rotten-egg gas that was mentioned previously, is quite poisonous. But, like the rattlesnake, it warns you before it strikes; the unmistakable smell telegraphs the presence of hydrogen sulfide in advance of toxic proportions.

When we are considering our standards for zoning ordinances, we should not forget that there is another body of law that is always in operation - the law of nuisance. While this research on the subject, to a layman, leads to the belief that it is all quite unclear as to what is nuisance and what is not nuisance, there is no doubt that the discharge of a poisonous gas in toxic quantities is definitely a nuisance. As such it will be promptly abated. Therefore, it is probably unnecessary to concern ourselves with clear nuisances in zoning.

One way of looking at our zoning regulation of some of these matters is to say that we are trying to regulate processes so that they never become nuisances. Standards for toxic concentrations of gases are easily available. Carbon monoxide, for example, is dangerous to human life at about 2,000 parts per million. The maximum safe concentration permissible in plants is set at 100 p.p.m. This is about the concentration found on a heavy traffic street.

Although we might prefer to forbid the release into the atmosphere of any noxious gas, it is unlikely that this can be accomplished. We may have to relegate the poison gas producers to the same district as the odor producers. The work we need to do here is to examine industries that are noxious gas producers, to see whether the escape of such gas can be completely eliminated. If it cannot, then we have at hand definite standards - that should be comparatively easy to adapt to zoning regulations.

(6) Glare and heat. The steel industry is the most spectacular producer of glare and heat. To watch a Bessemer converter blow off from some safe distance does not offend you. On the contrary, it fills you with awe and respect. Living close to it is not nearly so thrilling. The intensity of the light at night is great enough to make the neighborhood within several blocks as light as day. But the establishment of new blast furnaces and Bessemer converters is infrequent enough, and it presents so many special problems, that the glare and heat nuisance will never be a crucial consideration.

On the whole, this is a minor problem. It would probably arise most frequently from welding operations and acetylene torch cutting. Here we can get a performance standard - actually a prohibition. Such operations shall be performed so that they may not be seen from outside the property. This would mean that they would be inside a building where they could not be seen from outside. Or, if it is necessary to work outside, as it may be in scrap metal operations, the work will be behind a tight fence.

(7) Fire and safety hazard. In most of our cities we have, in our building code or our fire code, a list of "special hazards," operations and processes that are held to be unusually dangerous. These uses are customarily forbidden anywhere within our first "fire zone."

If these special hazards were adopted into our zoning regulations, there might be some advantage in coordinating fire zones and land use zones. However, the disadvantages of using the typical "special hazard" list outweigh the advantages. For example, you will probably find "paint spraying" and "fireworks manufacture" on the same list. Althou gh we may wish to prohibit both of these operations in our first fire district, we can't afford to treat them as equal in setting up our industrial zoning regulations.

What was in our minds when we wrote into our zoning ordinance that industries might be objectionable because of fire hazard? It wasn't to protect the hazardous

industry from itself, because wherever it locates it will still be hazardous to itself and its own employees. The answer, of course, is that we wished to protect the neighbors, to offer assurance to any present or future manufacturer that he could locate in this area without fear of having a hazardous plant come in next door to him. How can we measure this potential danger?

In fire insurance ratings we have a great body of practical experience to draw on for the answer to this question. Fire insurance rates are established by experienced technicians using a schedule that is a kind of score card. There are several schedules in use throughout the country, but the best one is known as the "Analytic" schedule.

Briefly, in the Analytic schedule, the cost of insurance starts with a base rate for the individual city, to which rate are applied several factors in the form of percentage. Some of the factors increase the cost of the insurance and others decrease the cost. The factors fall in four major groups:

(1) Building construction
(2) Occupancy
(3) Exposure
(4) Condition

Of these, all but "condition" can be determined before the plant is built.

The effect of type of building construction on the insurance rating is well known. The completely fire-proof building carries the lowest rating - costs the least to insure - and frame construction carries the highest rating.

Occupancy factors, which are of particular interest to us in zoning, depend solely on the use to which the building is put, without regard to the type of building construction, or the exposure of the building because of surrounding hazardous conditions. These factors range from zero - i.e., nothing added because of the occupancy - for ordinary offices, to as much as 245 per cent additional for bottling acetylene gas, or even more for other occupancies. Occupancy factors also take into account special features in a plant, such as the use of inflammable gas, enameling operations, and so on.

The third group of factors used to rate the fire hazard of a building covers the exposure of the building to nearby hazards. Since we are interested in setting a standard by which we can predetermine the acceptability of a given use, we are interested in the exposure hazard that the new plant brings in and not the one that it encounters when it gets there.

The rating factor applied for "condition" cannot be determined in advance of the construction and use of a building. It is based on housekeeping and general maintenance after the building is actually in use. Although it is important in arriving at the cost of insurance, it is not necessary to establish zoning standards.

In fire insurance rating, we have a method of setting up a definite numerical standard by which we can judge fire hazard. It is not going to be easy to set these numerical standards, but it does offer a chance to get away from naming names, and still be quite definite as to what we consider appropriate for our different industrial zones. We are interested in the hazard to other industries that our permitted uses will create. Therefore, we should recognize that there is no fire hazard we might create that cannot be eliminated by distance. We return to our old zoning tool - setbacks from property lines. Undoubtedly, the required setbacks to eliminate fire hazard caused by certain uses, such as gasoline tank farms, are going to be so great that economic necessity will force these uses to locate in our less valuable districts. This is as it should be, since it tends to direct the more intensive uses to the better locations.

There are some weaknesses in insurance rating schedules, but there is an opportunity to improve our zoning regulations by using them intelligently.

(8) Industrial sewage wastes. A municipal sewerage system is, or should be if it isn't, planned for a long time in the future. In some rare instances it may be possible to expand the system - laterals, mains, interceptors, disposal works - easily for any part of the city. But in the majority of cities, the sewerage system is a miscellany of sections, some of which can handle more sewage than they are taking, others that are up to or over capacity, still other sections that cannot be expanded economically. So it is quite important that we plan our industrial areas with the present and potential sewerage system in mind.

Industrial sewage differs from the other subjects covered thus far, in that it is not necessarily a nuisance. Of course, industrial waste discharged raw into a stream can be a nuisance. However, it is assumed that state and local health laws are effective in preventing this. If they are not, the zoning ordinance cannot be a satisfactory substitute. Delineating industrial zones based on the capacity of the sewerage system is primarily a land planning problem. Still, the principal tool for carrying out the land plan is the zoning ordinance. Industrial sewage standards should be in it.

Fortunately, we have excellent methods of measuring industrial wastes and in estimating them before the plant is built. For example: the production unit in a slaughterhouse is one hog. A steer is 2 1/2 hog-units. The amount of industrial waste accompanying the slaughter and preparation of one hog can be converted to a population equivalent. It is equal to the domestic sewage waste of 2.43 persons. A slaughterhouse with a daily capacity of 1,000 hots, or 400 steers, throws the same load on a sewerage system as would a population of 2,430 persons, or about six hundred families. The average cheese factory has a population equivalent of 2,000 to 3,000 persons; the average tannery has an equivalent of 18,000 to 20,000 persons; a beet-sugar factory equals 65,000 to 125,000 persons, depending on the process.

We have practically all the basic information that we need for industrial waste standards. When we set them up in our zoning ordinances, they will probably take

the form of density regulations. Thus, for an area in which we have ample sewerage, we might permit industrial waste up to a population equivalent of 1,000 per acre. In another area we might have to limit the waste to a population equivalent of 50 persons per acre.

Again, we are setting a performance standard. Just as soon as a meat packer can demonstrate that his process causes industrial wastes with a population equivalent of only one person per hog-unit instead of two persons per hog-unit, then we can allow him to build on half the amount of land that we now think he needs.

(9) Traffic and transportation. As mentioned previously under the heading of "Noise," the largest part of industrial noise comes not from the factory itself, but from the various transport operations connected with it. For 95 per cent of our factories, the noise from machinery is not objectionable. In fact, it is probable that if we lumped together factories that might be objectionable because of plant noise, odor, fire hazard, industrial sewage, dust, noxious gases, glare and heat, we still wouldn't have over 20 per cent of our factories. But for factories that might be objectionable because of the traffic they generate, the figure is so close to 100 per cent that the difference is not worth worrying about.

A good illustration of the lag in our thinking about zoning is the infrequent mention of the traffic generating potential of a particular land use. In this we find that our lay citizens are ahead of us. All you need to do is sit in on the hearing of a request to extend the boundaries of an industrial zone. You will find that the possibility of increased traffic bothers the neighbors more than any other aspect of industry in the neighborhood.

Traffic and transport are not objectionable per se. Again, it is the effects of traffic that bothers us. It is the noise of roaring trucks and banging switch engines. It is the poisonous carbon monoxide pouring from the exhaust of motor vehicles. It is the smoke and cinders belching from steam locomotives. It is the street hazard created by autos of employees streaming to and from work. It is the pre-emption of parking space by those same autos. It is the driving hazard caused by improper loading berths. It is the dirt raised, even from concrete streets, by thousands of wheels. In fact, the effects of traffic include most of the annoyances for which we are trying to set up our industrial performance standards. In arriving at standards for traffic, we need some basic thinking. Performance standards, as we have talked about them heretofore, are one step removed from the problem. For example: we have studies that show doubling the number of motor vehicles will increase the noise level about 3 decibels, which corresponds to about a 40 per cent increase measured in sones. If the number of vehicles remains the same, but the percentage of commercial vehicles doubles, we get about the same increase - 3 decibels, 40 per cent increase in sones. This gives us an idea of the overall effect of added traffic, and points up the annoyance power of commercial vehicles. It is hardly suitable, however, as a standard to write into a zoning ordinance.

Again, we have seen that we have quite definite standards on smoke production. These standards can be applied to railroad locomotives. But the control of locomotive smoke is not properly a responsibility of the industry served by that locomotive (unless it is an industrial locomotive owned by the plant).

From the viewpoint of semantics, it may be that our standards on industrial traffic will be called "specification" rather than "performance," but the distinction is not too important. The important point is to get some method of describing the limits in traffic generation that we wish to set up for a given district.

Our first step is to list the aspects of traffic and transport that we wish to recognize. There are probably a great many ways in which we could list these aspects. The following appears to be one for which we have background to set standards.

(a) Amount of employee traffic, based on number of employees and number of shifts.

(b) Amount of truck traffic, based on maximum daily truck-loads of raw materials in and finished products out.

(c) Railroad traffic, based on daily carloads in and out.

(d) Off-street parking space, based on number of employees, and number of company vehicles.

(e) Off-street loading docks, based on daily truck-loads in and out.

For the last two of these, off-street parking and off-street loading, modern ordinances now include regulations. These are still rule-of-thumb provisions, but from experience and from the National Industrial Zoning Committee survey, we may be able to improve them.

With the other items in the list, we are going to have some trouble. In setting limits on number of employees, we run head-on into the weakness present in our attempts to limit industrial activity in commercial districts. It isn't reasonable to say that a plant with 100 employees is all right, but one with 101 employees is objectionable. We may be able to get around this by specifying density of employment - 20 employees per acre of ground, for example. In this way we would spread out the focus of traffic generation.

A provision in the new residence-industry district in Cleveland is that industries locating in the district must operate only one shift and may not operate on Sundays, normal business holidays, or at night. This is an excellent method for reducing the objection to integrating industry into residence districts.

Standards for materials and products transportation are also going to be difficult to establish. A provision in the proposed New York City resolution states:

> "Whatever merchandise is received and shipped has a high value in relation to its size and weight, so that very little trucking traffic will be generated."

This points toward one method of measurement. Here also, a density measurement may be possible - truck-loads or carloads per day per acre.

The zoning ordinance is only part of the technique for handling industrial traffic. We must provide the industrial district with thoroughfares, proper truck routes and good mass transportation. The best way to keep a horde of auto-driving industrial employees off neighboring residential streets, is to provide them with more attractive methods of getting to and from the factory, preferably in public transit, or at least on well-designed major thoroughfares.

(10) Aesthetics. It may be questioned why aesthetics is included as one of the regulations that should be imposed on industrial buildings. Many new factories are handsome,intelligently-designed examples of functional architecture. They are set well back from the street in grounds that have been decently landscaped and that are carefully maintained. But not all new plants are built that way. In spite of the obvious advantages in employee satisfaction, as well as in company advertising and community relations, we still have industrialists who want to build an architectural monstrosity that covers every square inch of land. And, of course, they can always find an architect to help them.

The truth is that the great majority of our existing factories are eyesores - and unnecessarily so, in most cases. In spite of the fact that aesthetic control is not yet universally accepted, there are a number of legal decisions that recognize the right to control the appearance of buildings. If this were not enough, we need only note the voice of the people as expressed at zoning hearings and in aesthetic control ordinances. As usual, our supreme courts lag behind the wish of the citizens, but they will eventually catch up.

If we are going to re-think our industrial zoning, we should recognize aesthetics. This is particularly true if we wish to bring industry up out of the dumps and wastelands and house it among more pleasant surroundings. The more pleasant surroundings are now the domain of residences. Like Caesar's wife, industries are going to have to be completely without sin if they hope to live side by side with decent folk.

No attempt will be made to analyze aesthetic standards, partly because they are pretty hazy. For our purpose, they will call for simple regulations, specification standards pretty much the same as we now use in residence districts. We should have front yards, side yards, height regulations and prohibition of monstrous advertising signs. For those combined residence and industrial districts that we

shall develop some of these days, we may need review of the plans by a municipal art commission. We should not have much difficulty writing these regulations, nor in getting them accepted.

The avant garde may think these are feeble suggestions for aesthetic control. Compared with the complete anarchy that we now permit in industrial zones, they will be a long step forward.

(11) Psychological effects. When it comes to regulating uses on the basis of psychological effects, it is difficult to find a method of measurement. Even to illustrate, it is necessary to speak of definite uses. The clearest cases of land use objectionable because of psychological effects are those connected with the disposal of the dead. Crematoria have never been and probably never will be, accepted as harmless. People just don't like the idea. They always express fear of odors. Yet for the past fifty years there does not appear to be one case of a crematorium having created the faintest suspicion of a nuisance. In all probability there will never be such a case in the future.

The same psychological distaste exists for funeral homes and cemeteries, although not to the same degree. There is also strong dislike for mental and contagious disease hospitals, and for prisons of all kinds. The dislike has no connection with any annoyance created by the uses.

The uses named are not industries, although some zoning ordinances have tried to relegate crematoria and mental hospitals to industrial districts. However, we are undoubtedly going to face the same psychological antipathy for certain industries. The recent struggle in Detroit shows that no matter how sweet and clean we make a slaughterhouse, a lot of people don't want it for a neighbor. There are some other industries that people don't like, including glue factories, breweries, distilleries, and tanneries.

It may seem that this worry is unnecessary; that these psychological nuisances are principally ones that create odor pollution and haven't shown much interest in cleaning up the smell. They will be permitted only in districts in which we allow a certain amount of odor to escape, and those districts will be as far down-wind as we can put them.

The concern is not, however, without grounds. In the first place, the example of the slaughterhouse is correct - slaughterhouses can be and are being cleaned up. Properly designed, they do not create an odor nuisance. In the second place, there are very few industries that seem hopeless in their efforts to eliminate odor. Some day only the hopeless ones will be allowed to perfume the air. Those uses mentioned are not among the hopeless.

Finally, if our zoning ordinance is to function as we should like it to function, industries will be judged only on the effects they produce, and any industry will be permitted to go into any industrial district - including a combined residence-indus-

try district - if it can comply with our standards. This means that if the slaughterhouse meets the standards, it will be able to move into our combined district. You can be sure that this possibility will be pointed out by the citizens that are fighting the adoption of our modernized zoning ordinance.

As stated at the beginning, no method has been found of setting up standards to cover this subject. Perhaps we can assume that psychological hazards will be present in only the combined residence-industry district (but the Detroit slaughterhouse case contradicts that). For that combined district we may always have to prohibit certain industries by name.

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This completes a brief coverage of the outlook for new performance standards. In general, what can we expect in the zoning ordinance of the future?

The ideal regulation of industry would mention no industry by name. Of course, if the above analysis of psychological hazard is correct, there will be exceptions. Except for the exceptions then, our zoning ordinance will merely set up the standards for each zone, and any industry that can meet those standards will be permitted to locate in that zone. What we should work for is the elimination of named industrial uses for different zones. Our present ordinances truly smack of discrimination. The situation is quite similar to establishing separate residential zones for white, yellow and black; or for professional, white collar and labor.

A suggestion like this should not be left hanging in the air. It is about the same as making a city plan and not polishing it off with a capital improvement program. A specific recommendation is that either ASPO or the National Industrial Zoning Committee appoint a committee (or a sub-committee, as the case may be) which will be charged with the study of industrial zoning performance standards in detail. The committee should be small at first, perhaps three members. The three members would outline their objectives and methods. Then they would expand by appointing sub-committees to work in selected fields. On each sub-committee there would be at least one person familiar with zoning and at least one person technically qualified in the subject assigned to the sub-committee - in noise, or odors, or industrial waste, etc.

The sub-committee would report back to the parent committee, recommending standards; suggesting appropriate wording for zoning ordinances, or reporting the need for additional research, where that is necessary. The sub-committee reports could then be assembled to make the first manual of performance standards in industrial zoning.

Within a year, such a committee could undoubtedly make recommendations on industrial zoning that would revolutionize our procedure.

NOTES

(The following notes have been prepared for PLANNING ADVISORY SERVICE to supplement some of the information which was necessarily condensed in the original paper.)

(1) Noise. The loudness of sound is a subjective phenomenon. Nevertheless, it has been measured so many times and with such consistency of results that it has been possible to establish quite accurate units. Loudness is measured by comparing the loudness of the sound we wish to measure with a tone whose frequency is 1,000 cycles per second (approximately two octaves above middle C). When the two are equally loud, then the loudness of the tone we are measuring, expressed in phons, is equal to the decibel measurement of the 1,000 cycle sound. The loudness of a 1,000 cycle tone of 40 decibels intensity is 40 phons. However, to have a loudness of 40 phons with the very low frequency tone of 30 cycles, we need a sound intensity of 80 decibels - an intensity which causes a sound pressure about 14 times as great as the 1,000 cycle tone. Loudness levels at high frequency also require greater intensity of pressure.

While phons are satisfactory units of loudness to use with pure tones for some purposes, they have weaknesses in measuring noise. A tone whose sound pressure above the threshold of hearing has been doubled, has not necessarily doubled in loudness, and it has increased in pressure by only three decibels. An increase of three phons does not necessarily mean a doubling of loudness. To meet this weakness, acousticians have developed a new unit - the sone. This is defined as the loudness of a 1,000 cycle tone with a pressure 40 decibels above the threshold of hearing. A sound of 2 sones is twice as loud as one of 1 sone; a sound of 100 sones is twice as loud as one of 50 sones.

Another difficulty in measuring noise is that noise is not a pure tone, but is a mixture of many frequencies. The technique of measurement is now at a stage where individual measurements of the loudness of noise in various octave bands (100-200 cycles, 200-400 cycles, 400-800 cycles, etc.) can be taken and simply added together to give the total loudness. A still simpler method is to correlate the overall noise spectrum of noises from different types of sources with the loudness in one octave band. Then with a single rapid measurement, the total noise for the particular source may be estimated.

The range in city noises, as determined by the Chicago survey, is from about 2 sones in a quiet residential district to 250 sones for a subway train at 20 feet distance. Industrial district noises vary from 5 to 65 sones, with 50 per cent of the Chicago measurements falling between 10 and 23 sones.* Professor Bonvallet has suggested 40 sones as a limit for industrial noises, the measurement to be taken

*The loudness measurements quoted have been interpolated from charts, and may not agree strictly with the actual measurements found by the surveys.

25 feet from the property line. From the viewpoint of the zoning administrator, it would be better to take the measurements on the property line, because zoning is concerned with controlling the annoyance created on an adjoining property.

Questions remain to be answered. Is it practical to establish several noise standards for different types of zones, and what will they be - 10, 20, 40 sones? What are the effects of distance, shrubbery planting, architecture, etc.?

(3) Odor. One of the earliest ancestors of zoning was the control of a special group of occupations designated as the "offensive trades." The fact or common to all occupations in the group was an offensive odor. The list included blood boiling, gut cleaning, tanning, glue manufacturing, fat rendering, garbage reduction, and so on. It also included corpse bearing, which, in part, accounts for the origin of the present dislike of crematoria and cemeteries.

The worst of the offensive trades were prohibited inside the city walls. Those giving lesser offense were permitted inside the walls, but only in carefully restricted districts. Not only were some of the occupations forbidden to be carried on inside the city, but the workers themselves were not allowed within the city. They were not permitted to testify in court, on the grounds that their constant contact with blood made incorrigible liars of them.

It has been definitely determined that all of the odor of the offensive trades concerned with animals and animal products can be eliminated. Deodorization is accomplished generally by washing the air for soluble contaminants, chlorinating for insoluble contaminants, and discharging the air at a relatively low temperature (120° Fahrenheit). All of the air within the building must be so treated, if the deodorization is to be effective.

For the past several years the interest in odor control (and also the control of noxious gases) has centered on the improvement of working conditions within factories. The simplest method of improving the quality of air within a building is to draw in fresh air and exhaust the bad-smelling air through a vent on the roof. As a result, according to the judgment of the noses of the neighbors, offensive trades are becoming more offensive rather than less. We must not expect odors (and most of the other annoyances discussed in this paper) to be completely controlled by a zoning ordinance. The abatement of existing nuisances, or near-nuisances, should be carried out through regulations specifically director toward those nuisances.

(4) Dust and dirt. Most of the research to date on dust as a contaminant have dealt with industrial hygiene aspects. Dust produces a pulmonary disease called pneumoconiosis ("a lung containing dust"), of which only two variants are considered important: silicosis, caused by silica dust, and asbestosis, caused by asbestos dust. Because cement dust has been found comparatively harmless to human health, little attention has been paid to possible standards of contamination to be applied to a cement plant. Yet anyone who has seen the grey film of dust that cov-

ers all property for some distance around a cement mill is aware of the damage it causes.

From the viewpoint of establishing performance standards for zoning, it is probable that the health hazard of dust is of much less importance than the economic aspect - the dirt deposited in neighboring homes and other buildings, the cost of maintaining cleanliness, the damage that dust can do to nearby industrial operations. It is of little importance whether the dust is silica, cement, or coal.

Dust can be controlled. This is illustrated by the great variation that occurs within rooms where sandblasting is taking place; dust concentrations at different plants may vary from 232 million particles to 3140 million particles per cubic foot of air. As in odor control, however, the tendency in dust control is to clean up the inside of the plant and to exhaust the dust into the outside air.

There seem to be no generally accepted standards of dust pollution that are readily adaptable to zoning regulations. There are, however, several methods for determining the amount of dust in the air. With further research it may be possible to set up some standards. Measurements of dust are expressed in million particles per cubic foot of air. The following brief list illustrates the range of dust contamination that has been found:

	Million particles per cubic foot of air
Slate-finishing mill	1598.0
Cement mill - average	26.0
Cotton carding room	8.6
Grey iron foundry - general	17.0
Grey iron foundry - facing mills	2608.0
City - congested district	4.1
City - residential district	1.8

In addition to the contamination caused by the dusty trades, industries also can create a dust nuisance because of the loading and unloading operations, particularly of coal, and because of intra-property traffic, as from the parking of employee autos. It seems reasonable to believe that we can require all outside operations calling for vehicle movement to be conducted on dust-free surfaces. Well-designed modern plants are already doing this, putting a black-top or other all-weather surface on parking lots and roads and drives around the property.

(6) Glare and heat. Mr. Norman Williams, Jr., Director of Planning in the New York City Planning Commission, has suggested the application of foot-candle standards in lighting. While such standards would probably not be practical for acetylene torch and welding operations, they could possibly be applied to the iron and steel industry. However, outdoor lighting is extensively used in industry, to illuminate parking lots, to flood-light buildings and grounds, to light switch yards,

and to light advertising and name signs. This industrial lighting can very definitely be an annoyance to neighbors. The measurement of the quantity of light is now a relatively simple operation. Nearly all work on lighting thus far has attempted to establish minimum standards of illumination. However, it should not be difficult to set up permissible maximum limits in this field.

(8) Industrial sewage wastes. The population equivalent of industrial sewage waste is based on two factors: the volume of waste, and the biochemical oxygen demand (b.o.d). In considering the effect of industrial waste on the sewage collection system, we are interested primarily in the volume of waste (although an unusually large amount of suspended solids can also affect the collection system). In considering the effects on the sewage treatment plant, we are interested in both b.o.d. and quantity of waste. For this reason, the allowable standards must be very specifically related to the particular area and the individual city. In certain areas, it may not be possible to use a straight population equivalent; we may need to substitute separate standards for volume and b.o.d. The accompanying table lists some of the population equivalents that are now available.

INDUSTRIAL SEWAGE WASTE

Type of Plant	Unit of Processing	B.O.D. - 5 day P.P.M. Per unit	Vol. Gals. per unit	Population Equiv. Per unit
Laundry	100# dry wash	1000-1500	350-500	18.2-36.8
Meat packing	1 hog unit	900	550	2.4
Slaughterhouse	1 hog unit	2200	150	1.6
Stockyard	1 acre	65	25000	8.0
Poultry dressing	1000# live	2700	2200	29.1
Wool-scouring	100# wool	9000	100-150	4.4-6.6
Distillery	1000 bu. grain or 5000 gals. 100 proof spirits	34000	Thin slop: 25000-30000	4170-5000
Distillery (molasses)	1000 gals. 100 proof spirits	34000	Thin slop: 8000-10000	1334-1668
Brewery	31 gal. barrel	800-1200	300	1.2-1.8
Paper and pulp mills:				
Ground wood	1 ton of product	645	5000	15.8
Soda pulping	" " " "	110	85000	45.9
Sulfate or Kraft	" " " "	125	64000	39.3
Sulfite	" " " "	450	60000	132.5
Miscell. - no bleach	" " " "	19	39000	3.6
Miscell. - bleach	" " " "	24	47000	5.5
Paperboard	" " " "	121	14000	8.3
Srawboard	" " " "	695	26000	88.7
Cotton textile:				
Sizing	1000# of	820	60	0.24
De-sizing	goods processed	1850	1100	9.4
Kiering	" "	1240	1700	10.3
Bleaching	" "	300	1200	1.8
Scouring	" "	72	3400	1.2
Mercerizing	" "	55	30000	8.1
Dyeing	" "	55-1300	5400-19000	6.9-34.4
Flax retting	1 ton of flax	2200	5300	57.2
Beet sugar	1 ton of beets	3055	?	126
Tomato cannery (whole)	100 cases #2	?	750	150
Tomato cannery (products)	cans per day	?	7500	350
Cheese factory	1000 gals. milk per day	?	200	16
Factory sanitary waste per employee			25-40	0.3-0.5

Sources: Various