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State Regulation of Nontransportation Noise: Law and Technology

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Both authors are members of the Illinois Task Force on Noise. The task force was responsible for preparing the background studies and regulatory proposals which led to adoption by the Illinois Pollution Control Board in 1973 of the state's property-line noise regulations. In writing this Article the authors leaned heavily on the work of the task force. Other members of the task force to whom the authors are particularly indebted are Harlow W. Ades, John J. Desmond, and John J. O'Neill. The task force and the authors were fortunate to have the diligent services of two graduate Research Associates in Environmental Law at the College of Law, Larry Blackwood and Russell Eggert. The authors also had the benefit of the efforts of the Division of Noise Pollution Control, Illinois Environmental Protection Agency, and particularly those of its Manager, John S. Moore, a member of the task force, and staff members Robert Hellweg and William Seltzer. Insights into the complexities of regulating nontransportation noise were gained from public hearings of the Board, ably presided over by Professor Samuel T. Lawton, Jr., then a member of the Board, and his technical assistant, Edward H. Hohman; the extensive opinion prepared by them in collaboration with Jacob D. Dumelle, Chairman of the Board, in support of the regulations, was especially helpful to the authors. Finally the authors wish to express their appreciation to Michael Schneiderman, former Director, Samuel G. Booras, current Director, and Peter Loquercio, Associate Director, of the Illinois Institute for Environmental Quality, without whose support the task force could not have done its work. While the authors cannot claim sole responsibility for what is good in the Article, they do accept sole responsibility for all that is bad.

Q. How long have you lived at your present address, Mrs. Early?

A. Fifteen years this coming October.

Q. Will you describe for us the area that you live in, please?

A. At this time or the time we moved?

Q. Why don't you describe it at the time you moved in and at this time.

A. When we came out to Lisle, we had lived in an apartment for 10 years and we, being nature lovers, we wanted to move out.

We found this place. It was not what we wanted, but it had potential. So we bought it and we started to work to build it up.

It was out in the country, across the street from us was a corn field, one year in corn, the next year in beans, and it was quite open and it was very peaceful, quiet.

But, however, we had to do much hard work, hauling dirt to make the lawn, plant trees and so forth.

But it didn't seem like work. It was a joy.

It was a joy to do all this. Well, we fixed it up and we were enjoying it very much.

And then that was up until this, let's see, I suppose 1970. I believe it was April, then they started to build the factory across the street from us and everything changed.

Before we could sit in our living room and watch the sun set, watch the pheasants come across the road and eat the feed I had thrown out to them.

And then the factory started to go up. They filled in, they did not make it on the lay of the land but they built up.

First, I would like to make a statement. I want to make the record clear. I am not anti-industry. I believe in industry. I think that we need industry. Our town needs it. But I do believe in the fact that industry should stay in industry's place and not intrude upon the rights of the individual, but we all have this happen.

Well, we took that in stride. They built up, it was almost like sitting on top of us, about 100 feet, just across the street, directly across, and they built this factory 600 feet by 600 feet *which makes it 360,000 square feet. And then the back side of the building was next to us, as close as they could get it to the street.*

As far as the village would permit them to build. And then they turned on, they put in these—they had a storage room with two big exhaust fans and then they put this thing on top.

After I found out what it was, I come to find out their drying plant, it was a great big thing, looked like a big boat. Under that, it set up here like this. Under this was this big fan. I have never seen anything so huge.

When they turned all this noise on, well, that is when I thought I was going out of my mind, because nowhere in my house could I stand it. The noise. It was just—it was this big roar and I went in every spot but still—and I would stick my fingers in my ears—I couldn't shut it out.

I had put a pillow over my head at night. It was there like something that was consuming me. It was—and then my ears would hurt—that was the pain.

It is hard to describe the noise, but it was suffering, because I suffered from, well, when your ears get bad, I suppose that makes you dizzy and you feel nauseated, but my ears would hurt.

But there was something more than suffering and pain, the way I can describe it is torture. It was torture.

And then I was especially worried at this time, because my husband is a railroad man and he has a very hazardous job.

I was worried because he was not getting adequate sleep. He was supposed to have eight hours, but it was impossible with this noise, and then I worried about my hearing, too.

We were both getting pretty nervous and upset and we did not know what to do. We were like trapped animals or something, here we spent on our home, we had our life savings, and all the toil and the sweat and we knew better than to put it up for sale because no one would buy a home like that.

So I heard about the Environmental Protection Agency and wrote them a letter and asked for help and then Mr. Reid came.

(Testimony of Mrs. Earl Early, housewife, at a public hearing before the Illinos Pollution Control Board, Aug. 17, 1972. The name of the witness has been altered).

I. INTRODUCTION

A. NATURE AND SOURCES OF ENVIRONMENTAL NOISE

Noise is unwanted sound.[1] The term environmental noise, or community noise, means noise emitted across property lines, unwanted sound received at land on which it does not originate.[2] This excludes on-site noise, such as the in-plant sound of industrial machinery or the in-house sound of a vacuum cleaner.

Of all pollutants, noise is the only one which does not leave a residue. For one to be affected by or to measure it, it must be heard, measured, or recorded as it is made.[3] Noise also decreases rapidly as the distance from the source increases, so that its effects are relatively local.[4] Partly for these reasons, environmental noise sometimes is said to rank as one of the less serious pollutants.

But for many people like Mrs. Early, noise is serious. In a recent survey on citizen attitudes about pollution in Toledo, Ohio, noise was ranked as the "most serious" problem by 10 percent of the respondents. Some 73 percent agreed that noise pollution is a "very serious" problem, and 62 percent agreed that it has worsened in the past few years.[5]

The major sources of environmental noise divide into three broad categories: airplanes, ground transportation units (motor vehicles and railways), and nontransportation equipment and facilities. Although the emotional impact of a sonic boom or an unmuffled motorcycle in a quiet residential area may be greater than that of most nontransportation noises, the relative pervasiveness of the different classes of

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1. Anthrop, *The Noise Crisis*, in NOISE POLLUTION AND THE LAW 5 (J. Hildebrand ed. 1970). Other writings on regulation of environmental noise from nontransportation sources include UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, LAWS AND REGULATORY SCHEMES FOR NOISE ABATEMENT (1971); Hildebrand, *Noise Pollution: An Introduction to the Problem and an Outline for Future Legal Research*, 70 COLUM. L. REV. 652 (1970); York, *A Model Ordinance to Control Urban Noise Through Zoning Performance Standards*, 8 HARV. J. LEGIS. 608 (1971); York, *Controlling Urban Noise Through Zoning Performance Standards*, 4 THE URBAN LAW. 689 (1972); Comment, *Noise Abatement at the Municipal Level*, 7 U. SAN FRAN. L. REV. 478 (1973).

2. Depending on the intent of the rulemaker, the receiving land or airspace may not have to be separately owned. "Real property lines" may include the boundaries of leaseholds or even easements.

3. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, NOISE FROM INDUSTRIAL PLANTS 13 (1971).

4. *See* text accompanying note 33 *infra*.

5. 3 NOISE CONTROL REPORT, Mar. 4, 1974, at 47.

sources, as well as the stated reasons for actual citizen complaints, suggest that nontransportation facilities are equally serious sources of environmental noise. For example, of noise complaints filed with the Illinois Environmental Protection Agency between July 1, 1970 and June 22, 1972, 58 percent concerned nontransportation sources (including non-right-of-way facilities of rail and motor carriers, such as marshalling yards and loading docks, which are here treated as nontransportation sources); 33 percent related to ground transportation sources, and only 9 percent to airplanes.[6]

Nontransportation sources of environmental noise are numerous in kind and produce a great variety of sounds. A single industrial facility, for example, may contain hundreds of distinct sources of noise. Industrial noises, however, can be classified into five broad categories: electromechanical noise (motors, generators, transformers); mechanical noise (unbalanced machinery, gears, bearings); noise from fluid flow (fans, blowers, compressors); combustion noise (furnaces and burn-off flares); and impact noise (punch presses, stamping machines, forging hammers).[7] Aside from industrial facilities there are, of course, many other kinds of nontransportation noise sources, of which a few suggestive illustrations should suffice: construction equipment, automobile race tracks, car washes, air conditioners, loudspeakers, power lawnmowers, dogs, and children.

B. Current Regulation of Nontransportation Environmental Noise: Overview

The regulatory potential with respect to environmental noise from nontransportation sources is generally better than that for transportation sources. In many cases technology already exists to limit the former, measured at receiving property, to levels which will not impair human health or welfare. In some instances the economic feasibility of such stringent regulation is clear, while in others it is not. In any event, the situation from a technical point of view is quite different from that posed by jet plane noise near major airports or truck noise adjacent to interstate highways.

Nevertheless, while taking significant steps toward regulation of transportation noise, state and federal governments to date have done

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6. *Hearings on R72-2 Before the Illinois Pollution Control Board in the Matter of Noise Pollution Control Regulations* 147-49 (Testimony of John S. Moore, Manager, Division of Noise Pollution Control, Illinois Environmental Protection Agency, June 22, 1972) [hereinafter cited as *IPCB Hearings on R72-2*].

7. *Id.* at 151.

little to control environmental noise from nontransportation sources. Except for federal OSHA regulation of employee exposure to on-site noise,[8] the field has been left largely to local governments.[9] Only Colorado, Illinois, and New Jersey have adopted comprehensive statewide laws or regulations applicable to nontransportation noise, though New York has held public hearings on proposed regulations and may adopt some soon.

The picture with respect to transportation noise is quite different. Several states have adopted laws or regulations establishing numerical noise limits for various classes of motor vehicles.[10] Acting pursuant to the Noise Control Act of 1972,[11] the federal Environmental Protection Agency has published notice of proposed rule-making concerning aircraft noise,[12] and proposed regulations for noise from interstate motor[13] and rail[14] carriers. Previously the Federal Highway Administration had promulgated noise standards and procedures to govern the planning and construction of federal-aid highway projects,[15] and the Federal Aviation Agency had established maximum noise limits for type certification of new airplanes.[16]

The emphasis of state and federal attention on transportation noise to the detriment of nontransportation noise may be attributable to several factors: the intensity of the jet noise problem near airports; the special annoyance suffered at times by almost everyone from inadequately muffled motor vehicles; the fact that much industrial noise is not terribly loud or annoying, has existed for long periods so that neighbors have adapted to it, or affects primarily lower-income residents unac-

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8. Employee exposure to on-site noise is regulated by the federal Occupational Safety and Health Act (OSHA), 29 U.S.C. §§ 651 *et seq.* (1970), and standards promulgated thereunder by the Secretary of Labor. *See* 29 C.F.R. § 1926.52 (1972). Of course, reduction of on-site noise may also reduce environmental noise.

9. *But see* text accompanying note 229 *infra.*

10. *E.g.*, CAL. VEHICLE CODE § 23130 (West Supp. 1974); COLO. REV. STAT. ANN. § 66-35-1 (Supp. 1971); IDAHO CODE ANN. § 49-835 (Supp. 1973); MINN. STAT. ANN. § 169-691 (Supp. 1974). For a general compilation of state motor vehicle noise standards, see Comment, *Constitutionality of the Auto Muffler Statutes,* 48 J. URBAN L. 755 (1971).

11. 42 U.S.C. §§ 1901 *et seq.* (Supp. II, 1972).

12. 39 Fed. Reg. 6142 (1974). However, under the Noise Control Act of 1972, final authority for promulgation of aircraft noise standards is in the Federal Aviation Agency after consultation with the EPA.

13. 38 Fed. Reg. 20102 (1973).

14. 39 Fed. Reg. 24580 (1974).

15. 23 C.F.R. § 772 (1973).

16. Federal Aviation Regulations, pt. 36, pursuant to authority in 49 U.S.C. § 1431 (1970).

customed to taking effective political action; and the notion that nontransportation sources are localized nuisances better left to local control.

It now appears, however, that federal and state regulation of nontransportation sources will become prevalent. The Noise Control Act of 1972 provides for establishment of federal standards for noise emissions by new products sold in commerce. As in the cases of interstate railroads and motor carriers, the actual adoption of federal regulations limiting noise from new products will pre-empt state and local governments from imposing different limitations.[17] However, the Noise Control Act preserves to the states and their political subdivisions the right to establish controls on "environmental noise (or one or more sources thereof) through the licensing, regulation, or restriction of the use, operation, or movement of any product or combination of products."[18] This clear delineation of the nonfederal role should promote implementation of the Act. As between state and local governments, experience has shown that many local governments lack the resources or the will to do the job and, in fact, desire and will press for state regulation of environmental noise from nontransportation sources.[19]

II. NOISE MEASUREMENT, EFFECTS, AND ABATEMENT TECHNIQUES

A. Sound Characteristics and Measurement

Sound is a fluctuation in air pressure which stimulates the nervous system through the ear, eardrum, and connecting nerves. Characteristics of sound which determine its impact upon humans include the magnitude or intensity of the pressure fluctuations; their frequency distribution or pitch; variation of the sound with time; and spatial factors such as the directional distribution of the sound emissions and the distance from source to receiver.

1. *Magnitude*

The ear senses loudness by the magnitude of sound pressure fluctuations against the eardrum. The unit of sound magnitude is the decibel (dB), a nondimensional unit used to express the logarithmic ratio of a measured sound pressure to a standard reference pressure.[20] An

17. 42 U.S.C. §§ 4905, 4916-17 (Supp. II, 1972).

18. *Id.* § 4905(e)(2) (Supp. II, 1972).

19. *See* text accompanying note 121 *infra.*

20. The formula for determining the number of decibels which a sound generates is $SPL = 20 \log 10 \frac{P}{P_0}$ dB. SPL refers to the sound pressure level of the measured

arithmetic increase in the dB level represents a geometric increase in sound pressure. For every 10 dB increase the pressure of a sound more than triples.[21] In subjective terms, however, a 10 dB increase in sound pressure level produces only a 2 to 1 increase in loudness perceived by the human ear.[22]

Where there are multiple sources, producing equal or unequal sound pressure levels, the resulting total sound pressure level is not obtained by summing the dB levels of the individual sources. For example, the sound pressure level generated by two jet airplanes, each making 120 dB, is not 240 dB but 123 dB, while two 75 dB sources yield a total of 78 dB. Conversion tables are available for determining the overall level produced by unequal sources.[23]

2. *Frequency*

Frequency refers to the rate at which the sound pressure level oscillates with time. The frequency is expressed as the number of pressure cycles per second (cps), or Hertz (Hz). The frequency of a sound often is referred to as the pitch: low pitch means low frequency. A typical human ear can discern sounds with frequencies between 20 Hz and 15,000 to 20,000 Hz.[24]

a. Octave bands: Although the frequency range for audible sounds is continuous, for ease of measurement and description it is customary to divide the range into intervals. The basic interval used is the octave band, defined as a frequency interval having an upper limit equal to twice the lower limit. For example, an octave band with a lower limit of 45 Hz would have an upper limit of 90 Hz and a range of 45 Hz. An octave band with a lower limit of 710 Hz would have an upper limit of 1420 Hz and a range of 710 Hz. The audible spectrum consists of approximately nine octave bands.[25]

The frequency intervals are typically indicated by their center frequencies, which are the geometric means of the lower and upper lim-

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sound in decibels; P is the average pressure of the measured sound; and P_0 is the reference pressure of 0.0002 microbars, considered to be the weakest audible pressure which a young ear can detect under ideal listening conditions. C. BRAGDON, NOISE POLLUTION: THE UNQUIET CRISIS 51 (1970) [hereinafter cited as BRAGDON].

21. *Id.* at 52.

22. ILLINOIS POLLUTION CONTROL BOARD, OPINION IN R72-2 IN THE MATTER OF NOISE POLLUTION CONTROL REGULATIONS 9 (1973) [hereinafter cited as IPCB OPINION IN R72-2].

23. BRAGDON, *supra* note 20, at 52-54.

24. IPCB OPINION IN R72-2, *supra* note 22, at 10.

25. *Id.*

its. A set of preferred frequencies has been established which uses the center frequencies of the octave bands as the identifying quantities. The band frequency limits are then determined mathematically. These preferred center frequencies, and the corresponding octave band limits, are as follows:[26]

Preferred Center Frequencies (Hz)	Octave Band Limits (Hz)
31.5	22.4-45
63	45-90
125	90-180
250	180-355
500	355-710
1,000	710-1420
2,000	1400-2800
4,000	2800-5600
8,000	5600-11,200

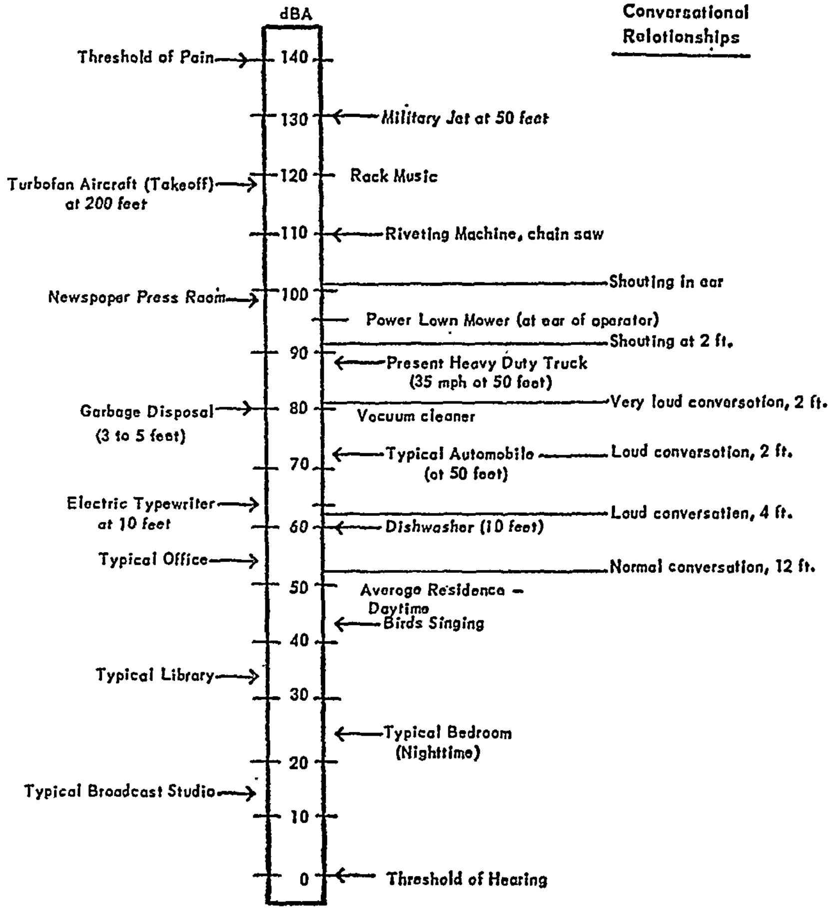
b. A-weighting scale: A human ear does not hear all frequencies with equal sensitivity. High frequencies are heard better than low frequencies. Thus, a sound having a frequency of 1,000 Hz and a sound pressure level of 60 dB would seem much louder than a 60 dB sound with a frequency of 63 Hz. It therefore is necessary to know both the sound pressure level and the frequency in order to evaluate the subjective loudness. Several methods of adjusting for the sensitivity or frequency response of the human ear have been established, the most often used being the A-weighting scale. The A-weighting scale is an approximation of an equal loudness judgment for sound of different frequencies. Use of the scale results in a single-number equivalent for a complex sound having many frequency components. The corrections applied to simulate the ear's sensitivity are:[27]

Sound Frequency (Hz)	A-weighting Correction (dB)
31.5	—39.5
63	—26.1
125	—16.2
250	—8.0
500	—3.3
1,000	0
2,000	+1.2
4,000	+1.0
8,000	—1.1

26. BRAGDON, *supra* note 20, at 55.
27. *Id.* at 54; IPCB OPINION IN R72-2, *supra* note 22, at 11.

Figure 1[28] indicates the A-weighted sound levels associated with some familiar facilities, and their effects upon conversational relationships.

FIGURE 1.
A-WEIGHTED NOISE LEVELS FOR VARIOUS SOURCES



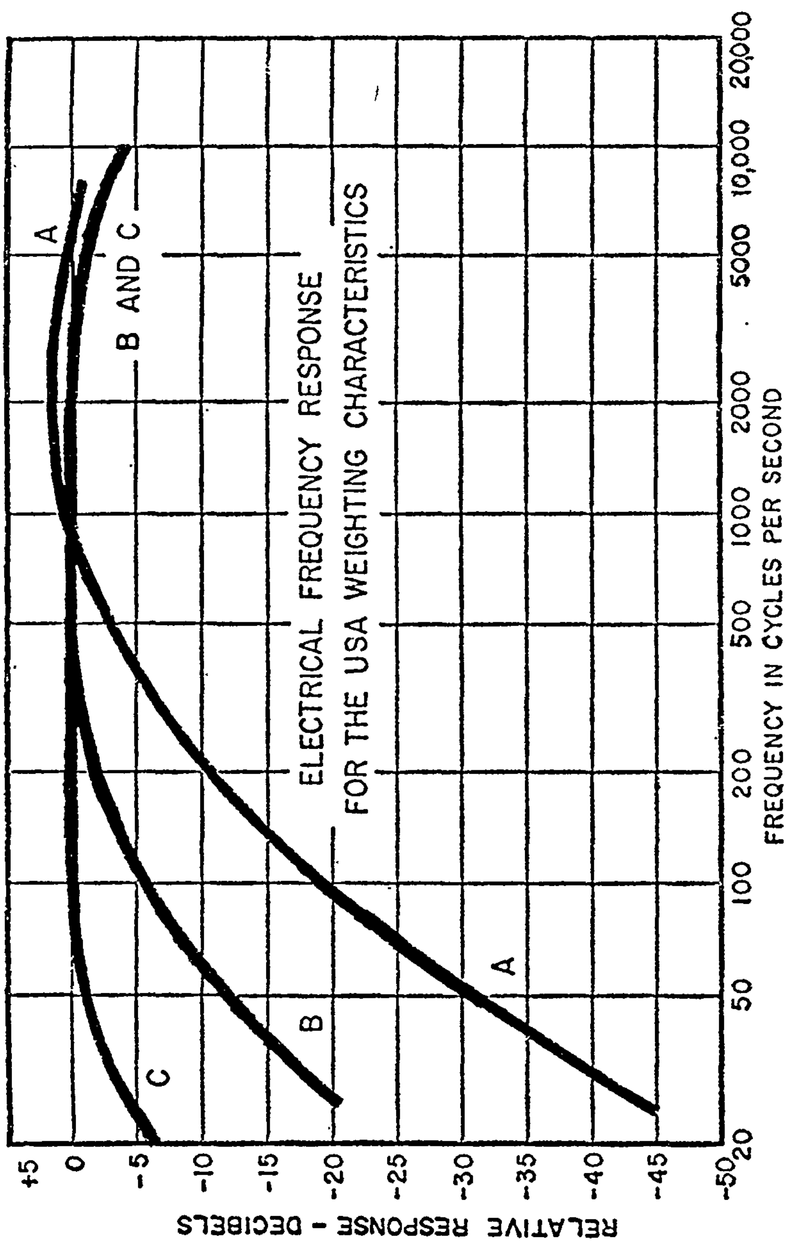
c. B- and C-weighting scales: Standard sound meters have A-, B-, and C-weighting scales. The B and C scales embody frequency response curves which, like the A scale but to different degrees, discriminate against low and high frequencies. The curves are shown in Figure 2.[29] The C-weighting scale closely resembles the "flat response" curve, passing all frequencies nearly equally. The dBC level

28. N.J. Dep't of Environmental Protection, Basis and Background Document for Proposed Noise Control Regulations 5 (1973).

29. A. PETERSON & E. GROSS, HANDBOOK OF NOISE CONTROL (1967).

FIGURE 2.

FREQUENCY RESPONSE CHARACTERISTICS IN THE ANSI STANDARD FOR SOUND LEVEL METERS



of a particular sound thus is essentially the same as the "overall sound pressure level" (in dB), in which uniform emphasis is given to all frequency components over the audible frequency range. The B scale attenuates or suppresses frequencies below 1000 Hz more than the C scale, but less than the A scale.[30]

3. *Variation with Time*

Many sounds are nonsteady, that is, the magnitude or frequency varies with time. Sirens, for example, may vary both in magnitude and in frequency, while punch presses vary only in magnitude.

On the basis of time variation and frequency components, environmental noises may be divided into the following categories:[31]

a. *Steady noise:*

(1) *Broad-band noise*: no audible discrete tones (air moving through ducts, background noise from a distant city, waterfall)

(2) *Narrow-band noise*: audible discrete tones, *i.e.*, components occurring at one or more discrete frequencies with significantly greater amplitudes than those of the adjacent spectrum (circular saw, jet engine, transformer)

b. *Nonsteady noise:*

(1) *Fluctuating noise*: sound pressure level varies with time over a substantial range, such as 6 dB, but is continuous rather than intermittent (heavy traffic nearby, pounding surf)

(2) *Intermittent noise*: discontinuous or transient noise (aircraft flyover, automobile passby in light traffic)

(3) *Impulsive noise*: brief bursts of sound pressure

(a) Isolated bursts (door slamming, pile driver, pistol shots)

(b) Repeated bursts: repetition rate such that noise becomes quasi-steady (pneumatic hammer, riveting).

Nonsteady sounds are subjectively more annoying than steady sounds having the same magnitude and frequency distribution. Similarly, narrow-band noise is more annoying than broad-band noise. Measurements in dBA generally will not reflect the additional human annoyance in either case.[32]

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30. BRAGDON, *supra* note 20, at 55-56; BOLT, BERANEK & NEWMAN, INC., I CHICAGO URBAN NOISE STUDY 37, 41 (1970) [hereinafter cited as CHICAGO URBAN NOISE STUDY].

31. II CHICAGO URBAN NOISE STUDY, *supra* note 30, at 107-09.

32. I *id.* at 14-15, 17.

4. *Spatial Factors*

Physical relationships between the source and receiver determine the manner in which sound pressure fluctuations are altered prior to being heard. Factors such as distance and the presence of intervening objects determine this alteration. The distance between source and receiver determines the amount of atmospheric diffusion or attenuation of sound energy and thus the decrease in sound pressure level. Under ideal conditions, doubling the distance decreases the sound pressure level received by 6 dB, while halving the distance increases the level received by 6 dB.[33] Pressure fluctuations often are generated by vibrating surfaces, so that less sound is received if the vibrating surface is shielded. Intervening objects such as buildings or barriers block and disperse the sound so that the amount received is decreased.[34]

B. HUMAN EFFECTS OF SOUND

The adverse effects of sound on humans fall into two major categories: physiological effects and activity interference. Activity interference includes speech interference, effects on performance of tasks, and psychological effects.[35]

1. *Physiological Effects*

a. *Hearing loss*: Exposure to sound can cause physical damage to the ear. The damage usually occurs in the inner ear, though extreme impulsive sounds such as blasts can rupture the eardrum. Damage to the inner ear can result either from sudden collapse of cells and nerves due to extreme vibration, or from gradual degeneration of the cells because of overwork from prolonged exposure to somewhat lower noise levels. In the latter case, hearing loss takes the form of threshold shift, an upward shift in the level at which a tone just barely can be detected. The shift represents a decrease in the ear's sensitivity to sound, and means that all levels of sound seem quieter. The amount of threshold shift depends on the magnitude, frequency, and duration of the sound producing the shift.[36]

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33. IPCB OPINION IN R72-2, *supra* note 22, at 11.

34. *Id.* at 12.

35. *See generally* K. KRYTER, THE EFFECTS OF NOISE ON MAN (1970) [hereinafter cited as KRYTER]; UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, EFFECTS OF NOISE ON PEOPLE (1971) [hereinafter cited as EFFECTS OF NOISE ON PEOPLE]; UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE (1973) [hereinafter cited as PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE].

36. *IPCB Hearings on R72-2, supra* note 6, at 46-60 (Testimony of Harlow W. Ades, June 22, 1972).

(i) *Temporary threshold shift*: Hearing loss in the form of threshold shift can be either temporary or permanent. Temporary shifts decrease with time, and the ear returns to its prior sensitivity. More severe exposures to sound can result in a residual shift after the temporary shift has subsided. Typically, A-weighted sound levels must exceed 60-80 decibels before people will experience temporary threshold shift even from exposures of 8 to 16 hours. Other things being equal, the greater the intensity above 60 to 80 dBA and the longer the exposure, the greater will be the threshold shift. There is less shift if the exposure involves frequent interruptions rather than continuous sound, and noises with energy concentrations between 2000 and 6000 Hz seem to produce larger shifts than sounds concentrated elsewhere in the audible range.[37] Typical threshold shifts as related to sound level and duration are shown in the following table:[38]

Sound Level (dB)	12	23	45	100	Exposure Time (Minutes)
85	3	5	7.5	12.5	Threshold Shift (dB) at 4000 Hz
90	9	14	19	23	
95	16	21	27	31	
100	20	26	33	42	

The time required for decay of temporary shift is also proportional to the sound level and duration. When the decay time exceeds several weeks, the threshold shift can be considered permanent.

(ii) *Permanent threshold shift*: Permanent hearing loss usually is caused by repeated exposures to sound over an extended period of time. Most studies of permanent hearing loss have involved workers in noisy occupations. The following table shows permanent threshold shifts resulting from occupational noise exposure as a function of noise level and time on job.[39]

Noise Level (dBA)	1	5	10	Time on Job (years)
83	2	5	12	Threshold Shift (dB) at 4000 Hz
92	2	19	27	
97	22	37	46	

(iii) *Recommended limits to avoid hearing loss*: Recently the federal Environmental Protection Agency issued a report recommending maximum levels of environmental noise believed to be consistent with public health and welfare (hereafter "levels document").[40] The report

37. EFFECTS OF NOISE ON PEOPLE, *supra* note 35, at 18.

38. IPCB OPINION IN R72-2, *supra* note 22, at 13.

39. *Id. See* EFFECTS OF NOISE ON PEOPLE, *supra* note 35, at 24-28.

40. UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, INFORMATION ON LEVELS OF ENVIRONMENTAL NOISE REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY (1974) [hereinafter cited as LEVELS OF ENVIRONMENTAL NOISE].

states that to avoid hearing impairment, the long-term annual averages of individual sound exposure doses per day should not exceed the equivalent of a continuous sound level of 70 dB for 24 hours (L_{eq} (24)=70 dB). The sound energy contained in an 8-hour exposure at 75 dB is equivalent to that contained in a 24-hour exposure at 70 dB, and would require that the average level during the remaining 16 hours be substantially lower (no more than about 60 dB in this case).[41]

In the case of Mrs. Early, the noise level outside her house produced by the electronics plant across the street was 64 dBA, 24 hours per day.[42] Of course, for the periods when she was indoors, noise attenuation by the walls of her house would have to be considered in determining the level of exposure. Surveys have shown that the walls of residential buildings with windows open typically produce about a 10 dBA noise reduction, and that closing the windows yields a further 10 dBA reduction.[43] Thus the continuous indoor noise level attributable to the plant was in the range of 45 to 55 dBA, and unlikely to impair hearing.

b. *Other physiological effects*: Besides damage to the inner ear resulting in hearing loss, noise can elicit many different physiological responses, such as pain in the auditory systems, loss of equilibrium, reaction of the orienting and startle reflexes, constriction of blood vessels, pupillary dilation, stress, fatigue, and sleep interference.[44]

Noise may arouse a person from sleep or prevent going to sleep. For example, one study found that the probability of subjects being awakened by a peak sound level of 40 dBA was 5 percent, increasing to 30 percent at 70 dBA.[45] At sub-arousal levels, noise may shift a person's sleep from a deep dreamless stage to a lighter stage. In either case, subjects may awake feeling tired and having headaches.

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41. *Id.* at 5, 28.

42. *IPCB Hearings on R72-2, supra* note 6, at 1107 (Testimony of James Reid of the Illinois Environmental Protection Agency, Aug. 17, 1972) [hereinafter cited as Reid Testimony].

43. UNITED STATES DEP'T OF HOUSING AND URBAN DEVELOPMENT, NOISE ENVIRONMENT OF URBAN AND SUBURBAN AREAS 15-16 and figs. 4.1 and 4.2 (1967). The International Organization for Standardization recommends corrections of 10 (windows open), 15 (single windows shut), and 20 dBA (double windows shut or sealed windows). INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, ACOUSTICS: ASSESSMENT OF NOISE WITH RESPECT TO COMMUNITY RESPONSE, app. Z (ISO Recommendation R1996, 1st ed., 1971) [hereinafter cited as ACOUSTICS].

44. PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, § 7.

45. *Id.* at 7-13.

Generally it is recommended that noise levels in sleeping quarters not exceed 30 to 35 dBA.[46] The EPA levels document recommends that for indoor residential areas the "L_{dn}" should not exceed 45 dB. L_{dn} is an integrated average of the sound energy over a 24 hour period, with a 10 dB penalty for sound during the nighttime hours of 10 p.m. to 7 a.m.; that is, L_{dn} represents L_{eq} (24) with a 10 dB nighttime weighting. Thus, an L_{dn} of 45 dB means an average daytime level of 45 dB and an average nighttime level of 35 dB.

Mrs. Early and her husband did not enjoy such a low nighttime level in their bedroom. With windows shut tightly—an unpleasant arrangement on a hot summer night without air conditioning—they would have had to sleep with an indoor noise level of about 45 dBA, or 10 dBA above the federal EPA's maximum recommended level. After consultations between the Illinois Environmental Protection Agency and the plant management, corrective steps were taken to reduce the noise.[47] As a result, the levels outside the house were reduced to 52 dBA during the daytime, and 50 dBA at night.[48] Thus, the indoor levels at night were in the range of 30 to 40 dBA, depending upon whether windows were closed or open.

With respect to the entire range of physiological responses not involving loss of hearing, there is as yet no conclusive evidence that continued activation of the responses leads to irreversible changes and permanent health effects.[49]

2. *Activity Interference*

a. *Speech interference*: Noise can interfere with speech communication, including radio, television, and telephone listening, in several ways. For the listener, the "masking" effect of the noise may reduce the relative or apparent sound level of the speech or cause it to be distorted or even unrecognizable; or the noise simply may be distracting.[50] For the speaker in a face-to-face situation, noise may cause him to raise the level of his voice.

The masking ability of noise depends on its frequency and level,

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46. *Id.* at 7-14.
47. Reid Testimony, *supra* note 42, at 1105-06.
48. *Id.* at 1125-26.
49. PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, at 7-20.
50. Masking is the interaction of two acoustic stimuli whereby one of them changes the perceived quality of the others, shifts its apparent location or loudness, or makes it completely inaudible. *Id.* at 6-1.

for speech is made up of many sounds at various frequencies and intensities. For example, in the word "sit," the sound of "s" consists of relatively high-pitched tones of moderate intensity; "i" is lower-pitched and stronger in intensity, and "t" consists mainly of high-frequency tones at low intensity. To understand the word when it is spoken, a listener must hear and identify each letter. If he misses the "t" because it is masked by another sound of similar frequency, he may mistake "sit" for "six"; if he misses the "i" he may not know whether the word was "sit" or "sat."[51]

(i) *Speech Interference Level (SIL)*: The most generally accepted criteria for evaluating the speech-masking capability of noise, absent nearby reflecting surfaces, are the articulation index (AI) and the speech interference level (SIL). The AI, though more accurate than SIL, requires a complex series of measurements and computations: (1) dividing the frequency range of 250 to 7000 Hz into 20 bands, each of which contributes 1/20 of the total intelligibility of speech; (2) determining the difference between the average speech level and the average level of the particular noise being rated (that is, the speech-to-noise ratio) for each of these bands; and (3) combining these numbers to give a single index.[52]

The SIL is a simplified substitute for the AI. Interference with intelligibility in the lowest and highest frequencies is ignored. As originally formulated in 1947, SIL was defined as the average of the sound pressure levels in the 600 to 1200, 1200 to 2400, and 2400 to 4800 Hz octave bands.[53] Since then, the preferred center frequencies have come into general use, and the more modern version of SIL therefore is the average of the sound pressure levels in the three octave bands centered at 500, 1000, and 2000 Hz. The shorthand notation for this version is PSIL, or SIL(.5, 1, 2).[54]

The relationship between PSIL and the voice level required for 60 percent reliable communication of individual words out of context, at varying distances from speaker to listener, is indicated by the following table:[55]

51. Beranek, *Noise*, SCIENTIFIC AM., Dec. 1966, at 66 [hereinafter cited as Beranek].

52. PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, at 6-2 to 6-3.

53. *Id.*

54. *Id. See* text accompanying note 26 *supra.*

55. L. BERANEK, NOISE AND VIBRATION CONTROL, Table 18.1 at 559 (1971).

		Normal	Raised	Very Loud	Shouting	Speaker's voice effort
Distance from speaker to listener (feet)	1	68	74	80	86	PSIL (dB)
	2	62	68	74	80	
	4	56	62	68	74	
	6	52	58	64	70	
	12	46	52	58	64	

The required voice levels indicated in the table are for average male voices. For female voices the speech-interference effects of noise are approximately 5 dB more severe. For example, for two males to converse over a distance of 6 feet at normal voice level requires that the ambient PSIL not exceed 52 dB. For two females to converse under the same conditions, the PSIL must not exceed 47 dB.[56]

In the case of Mrs. Early, octave-band levels of noise received from the electronics plant before and after abatement efforts were:[57]

Octave band center frequency (Hz)	Sound pressure level before abatement (dB)	Sound pressure level after abatement (dB)	
		Day	Night
31.5	79	66	64
63	76	66	64
125	64	60	56
250	59	52	50
500	61	50	50
1000	57	48	46
2000	54	43	42
4000	48	34	34
8000	37	30	26

The PSIL before abatement was 57 (the average of the three levels at the 500, 1000, and 2000 center frequencies), which would permit Mrs. Early to be understood outdoors at a distance of 4 feet if she spoke in a raised voice.

Although the differences between the PSIL and dBA values of different noises ordinarily will not be identical because the noise spectra will not be the same, for "average" or "not-unusual" noises the approximate A-weighted sound levels (dBA) which will permit conversation can be derived by adding 7 dB to the values in the table at footnote 55. Thus for two males to converse over a distance of 12 feet at normal voice levels would require that background noise not exceed 53 dBA.[58]

56. *Id.*

57. Reid Testimony, *supra* note 42.

58. *Id.*; PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, at 6-4.

(ii) *Preferred Noise Criterion (PNC) curves*: Another widely accepted method for estimating the effects of noise on speech communication, with particular application to rooms inside buildings, involves use of the preferred noise criterion (PNC) curves. The octave-band sound pressure levels associated with the PNC curves are shown in the footnote table.[59] The PNC rating of a particular steady noise is determined by comparing the sound pressure level of each octave band center frequency with the PNC curves shown in the footnote. The highest PNC curve so determined is the PNC value for that noise. By locating that value under the PNC curve heading in the following table, one can determine the quality of the acoustical environment associated with that value. The third column indicates approximate dBA equivalents for the various PNC curve values.[60]

Recommended category classification and suggested noise criteria range for steady background noise as heard in various indoor functional activity areas.

Type of space (and acoustical requirements)	PNC curve	Approximate L_A, dbA
Concert halls, opera houses, and recital halls (for listening to faint musical sounds)	10 to 20	21 to 30
Broadcast and recording studios (distant microphone pickup used)	10 to 20	21 to 30
Large auditoriums, large drama theaters, and churches (for excellent listening conditions)	Not to exceed 20	Not to exceed 30
Broadcast, television, and recording studios (close microphone pickup only)	Not to exceed 25	Not to exceed 34

59. Octave-band SPL values associated with the recommended 1971 preferred noise criterion (PNC) curves.

Preferred noise criterion curves	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
PNC-15	58	43	35	28	21	15	10	8	8
PNC-20	59	46	39	32	26	20	15	13	13
PNC-25	60	49	43	37	31	25	20	18	18
PNC-30	61	52	46	41	35	30	25	23	23
PNC-35	62	55	50	45	40	35	30	28	28
PNC-40	64	59	54	50	45	40	35	33	33
PNC-45	67	63	58	54	50	45	41	38	38
PNC-50	70	66	62	58	54	50	46	43	43
PNC-55	73	70	66	62	59	55	51	48	48
PNC-60	76	73	69	66	63	59	56	53	53
PNC-65	79	76	73	70	67	64	61	58	58

Beranek, Blazier & Figwer, *Preferred Noise Criterion (PNC) Curves and Their Application to Rooms,* 50 J. ACOUSTICAL SOC'Y OF AM. 1223, 1226 (1971).

60. *Id.* at 1227.

Small auditoriums, small theaters, small churches, music rehearsal rooms, large meeting and conference rooms (for good listening), or executive offices and conference rooms for 50 people (no amplification)	Not to exceed 35	Not to exceed 42
Bedrooms, sleeping quarters, hospitals, residences, apartments, hotels, motels, etc. (for sleeping, resting, relaxing)	25 to 40	34 to 47
Private or semiprivate offices, small conference rooms, classrooms, libraries, etc. (for good listening conditions)	30 to 40	38 to 47
Living rooms aud similar spaces in dwellings (for conversing or listening to radio and TV)	30 to 40	38 to 47
Large offices, reception areas, retail shops and stores, cafeterias, restaurants, etc. (for moderately good listening conditions)	35 to 45	42 to 52
Lobbies, laboratory work spaces, drafting and engineering rooms, general secretarial areas (for fair listening conditions)	40 to 50	47 to 56
Light maintenance shops, office and computer equipment rooms, kitchens, and laundries (for moderately fair listening conditions)	45 to 55	52 to 61
Shops, garages, power-plant control rooms, etc. (for just acceptable speech and telephone communication). Levels above PNC-60 are not recommended for any office or communication situation	50 to 60	56 to 66
For work spaces where speech or telephone communication is not required, but where there must be no risk of hearing damage	60 to 75	66 to 80

Inside Mrs. Early's house with windows open, assuming a 10 dB attenuation of the outdoor noise in each octave band, the pre-abatement PNC rating would have been 50. According to the table, the resulting listening conditions were only "moderately fair," well below those recommended for living rooms and similar spaces in dwellings where conversation and radio or TV listening occurs.

The EPA levels document recommends that to avoid interference with speech and other human activity, the L_{dn} for indoor residential areas should not exceed 45 dB, and the $L_{eq}(24)$ for other indoor areas with human activities, such as schools, should not exceed 45 dB.[61] In short, the EPA suggests a maximum average noise level of 45 dBA between 7 a.m. and 10 p.m. where speech communication is likely.

In Mrs. Early's house, before noise-abatement steps were taken by the adjacent factory, a 45 dBA level was achievable only by closing

61. LEVELS OF ENVIRONMENTAL NOISE, *supra* note 40, at 4.

all the windows. After abatement, the indoor level during daytime hours was approximately 42 dBA with windows open and 32 dBA with windows shut.[62]

b. *Effects on performance of tasks*: When a task involves auditory signals, whether speech or nonspeech, noise at any intensity sufficient to mask or interfere with perception of the signals obviously will interfere with performance of the task. Where mental or motor tasks do not involve auditory signals, the effects of noise on performance appear varied and difficult to assess. Studies show that noise sometimes interferes with, sometimes improves, and sometimes produces no significant effects on performance. According to the federal EPA, the following general conclusions emerge from the scientific literature:[63]

> (1) Steady noises without special meaning do not seem to interfere with human performance unless the noise level exceeds about 90 dBA, and results are not consistent even then.
>
> (2) Intermittent and impulsive noises are more disruptive than steady-state noises. Even when the sound levels of irregular bursts are below 90 dBA they may sometimes interfere with performance of a task.
>
> (3) High-frequency components of noise (above about 2000 Hz) usually produce more interference with performance than low-frequency components.
>
> (4) Noise usually does not influence the overall rate of work, but high levels of noise may increase the variability of the workrate. There may be "noise pauses" or gaps in response, sometimes followed by compensating increases in work rate.
>
> (5) Noise is more likely to reduce the accuracy of work than to reduce the total quantity of work.
>
> (6) Complex or demanding tasks are more likely to be adversely influenced by noise than simple tasks.

The World Health Organization has estimated that office noise, which rarely exceeds 90 dB, causes inefficiency amounting to $4 million every workday.[64] Another study indicates that only a one percent loss in efficiency would yield a loss of $3 billion annually if lost efficiency were related directly to reduction in GNP.[65]

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62. *See* text accompanying notes 42, 43, 48 *supra*.

63. PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, at 8-1, 8-2.

64. Lehman, *Noise and Health*, UNESCO COURIER, July 1967, at 31.

65. NOISE POLLUTION: A REVIEW OF ITS TECHNO-SOCIOLOGICAL AND HEALTH ASPECTS (G. Bugliarello ed. 1968).

The foregoing data and conclusions relate to noise which is concurrent with performance. Of course, performance also can be affected by physiological or psychological conditions resulting from earlier exposures to noise, such as fatigue due to sleep interference.

c. *Psychological effects*: (i) *Effects other than annoyance*: Noise exposure may cause conditions such as headaches, irritability, argumentativeness, nervousness and insomnia.[66] One study even led the researchers to surmise that the amount of noise in different neighborhoods was directly related to the prevalence of mental illness as evidenced by admissions to psychiatric hospitals.[67] However, conclusions in these areas are tentative at best and do not form a sound basis for quantitative noise regulations.

(ii) *Annoyance—in general*: The major established psychological effect of noise is annoyance. It occurs primarily as a result of interference with relaxation or sleep, but it may also result from disruption of other activities because of the unpleasantness of the noise or the message which it conveys.[68]

The annoyance value of a particular sound can depend on a number of factors:[69]

(a) Kind of noise: intensity, spectral characteristics, presence of impulses or discrete frequency components, fluctuation or intermittency, abruptness of onset or cessation, duration, and information content.

(b) Other background noise: noise whose level substantially exceeds the pre-existing ambient noise level is frequently found objectionable.

(c) Type of community: *e.g.*, residential or industrial.

(d) Time of day and activity of receivers: noises which are acceptable during the working day may be objectionable in the evening or on a weekend.

(e) Geography, season and climate: noise may be more objectionable when people are outdoors a large part of the time.

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66. PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, at 7-18, 7-20.

67. Abey-Wickrama, *et al.*, *Mental-Hospital Admissions and Aircraft Noise*, LANCET, 297, 1275-78 (1968).

68. PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, at 3-1, 7-17.

69. *Id.* § 3; BRAGDON, *supra* note 20, at 155-62; ACOUSTICS, *supra* note 43, § 4.

(f) Community experience with noise: new noises may be more objectionable than those which have continued for some period of time.

(g) Relationship to community welfare: annoyance may depend upon the relationship of the activity associated with the noise source to community welfare.

(h) Feasibility of abatement: receivers may be more annoyed if they believe the noise could be controlled.

(i) Fear associated with noise: annoyance is greater where receiver connects noise with danger, *e.g.*, airplane noise with threat of crash, or squealing auto tires with danger to child.

Studies of the annoyance effect have been conducted involving interviews of thousands of people in noisy areas of U.S. and foreign cities. Results of investigations prior to 1967 were summarized as:[70]

> In any noisy environment, whatever the intensity of the noise, about a fourth of the inhabitants say they are not perturbed by the noisy activities. These people apparently are able to live happily next to elevated railroads, trucking routes, airplane flight paths, and other loud noise sources. At the other extreme, about a tenth of those interviewed seem to be disturbed by almost any noise not of their own making, regardless of how faint it may be . . . .
>
> In areas where a specific source (such as airplanes) produces a constant din, about a third of the people said they tended to get used to the noise; on the other hand, a fourth said they were increasingly bothered by the noise as time went on. Personal reactions to noise did not appear to be correlated to any significant extent with age, sex, income or education.

Personal annoyance about unwanted sound may or may not be reflected at the community level by some kind of formal complaint, such as telephoning or writing an official, signing a petition, or joining a protest organization.[71] Surveys indicate that the propensity to complain to others than family and friends depends both upon the degree of annoyance and upon the individual's status in the community and the results

70. Beranek, *supra* note 51, at 68. *See* the results of a recent survey in Toledo, Ohio, discussed in text accompanying note 5 *supra.*

71. A night worker in Chicago, angry because noise had interrupted his daytime sleep, expressed his complaint by bursting out of his apartment building with a gun shouting, "I want to kill someone," and firing four shots at bystanders, wounding one of them. Chicago Daily News, Aug. 3, 1972, at 1, col. 3.

which he believes his complaint will achieve.[72] Therefore, even though a person suffers annoyance, he may not complain. Studies in Europe have shown that few people actually register formal complaints about noise. In Great Britain, for example, only 20 to 23 percent of individuals who felt that they had a serious local problem even considered calling or writing to a public official; and only about 2 to 4 percent actually registered complaints.[73] It is important, therefore, that legal efforts to control environmental noise consider the statistical likelihood of adverse personal reactions to noise, *i.e.*, subjective annoyance, as well as the probability of complaints. While the number of complaints to authorities about noise is small compared to the number of people annoyed, the number of such complaints is highly correlated with the proportion of the community who express high annoyance when surveyed.[74]

(iii) *Annoyance—ISO method for predicting complaints as a measure of annoyance:* The International Organization for Standardization (ISO) has developed a method for estimating community response to environmental noise.[75] ISO has concluded that, in general, a noise is likely to provoke complaints by occupants of residential premises whenever its level exceeds by a certain margin the pre-existing ambient or background noise.[76] The basic relationship between the amount by which a specific noise exceeds the ambient and the degree of expected community response, based upon extensive survey research, is shown in the following table:[77]

Excess Noise (dBA or NR numbers)	Expected Community Response: Category	Description
0	None	No observed reaction
5	Little	Sporadic complaints
10	Medium	Widespread complaints
15	Strong	Threats of community action
20	Very strong	Vigorous community action

In order to apply this table one must understand the methodology for determining the appropriate ambient noise level and for measuring and rating the specific noise in question. In some non-rule-

72. *IPCB Hearings on R72-2, supra* note 6, at 124 *et seq.* (Testimony of Dr. John J. O'Neill, June 22, 1972).

73. *Id. See* PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE, *supra* note 35, at 3-4, 3-5, 3-7.

74. PUBLIC HEALTH WELFARE CRITERIA FOR NOISE, *supra* note 35, at 3-7, 3-9.

75. ACOUSTICS, *supra* note 43.

76. *Id.* § 4.2.

77. *Id.* Table 4.

making situations, such as where a factory to be constructed at a known site is being designed to avoid noise emissions in excess of existing levels, the ambient at that site actually can be measured. However, to formulate regulatory noise limits for application throughout a large area with diverse land uses, ambient levels must be estimated; ISO has developed a computational method for doing this. With respect to specific noise for which community response is to be predicted, the ISO provides alternative measurement and rating methods: one uses simple dBA levels, while the other, permitting more accurate predictions of response, employs octave band sound pressure levels and noise rating (NR) curves.

(a) *Computing the ambient*: For computing the approximate levels of ambient noise in different kinds of rural, suburban, and urban areas, the basic criterion or norm is 35 to 45 dBA, based upon the ambient for rural residential areas.[78] Corrections to account for the predominant character of the area being rated are:

Rural residential, hospital zones, recreation areas	0
Suburban residential with little traffic	+5
Urban residential	+10
Urban residential with some shops or with main roads	+15
Central city commercial	+20
Heavy industry	+25

In addition, the following corrections should be made for different times of day:

Daytime	0
Evening	-5
Nighttime	-10 to -15

Finally, where the specific noise for which response is being predicted is rated in NR numbers rather than in dBA, a further correction of -5 is made to yield an NR ambient rating.

(b) *Rating the specific noise—dBA level*: For steady broad-band noise, the dBA rating is simply the A-weighted sound level of that noise. If the noise is impulsive or contains audible discrete tones, an adjustment of +5 is made to the measured level to account for the greater annoyance produced by such noise.[79]

If the noise being rated varies with time, the ISO suggests that a correction factor may be appropriate to take account of the reduced

78. *Id.* § 4.1.

79. *Id.* Table 1; IPCB OPINION IN R72-2, *supra* note 22, at 18. *See* text accompanying note 31 *supra* for definitions of different categories of noise.

duration.[80] For example, if a noise with a constant level is interrupted by pauses, the ISO suggests the following corrections:

Duration of noise as percentage of relevant time period	Correction
56 to 100	0
18 to 56	-5
1.8 to 6	-15
0.6 to 1.8	-20
0.2 to 0.6	-25
Less than 0.2	-30

For noise which varies with time in a more complicated manner, ISO suggests use of the L_{eq}. However, ISO recognizes that time averaging may serve to understate the annoyance value of noise. Thus, for noise during the night, ISO says that it may be desirable to set an absolute limit because noises with high levels and short duration may be particularly disturbing for sleep.

Parenthetically, it should be noted that the federal EPA in its levels document recommends the following time-averaged limits for total environmental noise from all sources to avoid activity interference and annoyance: $L_{dn}=45$ dB for indoor residential areas; $L_{dn}=55$ dB outdoors in residential areas and farms, in other outdoor areas where people spend widely varying amounts of time, and in places in which quiet is a basis for use; and $L_{eq}(8)=55$ dB in outdoor areas where people spend limited amounts of time, such as schoolyards.[81]

As the ISO points out, however, L_{eq} and L_{dn} levels may have little relationship to the annoyance value of the total environmental noise or of individual sources contributing to it. One acoustician illustrated this to the EPA with data showing that during one night from 10 p.m. to 7 a.m. the L_{eq} level at his house in a Chicago suburb was fixed largely by wind through the oak trees and by traffic on an expressway a mile away, and was barely affected by the two most annoying noise sources in the neighborhood, a barking German shepherd dog a few doors away and overflights by jet airplanes going to and from O'Hare field.[82]

(c) *Rating the specific noise—octave band levels and NR curves:* Measuring specific noise emissions in dBA, as described in the preceding section, can be done by relatively unskilled personnel using rela-

80. ACOUSTICS, *supra* note 43, § 3.

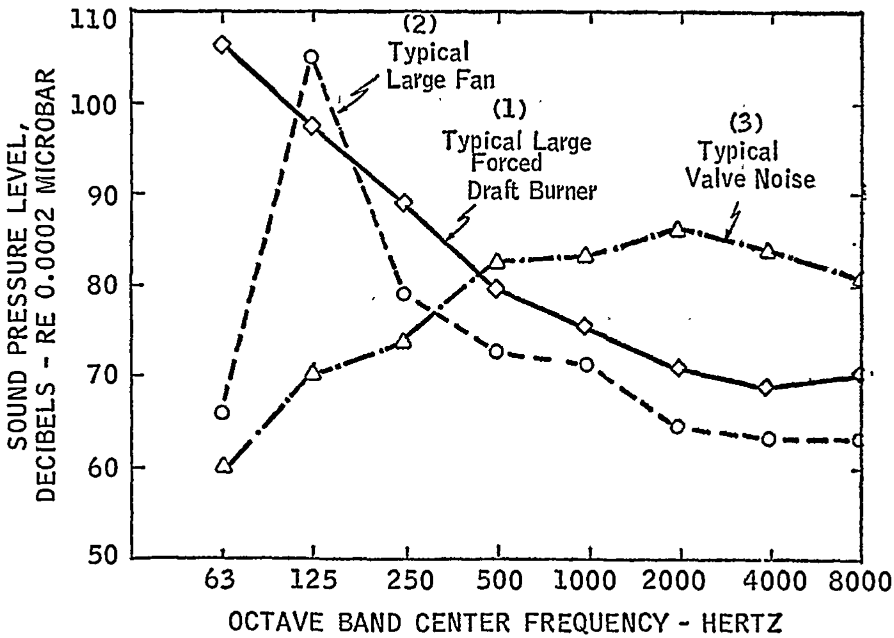
81. LEVELS OF ENVIRONMENTAL NOISE, *supra* note 40, at 4.

82. Letter from George W. Kamperman to Simone Yaniv of the federal EPA, Nov. 15, 1973, on file with the authors.

tively unsophisticated equipment. In some circumstances dBA measurements may be adequate. However, a single-number sound level, such as dBA, gives no information regarding the character of the noise. This point is illustrated by Figure 3[83] which shows sound pressure levels versus frequency for three pieces of equipment, each producing approximately 90 dBA, and each having a distinctive frequency spectrum and hence a distinctive sound. Curve 1, representing a large forced draft burner, would appear to the listener as a rumbling low-pitched noise. Curve 2, typical of a large forced air fan with most of its acoustic energy concentrated in the 125 Hz octave band, would have a readily detectable discrete tone component. Curve 3, depicting the noise from a control of letdown valve, would have a high-pitched hissing sound.[84]

FIGURE 3.

COMPARISON OF EQUIPMENT NOISE SPECTRA APPROXIMATING 90 dBA



With respect to Curve 2, we have seen that the ISO recommends a +5 correction to the measured levels of audible discrete tones be-

83. DeBiase, *Criteria and Design Specifications for Noise Control of Industrial Plants*, in NOISE AND VIBRATION CONTROL ENGINEERING (Crowley ed. 1971) [hereinafter cited as DeBiase].

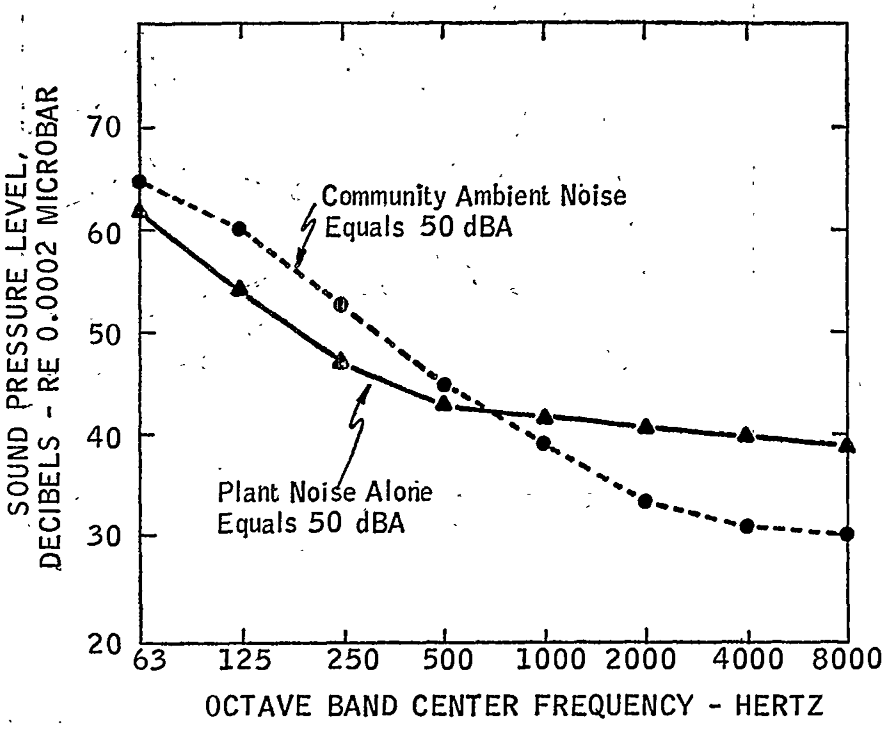
84. *Id.* at 135-41.

cause they are particularly annoying. However, no correction is provided for noises such as those represented by Curves 1 and 3. Yet, because noises with sound energy concentrated in the low or the high frequencies of the audible spectrum can cause annoyance disproportionate to their dBA levels, single-number community intrusion limits will in some cases prove inadequate.

The potential effect of the noise represented by Curve 3 can be illustrated by reference to Figure 4,[85] which shows the spectra of the pre-existing ambient noise and of the noise from a new factory in the community. Although both produce 50 dBA, the plant noise exceeds the former ambient in four octave bands. This increase would be noticeable and could result in complaints.[86] A noise spectrum like that of Curve 3 in Figure 3, even if the overall level were considerably lower, would have the same annoying effect in an ambient of the type shown in Figure 4.

FIGURE 4.

COMPARISON OF EQUIVALENT dBA SPECTRA



85. *Id.*

86. *Id.* at 136.

The annoyance which could be caused by a noise of the type depicted in Curve 1, Figure 3, is indicated by testimony in the case of Mrs. Early. There, pre-abatement levels were 79 dB and 76 dB at 31.5 Hz and 63 Hz respectively, well below the levels shown in Curve 1. George W. Kamperman, an acoustical consultant, explained that although 79 dB at 31.5 Hz would produce only 40 dBA because of the severe attenuation of low frequency sound by the A-weighting scale,[87] it would literally shake the house and make the dishes rattle.[88]

The most accurate method of predicting community response to noise involves application of noise-rating (NR) curves recommended by the ISO and shown in Figure 5.[89] To use the NR curves one first makes an octave-band analysis of the noise to determine the sound pressure level at each of the center frequencies indicated in Figure 5. Then, after correcting each octave band level for impulsive characteristics, audible discrete tones, and variation with time, as described in the preceding paragrahps, the table is consulted to determine an initial NR number of each octave band. The *highest* of the NR numbers is the NR rating of the noise. This NR rating then is compared with the computed NR rating of the ambient noise level which, as previously stated, is 5 less than the computed dBA level of the ambient. Expected community response depends upon the amount by which the NR rating of the noise exceeds the NR rating of the ambient; responses are indicated in the table following note 77.[90]

Let us apply the octave-band NR rating method to estimate response to the post-abatement daytime noise at Mrs. Early's property. The computed ambient in NR numbers always is 5 less than the dBA ambient; in this case the NR rating of the ambient is 35 to 45. Octave-band sound pressure levels of the plant noise are given above at note 57. No corrections are needed for impulsive characteristics, audible discrete tones, or variance with time. Using the NR curves, we find that the NR rating of the post-abatement daytime noise is 50 (48 dB at 1000 Hz yielding the highest NR number). The difference between the NR ratings of the ambient and the noise is 5 to 15, so that we should expect community response to vary from "sporadic complaints" to "threats of community action."

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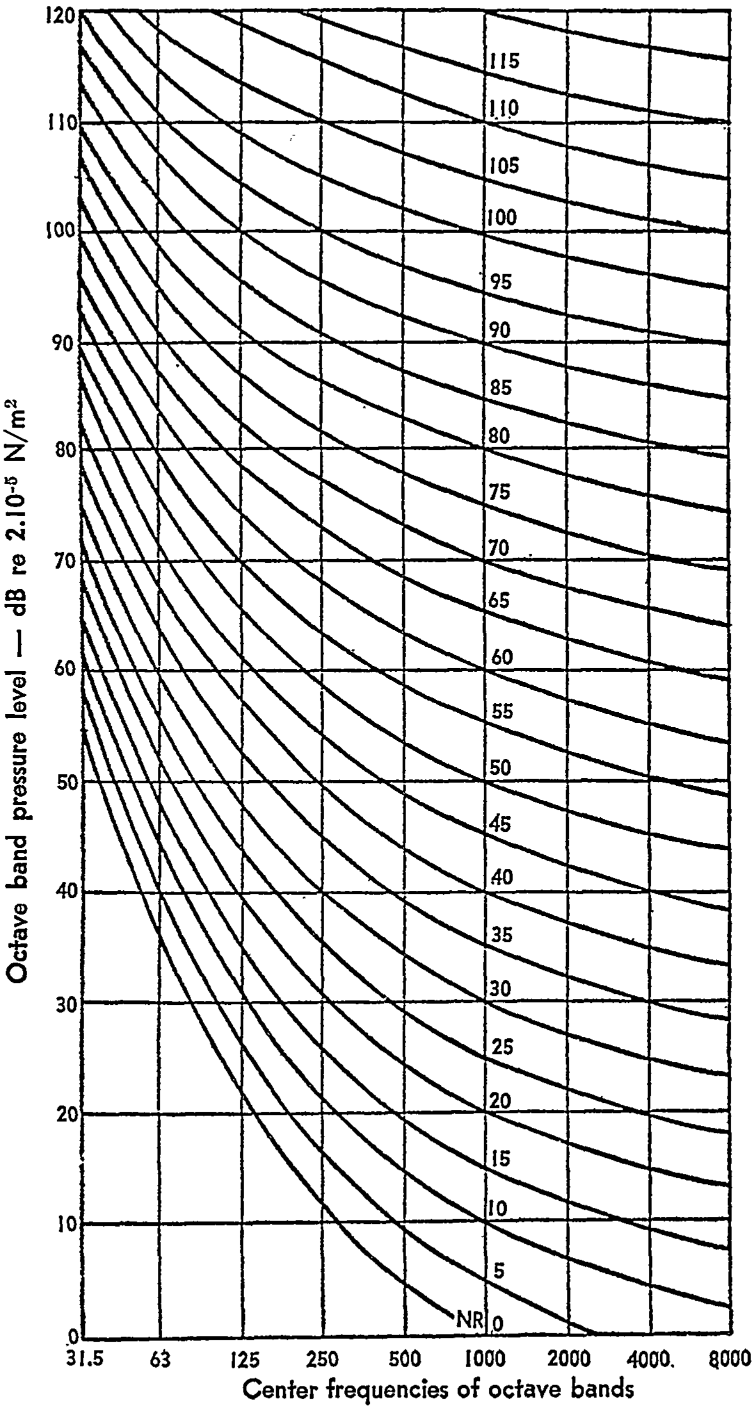
87. *See* text accompanying note 27 *supra*.
88. *IPCB Hearings on R72-2, supra* note 6, at 1132.
89. ACOUSTICS, *supra* note 43, app. Y.
90. *Id.*

FIGURE 5.


Octave band pressure level — dB re 2.10⁻⁵ N/m²
120
110
100
90
80
70
60
50
40
30
20
10
0
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
NR
0
31.5
63
125
250
500
1000
2000
4000.
8000
Center frequencies of octave bands

(iv) *Annoyance—C-minus-A method:* Recognizing the inadequacy of dBA levels alone for regulatory purposes, but still seeking a simple alternative to octave-band analysis for predicting human response to noise, Botsford has proposed a method which considers not only the A-weighted level but also the difference between the C-weighted and A-weighted levels.[91] From evaluation of more than 950 different noises, he found that his C-minus-A method correlated quite well with the ISO's NR method as a predictor of annoyance as evidenced by community response.

Each noise limit prescribed by a law or regulation applying the C-A method would be two-dimensional: it would involve a limit on the dBA level, and also a limit on the difference between the dBC and dBA levels. As will be recalled, the C scale gives almost equal weighting to all frequencies, while the A scale strongly suppresses meter response at frequencies below 1000 Hz.[92] Hence the dBC level of a particular noise generally will exceed the dBA level if the spectrum includes those lower frequencies. The maximum allowable difference between dBC and dBA levels for regulatory purposes would depend upon the extent to which the rulemaker desired to restrict low frequency sound. In order to do so to approximately the same extent as the octave-band limits in the Illinois rule governing daytime emissions from industrial sources to residential receivers (Section IV.D.1) a C-A rule would establish a maximum dBA level of 61 and a maximum difference of 20 between the dBC and dBA levels.[93]

Since the C-weighting scale suppresses high frequencies in the audible range slightly more than does the A scale, the C-A method is no answer to the problem, discussed in the preceding section, of the inadequacy of dBA levels as predictors of annoyance and community response due to noise which exceeds the ambient in the range of 1000 to 8000 Hz.

C. Noise Abatement: Introduction to Technology and Economics

Methods of noise control can best be understood against a background of the ways in which sound is transmitted. Sound emitted from a source eventually reaches the ear as pressure fluctuations in the air.

91. Botsford, *Using Sound Levels to Gauge Human Response to Noise*, Sound and Vibration, Oct. 1969, at 16.

92. *See* text accompanying note 29 *supra*.

93. Information obtained from George W. Kamperman, acoustical consultant of Downers Grove, Ill., Apr. 6, 1974.

The fluctuations may travel through the air directly from source to receiver, or they may be transmitted indirectly through an intervening structure. For example, vibrating machinery may transmit noise into the floor and to the walls, which then transmit it into the air. In such a case, blocking only the noise transmitted directly from the machine to the receiver may prove inadequate for abatement purposes.[94]

The variety of noise control approaches which may be considered in a particular case is suggested by the following outline:[95]

Source Modifications

Physical	Operational
Reduce speeds of aerodynamic or mechanical flow	Relocate source
Add mufflers or silencers	Restrict time of operation
Isolate or damp vibrating elements	
Enclose source with sound-absorbing material	

Path and Receiver Modifications

Erect barriers
Modify buildings, or close windows
Manage land use: establish buffer or relocate receiver

1. *Distinction Between New and Existing Sources:* At the outset it should be emphasized that the technical and economic problems in quieting an existing noise source may be substantially different and more severe than those in designing a similar new facility to meet the same standards. In many cases retrofits are less effective and more expensive. For example, in the case of an oil refinery, which contains many distinct sources of noise, abatement steps to quiet an existing installation to 45 dBA at 1000 feet may cost two to four times as much as preventive steps taken in the design and construction of a new refinery to achieve the same level.[96] Much of the machinery and other equipment found in existing industrial plants is noisier than corresponding new equipment, or than equipment which will be coming onto the market as federal and state governments undertake—as explained in the next section—to regulate noise levels produced by new products. As time goes on, more of the noise control burden will be placed on

94. *IPCB Hearings on R72-2, supra* note 6, at 2008 (Testimony of George W. Kamperman, Nov. 9, 1972).

95. III Chicago Urban Noise Study, *supra* note 30, at 4-7. *See also Buyer's Guide to Materials for Noise/Vibration/Shock Control,* Sound and Vibration, July/Aug., 1972.

96. *IPCB Hearings on R72-2, supra* note 6, at 309-14 (Testimony of George W. Kamperman, June 22, 1972).

makers of the equipment used in facilities which create environmental noise. Thus, the cost of noise abatement will be less apparent as it is included in the standard prices of the equipment.

In the long run, noise control at the immediate source is likely to be the most practical and economical method of dealing with our environmental noise problem. In the interim it will be necessary to erect barriers, install silencers, enclose sources, and employ other techniques outlined above.

2. *Retrofit of Existing Sources:* In the case of Mrs. Early, noise from the electronics plant across the street was reduced relatively easily. The speed of the largest fan was reduced and the pitch of the blades changed. The two smaller vent fans were removed from the side of the building and reinstalled on the roof, farther from Mrs. Early's house. Finally, a new mounting was provided which prevented transmission of a throbbing sound from a compressor. Total cost was approximately $12,000.[97]

Prior to adoption of noise control regulations in 1973, the Illinois Pollution Control Board received evidence of many other cases in which substantial noise reductions were achieved at reasonable costs. The problems ranged in complexity from controlling the sound from a single machine to controlling an entire industrial complex. The following table summarizes some representative cases, indicating types of noise sources, control techniques, results, and costs.[98] Where a range of noise reduction is shown, *e.g.*, 20 to 45 dB in case 1, the decreases in the sound pressure levels at various octave-band center frequencies varied within that range.

Noise Source	Control Technique	Noise Reduction	Cost
1. steam vent	silencers	20-45 dB	$ 1,100
2. refinery	mufflers on process heater units	5-9 dB in neighborhood	$ 90,000
3. fans	fan blade modification fan relocation	12 dBA	$ 12,000
4. air conditioner	duct silencers, reduce fan speed	18 dBA	$ 2,000
5. sewage treatment plant	mufflers on blowers	31 dBA	$ 900
6. cooling tower	duct silencers	13 dBA	$ 37,500
7. gas blowdown valve	silencer	40 dBA	$ 12,000 (approx.)
8. steam drop hammer	silencer on steam vent	44 dBA	$ 200

97. Reid Testimony, *supra* note 42, at 1126.

98. IPCB OPINION IN R72-2, *supra* note 22, at 37-38.

9.	pan feeder	surface lined with armaplate rubber sheet	17 dBA	$ 2,100
10.	piggy back unloader	sound cabinet on diesel, vibration isolators, muffle exhaust, relocate trucks	10 dBA	$ 28,800
11.	screw machine	acoustical stock tube	12-34 dB for machine	$ 30-120
12.	vibrating conveyor	armaplate applied	17 dBA	$ 1,100
13.	compressor station surge tank	damping compound applied	2-18 dB	$ 500 (approx.)
14.	exhaust fans	sound barriers	11 dBA	$ 500 (approx.)
15.	air conditioner	sheet metal barrier	15 dBA	$ 500 (approx.)
16.	air conditioner	acoustically treated barrier	15 dBA	$ 1,000
17.	refrigeration unit	brick barrier	15 dBA	$ 2,000
18.	refrigeration unit	enclosure plus deflecting baffle	4-9 dB	$ 1,900
19.	ventilation system	relocate sources plus acoustic ducts	up to 9 dB	$ 3,700
20.	gas turbine alternator	complete enclosure	up to 54 dB	$ 50,000
21.	exhaust fans	silencer and muffler	now below ambient	$ 5,000
22.	printing press	relocation, closed windows	12 dBA	only labor costs
23.	rotary swaging unit	acoustically lined enclosures	9-19 dB for lining alone	$ 200
24.	transformer substation	acoustic block barriers around 3 sides of transformers	13 dB in neighborhood	$180,000
25.	natural gas pipeline	spray insulation on pipe	18 dB	$ 300
26.	diesel compressor	muffler	32 dBA	$ 4,500 (approx.)
27.	gas turbine	enclosure lined	10 dB due to lining	$ 700
28.	cooling water pumps	enclosure surfaces lined	17 dB due to lining	not known
29.	punch press (2)	silo-like enclosures lined w/acoustical material	19 dBA at operator	$ 4,500 each
30.	punch press	3 wall roofed enclosure with access doors and vent fan	18 dBA	$ 4,800
31.	plastic grinder	partial enclosures	15-20 dB	as low as $ 300
32.	gas-fired burner fans	inlet silencers	now below ambient	$ 68,400
33.	air compressor	pulse silencer	annoyance eliminated	$ 75
34.	transformer	lined steel barrier	17 dB	$ 5,000 (approx.)
35.	nail making machine	vibration isolators	4-15 dB in shop	$ 500 (approx.)
36.	control valve	blowoff silencer	45 dBA (approx.)	$ 10,000
37.	gas turbine power plant	enclosure, inlet and exhaust silencers	meets C/A	$ 47,300
38.	transformer	L-shaped acoustic block barrier	6 dB in neighborhood	$ 3,000
39.	compressor station	spray insulation on building walls and ceiling	4-25 dB	$ 3,400
40.	motor generator set	enclosure with ventilation system	34 dBA	$ 700
41.	granulators (4)	U-shaped enclosures	now below factory ambient	$ 5,000 each
42.	cut-off saw	enclosure with ventilation	13 dBA	$ 1,500
43.	transformer	barrier	5 dB at residence	$ 4,000
44.	fan	barrier plus inlet silencer	15 dBA	$ 2,800

The cost of abating noise emanating from many sources may not be the sum of the costs of controlling all the individual sources. Where there are multiple sources, one or more often are sufficiently noisy that they mask the others. By quieting these especially noisy sources, effective control often can be achieved at less cost than would be required to silence every source equally. For example, if three machines emit 60, 50 and 45 dBA, respectively, and if noise control technique 1 can reduce the level of sound from the first machine by 10 dBA and at one-third the cost of technique 2, which can reduce the sound level from each machine by 10 dBA, the comparative results of utilizing the two techniques are:[99]

Situation	Machine Noise Levels (dBA)	Total Noise Level (dBA)	Cost to Control
Original	60, 50, 45	60.5	no cost
Technique 1	50, 50, 45	53.6	some cost
Technique 2	50, 40, 35	50.5	three times the cost of technique 1

In terms of noise abatement per dollar, technique 2 achieves better results but is more than twice as expensive per dBA of reduction.

3. *Noise Surveys:* The economics of obtaining sound level measurements also should be mentioned. Previous portions of this article have shown that frequency analysis of a noise affords greater accuracy in predicting its effects on people. What has not been pointed out is that while such analysis is *desirable* for rating purposes, it is *essential* in many contexts in order to determine what corrective measures must be taken to reduce the noise.[100] Evidence in the hearings on the Illinois noise control regulations showed that approximately 1½ days are required for an acoustical consultant to obtain octave-band measurements around a typical industrial site, and that the maximum charge for such consultants was $320 per day. Hence, the cost of a noise survey (not including proposed abatement measures) usually would not exceed $500. The purchase price of all equipment needed for the octave-band survey, if one preferred to do it himself, would be about $6,600; or the equipment could be rented for $175 per day.[101] A simple sound level meter with only the A, B, and C scales, on the other hand, can be purchased for less than $400.

99. *Id.* at 39.
100. ACOUSTICS, *supra* note 43, app. Y.
101. IPCB OPINION IN R72-2, *supra* note 22, at 39.

III. FORMULATING A STATE REGULATORY SYSTEM: PROBLEMS OF ROLE AND SCOPE

Once it is determined that environmental noise from nontransportation sources is a problem requiring public regulation, consideration must be given to the allocation of responsibility and authority among federal, state, and local governments. An initial allocation has already been made in the Noise Control Act of 1972,[102] which, among other things, calls for establishment of federal noise emission standards for products distributed in interstate commerce. Insofar as the regulatory power has not thereby been pre-empted, there remains the matter of the appropriate roles of state and local governments.

A. Role and Scope of Federal Regulation

The Noise Control Act of 1972 establishes a federal noise control program which is to involve noise emission standards and labelling for products distributed in commerce; aircraft noise standards; and railroad and motor carrier noise standards. The parts of the act bearing directly on the control of sound from nontransportation sources are those dealing with products distributed in commerce and, to a lesser extent, with interstate railroads and motor carriers.

1. *Product Noise*

a. *Reports by federal EPA:* The act requires the Administrator of the federal Environmental Protection Agency to undertake a detailed program of study and regulation of noise emanating from products distributed in commerce. Within 9 months of the effective date of the act (October 27, 1972), and after consultation with appropriate federal agencies, he was to publish "criteria" reflecting the scientific knowledge most useful in indicating the kind and extent of effects of noise on the public health and welfare. Within 12 months, he was to publish information on the levels of environmental noise, the maintenance of which is necessary to protect the public health and welfare in various areas and conditions.[103] The criteria document was issued within the prescribed time; the levels document was finally pried out of the Office of Management and Budget by Senator Tunney and the Environmental Defense Fund in discovery proceedings, and signed by EPA Administrator Russell Train on March 29, 1974.

102. 42 U.S.C. §§ 4901 *et seq.* (Supp. II, 1972).
103. *Id.* § 4904(a)(1), (2) (Supp. II, 1972).

Within 18 months of the effective date of the act, the Administrator was to publish the first of a series of reports identifying products or classes of products which in his judgment were "major sources" of noise and giving information on techniques for control of noise from those sources. Proposed regulations for any products so identified for which noise emission standards were judged feasible and which fell into the categories of construction equipment, transportation equipment (including recreational vehicles and related equipment), any motor or engine (including any equipment of which an engine or motor is an integral part), and electrical or electronic equipment, also were to be published within 18 months of the date of the act (or the date of their identification as major noise sources if that was later than 18 months after the date of the act).[104] Six months following the publication of the proposed regulations, and after interested persons had been allowed to participate in the rulemaking, final regulations were to be adopted.[105] In addition, the Administrator was empowered, but not required, to establish regulations for products which did not fall within the foregoing categories, but for which he judged that noise emission standards were feasible and necessary to protect the public health and safety.[106]

b. *Content of federal product noise regulations:* All product regulations under the act are to include a noise emission standard limiting noise emissions from the regulated product to a level judged requisite to protect the public health and welfare, taking into account the magnitude and conditions of use of the product (alone or in combination with other noise sources), the degree of noise reduction achievable through the application of the best available technology, the cost of compliance, and "appropriate consideration" for standards under other laws designed to safeguard the health and welfare of persons, including the National Traffic and Motor Vehicle Safety Act of 1966, the Clean Air Act, and the Federal Water Pollution Control Act.[107]

c. *Prohibited acts:* After the effective date of any such regulation it is unlawful to distribute in commerce for use in any state, or to import into the United States, any "new product" to which the regulation applies unless the product is in compliance.[108] Manufacturers

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104. *Id.* § 4905(a)(1)-(2). Medium and heavy-duty trucks were identified, along with certain portable air compressors, as major sources of noise on June 21, 1974, 39 Fed. Reg. 22297 (1974), after issuance of proposed regulations applicable to interstate motor carriers. *See* text accompanying note 14 *supra* and text accompanying note 229 *infra*.

105. *Id.* §§ 4905(a)(2), (c)(3).

106. *Id.* § 4905(b).

107. *Id.* § 4905(c)(1).

108. *Id.* §§ 4909(a)(1), (b)(2).

must warrant to ultimate purchasers that the products are in compliance with the regulation at the time of sale.[109] Once federal noise regulations are adopted for a product, the states are specifically prohibited from adopting or enforcing any different noise regulations for such products manufactured after the effective date of the federal regulations.[110] States may, however, adopt regulations identical to those promulgated by the Federal EPA and thus participate in their enforcement.

d. *Federal pre-emption of state noise regulation:* (i) *Power of Congress*: The effect of the prohibition contained in section 6(e) of the federal act is to pre-empt individual states from regulating in an area of public health or welfare which, but for the pre-emption, would presumably be an area subject to state power. By virtue of the supremacy clause of the Constitution,[111] Congress has the power to pre-empt state law in any field in which Congress has power to act, and the only question in any case is whether it has done so.[112]

Of course, the fact that Congress can pre-empt does not necessarily mean that it has pre-empted, in whole or in part. In construing federal legislation and the intent of Congress, courts recognize the value of preserving state power in areas of traditional importance to the states, where state authority can be left undisturbed without undue interference with the federal scheme.[113] The fact that, as Senator Tunney suggested,[114] the Noise Control Act of 1972 was enacted pursuant to the power of Congress to protect the public health and welfare, and not under its broader power over interstate commerce, may indicate a Congressional intent to limit the scope of pre-emption under the act.

(ii) *Areas pre-empted under section 6(e) of the federal act:* Section 6(e)(1), the general pre-emption provision, applies only to adoption and enforcement of standards with regard to "new products." The scope of pre-emption of state noise regulations applicable to products thus depends on the definition of that phrase. It is quite broad. A "product" is "any manufactured article or goods or component there-

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109. *Id.* § 4905(d).

110. *Id.* § 4905(e).

111. U.S. CONST. art. VI, § 2.

112. *Ex parte* Bransford, 310 U.S. 354 (1940). *See* Note, *Environmental Control: Higher State Standards and the Question of Preemption,* 55 CORNELL L. REV. 846 (1970).

113. *See* Rice v. Board of Trade, 331 U.S. 247 (1946).

114. 118 CONG. REC. S 37317 (1972) (remarks of Senator Tunney).

of."[115] Specifically excepted are aircraft and aircraft engines, propellers, and appliances as defined in section 101 of the Federal Aviation Act of 1958; military weapons or equipment designed for combat use; and experimental rockets or research equipment designed for use by NASA or elsewhere in the federal government to the extent provided for by regulations of the Administrator. A "new" product is one the legal or equitable title to which has never been transferred to an "ultimate purchaser,"[116] who in turn is defined as "the first person who in good faith purchases a product for purposes other than resale,"[117] or one which is imported or offered for importation into the United States and which was manufactured after the effective date of a regulation relating to such products.

The broad range of new products for which state and local noise regulations will be pre-empted is demonstrated by the last two categories of section 6(a)(1)(C), which include as classes of products for which new-product noise regulations *must* be established for major noise sources "any motor or engine (including any equipment of which an engine or motor is an integral part)" and "electrical or electronic equipment." This appears to include most of the noise-producing equipment of stationary sources such as factories. The breadth of coverage was further illustrated by a federal EPA statement before the Senate Subcommittee on Air and Water Pollution, listing as examples of possible subjects of federal regulation new automatic car wash facilities and large commercial air conditioning equipment.[118]

(iii) *Areas not pre-empted under section 6(e) of the federal act:* Section 6(e)(1) preserves to the states the right to regulate noise emissions from all products for which federal noise regulations have not become effective, or for which federal regulations have become effective but which were manufactured before the effective date of the regulations (*i.e.*, non-new products). Further, section 6(e)(2) explicitly preserves to the states and their political subdivisions a much broader authority: the right "to establish and enforce controls on environmental noise (or one or more sources thereof) through the licensing, regulation, or restriction of the use, operation, or movement of any product or combination of products." "Environmental noise" is

115. 42 U.S.C. § 4202(3) (Supp. II, 1972).
116. *Id.* § 4902(5).
117. *Id.* § 4902(4).
118. *Hearings on S. 1016, S. 3342 and H.R. 11021 Before the Subcomm. on Air and Water Pollution of the Senate Comm. on Public Works*, 92d Cong., 2d Sess. 345 (Additional Information Supporting EPA Statement on Noise Control Legislation).

defined as "the intensity, duration, and character of sounds from all sources."[119] The state regulatory scheme envisioned in section 6(e)(2) is precisely that which is discussed herein and was adopted in Illinois in 1973. No state-imposed limits are suggested for noise emissions from individual products which might later be regulated, and thus pre-empted, by the federal government. Rather, state-imposed limits are applied to the total character and intensity of sounds which may be emitted to receiving land from all noise sources—"products and combinations of products"—on the emitting land. Noise emitters are free to use any products whatever so long as they are used or operated in such a fashion as not to emit noise to receiving land in excess of the specified limits.

Several illustrations of this distinction between noise emission standards on products which may be pre-empted by federal regulations and standards on the "use, operation, or movement" of products, which are reserved to the states or localities by section 6(e)(2), were presented in the EPA statement just referred to. One point, for example, was that even though a state or city could not enforce a noise emission standard on new window air conditioners different from that established for such units by the federal government, it could adopt and enforce environmental noise limits in certain zones which would result in some window units requiring special modification or installation for use in those zones, even though the units met the federal standards. Similarly, the EPA said that local regulations on noise emitted to residential units could require a facility such as an automatic car wash or a large commercial air conditioning system to incorporate additional acoustical treatment even though all of its components satisfied applicable federal noise standards without the treatment.

2. *Noise from Equipment and Facilities of Interstate Railroads and Motor Carriers*

In addition to prescribing the foregoing general plan for federal-state regulation, sections 17 and 18, respectively, of the 1972 act provide for even broader federal control and pre-emption with respect to noise from "operation of the equipment and facilities of surface carriers engaged in interstate commerce by railroad" and "operation of motor carriers engaged in interstate commerce." State control of noise from any such activities for which federal regulations have been adopted is pre-empted, except that the states can adopt and enforce regulations

119. 42 U.S.C. § 4902(11) (Supp. II, 1972).

identical to the federal ones, and the Administrator of the federal EPA, after consultation with the Secretary of Transportation, may determine that particular state standards or controls on levels of environmental noise or on the use, operation, or movement of any product are necessitated by "special local conditions" and are not in conflict with federal regulations.

While the expansive language of sections 17 and 18 may provide a valid legal basis for federal regulation of noise from virtually every activity of most rail and motor carriers, many such activities do not require national uniformity of treatment to facilitate interstate commerce and can best be controlled by local measures. Thus, federal regulation may be most appropriate for engine noise from equipment which regularly moves across state lines, but different considerations may apply to stationary facilities such as terminals, marshalling yards, and maintenance shops. Environmental noise from such permanent installations can be reduced by techniques similar to those used for sources unconnected with the transportation industry, *e.g.*, sound barriers, buffer zones, rescheduling of operations to reduce noise at times of day when the impact is most severe, and locating noisy equipment such as idling locomotives and parked refrigerator cars and trucks as far as possible from adjacent noise-sensitive property. As previously stated, the term "nontransportation noise sources", as used in this article, includes such stationary facilities of rail and motor carriers, since the federal CPH has indicated its intention not to establish pre-emptive noise regulations for such installations.[119a]

B. Role and Scope of Local Regulation of Nontransportation Noise Sources

A recent study commissioned by the federal EPA surveyed the regulatory activities of local governments in the area of nontransportation noise, among others.[120] The study found a wide range of regulations and regulatory practices. Some cities had ordinances, applicable generally to commercial and industrial establishments, prohibiting excessive or unusual noise. More often the pattern seemed to be one of cities experiencing unwanted sound from specific commercial establishments or activities, and then enacting specific ordinances to deal with the particular noise source. Typically these ordinances contained

119a. *See* proposed rules, 39 Fed. Reg. 24580 (1974).

120. Environmental Protection Agency, Laws and Regulatory Schemes for Noise Abatement 1-117 to 1-137 (1971) [hereinafter cited as Noise Abatement].

subjective standards, rarely specified enforcement agents, and often failed to prescribe penalties.

On the other hand, many municipalities were found to have included provisions governing noise in their local zoning ordinances. Not infrequently these provisions were stated in terms of performance standards, utilizing objective decibel noise limits. However, the limits were found to vary widely, and some included decibel levels so low as to be virtually unenforceable.

If there was a trend in local noise regulation, it seemed to be a movement among the more noise-impacted cities away from the vague and subjective criteria toward measurable performance standards. The movement could not be called massive, however, due in part to the complexities of determining appropriate objective levels and to the fact that the establishment of noise control offices with extensive enforcement powers places an added strain on the already burdened financial and human resources of these cities. The study concluded that "noise regulation at the local level has generally been by the piecemeal enactment of certain restrictions in response to particular community problems, instead of . . . broadly applicable legislation coming after an in-depth study of the noise problem of the municipality and a realization on the part of its citizens that some steps are necessary to lower the general noise level of the community."[121]

The inadequacies of local regulation of noise sources was testified to by a number of persons at the Illinois hearings, including some city officials. The reasons for these inadequacies were most often stated to be the unenforceability of ordinances with subjective criteria and the lack of technical expertise at the local level to administer an ordinance with objective performance standards. In one case it was reported that one city with an objective standards ordinance was no longer enforcing it "because they had lost their sound meter."

Is there a place, then, for local government in the regulation of nontransportation noise sources? Clearly yes. There will continue to be a need for addressing specific problems in individual communities, a role local government has filled with some success. Further, whatever levels are established in statewide or national control of noise sources, there will be some communities which wish to create a better than "average" noise environment for themselves. Within the limits

121. *Id.* at 1-137.

of sound national and state policy, they clearly should be free to do so.

C. Role and Scope of State Regulation of Nontransportation Noise Sources

On the basis of the preceding discussion, the broad outlines of a statewide system for abatement and control of nontransportation noise emerge: the focus is on environmental noise, the area expressly reserved to the states by the Federal Noise Control Act,[122] and the function is to provide uniform statewide protection for all persons from excessive noise from nontransportation sources. Local governments, if they see fit, are left to impose more stringent standards tailored to meet the local interests and concerns. In designing such a system, a number of basic questions must be considered:

(1) should the system be based upon objective performance standards, a relatively untried approach, or upon more traditional standards of a subjective nature;

(2) assuming objective standards are to be utilized, should these vary according to the noise sensitivity of the receiver, the noise generating characteristics of the emitter, or both;

(3) must there be some individual shown to be adversely affected by a sound in order for it to be deemed excessive noise, or is it enough that a stated standard, based on reasonable probabilities of reception, was exceeded;

(4) should noise receivers and emitters be described and classified on the basis of actual existing uses, planned land uses, or zoned uses; should each individual activity be recognized, or should larger land areas be classified based on predominant activity?

1. *Objective Performance Standards Versus Subjective Criteria*

Regulation of noise at the state level historically has been through statutes defining noise in terms of general nuisance, disorderly conduct, or disturbing the peace. Such laws rarely included quantitative standards; they were just as rarely enforced on anything like a uniform basis. In Illinois, for example, there has been a general nuisance law in some form or another since 1821; the present statute was written in 1961.[123] There is little evidence of enforcement of the statute,

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122. 42 U.S.C. § 4905(e)(2) (Supp. II, 1972).

123. Ill. Rev. Stat. ch. 38, §§ 26-1, 37-1 (1970).

however. One study indicates that only two cases have reached the appellate level.[124] There are probably other cases involving convictions for disorderly conduct, and there may have been cases where individuals sought to enjoin a noisy activity. What seems clear is that the statute has never been used for a broad attack on major noise sources such as factories or other industrial facilities, since those cases undoubtedly would have been appealed.

A similar pattern exists at the local level. Many municipalities have ordinances prohibiting excessive or unusual noises. It is extremely difficult to obtain hard data on the level of enforcement of these laws. In most cases enforcement appears to be on the basis of citizens' complaints, and the level of complaints varies not only with the amount of noise, but probably to a greater extent with socio-economic factors and with the degree of confidence which citizens feel about the effectiveness of their complaints.[125]

Traditionally, response to citizen complaints is likely to be in the form at best of a warning from the local policeman to the offender, or a call from the health department or other agency seeking voluntary cooperation in reducing noise. No statistics generally are kept concerning even the cases where citations are issued, and since these are minor cases, there are few judicial precedents to consult. Where, as in the majority of cases, "unnecessary" noise is not defined by quantified standards, enforcement is difficult because it must depend on the discretion of policemen. One study concludes that "in general it is safe to say that the level of enforcement is uniformly low."[126]

An argument that is often made to support the thesis that present laws are inadequate is that over the past 30 years the ambient noise level in urban communities has been rising at the rate of 1 decibel per year, doubling every 10 years.[127] It is alleged that if this rate continues unchecked, city dwellers may approach deafness by the beginning of the next century.[128] It is difficult to know just what conclusions justifiably can be drawn from these data. Do they indicate primarily a failure in effective governmental control over noise sources? Or are they the result of virtually uncontrolled growth and noise-producing technology with which no regulatory program could cope?

124. NOISE ABATEMENT, *supra* note 120, at 3-31.

125. *See* discussion of the complaint question in Section II.B.2 *supra.*

126. NOISE ABATEMENT, *supra* note 120, at 3-41.

127. *See, e.g.,* York, *Controlling Urban Noise Through Zoning Performance Standards,* 4 URBAN LAW. 689-90 (1972).

128. *Id.* at 690.

And what are the respective roles of transportation and nontransportation sources in creating this excessive noise ambient? It is generally agreed that the controlling ambient in the typical central city area is traffic noise.[129] But in individual locations, or in areas away from major arterials, one or more nontransportation sources may predominate. Further, it is by no means clear what the long range effect of the current energy crunch will be on urban life styles, particularly with regard to the automobile. Perhaps the best that can be said about this rising ambient problem is that it is indeed a problem and that, whatever its causes, to the extent a regulatory program can be implemented to control and abate noise sources of all types, the effort appears well worthwhile.

If one concludes that a system based on subjective criteria has not proven to be effective, can an enforceable system be built using objective performance standards? As discussed in preceding parts of this Article, there now exists a substantial body of scientific knowledge with regard to the effects of various levels of noise on people, and the measurement technology necessary to monitor and report on environmental noise. But it is one thing to establish this type of scientific information. It is another to incorporate the scientific methodology into an effective law enforcement program.

For one thing, decibel limits present technical problems in monitoring because of the difficulties of separating sources of noise. Another problem is the lack of proficiency on the part of policemen or other enforcement agents (such as zoning inspectors) with sound meters and monitoring equipment. This is related to a third problem—the cost of developing and operating a noise abatement program. While this cost need not be very large, it still may be a significant cost which can become a serious constraint because government budgets are already strained. A substantial part of that cost appears in the form of trained personnel, who are in very short supply.

Despite these problems, the experience with subjective criteria is such as to suggest that, if there is to be effective regulation of noise and meaningful enforcement of noise control regulations, the regulations must be based upon objective performance standards. Recent state legislation indicates trends which are clearly consistent with this view. Several states in the last few years have authorized state agencies, in many cases newly created, to include among their environ-

129. I CHICAGO URBAN NOISE STUDY, *supra* note 30, at 27.

mental concerns the area of noise, and to adopt regulations specifically governing noise. In several instances the statutes expressly call for establishment of performance standards or objective criteria.

For example, in 1971 the State of Florida amended its pollution control act to incorporate noise abatement. The then-existing Department of Pollution Control had authority to control and prohibit air and water pollution in accordance with the enabling law and with the rules and regulations promulgated by the Department. The amendment charged the Department with the duty to establish "standards for the abatement of excessive and unnecessary noise" and, in cooperation with the Florida Department of Transportation, to establish "maximum decibels of sound permissible" from motor vehicles.[130] Hawaii, in 1972, enacted a comprehensive environmental quality act covering air, water, noise, and solid waste pollution.[131] The act authorizes establishment of regulations to control excessive noise, defined in part as "the presence of sound as measured by standard testing devices."[132]

Illinois, in 1970, enacted comprehensive legislation creating coordinate state agencies with statewide responsibilities for pollution control.[133] One of these agencies is the Pollution Control Board, whose duties include the promulgation of standards and regulations and adjudication of alleged violations. The statute specifically mandates the Board to "categorize the types and sources of noise emissions that unreasonably interfere with the enjoyment of life, or with any lawful business, or activity, and . . . prescribe for each such category the maximum permissible limits on such noise emissions."[134] Comprehensive statewide regulations prescribing maximum decibel limits governing nontransportation sources of noise were adopted by the Board in July, 1973, effective August 9, 1973.[135]

Some states in authorizing agency rule-making to control noise sources did not mandate the establishment of performance standards, although the authorizing legislation appears broad enough to permit such standards. New Jersey, in 1971, enacted the Noise Control Act

130. LAWS OF FLA. ch. 71-36, § 2 (1971), *amending* FLA. STAT. ANN. § 403.061 (13). *See also id.* § 403.031(3).

131. HAWAII REV. STATS. § 342 (Supp. 1973).

132. *Id.* § 342-41.

133. ILL. REV. STATS. ch. 111 1/2, §§ 1001 *et seq.* (Supp. 1973).

134. *Id.* § 1025.

135. Illinois Pollution Control Board Rules and Regulations ch. 8 (Noise Regulations) July 26, 1973 [hereinafter cited as IPCB Rules].

of 1971.[136] Under this act, the state's Department of Environmental Protection was expressly given the authority to adopt and enforce reasonable codes, rules, and regulations to deal with noise as defined in the statute. That agency has adopted statewide regulations for nontransportation sources, utilizing objective performance standards.[137]

New York, in 1970, enacted a new Environmental Conservation Law, which was recodified in 1972. The State Department of Environmental Conservation, acting under the general authority of the act to control air pollution, which includes noise, is developing a program of noise control.[138] Objective performance standards for control of nontransportation noise sources have been proposed.[139]

North Dakota, in 1971, passed a bill authorizing the State Health Council to establish reasonable standards, rules, and regulations to prevent and minimize hazards to health and safety caused by excessive noise.[140]

California, in 1973, enacted the Noise Control Act of 1973, which in general provided for a state policy requiring appropriate governmental agencies to administer their programs so as to provide a noise-free environment. An Office of Noise Control was established to conduct research and coordinate state activities in noise abatement.[141] By statute California has enacted objective performance standards governing noise from several different sources, including motor vehicles and airports.[142] No nontransportation standards are presently in effect.

In general, laws on the state level are becoming more sophisticated. Instead of enacting prohibitions in terms of the traditional phrases such as "unreasonable" and "unnecessary," more states are authorizing or directing state agencies to adopt standards and rules of an objective type. Most of these statutes are broadly written and presumably encompass both transportation and nontransportation noise sources. As noted above, as of this writing the environmental rule-

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136. N.J. REV. STAT. § 13:16.1 *et seq.* (Supp.1973).

137. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS, N.J. ADMIN. CODE 7:29-1.2(a) (1973).

138. *See* N.Y. ENVIRONMENTAL CONSERVATION LAW arts. 3, 19 (McKinney 1973), especially § 19-0107(2).

139. N.Y. Dep't of Environmental Conservation, Proposed Regulations for the Prevention and Control of Environmental Noise Pollution (1973) [hereinafter cited as N.Y. Proposed Regs.].

140. N.D. CENT. CODE § 23-01-17 (Supp. 1973).

141. CAL. HEALTH & SAFETY CODE, §§ 39800-80 (1973).

142. *See, e.g.,* CAL. PUB. UTIL. CODE § 21669 *et seq.* (West Supp. 1973); CAL. VEHICLE CODE, §§ 23130, 27160 (West 1971).

making agencies in Illinois and New Jersey have acted under their statutory mandates and have established performance standards governing nontransportation sources of noise.[143] The New York agency has prepared a proposed regulation also based on numerical performance standards. This regulation has been in the public hearing stage for some months.

In addition to these three states, one state, by direct state legislation rather than administrative rule-making, has established performance standards for nontransportation sources. Colorado, effective July 1, 1971, set noise limits on a broad range of commercial and industrial activities.[144] The similarities and differences in approach among these four regulatory systems will be considered in more detail in the material to follow.

2. *Basing Objective Performance Standards on the Noise Sensitivity of Receivers, the Noise Characteristics of Emitters, or Both*

In designing a regulatory matrix based on objective performance standards, the standards could be made to vary (1) only according to the noise sensitivity of the receiver, (2) only according to the noise generating characteristics of the emitter, or (3) according to both the needs of the noise receiver and the problems of the noise emitter. The difference can be illustrated by hypothesizing a residential use which has on one side of it a commercial use and on the other an industrial use. The commercial use is perhaps a shopping center, with its noise primarily from sources such as truck loading docks and machinery (fans and compressors) associated with the air conditioning and heating system. The industry is a steel fabricating plant with an array of noise sources including bailing and loading equipment, stamping presses, metal cutters, and so on.

From the viewpoint of the residential receiver whose needs are determined by the various criteria discussed earlier, such as speech and sleep interference factors,[145] the source of the noise is irrelevant. From the viewpoint of different noise emitters, however, the problems of quieting may be very different. The technical complexities and corresponding costs of quieting may be very much greater for the industry than for the shopping center. If industry testimony at the Illinois public hearings is to be believed, the technical and economic

143. *See* notes 135, 137 *supra*.
144. COLO. REV. STAT. ANN. §§ 66-35-1 to 66-35-5 (Supp. 1971).
145. *See* section II.B.2 *supra*.

problems of quieting down to the stated Illinois standards for some industries are, if not insurmountable, at least severe.[146] These predictions were made in response to levels contained in a regulation the Illinois Board later characterized as one that "allows a moderately noisy environment to occur."[147]

a. *Receiver only*: One way to deal with this issue is to set standards solely in terms of noise receivers. Of course, the needs of noise receivers will vary. Residential uses, schools, hospitals, and similar activities where speech communication, relaxation, and sleep are important factors will require the most quiet. Somewhat less protection may be appropriate where there is a good bit of human activity which itself tends to generate noise, although machinery noise is only an incidental element in the environment. Examples here might be retail stores, office buildings, banks, and other commercial settings involving public use. The least need for protection from external noise would be felt by those activities which themselves were intrinsically noisy, and where no special requirements existed for protection. General manufacturing and similar types of industrial activities fit here.

This suggests that three broad classes of receivers could be identified, and appropriate levels set for each. Of course, more than three classes could be established, and classes and their makeup could be described differently. These matters will be discussed in more detail below.[148] For purposes of this discussion, however, it is sufficient to assume three general classes of receivers based on the three described levels of need for quiet. These can be denominated residential, commercial, and industrial. The process then is to establish for each class of receivers the appropriate standard or noise level. No adjustment is provided insofar as different categories of emitters are concerned.

Initially, these levels could be set solely on the basis of an optimal noise-free environment, as defined for each class of receivers in terms of physiological effects, speech and sleep interference, annoyance factors, and so on. Assuming that sufficiently rigid standards for the protection of receivers have been set, emitters which have no feasible way of meeting the prescribed standards would either shut down or obtain administrative exemptions. If, however, administrative exemptions occurred with regard to any significant number or size of activties,

146. *See, e.g., IPCB Hearings on R72-2, supra* note 6, at 1947, 2278. Specific problem industries are discussed in detail in section V *infra.*

147. *See* IPCB Opinion in R72-2, *supra* note 22, at 21.

148. *See* section II.C.4 *infra.*

whether done by official action through a variance mechanism or by simple failure to prosecute, the regulation would be unrealistic and hence essentially unenforceable.

If the latter is seen as a problem likely to occur, one avoidance mechanism would be to set the standards at a level which the noisier industries on the whole can meet. The remaining few which cannot may be dealt with on a case by case basis. However, the effect of this probably would be to establish the level at a point well above that which can be met by many industrial activities, including those noisier ones which in fact could be quieted down with reasonable effort. There would thus be no incentive for these emitters to quiet down, and no reason for quieter activities to make an effort to remain so. While a nondegradation provision might be incorporated to deal with the latter cases, there would be no comparable route for handling the former ones. Further, the problems of designing and enforcing a nondegradation provision in this context are such as to suggest that its effectiveness is subject to serious question.

There is a further problem created by a system that focuses (either solely or only partly) on the receiver. This is the problem of sequential siting. The problem arises when a noise emitter is located adjacent to property that has a receiving use classified for a low level of protection (for example, industrial, under the classification assumed in this discussion). The emitter either already meets the standard or undertakes and completes the necessary abatement steps to do so. Thereafter, the adjacent receiver changes its activity so that it is now in a classification entitling it to a higher level of protection. For example, a residential use is established, with a higher applicable standard of quiet required.

Does the after-established residential use have the right to any protection against excess noise emission from the industry? The answer of course has to be yes. The mere fact that one property owner develops his land first cannot entitle him to claim the right to use some part of his neighbor's land to dispose of his wastes, whether they be smoke, polluted water, or noise. The industry therefore should be required to establish and maintain a noise environment that is reasonable and within its capability, both economically and technologically. On the other hand, is it reasonable for the residential user which has knowingly established himself adjacent to the industry to claim a right to the same noise environment which could be demanded if he had established a residential use adjacent to other residential uses or to less noisy commercial uses? Put another way, must one accept some degradation of his new use in the noise environment by virtue of his choice of location?

The problem does not lend itself to easy solution. To protect the industry from having to meet the higher standard is to deny to the receiving residential use the noise environment which presumably has been declared the minimum necessary for the protection of residential uses. But to require the industry to quiet down to the more stringent standard is to tell it that in undertaking noise abatement there is no assurance that compliance with anything less than the standard applicable to the most restrictive class of receivers will be sufficient. And to conform to that standard initially (when it costs less to do so than through subsequent retrofitting) may be quite costly and unwarranted by the circumstances where no such use is or may ever be present.

This problem also raises the spectre of extortion—the threat by a property owner adjacent to a major noise emitter to establish a high-protection classification on his adjacent land, not because of a legitimate desire to develop the land, but in order to extort money or other consideration from the emitter. If a classification scheme for receivers provides that some receiving property is left wholly unprotected, as might be the case for vacant land where no one is likely to be bothered by the noise, the possibilities for both legitimate and extortive development are increased.

While there may not be an easy solution to the sequential siting problem, there are several ways in which it can be alleviated. One way in which an industry moving into a generally undeveloped area could protect itself from later having to meet a higher standard required by a residential receiver as compared to an industrial receiver would be to acquire sufficient buffer space so that the emitter actually meets the most stringent level at its property line. Another way is to provide that an appropriate governmental unit may designate the adjacent land, either by zoning it to such a classification or by classifying it for purposes of noise abatement, as an industrial receiver. This latter mechanism raises related questions of the relationship between the classification scheme for noise and other land use or zoning classifications and requirements, an issue dealt with in a later section of this Article.[149]

b. *Emitter only*: A second approach is to set standards solely in terms of noise emitters. Here again a classification system would

149. *Id.*

seem in order, since not all noise emitters have the same problems. As suggested in the hypothetical earlier, the problem of quieting noise from a manufacturing process involving equipment such as stamping presses and cutting and punching machines may be considerably more difficult to solve than that of the shopping center with a noisy air conditioning compressor. Ventilation and safety requirements for workers in the manufacturing plant may limit the options for abatement through techniques such as enclosing the machinery or otherwise interrupting the sound path. By contrast, a relatively simple solution to the compressor problem may be to relocate it where it can be baffled.

Again, for purposes of discussion, let us assume that a three-class system—corresponding to the residential, commercial, and industrial classification of receivers—is applicable to noise emitters. The process then would be to set the levels for each class to reflect the emission characteristics and quieting capabilities of that class. This scheme has the advantage of directly accommodating the noise generating characteristics and noise abatement technology of different noise sources, assuming classification is done properly.

The scheme has a major shortcoming, however. If the standards are set to require the maximum feasible quieting, they may impose an unnecessary burden on an industry or other noise emitter located in a setting where such a level could not be justified by the needs of the receivers. Since different noise receivers have different needs, the degree of quieting properly demanded of an industry adjacent to a residential complex might be unnecessary when adjacent to a shopping complex, and might border on the unreasonable when adjacent to an equally noisy industry. This raises the question of whether noisy sources, such as industry, should be held in all cases to a standard that assumes they are adjacent to residential uses, to other noisy uses, or to something in between. The first creates the situation described above, protecting residential uses at the expense of overprotecting others; the second tends to leave residential uses essentially unprotected; the third has the disadvantages of both.

The sequential siting problem, discussed in the preceding section,[150] appears here as well. The problem arises when a residential use is established first, and then an industry moves in adjacent to the existing residential use. Assume that the residential use previously enjoyed a quiet noise environment because all surrounding land was undeveloped

150. *See* subsection (a) *supra*.

or occupied only by other residences. This was the case of Mrs. Early. The industry then creates a noise environment which is considerably less satisfactory. Does the residential use have a right to continuation of the pre-existing noise environment? Certainly the argument cuts both ways with regard to the claim of the residential use to some special limitation on the development of adjacent land. That is, the prior use cannot claim as a matter of law that the adjacent property must be maintained in a vacant or less developed state in order that the residential use can enjoy the benefit of a quiet environment. The adjacent land is entitled to reasonable development. At the same time, if industry chooses to locate adjacent to residential uses, should it not be required to provide a quieter environment than if it had located adjacent to another industrial use? As a practical matter, a regulatory scheme which focuses solely on standards for emitters without reference to receivers does not provide feasible mechanisms for protecting existing receivers from degradation, either in whole or in part.

c. *Combining receivers and emitters:* A third approach to the basic problem is to set standards interrelating the different classes of noise receivers with those of noise emitters. This system would contemplate a matrix in which the classification scheme—assume again the three-class scheme of residential, commercial, and industrial—would be structured so that if the receiving use were in a residential class, the allowed levels of noise received from other residential uses (emitters) would be the most stringent, on the assumption that the problems of quieting would be the least. The levels demanded of commercial emitters would be less stringent; those from industrial the least so. If the receiving use were a commercial use, the levels of protection would be less than for residential, but again would be differentiated based on whether the emitter involved a residential, commercial, or industrial use.

This scheme eliminates some but not all of the problems found in the receiver-only and emitter-only schemes. It has the advantage of providing a mechanism for establishing levels which give the different classes of receivers the maximum feasible protection according to their needs and to the abilities of different classes of emitters to quiet down. At the same time, it does not impose a higher standard on the emitter than necessary to respond to the different classes of receivers.

One problem it does not solve is the sequential siting problem. In one sense it increases the problem, since it incorporates the problem from both the receivers' viewpoint and from the emitters', whereas the other schemes have one or the other but not both. But the problem of residential uses adjacent to noisy industrial uses, regardless of which use came first, is not a problem created by a noise regulation. The real difficulty is the incompatible relationship of certain uses with others. The solution to this problem is to have well-planned and effective land-use regulations which would preclude such incompatible development, not only on the basis of noise considerations, but on the basis of the whole array of considerations that go into sound planning and zoning. As a general proposition this problem is primarily the responsibility of the planning and zoning program. It is there that the development decisions must be made which will prevent incompatible uses causing difficulties not only in the noise area but also in all other aspects of the total community environment.

d. *Current systems:* Interestingly enough, of the three regulatory programs in effect—Colorado, Illinois, and New Jersey—no two adopt the same approach; all three approaches described above are represented. The Colorado system is keyed solely to the noise characteristics of the emitter. The Colorado statute establishes four general classifications, entitled residential, commercial, light industrial and commercial, and industrial. Each classification establishes a dBA daytime limit and a dBA nighttime limit, which a particular noise source of that classification cannot exceed. The measurement is made at a distance of 25 feet or more from the property line of the emitter.[151]

New Jersey, on the other hand, has a regulatory scheme keyed solely to the classification of the receiver. The regulation establishes three general classifications, entitled residential property, commercial operation, and industrial operation. For residential receivers, both single-number dBA limits—one for daytime and one for nighttime—and corresponding maximum octave-band sound pressure levels (dB) are fixed; the same numbers apply regardless of whether the emitter is in the commercial or industrial classifications. A similar arrangement is established for commercial receivers, regardless of whether the emitter is industrial or another commercial activity. Noise from residential emitters is not regulated. Measurement is made at the property line of the receiver.[152]

151. *See* COLO. REV. STAT. ANN. § 66-35-1 *et seq.* (Supp. 1971).
152. *See* N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.1 *et seq.* (1973).

The proposed New York regulation follows the pattern of New Jersey. Three receiver classes, roughly comparable to the residential, commercial, and industrial classifications found in the New Jersey regulation, are established. (A fourth class, with special standards, is established for special noise-sensitive uses.) For each of these three receiver classifications specific dBA and octave band limits are established. Sound in excess of either applicable level may not be emitted from other land to the receiving land.[153]

Illinois has adopted the third approach, relating the standards to both receivers and emitters. The Illinois regulations establish three classifications (denominated A, B, and C), roughly approximating residential, commercial, and industrial, applicable to both receivers and emitters. A series of tables list, for each specified receiving class, separate levels for sounds originating from the three classes of emitters. For example, Table 1 of the Illinois regulation specifies allowable levels of sound emitted to any receiving class A land from class C land, class B land, and class A land. Other tables provide similar listings for receiving class B land and receiving class C land. Measurements are made within the receiving class land, but not less than 25 feet from the noise source. Separate levels are provided for class A receiving property during nighttime hours.[154]

3. *Who Hears?*

Must there be some individual shown to be adversely affected by a sound in order for it to be an unlawful or prohibited sound, or is it enough that a stated standard, based on reasonable probabilities of human reception, was exceeded? There are really two parts to this question: (1) must there be someone to hear the sound, and (2) if so, must that person be adversely affected? The question goes to the heart of the difference between the traditional control of noise through nuisance law, and the newly developed methodology involving performance standards based on findings regarding the effects of noise on people.

Under traditional nuisance concepts, the assumption is that there is some individual or group of individuals specifically affected by the offending activity. The affected individuals complain to the government, either by filing suit directly against the offender or by stimulat-

153. *See* N.Y. Proposed Regs., *supra* note 139, ch. IV, subch. C. (1973).
154. IPCB Rules, *supra* note 135, ch. 8.

ing a public official to file suit on their behalf. The forum for decision is the court. The issue for decision is whether, on balance, the defendant's conduct is unreasonable in the light of the extent and nature of the harm being caused the complainant, the effect that ceasing or abating the offending conduct would have on the defendant, the social utility of the defendant's activity, whether the complainant or defendant was there first, and other factors which the particular circumstances might raise.[155] Even if defendant's conduct is deemed unreasonable under the circumstances, relief by way of abatement or injunction might be denied.[156] It seems clear that traditional nuisance law, as applied to the problem of excessive noise, requires as a practical matter that someone hear the offending sound, and that that someone be adversely affected by it.

But to the extent noise pollution is seen as a social or community problem, rather than an individual problem, there is good evidence, as discussed previously, that the willingness of people to complain, and even more to undertake personally to vindicate the public interest in a quieter environment, is a poor measure of the problem.[157] It would appear proper to assume that when a legislature declares excessive noise to be a social problem warranting state-wide standards and general governmental enforcement, this carries with it certain inferences. One of these inferences is that there need not be a private complainant as a precondition to the enforcement of the standards; enforcement of the law cannot be dependent on the whims or willingness of individual citizens. Other inferences seem to follow. If enforcement of the law is not dependent on the fortuitous finding of a willing complainant, then the presence of an unwilling complainant is equally noncontrolling. Put another way, the fact that the current occupant of the receiving land is not bothered by the noise, or even further, the fact that he objects to having the emitter held to the standard of the law, does not negative the fact of a violation. Whether it would serve as a matter in mitigation or perhaps under some circumstances as a defense depends on the applicable provisions of the enabling law.

Does it follow from this that the presence or absence of people—of humans who are or may be affected by the noise—is immaterial? The answer is no. It is, after all, people whom the society is seeking

155. *See generally* W. PROSSER, LAW OF TORTS §§ 86-91 (4th ed. 1971).
156. *Id.* § 90.
157. *See* text accompanying notes 71-74 *supra*.

to protect by enacting noise pollution standards. There must be some reasonable relationship between the areas or activities protected from excessive noise and the presence of people to be protected. But this is not an individual, case-by-case relationship; it is a relationship based on common sense and an understanding of people's behavior. The housewife who is downtown shopping when the enforcement official determines that her home is subjected to noise from a nearby source in excess of the standards is no less entitled to the benefit of that determination than if she were an invalid confined to the house. On the other hand, if the house stands vacant, as that term is commonly understood, and the property is otherwise unoccupied, enforcement of a noise standard based on readings made on that property would appear to be an exercise of governmental power for no purpose, and an arbitrary and capricious act.

In the light of this analysis, it is interesting to look again at the systems currently in effect to see the extent to which they recognize or act on the basis of the different assumptions of nuisance law and performance standards law. None of the systems now in effect (Colorado, Illinois, New Jersey) or proposed (New York) deals expressly with the issue. They all appear, however, to be operating on the suggested inference. The Colorado statute, for example, protects "zones." The residential "zone" is defined as "an area of single or multi-family dwellings . . . ." The commercial "zone" means "an area where offices, clinics, and the facilities needed to serve them are located . . . ." Light industrial and commercial "zone" means "an area containing light industrial activities which are clean and quiet . . ."; and the industrial "zone" means "an area in which noise restrictions on industry are necessary to protect the value of adjacent properties for other economic activity."[158]

The New Jersey regulation protects "residential property," meaning "property used for human habitation."[159] The other two classifications are described somewhat differently. One of them, entitled "commercial operation," is defined as "any facility or property used for the purchase or utilization of goods, services, or land or its facilities."[160] The third classification, "industrial operation," means "any facility or property used for the following: Storage, Warehouse and

158. COLO. REV. STAT. ANN. § 66-35-2(16) to (19) (Supp. 1971).

159. *See* N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.1 (1973).

160. *Id.*

Distribution . . .; Property used for the production and fabrication of durable and nondurable man-made goods; Activities carried out on the property."[161]

The New York regulation speaks in terms of protecting:

> lands where the qualities of serenity, tranquillity and quiet are of extraordinary significance. . . [class AA]; Lands where human beings sleep [class A]; Lands where human beings are likely to communicate with one another by speech [class B]; Lands where human beings are likely to remain for long periods of time while engaged in activities for which communication by speech is only occasionally necessary [class C].[162]

The Illinois regulation is similar to the New York regulation in that it describes the three classes protected as "land used as specified" by the various use codes incorporated in the regulation.[163]

It will be seen that in all these regulations the receiving unit is described not directly in terms of people, but rather in terms of kinds of activities or uses. A close examination of these various classifications and their definitions indicates that they are areas where human activities are likely to occur, even though there is no express requirement that people actually be on the receiving property at any given moment in order for a violation to exist.

This is not to say that the governing statutes are always consistent in maintaining the distinction between the establishment of environmental noise standards and the concept of noise as a public nuisance. The Colorado statute begins with a legislative declaration that "noise in excess of the limits provided in this article constitutes a public nuisance."[164] It then proceeds to blend public nuisance concepts with performance standards in a somewhat confusing manner. In the same section that specifies maximum permissible noise levels, the act provides that "sound levels of noise . . . in excess of the dB(A) established . . . in this section, shall constitute prima facie evidence that such noise is a public nuisance."[165] The act then goes on to state that:

> whenever there is reason to believe that a nuisance exists, as defined in Sec. 66-35-3 [the section containing the maximum per-

161. *Id.*
162. N.Y. Proposed Regs., *supra* note 139 §§ 002.2-.4 to -.5.
163. IPCB Rules, *supra* note 135, Rule 201.
164. COLO. REV. STAT. ANN. § 66-35-1 (Supp. 1971).
165. *Id.* § 66-35-3(1).

> missible noise levels], any resident of the state may maintain an action in equity . . . to abate and prevent such nuisance. . . .[166]

Arguably, a defense to an enforcement action under the Colorado statute might be that, in the absence of an individual or individuals actually adversely affected by the noise, there would be no legally proscribed public nuisance, even though the sound level exceeded the numerical standard. At the least, the language describing a violation of the numerical standards as "prima facie evidence" that the noise is a public nuisance leaves open the possibility that the absence of a directly affected individual would be a defense under the statute.

4. *Classifying the Activity or Use to be Controlled or Protected*

There are two issues to be explored here. The first is whether noise receivers and emitters should be classified and described in terms of actual existing activities or uses, planned activities or uses, or locally "zoned" activities or uses. The second is whether each individual activity or use, however classified and described, should be recognized, or whether predominant usage should govern where there are mixed uses and activities. To some extent the answer to the latter will be affected by the answer to the former.

Before exploring the alternatives, it may be useful to specify some relevant criteria. First, it seems to make sense that the system, insofar as possible, should reflect actual land uses rather than potential land uses or proposed land uses. It is the actual use that determines the ability of the emitter to abate his noise, and it is the actual use that determines the need of the receiver. Second, the classification system has to be sufficiently discriminating so as to permit differentiation between important categories of land uses relevant to the noise problem (*i.e.*, the different classifications of noise-emitting and noise-sensitive uses). At the same time, the classification system has to be simple enough so that it does not require elaborate and difficult distinctions to be made in the enforcement process and on the part of noise emitters who seek to comply with the regulatory requirements. Third, the system should be one which places the noise problem in proper perspective—that is, one in which noise is recognized as being only one of a number of elements that have to be taken into consideration in development decisions. In other words, the noise problem should be a factor, often an important factor, taken into account by

166. *Id.* § 66-35-4.

developers and government, but it should not dictate or distort the overall operation of state and local regulatory programs in the land development area.

With these general criteria in mind, it is possible to evaluate alternative classification methods. One alternative is to base the scheme on zoning categories. While this might be feasible for a jurisdiction under one zoning code such as a municipality, it is not feasible statewide. Zoning has not been adopted in every city or county in most states; indeed in many counties there may be no zoning whatever. Even in those cities and counties which have zoning, the zoning categories are not uniform. One city might have a zoning classification scheme for land uses which involves four to six use classifications, while another might have 15 to 20, or as many as 25 in the larger cities. Even if it were possible, it would not be simple to relate this diversity of zoning classifications to some standard state noise classification scheme.

Further, zoning does not always reflect actual land uses. In some jurisdictions where zoning has been applied to uses already established, there may be any number of non-conforming uses. These uses typically differ materially from the zoning classification applicable to the land on which the uses are being conducted. In addition, in some states the use variance is a fairly common aspect of zoning, resulting in changes in actual uses without changes in the legal zoning classification. As in the case of the non-conforming use, this tends to put the zoning classification at variance with the actual use activity.

Finally, one should approach with some care the establishment of a close relationship between a state noise regulation program and local zoning. There are a variety of reasons why zoning classifications might be changed at the local level, depending upon the local planning program and economic and other considerations which are taken into account by local government. There is some risk in locking the noise environment problem to zoning since noise might become an overriding concern in some situations, or one largely ignored in others.

A closely-related alternative is to base the classification scheme on a land-use plan which takes into account both existing and future uses. In most respects this differs little from basing the scheme on local zoning, with the addition of raising the questions of who is to make the plan (*i.e.*, city planning commission, county planner, local legislature, state agency) and on what criteria it is to be based.

A third alternative is a classification scheme which relies directly on actual and existing land uses and activities. This comes closest to meeting the criteria suggested above, and avoids the creation of yet another manipulative device in the land regulation and development area.

The Colorado legislature chose to use a classification scheme based on actual land uses, broken into four categories. As indicated earlier, the four categories are residential, commercial, light industrial and commercial, and industrial. Each category is defined in the Act in some detail. The specific definitions of these categories are set out in the footnote below.[167]

The New Jersey regulations also are based on actual land uses, but specify three categories: residential property, commercial operation, and industrial operation. The definitions of these categories previously were described in some detail, but the exact language is provided in the footnote below.[168]

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167. (16) "Residential zone" means an area of single or multi-family dwellings where bnsinesses may or may not be conducted in such dwellings. The zone includes areas where multiple-unit dwellings, high-rise apartment districts, and redevelopment districts are located. A residential zone may inclnde areas containing accommodations for transients such as motels and hotels and residential areas with limited office development, but it may not include retail shopping facilities. "Residential zone" includes hospitals, nursing homes, and similar institutional facilities.

(17)(a) "Commercial zone" means:

(b) An area where offices, clinics, and the facilities needed to serve them are located;

(c) An area with local shopping and service establishments located within walking distances of the residents served;

(d) A tourist-oriented area where hotels, motels, and gasoline stations are located;

(e) A large integrated regional shopping center;

(f) A business strip along a main street containing offices, retail businesses, and commercial enterprises;

(g) A central business district; or

(h) A commercially dominated area with multiple-unit dwellings.

(18)(a) "Light indnstrial and commercial zone" means:

(b) An area containing clean and quiet research laboratories;

(c) An area containing light industrial activities which are clean and quiet;

(d) An area containing warehousing; or

(e) An area in which other activities are conducted where the general environment is free from concentrated industrial activity.

(19) "Industrial zone" means an area in which noise restrietions on industry are necessary to protect the value of adjacent properties for other economic activity, but shall not include agricultural operations.

COLO. REV. STAT. ANN. § 66-35-2(16) to (19) (Supp. 1971).

168. Residential Property: Property used for human habitation, including but not limited to the following:

(a) Commercial Living Accommodations, commercial property used for human habitation.

New York follows a somewhat similar pattern, although the regulation introduces a significant additional factor. Initially the New York pattern is based on four classifications, denominated classes AA, A, B, and C. Class AA is defined in the Act as "lands where the qualities of serenity, tranquility, and quiet are of extraordinary significance and serve an important need, and where the preservation of such qualities is essential if the land is to continue to serve its intended purpose. Specific examples of such lands appear in the Act and are set out in full in the footnote below.[169] The other classes, (A, B, and C) are analogous to those in the New Jersey regulation, namely residential, commercial, and industrial. The classes are defined through various verbal descriptions, which specify the types of uses included within the classifications. These are set out in the footnote below.[170]

(b) Recreational and entertainment property used for human habitation.
(c) Community service property used for human habitation.

Commercial Operation: Any facility or property used for the purchase or utilization of goods, services, or land or its facilities, including but not limited to:

(a) Commercial Dining Establishments
(b) Non-commercial Vehicle Operations
(c) Retail Services
(d) Wholesale Services
(e) Banks and Office Buildings
(f) Recreation and Entertainment
(g) Community Services
(h) Public Services
(i) Other Commercial Services

Industrial Operation: Any facility or property used for the following:

(a) Storage, Warehouse or Distribution, provided that said operation shall not be construed to be an industrial operation when it is part of a commercial motor vehicle operation as defined herein.
(b) Property used for the production and fabrication of durable and nondurable manmade goods.
(c) Activities carried out on the property.

N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.1 (1973).

169. Class AA LUDNC: Lands where the qualities of serenity, tranquility, and quiet are of extraordinary significance and serve an important public need, and where the preservation of such qualities is essential if the land is to continue to serve its intended purpose. Examples of such lands are the wilderness zones of State lands, outdoor amphitheaters when in use, particular parks or portions of parks, open spaces which are dedicated or used for activities requiring special qualities of serenity, tranquility, and quiet, and lands where any statute, local law, or ordinance requires such designation.

N.Y. Proposed Regs., *supra* note 139, § 002.2.

170. Class A LUDNC: Lands where human beings sleep. Such land shall include the residence, building, or structure where sleeping normally takes place and any location within three feet (approximately 0.9 meter) of the major surfaces of such residence, building, or structure. Only areas designated to be residential based on Section 002.1 of this part shall be Class A. Typically, Class A LUDNC will be on the following types of property used for human habitation:

Thus far the New York scheme is not materially different from that of either the Colorado statute or the New Jersey regulation. Each of these classification schemes is keyed to the actual land uses described, although the precise inclusions within the several categories differ somewhat. But the New York regulations contain an additional provision. The classification scheme under the New York regulations is called "a land use designation for noise control" (LUDNC). LUDNC's can be established in four ways: (1) a local government may approve its own LUDNC specifically for noise control, provided it is "not inconsistent with this part" (the sections dealing with

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(a) Residential (e.g., year-round residences, rural residences with acreage, estates, seasonal residences, and individual mobile homes)
(b) Commercial Living Accommodations (e.g. hotels, motels, apartments, mobile home parks, camps, cottages, bungalows, inns, lodges, boarding and rooming houses, tourist homes, and dormitories)
(c) Recreational and Entertainment (e.g. camps, camping facilities, and resorts)
(d) Community Service (e.g. orphanages, benevolent and morale associations, home for aged, hospitals, health and correctional facilities).

Id. § 002.3.

Class B LUDNC: Lands where human beings are likely to communicate with one another by speech. Only areas designated to be residential or commercial based on Section 002.1 of this part shall be Class B. Typically Class B LUDNC will be those portions of the types of property listed in Section 002.3 of this part whieh are not Class A, and the following types of property:
(a) Commercial Dining Establishments (e.g. restaurants, diners, luncheonettes, snack bars, drive-ins, ice cream bars, and night clubs)
(b) Motor Vehicle Services (e.g., auto dealers-sales and service, service and gas stations, auto body, tire shops, car wash, and parking garage)
(c) Retail Services (e.g. shopping centers, retail outlets and supermarkets)
(d) Banks and Office Buildings
(e) Miscellaneous Commercial Services, property not used for human habitation (e.g. Funeral homes, dog kennels and veterinary clinics)
(f) Recreation and Entertainment, property not used for human habitation. (e.g. theaters, stadiums, racetracks, fairgrounds. amusement parks, game farms, skating rinks, golf courses, riding stables, beaches, and parks)
(g) Community Services, property not used for human habitation (e.g. educational, religious, governmental, cultural, recreational facilities and cemeteries)
(h) Forest lands, preserves, and private hunting and fishing clubs.

Id. § 002.4.

Class C LUDNC: Lands where human beings are likely to remain for long periods of time while engaged in activities for which communication by speech is only occasionally necessary. Typically Class C LUDNC will be on the following types of property:
(a) Storage, Warehouse and Distribution Facilities, property used for storage. (e.g. gasoline storage and/or distribution, grain elevators, lumber yards, coal yards, trucking terminals and piers)
(b) Industrial, property used for the production and fabrication of durable and nondurable man-made goods. (e.g. manufacturing, mining, quarrying and wells)
(c) Agricultural, property used for the production of crops or livestock. (e.g. livestock and products; field, truck and orchard crops; fruits, nursery and greenhouse stock, and fur products)

Id. § 002.5.

LUDNC's); (2) a LUDNC may be based on a local zoning ordinance; (3) in the absence of a zoning ordinance, the LUDNC may be based on a comprehensive community plan; and (4) if none of these are applicable, the Commissioner of the state Department of Environmental Conservation "shall determine the land-use designation for the purpose of noise control," based on stated general criteria.[171]

Under the first alternative, it appears that the specific classification to be applied to a given tract of land is to be locally determined, within the broad categories described in the regulations. Presumably, a locally established LUDNC can reflect more than existing uses; otherwise there would be no need for a local LUDNC—the descriptions in the state regulations would be sufficient. For example, an unimproved tract of land presumably could be classified Class A, B, or C, as the local government saw fit, provided that such a classification is not deemed "inconsistent" with the regulation. Could an existing residential use (Class A) be classified industrial (Class C), or vice versa?

That actual use is not the sole criterion is shown by alternative 2: if there is no locally approved LUDNC, the LUDNC "shall be based on the permissible land use as designated by a local zoning ordinance."[172] This provision has the disadvantages discussed earlier with regard to protecting land, or controlling emissions from property, which in fact has uses on it at variance with the designated classification. To some extent, though, it does appear to overcome the objection regarding the difficulty of matching statewide classifications to local zoning patterns. Apparently, the zoning classifications are controlling, and the state classification descriptions are to be treated as merely illustrative. Similarly, if there is no local zoning in effect, but there is a comprehensive community plan, the LUDNC is to be based "on the intended land use if designated by a comprehensive community plan."[173] A comprehensive community plan is defined in the regulations as "a land use plan that has the approval of the local government. If the local government has not approved a land-use plan, comprehensive community plan shall mean a land-use plan that has the approval of the local planning board."[174]

The final alternative is one that could cause the Commissioner

171. *Id.* § 002.1.
172. *Id.*
173. *Id.*
174. *Id.* § 001.1(g).

of the Department some grief, and has been the subject of considerable comment in the state hearings.[175] Under this provision the Commissioner, presumably on a case-by-case basis, is to determine the applicable land-use designation, taking into consideration "the present, future and historical usage, as well as the usage of adjoining, adjacent and other lands in the vicinity."[176] Matching existing uses to the described classifications might be manageable, although an administrative nightmare, if a large number of cases must be processed. But attaching an initial classification to vacant lands, or reclassifying existing uses to an inconsistent classification based on the stated criteria, is not likely to put a state official in a position of pleasing many people.

The Illinois classification system differs materially in detail from the other three, although the basic concept is similar. The Illinois classification is based on the Standard Land Use Coding Manual (SLUCM) of the U.S. Department of Transportation.[177] This manual is the most complete set of classifications of land use available. The SLUCM code employs nine major categories of land use:

Code Series	Category
100	Residential
200-300	Manufacturing
400	Transportation, Communication, & Utilities
500	Trade
600	Services
700	Cultural, Entertainment & Recreational
800	Resource Production & Extraction
900	Underdeveloped Land & Water Areas

The nine code categories were compressed into three in order to avoid excessive detail which would not be responsive to the needs of a noise program and would be potentially confusing in the evaluation and enforcement process. This made the classifications more reflective of noise considerations.

Thus, the Illinois classification scheme calls for three classes, A, B, and C, with the functional grouping as follows:

A. Class A uses are roughly equivalent to a residential and institutional use classification, plus enclaves of quiet, such as special park

175. Telephone interview with Dr. Fred Haag, N.Y. Dep't of Environmental Conservation, Mar. 22, 1974.

176. N.Y. Proposed Regs., *supra* note 139, § 002.1.

177. United States Dep't of Transportation, Federal Highway Administration, Bureau of Public Works, Standard Land Use Coding Manual (1969).

and forest areas. These are the areas most in need of protection from undesirable noise intrusion from the receivers' viewpoint and where noise-making activities are generally not such as to create particularly difficult problems in abatement. While the dominant uses are residential, with their high sensitivity to noise, such related uses as medical, educational, and religious activities also are included.

B. Class B uses are roughly equivalent to commercial and business uses. Here the dominant land use is wholesale and resale trade. Also included in Class B are noise-sensitive manufacturing and communications activities. Closely allied to these business and commercial areas are the professional services, except those few which are included in Class A. Less noise-sensitive outdoor recreational areas and public assembly activities are also included.

C. Class C uses are roughly equivalent to industrial and manufacturing uses. Also included are centralized transportation facilities such as terminals, garages, and yards, which are treated as nontransportation sources. Included in Class C uses are agricultural activities, utilities, mining operations, and similar activities where the ability to control noise and the need for a noise controlled environment are less than in the other two categories.

It is possible that the industrial classification, Class C, could be subdivided to take into account differences between light industry and heavy industry. In the initial stage of the regulatory program, it was the judgment of the Illinois drafters that the standards being applied were reasonable with regard to all classes of industry. As experience develops, there may be a need for more stringent standards on certain classes of industry than those called for in the regulations; at such time additional classifications might well be warranted.

While the Illinois classification scheme is based essentially on actual land uses, Illinois, like New York, authorizes local governments to relate the noise abatement classifications to local planning and zoning concerns. The Illinois provision is much more limited, however. Rule 201(d) of the Illinois regulations states that:

> A parcel or tract of land used as specified by SLUCM Code 81, 83, 91, or 922, when adjacent to Class B, or C land may be classified similarly by action of a municipal government having zoning jurisdiction over such land. Notwithstanding any subsequent changes in actual land use, land so classified shall retain such B or C classification until the municipal government removes the classification adopted by it.

The SLUCM Code references are to land classified as agriculture (10 or more acres), forestry activities and related services, undeveloped and unused land area (excluding noncommerical forest development), and nonreserve forest (undeveloped). The thrust of this provision is to permit local governments a limited degree of discretion in classifying essentially undeveloped or unused land. This discretion allows local government to protect an existing industry or commercial activity from having to meet a higher standard should development occur on the unused land-development which would otherwise cause that property to be given a new classification. In these instances the effective noise classification would be based not on actual land use but on the local government's determination of the level of noise protection which should be afforded the property, even if the property were subsequently developed in a manner inconsistent with that determination. The purpose of this provision was to provide some protection for industry which might otherwise be affected by the sequential siting problem.[178]

One final point regarding classification remains. Should each individual activity or use be recognized, or should predominant usage govern where there are mixed uses and activities? Under a land classification scheme such as Illinois' or New Jersey's, it seems clear that the system is designed to deal with individual tracts, of whatever size. This is necessary if the stated criterion of responding to actual uses is to be met. Under a scheme such as New York's, to the extent a LUDNC is based on a zoning ordinance, and the zoning ordinance in turn incorporates a zoning map agglomerating mixed uses into single classifications, the noise regulation will be based on the agglomerated classification. The preceding discussion suggests that agglomeration would make sense if the subject of regulation were the overall ambient noise level, rather than individual noise emissions; however, all the current systems establish standards for noise emissions by individual emitters, not standards for ambient noise levels.

IV. FORMULATING A STATE REGULATORY SYSTEM: A PROTOTYPE

A. Introduction

To assist the reader in putting together the somewhat complex technical and legal considerations discussed thus far, and to illustrate ways in which law and technology may be combined into a comprehensive

178. *See* Section III.C.2(a), (b) *supra*.

regulatory system, we set out in this section some prototypical provisions which might be found in a statewide regulation governing non-transportation sources of environmental noise. Since the authors were members of the task force which prepared the Illinois regulations and were responsible for a substantial part of the drafting, it should not be surprising that there will be a strong resemblance between what is presented here and those regulations. Nevertheless, this material is primarily to illustrate the possibilities, and only secondarily to suggest preferences.

Insofar as these prototypes are based on considerations explored in previous sections, reference will be made to the earlier discussion. When additional issues are raised, they will be discussed herein.

B. Definitions

Definitions are always a troublesome part of any statute or regulation. Draftsmen differ on how to state them and where to put them. For purposes of the prototypes set out here, key terms will be defined when they first appear in the substantive provisions, rather than setting them out separately as might be done in an actual regulation. The reader should understand that once a term is defined, that definition continues to apply to later provisions unless otherwise indicated.

C. Classification of Land According to Use

(a) **Class A Land**

Class A land shall include all land used as specified by SLUCM Codes 110 through 190 inclusive, 651, 674, 681 through 683 inclusive, 691, 711, 762, 7121, 7122, 7123 and 921.

(b) **Class B Land**

Class B land shall include all land used as specified by SLUCM Codes 397, 471 through 479 inclusive, 511 through 599 inclusive, 611 through 649 inclusive, 652 through 673 inclusive, 675, 692, 699, 7124, 7129, 719, 721, 722 except 7223 used for automobile and motorcycle racing, 723 through 761 inclusive except 7311 used for automobile and motorcycle racing, 769 through 790 inclusive, and 922.

(c) **Class C Land**

Class C land shall include all land used as specified by SLUCM Codes 211 through 299 inclusive, 311 through

396 inclusive, 399, 411 except 4111, 412 except 4121, 421, 422, 429, 441, 449, 460, 481 through 499 inclusive, 7223 and 7311 used for automobile and motorcycle racing, and 811 through 890 inclusive.

The classification system indicated here is based on the following assumptions and conclusions: (1) a three-category classification (approximating residential, commercial, industrial) provides sufficient discrimination among uses for both receivers and emitters, if both are to be a part of the regulatory matrix, without being too complex to administer; (2) the regulation deals primarily, if not exclusively, with actual land uses, rather than zoned or planned classifications and with specific uses rather than predominant or area use patterns; (3) the SLUCM codes provide a handy, shorthand, yet reasonably precise method for describing the variety of possible land uses, without the inherent ambiguities and endless debates created by verbal generalizations; (4) the SLUCM codes provide a mechanism for "fine-tuning" the classifications without the inordinately intricate language of an internal revenue code.

The first two points were dealt with at some length in section III-C-4, *supra.* The latter two may need some elaboration. As will be seen in the excerpt below, the SLUCM code uses a two-, three-, and four-digit system, based on descending order of generality. The two-digit number thus incorporates all three- and four-digit entries beginning with the same two numbers. For purposes of noise classification, the two-digit categories are too broad; the three-digit are more descriptive and not so numerous as to be unmanageable, especially since similar uses carry sequential numbers permitting inclusive references (*i.e.*, "Codes 110 through 190 inclusive").

A STANDARD SYSTEM FOR IDENTIFYING AND CODING LAND USE ACTIVITIES—TWO-, THREE-, AND FOUR-DIGIT LEVELS

Code	*Category*	*Code*	*Category*	*Code*	*Category*
11	Household units.	110	Household units.	1100	Household units.
12	Group quarters.	121	Rooming and boarding houses.	1210	Rooming and boarding houses.
		122	Membership lodgings.	1221	Fraternity and sorority houses.
				1229	Other membership lodgings, NEC.*
		123	Residence halls or dormitories.	1231	Nurses' homes.
				1232	College dormitories.
				1239	Other residence halls or domitories, NEC.
		124	Retirement homes and orphanages.	1241	Retirement homes.
				1242	Orphanages.
		125	Religious quarters.	1251	Convents.

				1252	Monasteries.
				1253	Rectories.
				1259	Other religious quarters, NEC.
		129	Other group quarters, NEC.	1290	Other group quarters, NEC.
13	Residential hotels.	130	Residential hotels.	1300	Residential hotels.
14	Mobile home parks or courts.	140	Mobile home parks or courts.	1400	Mobile home parks or courts.
15	Transient lodgings:	151	Hotels, tourist courts, and motels.	1510	Hotels, tourist courts, and motels.
		159	Other transient lodgings, NEC.	1590	Other transient lodgings, NEC.
19	Other residential, NEC.*	190	Other residential, NEC.	1900	Other residential, NEC.

* "NEC" is an abbreviation for "not elsewhere coded".

The code also provides an easy mechanism for exclusion, in either broad or narrow terms. As discussed in section III-C-3, a noise control system based on performance standards does not require for enforcement that there be in each instance an adversely affected complainant. But it does assume the likelihood of people being exposed to levels deemed unacceptable. It follows that vacant houses, certain kinds of open space areas such as forests not used for public recreation, and similar non-peopled areas need not be protected. Emitters adjacent to such uses should not be subject to abatement based on receiver needs. The prototype given above does this simply by not including certain code numbers in any of the three classifications, *e.g.*, codes 91 (undeveloped and unused land area . . .), 93 (water areas), 94 (vacant floor area), 95 (under construction), and 96 (other undeveloped land and water areas, NEC). Since these uses are unclassified, they are unprotected.

Another group of uses that may need exclusion involves transportation activities. With the exception of fixed facilities, such as marshalling yards and truck terminals, effective control of ground transportation noise must be based on controlling the equipment, rather than the environment in which it operates. Further, because of the legal and technical problems, it may be best to exclude airport and aircraft noise problems, including the fixed airport facility, saving this can of worms for separate regulation.

In the prototype, these distinctions are made first, by omitting completely code 43, aircraft transportation, and second, by including code 411, railroad transportation, and code 412, rapid rail transit, but excepting code 4111, railroad right-of-way, and code 4121, rapid rail transit right-of-way. This latter has the effect of including switching and marshalling yards and terminals, but not the strips of track between them. The curious reader, by examining closely the pattern of inclusions and exceptions in the prototype provision, will find other such examples.

D. Specifying Applicable Standards

1. *Protecting Residential Uses—Daytime Standards*

SOUND EMITTED TO CLASS A LAND DURING DAYTIME HOURS

No person shall cause or allow the emission of sound during daytime hours from any property-line noise source located on any Class A, B, or, C land to any receiving Class A land which exceeds any allowable octave band sound pressure level specified in Table 1, when measured at any point within such receiving Class A land, provided, however, that no measurement of sound pressure levels shall be made less than 25 feet from such property-line noise source.

TABLE 1

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	75	72	72
63	74	71	71
125	69	65	65
250	64	57	57
500	58	51	51
1000	52	45	45
2000	47	39	39
4000	43	34	34
8000	40	32	32

The provision is based on the following assumptions and conclusions: (1) the system expressly relates the needs of receivers to the problems of emitters; (2) standards are stated in terms of octave band sound pressure levels; (3) measurement of emissions is made anywhere on the receiving land, but not closer than 25 feet to the emission source; (4) measurement is based on single-event noise, rather than time-averaged noise.

a. *Receivers v. emitters*: In a previous section we examined the considerations affecting the decision to focus on the receiver, the emitter, or both.[179] This provision focuses on both. Note that Class A emitters are not held to a more stringent standard than that required of Class B emitters. This is because some Class A emitters, such as

179. *See* Section III.C.2 *supra.*

hotels, motels, and lodges, have abatement problems not significantly different from other commercial emitters included in Class B. The Class C emitters, comprising primarily industrial uses, are given anywhere from a three to eight decibel forgiveness, depending on the sound frequency.

b. *Octave band limits*: The standards described in the prototype are stated in terms of various octave band sound pressure levels (dB), and are those found in the Illinois Regulations.[180] The problems with using a single-number dBA standard, such as was done in the Colorado statute, instead of the more complex octave band levels, are discussed in the text above following note 82. As is indicated there, a C-minus-A standard is preferable to a dBA standard, but is not as accurate as octave band limits.

Another alternative is to state the standards in terms of both dBA and octave band levels. A violation of either is a violation of the regulation. This is the method used in the New Jersey regulations and in those proposed for New York. The Illinois regulations at an early stage of their development included alternative dBA levels. However, the intention was to use the dBA standard, because of its limitations, only for monitoring and survey purposes, as a means of determining whether octave band measurements should be made.[181] Since a dBA level survey could be made by the Environmental Protection Agency with or without express authority from the Pollution Control Board, inclusion of the alternative dBA numbers was considered unnecessary and confusing, and they subsequently were dropped.

c. *Selecting the numerical limits*: For a regulatory system concerned with the needs of receivers and the problems of emitters, there are three major considerations in determining noise limits. From the emitter's viewpoint the question is one of technical and economic capability. This was discussed in section II-C above and will be explored further with respect to certain problem emitters in section V below. From the viewpoint of receivers, there are two goals. The first is to set levels which do not exceed those known to produce adverse effects on people—hearing loss, sleep interference, and speech interference. The second is to set the limits at or below existing ambient levels in the relevant urban, suburban, and rural settings. This is for the pur-

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180. *See* IPCB Rules *supra* note 135.

181. *See* ILL. INSTITUTE FOR ENVIRONMENTAL QUALITY, CONTROL OF NOISE FROM STATIONARY SOURCES: REPORT OF THE TASK FORCE ON NOISE 14 (1972).

pose of avoiding the community annoyance caused by noises which significantly exceed the ambient. In addition, this will have the effect of retarding further degradation of the community's acoustical environment, although it must be recognized that permitting additional noise equal to the ambient results in "creeping ambient" because multiple sounds of the same magnitude produce a total sound of greater magnitude.

The only noise emissions permitted under the prototype rule which might threaten some degree of hearing loss seem to be those applicable to Class C receivers—the equivalent of 70 dBA for Class C emitters and 66 dBA for Class A and B emitters. Therefore, the justification for the limits for Class A and B receivers must be primarily prevention of speech interference and annoyance. It will be recalled that two methods—the speech interference level (SIL) and the preferred noise criterion (PNC) curves—commonly are used to rate the speech-interference potential of various noise levels,[182] and that the ISO noise rating (NR) curves provide the most accurate method for predicting annoyance as evidenced by community response.[183]

Applying the formula discussed in section II-B-2-a above, we find that the PSIL associated with the C-to-A daytime limits is 52 dB.[184] This means that reliable speech communication, outdoors with normal voice effort, is barely possible at 6 feet with a male speaker and at 4 feet with a female speaker.[185] Two women conversing on a front porch would have to speak in raised voices at 6 feet and in very loud voices at 12 feet. The PSIL for the B-to-A and A-to-A limits is 45, which at a distance of 12 feet would just permit male speech at normal voice level and female speech at a raised level.

Indoors on receiving residential property with windows open, assuming a 10 dB attenuation of sound in each octave band because of the walls, the PNC ratings are 46 for the C-to-A daytime limits and 42 for the B-to-A and A-to-A daytime limits.[186] Referring to the table presented in Section II-B-2-a,[187] we see that with a Class C emitter, listening conditions inside the receiving residence are "fair" to "moderately fair," poorer than recommended for conversing or listening to radio and TV. With a B or A emitter, listening conditions would be

182. *See* text accompanying notes 52-60 *supra.*
183. *See* text accompanying notes 83-90 *supra.*
184. *See* text accompanying note 55 *supra.*
185. *See* text accompanying note 56 *supra.*
186. *See* note 59 *supra.*
187. *See* table at text following note 60 *supra.*

"moderately good" to "fair," still below the standard for conversation, radio, and TV.

In short, the prototype limits provide for less than optimal conditions for speech communication on residential as well as commercial and industrial property. Hence, they represent a compromise in that they provide some degree of protection but not as much as would be desirable.

The same is true with respect to protecting against annoyance. It will be recalled that application of the ISO noise rating methodology involves comparison of the NR rating of the noise being evaluated and the computed NR ambient rating for the type of area in which the receiving residence is located.[188] Assuming a "suburban residential" district with little traffic, the NR rating of the ambient would be 35 to 45, and the NR rating of noise at the daytime limits in the prototype would be 55 for Class C emitters and 50 for Class A and B emitters. Thus community response to C emitters could be expected to range from "widespread complaints" to "vigorous community reaction," while response to the lower A and B emission levels would vary from "sporadic complaints" to "threats of community action." If the area was "urban residential with some shops or with main roads," with a corrected NR ambient rating of 45 to 55, the ISO method would suggest maximum reactions of "widespread complaints" about noise at the C-to-A daytime limits, and "sporadic complaints" at the A-to-A and B-to-A limits.

Finally, the prototype limits do approximate actual measured ambient noise levels. One of the major noise measurement surveys of a modern city was a three-year study by Bonvallet in Chicago.[189] The daytime octave band limits in the prototype are largely in agreement with the Bonvallet levels. Bonvallet's nighttime findings—ambient noise 5 to 15 dB below daytime levels in the various octave bands—are reflected in the prototype. The dBA equivalents of the prototype limits also are consistent with recently measured levels of environmental noise at eighteen sites throughout the United States, ranging from wilderness to central city, with major emphasis on urban and suburban residential areas.[190]

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188. *See* text following notes 77, 89 *supra.*

189. Bonvallet, *Levels and Spectra of Traffic, Industrial, and Residential Area Noise,* 23 J. ACOUSTICAL SOC'Y OF AM. 435 (1951).

190. United States Environmental Protection Agency, Community Noise (1971).

In the prototype provision above, the equivalent dBA standard for A or B to A is 55 dBA; for C to A it is 61 dBA.[191] The level established in the Colorado statute for residential emitters, assuming a residential receiver, is comparable (55 dBA), whereas commercial or industrial emitters are subject to considerably more lenient standards: 60 dBA for Commercial (Class B), 70 dBA for Light Industrial (Class C), and 80 dBA for Industrial (Class C).[192] The stated levels for residential (Class A) receivers in the New Jersey regulations are 65 dBA for both Commercial (Class B) and Industrial (Class C) emitters.[193] There is no standard applicable to residential (Class A) emitters. The proposed New York levels are essentially the same as New Jersey's.[194]

Several things must be remembered in assessing the kind of noise environment which these standards will permit. First, in each of the systems the standards deal only with noise from a single emitter, and not with the total ambient existing on any particular receiver's land. For example, a residence receiving noise from a single industry at the allowed limit is subjected to less noise than a residence surrounded by four equally noisy industries, each emitting at the allowable limit. Of course, the total noise in the latter case is not four times as loud, since a doubling of the sound pressure level adds about 3 dBA. The difference in our hypothetical between the single industry and the four would be six dBA.[195] This would create an ambient, assuming the 61 dBA level of the prototype, of about 67 dBA, which would be perceived as being almost twice as noisy as the single industry case.

Secondly, the required levels stated in these different regulatory systems are prescribed in terms of the point at which they are measured. The location of this point is important, since noise decreases rapidly with distance.

d. *Point of measurement*: The prototype prescribes the point of measurement as "any point within such receiving Class A land, provided, however, that no measurement . . . shall be made less than 25 feet from such property-line noise source." The specification that

191. IPCB Opinion in R72-2, *supra* note 22, at 27.

192. Colo. Rev. Stat. Ann. § 66-35-3(1) (Supp. 1971).

193. N.J. Dep't of Environmental Protection, Noise Control Regulations § 7:29-1.2(a)(1) (1973).

194. *See* N.Y. Dep't of Environmental Conservation, Proposed Regulations for the Prevention and Control of Environmental Noise Pollution § 003.2(a)(1) (1973).

195. SPL × 2 = SPL + 3 dBA; (SPL + 3 dBA) × 2 = SPL + 6 dBA.

the measurement may be made at any point within the receiving land means precisely that. There is no requirement, for example, that the measurement be made *on* the property line (of either the emitter or the receiver). If the point of measurement is designated as the property line of the emitter, the question is raised, what about receivers who do not abut on the emitter's property? Is no credit to be given for the attenuation effect of an intervening vacant parcel? Of course, if the regulatory system is based solely on noise from emitters, without reference to receivers,[196] no such credit can be given, and the point of measurement can be based on the emitter's property line. The Colorado statute is an emitter-only system, and the statute proscribes "sound pressure levels of noise [in excess of the stated standards] radiating from property line [sic] at a distance of twenty-five feet or more therefrom . . ."[197]

In a system that relates to receivers, the problem of the non-abutting receiver can be dealt with by prescribing the standard in terms of receivers. New Jersey's regulation does this by prescribing the point of measurement as the "residential property line."[198] While this avoids the non-abutting problem, it at least arguably creates another. Does an element of a case for enforcement require detailed evidence as to where the property line of the receiver is located? And that the measuring instrument was placed precisely on that line?

The New York proposal avoids this dilemma by specifying proscribed sound as "either in or entering into areas designated Class A."[199] The Illinois regulation and the prototype deal with the problem similarly: it is enough to show that the reading was taken within the property of the receiver.

The requirement in the prototype that measurement be made a minimum of 25 feet from the sound source is simply to give the emitter some benefit from atmospheric attenuation. In the usual case, zoning setbacks and other spatial factors, such as intervening streets or alleys, will make the 25 feet requirement relatively unimportant. In some cases, however, the requirement may become significant. The case of the utility pole transformer located on a ten foot easement

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196. *See* discussion Section III.C.2.b *supra*.

197. COLO. REV. STAT. ANN. § 66-35-3(1) (Supp. 1971).

198. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.2(a) (1973).

199. N.Y. Proposed Regs., *supra* note 139, § 003.2.

over residential property is an example. Under the prototype classification scheme, the easement is classified Class C (code 481). In applying the standards, the point of measurement cannot be closer than 25 feet to the transformer. The Colorado statute also contains a 25-foot minimum requirement; neither the New Jersey nor New York provisions contain a similar allowance.

e. *Single-event versus time-averaged measurement*: There are two different concepts with regard to measurement for determining whether a stated noise level is exceeded. One is the single event. Simply stated, it means that any noise which exceeds the established level, regardless of duration, is a violation. From the viewpoint of measurement technology this is the simplest approach, since it does not require the meter operator or a recorder to remain at the site for hours. Where, as in the prototype, noise limits are given as a function of sound frequency, an octave-band sound analyzer is required. The alternative concept is time-averaged measurement. This means monitoring the sound source for a stated period, such as eight hours, and then determining an average sound level for that period. This procedure requires substantially more time by trained personnel, as well as more complex equipment.

A detailed analysis of the differences between these concepts is given in the text following notes 40, 46 and 79. For our purposes here, it is enough to note that, in addition to the differences in equipment needs and related costs and training for personnel, there is also an important difference in function. In setting levels to avoid physiological effects from excessive noise, the time-averaged measurement can be useful. With the exception of a sudden sound so loud as to rupture the eardrum or cause other direct injury to the hearing apparatus, physiological harm is a function of the duration of exposure. But as a test for specific annoyance characteristics, time-averaged measurement is not as effective as single-event measurement for the reasons discussed earlier.

The concept of the single-event noise constituting a violation is not as harsh on emitters as it may first appear. For example, what of the otherwise complying industry which experiences a boiler accident and explosion, causing a single noise in excess of the standards? As a practical matter, there will be no one standing around ready to read the meter. And there is more than ample law on the issue of intervening acts of God as a defense. In reality, what will be measured and prosecuted will be continuous or repetitive sounds which exceed the stated limits, as determined by one or more measurements at various points. Obviously, the more measurements the stronger the case. The prototype as well as the four current systems (Colorado, Illinois, New Jersey, New York) all contemplate the single-event approach; no provision is made in any of them for time-averaging.

2. *Protecting Residential Uses—Nighttime Standards*

Sound Emitted to Class A Land During Nighttime Hours

No person shall cause or allow the emission of sound during nighttime hours from any property-line noise source located on any Class A, B, or C land to any receiving Class A land which exceeds any allowable octave band sound pressure level specified in Table 2, when measured at any point within such receiving Class A land, provided, however, that no measurement of sound pressure levels shall he made less than 25 feet from such property-line noise source.

TABLE 2

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from Class C Land	Class B Land	Class A Land
31.5	69	63	63
63	67	61	61
125	62	55	55
250	54	47	47
500	47	40	40
1000	41	35	35
2000	36	30	30
4000	32	25	25
8000	32	25	25

Nighttime hours are 10:00 p.m. to 7:00 a.m., local time.

This provision is based on essentially the same assumptions and conclusions as the preceding provision, with the exception that it incorporates more stringent standards so as to provide a quieter environment during nighttime hours.

a. *Purpose of a nighttime standard*: The purpose of a nighttime standard is to account for receiver needs that differ between nighttime and daytime. With regard to industrial or commercial receivers, no significant differences seem to exist—the activities, if they continue at night, remain generally the same. With regard to residential receivers, there are two differences. First it seems safe to assume that more people will be home in the evenings and night than during the day. More significantly, a primary usage of residential property during certain hours of the night is rest and sleep. Levels that may be appropriate for protection from speech interference and general annoyance during daytime activities may not be adequate for protection at night, since ambients are lower at night than during the day, and sleep disturbance becomes an important factor.

The prototype (and Illinois) levels drop in the range of 9 to 7 dB, depending on the octave band frequency, for B or A to A emissions; from 6 to 8 dB for C to A.[200] The equivalent dBA level drop is from 55 (daytime) to 45 (nighttime) for B or A to A; and from 61 (daytime) to 51 (nighttime) for C to A.

Evaluating the prototype nighttime limits in terms of potential for sleep interference and annoyance effects, we see that the C-to-A standard does not afford the 35 dBA sleeping conditions recommended by the federal EPA[201] if bedroom windows are left open (10 dBA attenuation by walls). Applying the ISO noise rating methodology to a receiving residence in an "urban residential" district (corrected nighttime NR ambient rating of 25 to 40), one would predict community response to noise at the C-to-A limits (NR-45) ranging from "sporadic complaints" to "vigorous community action"; and to noise at the limits for B and A emitters (NR-40), from "no reaction" to "threats of community action."[202]

New Jersey, with a combined commercial-industrial (prototype Classes C and B) to residential (Class A) standard, drops in the range of 7 to 10 dB from its daytime to nighttime standard. The dBA equivalents are 65 (daytime) and 55 (nighttime),[203] considerably higher than the prototype. Effective January 1, 1976, the drop will be in the range of 10 to 15 dB, with equivalent dBA levels of 65 (daytime) and 50 (nighttime).[204] The levels of New York's proposed nighttime regulation come closer to those of Illinois, with the equivalent dBA levels of 65 (daytime) and 45 (nighttime), the latter being the same as the prototype.[205] The range of drop from daytime to nighttime is 20 dB, however, considerably more than Illinois, but this is because the Illinois daytime standard is more stringent. There is no time phas-

200. IPCP Rules, *supra* note 135, Rule 203.

201. *See* text accompanying note 46 *supra*.

202. *See* text accompanying notes 75-78, 88-90 *supra*.

203. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.2(a)(2) (1973).

204. *Id.* § 7:29-1.2(a)(4).

205. N.Y. Proposed Regs., *supra* note 139, § 003.2(b).

ing provision in either New York or Illinois comparable to the one in New Jersey.

Colorado departs from the pattern described thus far. The Colorado statute provides for a nighttime standard 5 dBA below the daytime standard, applicable to all categories. Thus all emitters must meet the lower nighttime standard, regardless of the classification of the receiver. This pattern demonstrates another of the problems with an emitter-only system.

b. *The meaning of nighttime*: Since a primary difference for noise purposes between daytime and nighttime residential usage is one of sleep, the nighttime hours are those generally devoted to sleep. Illinois defines these as "10:00 p.m. to 7:00 a.m., local time."[206] New Jersey uses the same hours;[207] New York uses 11:00 p.m. to 7:00 a.m.[208] Colorado, interestingly enough, uses 7:00 p.m. to 7:00 a.m.[209]

The prototype uses the 10 p.m. to 7 a.m. hours. This is a spread of 9 hours. For noise-emitting industries working two 8-hour shifts, the nine hour spread may cause problems due to the one hour overlap. The New York spread is eight hours, accommodating this problem. The difficulty is that 11:00 p.m. is rather a late hour before imposition of the more stringent standard.

3. *Protecting Commercial and Industrial Uses*

Similar octave band schedules should be constructed for sound emitted to Class B land and for sound emitted to Class C land, in each case from Class A, B, and C emitters. No new conceptual or structural problems are created; the major questions concern what levels to set.[210]

For Class B receivers the equivalent dBA levels for the octave band schedules in the Illinois regulation are 66 dBA for emissions from Class C uses, 62 dBA for emissions from Class B uses, and 55 dBA for emissions from Class A uses. This would provide the following noise environment:

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206. IPCB Rules, *supra* note 135, Rule 101(i).

207. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.2(a)(2), (4) (1973).

208. N.Y. Proposed Regs., *supra* note 139, § 003.2(b).

209. COLO. REV. STAT. ANN. § 66-35-3(1) (Supp. 1971).

210. *See* discussion on how levels are set in text accompanying note 182 *supra*.

Class C Emitter

For just acceptable speech and telephone communication. Normal voice level conversation is possible at 3 to 4 feet for males and at 2 feet for females. Raised voice level conversation is possible at 7 feet and very loud voice level conversation at 13 feet.

Class B Emitter

For just acceptable speech and telephone communication. Normal voice level speech is possible at 6 feet for males and at 3 feet for females. Raised voice level speech is possible at 12 feet for males.

Class A Emitter

For moderately fair listening conditions. Normal voice level speech is possible at 13 feet for males and at 8 feet for females. Raised voice level speech is possible in excess of 20 feet for males.[211]

For Class C receivers the levels are 70 dBA for Class C emitters, and 62 dBA for both Class B and Class A emitters. The resulting noise environment can be characterized as:[212]

Class C Emitter

For work spaces where speech or telephone communication is not required. Normal voice level speech is possible at 2.5 feet for males and at 1.5 feet for females. Very loud voice level speech is possible at 10 feet for males.

Class B or A Emitter

For just acceptable speech and telephone communication. Normal voice level speech is possible at 6 feet for males and at 3 feet for females. Raised voice level speech is possible at 12 feet for males. New Jersey has a standard for receivers in the commercial operation class of 65 dBA for commercial or industrial emitters, although the alternative octave band levels do not appear equally stringent.[213] No standard is applicable to industrial class receivers.

New York's proposed regulation, with a similar standard for commercial class receivers of 65 dBA for other commercial or industrial emitters, has an alternative octave band schedule as much as 16 dB lower than New Jersey's.[214] The New York regulation also has a

211. IPCB OPINION IN R72-2, *supra* note 22, at 28.

212. *Id.*

213. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.2(a)(3) (1973).

214. N.Y. Proposed Regs., *supra* note 139, § 003.3.

standard applicable to industrial receivers, set at 80 dBA.[215]

Overall, for the reasons stated earlier, based on the different approaches taken in the Colorado, Illinois, New Jersey, and New York systems, it is difficult to make meaningful direct comparisons among them with regard to their stated levels. The Colorado statute is sui generis, and one would guess the levels are difficult to enforce in an even-handed manner. The proposed regulations for New York contain a few anomalies, such as the fact that the octave band levels for both residential (daytime) and commercial receivers are the same.[216] These levels are identical with the Illinois levels applicable to Class B receivers (commercial) for sound emitted from Class C (industrial) emitter.[217] While the standard seems generally reasonable for commercial receivers, it is probably wholly inadequate for protection of residential receivers.

The New Jersey regulations contain the same anomaly. The octave band levels for residential (daytime) receivers are identical with those for commercial.[218] The lack of protection for residential uses resulting from this is compounded by the fact that these stated octave band levels approximate or exceed the standards in the Illinois and New York regulations applicable to the least protected (industrial) receivers. As noted earlier, the New Jersey dBA standard, stated as a separately enforceable alternative to the octave band schedule, is 65 dBA, whereas the octave band level equivalent is probably closer to 78 to 80 dBA. There appears to be an inherent inconsistency in these levels.

The Illinois levels are, because of the structure of the regulations, somewhat more involved. There are seven variables, rather than the three in the others. The following table presents the dBA equivalents for the octave band schedules contained in the Illinois regulation.

		Emitting Land Use C	B	A	
receiving land use	C	70	62	62	equivalent dBA levels
	B	66	62	55	
	A (day)	61	55	55	
	A (night)	51	45	45	

The Illinois Pollution Control Board summarized the noise environment established by these levels:

215. *Id.* § 003.4.

216. *Id.* § 003.2(a)(2), 003.3(b).

217. IPCB Rules, *supra* note 135, Rule 204.

218. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.2(a)(1) and (3).

Based on the previous discussion of physiological and psychological effects of noise, the protection to the citizen resulting from the regulation of the numerical limits of Rules 202 through 205 can be specified. As a general statement the levels are below those causing noise induced hearing loss although the C to C limit of 70 dBA is at the threshold. . . . Instead, protection is against unwarranted annoyance and speech and sleep interference. The protection . . . is based on a single noise emitter operating at the limits; the presence of more than one emitter will decrease the protection provided.

. . . .

The conclusion to be drawn is that the regulation allows a moderately noisy environment to occur.[219]

E. Special Standards

1. *Impulsive Sound*

No person shall cause or allow the emission of impulsive sound from any property-line noise source located on any Class A, B, or C land to any receiving Class A, B, or C land which exceeds the allowable dBA sound level specified in Table 3, when measured at any point within such receiving Class A, B, or C land, provided, however, that no measurement of sound levels shall be made less than 25 feet from the property-line noise source.

TABLE 3

Classification of Land on which Property-Line Noise Source is Located	Allowable dBA Sound Levels of Impulsive Sound Emitted to Designated Classes of Receiving Land			
	Class C Land	Class B Land	Class A Land	
			Daytime	Nighttime
Class A Land	57	50	50	45
Class B Land	57	57	50	45
Class C Land	65	61	56	46

Impulsive sound is defined as either a single pressure peak or a single burst (multiple pressure peaks) for a duration less than one second.

Impulsive sound can be considered as sound having less than one second duration. Typical examples of this type of sound include blasts, hammering, impact of drop forges, and punch presses. When compared subjectively to continuous noise, impulsive noise is generally judged to be more annoying. According to the ISO, a 5 dBA penalty is necessary in assessing the annoyance value of impulsive sound. In addition, the community noise equivalent level (CNEL) rating

219. IPCB Opinion in R72-2, *supra* note 22, at 21, 27.

scheme, used by the State of California in monitoring noise sources, has been shown to correlate well with community reaction if a 5 dB decrease in the allowable levels of impulsive noise is included.[220] Thus, it appears that impulsive sound levels should be 5 dB less than continuous sound levels if the same subjective reaction is to be maintained in both instances.

The short duration of impulsive sounds does not allow the determination of octave band sound levels using portable measuring equipment consisting of a sound level meter and octave band analyzer. More costly and sophisticated equipment, including a precision tape recorder and spectrum analyzer, would be required and would not permit easy use in the field. In addition, it appears that dBA levels correlate sufficiently well for all types of impulsive noise so that the octave band levels are not required.[220a]

The prototype impulsive sound rule, set out above, established sound emission limits in dBA that are 5 dBA more strict than the corresponding standards in the prototypes for non-impulsive sounds discussed in the preceding sections.

2. *Prominent Discrete Tones*

(a) **No person shall cause or allow the emission of any prominent discrete tone from any property-line noise source located on any Class A, B, or C land to any receiving Class A, B, or C land, provided, however, that no measurement of one-third octave band sound pressure levels shall be made less than 25 feet from such property-line noise source.**

(b) **This rule shall not apply to prominent discrete tones having a one-third octave band sound pressure level 10 or more dB below the allowable octave band sound pressure level specified in the applicable standards for broad band sounds for the octave band which contains such one-third octave band.**

A prominent discrete tone is defined as sound, having a one-third octave band sound pressure level which, when measured in a one-third octave band at the preferred frequencies, exceeds the arithmetic average of the sound pressure levels of the two adjacent one-third octave bands on either side of such one-third octave band by:

220. *Id.* at 18.
220a. *Id.*

(a) **5 dB for such one-third octave band with a center frequency from 500 Hertz to 10,000 Hertz, inclusive. Provided: such one-third octave band sound pressure level exceeds the sound pressure level of each adjacent one-third octave band, or;**

(b) **8 dB for such one-third octave band with a center frequency from 160 Hertz to 400 Hertz, inclusive. Provided: such one-third octave band sound pressure level exceeds the sound pressure level of each adjacent one-third octave band, or;**

(c) **15 dB for such one-third octave band with a center frequency from 25 Hertz to 125 Hertz, inclusive. Provided: such one-third octave band sound pressure level exceeds the sound pressure level of each adjacent one-third octave band.**

Prominent discrete tones are sounds with easily identifiable frequency or pitch components, examples of which include whistles, transformer hum, motor noise, and musical instruments. In terms of noisiness, these tones are more annoying than sound not having such tones, so that again a penalty should be imposed.

The first problem is the determination of when a sound contains prominent discrete tones. ANSI Standard S1.13-1971, "Methods for the Measurement of Sound Pressure Levels," suggests that, based on a panel of listeners, a prominent discrete tone would typically be present if the tone were from 5 to 15 decibels higher than the level at which the tone would just be audible in the presence of broad band noise. Accordingly, 10 dB is suggested as the level for the establishment of prominent discrete tones.[221]

However, Fletcher, Munson, and others have shown that the car's sensitivity to discrete tones varies with the frequency of the sound.[222] Therefore, the definition of a discrete tone as being prominent should be a function of frequency. Using the Fletcher and Munson concepts along with the 10 dB criterion, the following table gives, for 1/3 octave bands, the decibel differentials for the 1/3 octave discrete tone and the adjacent 1/3 octave bands required for a prominent discrete tone, as a function of frequency:[223]

221. *Id.*
222. *IPCB Hearings on R72-2, supra* note 6 (Ill. EPA Exhibits 63, 117).
223. IPCB OPINION IN R72-2, *supra* note 22, at 18-19.

1/3 Octave Band Center Frequency (Hz)	Excess SPL required for prominent discrete tone (dB)
100	16.0
200	10.7
400	7.2
800	4.8
2000	3.5
4000	3.3
8000	4.9

The prototype definition of prominent discrete tones, subdivided into three steps as a function of frequency, is intended to account for the ear's sensitivity to these tones, since the ear more easily identifies discrete tones as being prominent at high frequencies than at low frequencies.

Once a sound is determined to have these prominent discrete tones, the next problem is to rate the sound in terms of annoyance in relation to sound devoid of such tones. The ISO recommendation would penalize prominent discrete tones by 5 dBA in assessing their relative annoyance. In addition, Kryter in his book, *The Effects of Noise on Man*, establishes the following correction factors to be applied in estimating noisiness from sound pressure level readings in octave bands.[224] The factors depend both on frequency and on the excess sound pressure level of the prominent discrete tone.

Excess Sound Level (dB)	Frequency (Hz)	Correction Factor (dB)
8	400-1600	4
5	400-1600	3
5	1000-4000	5
5	4000-8000	3

Thus, it appears that a correction factor of around 5 dB based on the ISO and Kryter material seems appropriate in terms of equating equal noisiness between sounds with prominent discrete tones and those without.

The prototype definition and rule for prominent discrete tones in effect establish on a 1/3 octave basis a penalty equivalent to 5 dB for sounds containing prominent discrete tones. This is based on the relative annoyance values as discussed above.[225] Subsection (b) of the rule establishes a floor below which a sound source will not be classified as having prominent discrete tones. The purpose of this floor is discussed in section V-B on electrical generating and distribution equipment.

224. KRYTER, *supra* note 35, at 289-90.
225. IPCB OPINION IN R72-2, *supra* note 22, at 29.

V. FORMULATING A STATE REGULATORY SYSTEM: SPECIAL PROBLEMS

A number of nontransportation sources found in most states face special technical or economic problems in achieving sufficient noise reduction to comply with quantitative standards designed to prevent speech interference and annoyance on nearby land. This is especially true where the receiving land is used for residential or other purposes particularly sensitive to noise.

Because it is difficult to explain these problems except in the context of specific noise standards, the following discussion will assume the maximum limitations stated in the prototype provisions, equal to those adopted in Illinois, and discussed in sections IV-D and E, for application to noise emitted from Class C industrial land to Class A residential land. These include the separate daytime and nighttime limits, with penalties for impulsive sounds and prominent discrete tones.

A. Construction Sites

Figure 6 depicts the ranges of noise levels, measured in dBA at 50 feet, produced by various types of construction equipment.[226] It is obvious that the levels are well in excess of what would be acceptable to receivers in adjacent residences with open windows during either daytime or nighttime hours.

Immediate noise abatement potential at construction sites may be rather limited. The table following indicates sound-reduction capabilities, as of 1971, for various types of equipment.[227] The estimated reductions do not approach those needed to meet limits of the stringency here assumed. Of course, equally noisy equipment is used in other industries, but they have better opportunities to limit the sound emitted across property lines through techniques such as enclosing or relocating the source, erecting barriers, modifying buildings, and managing land use.[228] Such measures usually are not possible at urban construction sites for buildings and highways.

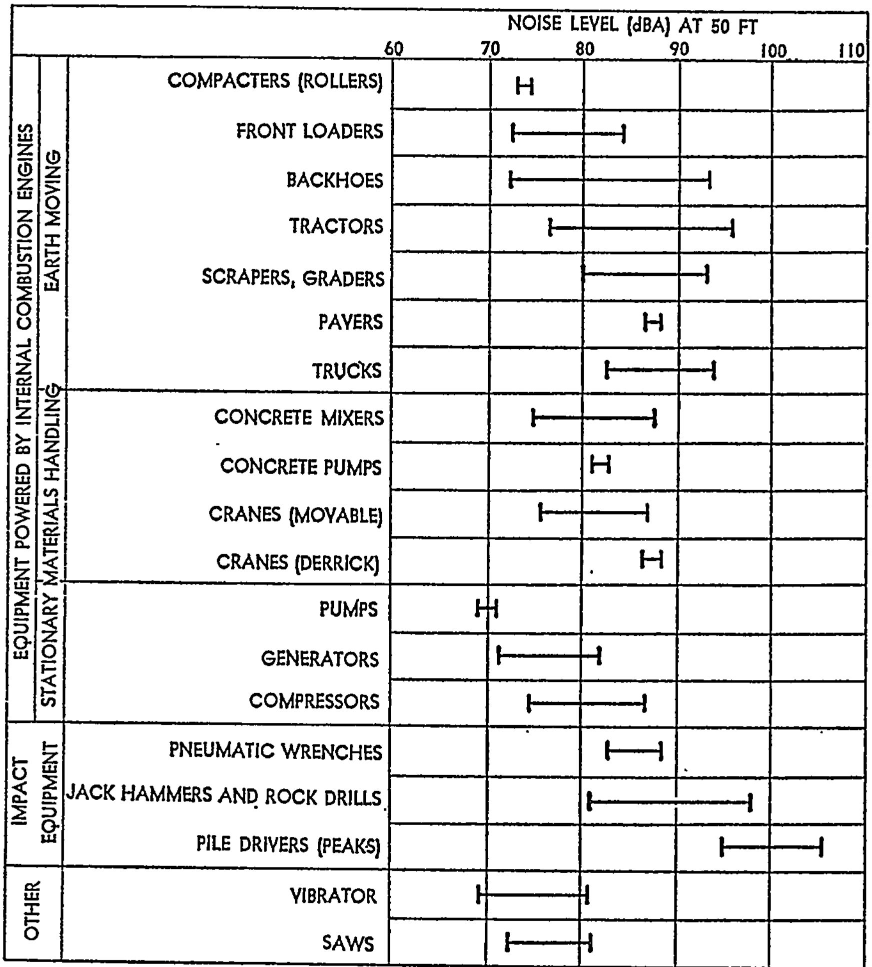
226. United States Environmental Protection Agency, Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances 11 (1971).

227. *Id.* at 26.

228. *See* text accompanying note 95 *supra.*

FIGURE 6.

CONSTRUCTION EQUIPMENT NOISE RANGES



Note: Based on Limited Available Data Samples

IMMEDIATE ABATEMENT POTENTIAL OF CONSTRUCTION EQUIPMENT

Equipment	Noise Level in dB(A) at 50 ft Present	With Feasible Noise Control[1]	Important Noise Sources[2]	Usage[3]
Earthmoving				
front loader	79	75	E C F I H	.4
backhoes	85	75	E C F I H	.16
dozers	80	75	E C F I H	.4
tractors	80	75	E C F I W	.4
scrapers	88	80	E C F I W	.4
graders	85	75	E C F I W	.08
truck	91	75	E C F I T	.4
paver	89	80	E D F I	.1

Materials Handling				
concrete mixer	85	75	ECFWT	.4
concrete pump	82	75	ECH	.4
crane	83	75	ECFIT	.16
derrick	88	75	ECFIT	.16
Stationary				
pumps	76	75	EC	1.0
generators	78	75	EC	1.0
compressors	81	75	ECHI	1.0
Impact				
pile drivers	101	95	WPE	.04
jack hammers	88	75	PWEC	.1
rock drills	98	80	WEP	.04
pneumatic tools	86	80	PWEC	.16
Other				
saws	78	75	W	.04
vibrator	76	75	WEC	.4

Notes:

1. Estimated levels obtainable by selecting quieter procedures or machines and implementing noise control features requiring no major redesign or extreme cost.
2. In order of importance:
   T Power Transmission System, Gearing
   C Engine Casing
   E Engine Exhaust
   P Pneumatic Exhaust
   F Cooling Fan
   W Tool-Work Interaction
   H Hydraulics
   I Engine Intake
3. Percentage of time equipment is operating at noisiest mode in most used phase on site.

Sleep interference caused by construction equipment can be minimized by prohibiting operation during nighttime hours. Beyond that, however, the shortrun prospect for limiting noise emissions from construction sites to 61 dBA, or 56 dBA for impulsive sounds, does not appear promising. One way of dealing with the problem is to treat it as noise from individual pieces of mobile equipment rather than as noise from a single site or source. The activity is essentially temporary, and the locational context is typically one over which the constructor has little control. He does have control over his equipment, however. As new product standards for construction equipment are established by federal and state governments, it can be expected that the controllable aspects of noise from construction will be substantially reduced. The federal EPA has already published advanced notice of proposed rulemaking for new portable air compressors.[229] The question of retrofitting existing equipment becomes one of balancing costs against time for phasing out and replacement.

The Illinois regulations exempt from the numerical standards "sound emitted from equipment being used for construction";[230] con-

229. 39 FED. REG. 7594 (1974). *See* EPA draft standard (76 dBA at 7 meters), NOISE REG. REP., Sept. 16, 1974, D-35.

230. IPCB Rules, *supra* note 135, Rule 208(d).

struction equipment is to be the subject of separate regulations to be proposed by the Illinois Noise Task Force. New York in its proposed regulations also exempts construction noise from the stationary source standards.[231] In an earlier draft proposal, construction noise was included.[232] The later proposal states, "Information received at a public hearing has shown that regulation of construction noise involves several complex considerations. Because construction is a temporary activity and because the contractor is generally limited in his ability to obtain quieter equipment, a separate regulation is being developed for construction."[233]

By contrast, the Colorado act specifically subjects construction projects to the maximum permissible noise levels specified for industrial zones.[234] The New Jersey regulations do not expressly include or exclude construction noise. The only reference to the issue is a specific exception from the standards for "emergency work to provide electricity, water, or other public utilities when public health or safety are involved."[235] Since the noise created by such activity is essentially construction noise, the inference seems to be that non-excepted construction noise is regulated. Whether it is classified as commercial or industrial is unclear but also unimportant as long as it is one or the other, since the applicable emission standards under the New Jersey regulations are the same. It is probable that the regulations were not intended to cover construction noise; the explanatory document that accompanied the draft of the regulations at the hearing stage indicated that there would be a future chapter on noise from construction equipment and construction sites.[236]

B. Electrical Generating and Distribution Equipment

Evidence presented by Commonwealth Edison Company during public hearings concerning the Illinois noise regulations indicates that certain equipment of electric utility companies, when located in residential areas, is difficult to bring into compliance with stringent nighttime and discrete-tone standards. Such equipment includes transformers, gas

231. N.Y. Proposed Regs., *supra* note 139 § 006.4.

232. N.Y. Dep't of Environmental Conservation, Proposed Regulations for the Prevention and Control of Environmental Noise Pollution (1972).

233. N.Y. Dep't of Environmental Conservation, Explanation of Noise Control Regulations for Sound Source Sites 10 (1973).

234. Colo. Rev. Stat. Ann. § 66-35-3(5) (Supp. 1971).

235. N.J. Dep't of Environmental Regulations § 7.29-1.4(5) (1973).

236. N.J. Dep't of Environmental Protection, Noise Control Regulations, Basis and Background Document 2 (undated).

turbine peakers, and fans supplying combustion air to furnaces at base load generating stations.

1. *Transformers*

A major problem is transformer noise, which usually includes a hum that is a discrete tone. Transformers can be divided into three classes: distribution transformers, varying in size from 5 to 500 KVA, with the majority being located on utility poles in streets, alleys, and easements along rear property lines; small and medium power transformers of between 750 and 5000 KVA, located on substation or distribution center property (sometimes in a building and sometimes not), or on the grounds of commercial and industrial customers; and large power transformers, 5000 KVA and above, located in generating stations, distribution centers, and substations.[237]

Distribution transformers are a particular problem because they are so numerous and many are located in residential areas. Commonwealth Edison, which operates in northeastern Illinois, has almost 340,000 in its system, replacing some 22,000 annually as part of its regular maintenance program. Models 6 dB quieter than those presently used are available but cost 27 percent more. Relying upon evidence produced by the Company and others at public hearings, the Illinois Pollution Control Board found that up to 24,000 of Com Ed's existing distribution tranformers might violate the C-to-A daytime standard, and that the cost of replacing just those would approximate $25 million. None were shown to exceed the daytime limit ultimately adopted for prominent discrete tones.[238] The Illinois nighttime standards presented a more difficult problem, as is indicated by the comparative data in the footnote below.[239] Com Ed contended that to

237. *IPCB Hearings on R72-2, supra* note 6, at 414-25 (Testimony of E.C. Edwards and J.J. Qurollo of Commonwealth Edison Co., June 23, 1972) [hereinafter cited as Edwards Testimony].

238. IPCB Opinion in R72-2, *supra* note 22, at 40-41.

239.

Octave Band Center Frequency (Hz)	Illinois C-to-A Daytime Limits	Illinois C-to-A Nighttime Limits	Group of 3 167 KVA Distrib. Transf.	Group of 3 50 KVA Distrib. Transf.	100 KVA Distrib. Transf.	50 KVA Distrib. Transf.
31.5	75	69	64	60	61	53
63	74	67	70	66	63	59
125	69	62	71	68	64	59
250	64	54	64	64	56	53

meet the nighttime limits, it would have to replace almost every distribution transformer—as well as almost every small, medium, and large power transformer—which was situated near residential property. This would have cost $492 million, or $1.75 billion with carrying charges.[240]

With respect to small and medium power transformers, the Illinois experience indicates that perhaps one in three would violate the C-to-A daytime octave band limits which were adopted. Commonwealth Edison had a total of 5000 small and medium power transformers which could be replaced with units 6 dB quieter at an average cost of $8,400 per unit. In some cases it might be cheaper to build sound barriers around the transformers rather than to replace them, though that was not clear from the evidence presented. The Pollution Control Board therefore concluded that one-third of the 5,000 transformers might have to be replaced at a cost of approximately $14 million.[241]

It also was shown in Illinois that up to 50 percent of large power transformers might emit noise in excess of that allowed under the daytime limits for residential property. The most effective way to attenuate noise from these transformers is to construct sound barriers. To illustrate, the Baltimore Gas and Electric Company had a problem with six large transformers on one site. Total on-site investment at the station was $2.6 million. The company erected a three-sided concrete-block barrier, 35 feet tall and 500 feet long, which achieved a 13 dBA reduction in noise at a cost of $230,000. Commonwealth Edison has, in Illinois, approximately 1,500 large power transformers, of which half might require noise reduction. The Pollution Control Board found that, depending on the size of the transformer, barriers would cost between $3,000 and $54,000 per unit, for a total of $6 million, far less than Com Ed's estimate of $192 million to replace the transformers with quieter ones.[242]

500	58	47	58	57	52	40
1000	52	41	52	50	47	38
2000	47	36	50	46	42	36
4000	43	32	44	38	33	31
8000	40	32	39	30	25	24
	(61dBA)	(51dBA)	(62dBA)	(59dBA)	(54dBA)	(48dBA)

Edwards Testimony, *supra* note 237 Exhibit B. All the distribution transformers were pole-mounted, and the sound was measured 25 feet from them.

240. IPCB Opinion in R72-2, *supra* note 22, at 40.

241. *Id.* at 41.

242. *Id.* at 41-42.

2. *Peakers*

Gas turbine peaking units consist of electrical generators driven by jet or industrial gas turbine engines. Noise is caused primarily by the movement of massive amounts of air at very high speeds. Predominantly high frequency sound emanates from the turbine intake where air is compressed, and predominantly low frequency sound from the turbine exhaust. Residual sound, such as that caused by generator vibration, has broad-band characteristics.[243] Figure 7[244] shows the noise spectra of the intake and exhaust of an unmuffled 20 MW turbine measured at 1000 feet, a common distance from peaker installations to residences. The low frequency noise is the most difficult problem to overcome, particularly where octave band rather than A-weighted limits are established.

Commonwealth Edison has 86 peaker units located at nine sites within its system. Such units ordinarily are purchased with the intention that they will be used to supply energy only during hours of peak demand, which do not include nighttime hours from 10 p.m. to 7 a.m. However, sometimes they are used during the latter hours. If they are located in residential areas, substantial expenditures for mufflers or barriers may be required to achieve compliance with limits like the Illinois daytime or nighttime levels.[245] The Illinois Pollution Control Board found insufficient evidence to dispute Commonwealth Edison's estimate of $9.3 million to silence by varying amounts 36 peakers at 7 sites, that dollar figure being approximately 5.5 percent of total on-site investment.[246]

3. *Fans*

The third major problem which appeared from the Illinois hearings was the noise from fans supplying combustion air to furnaces at base load generating stations. The Illinois Pollution Control Board found that of Commonwealth Edison's eleven such stations, two had received

243. *IPCB Hearings on R72-2, supra* note 6, at 404-05 (Testimony of E.M. Lacey, June 23, 1972).

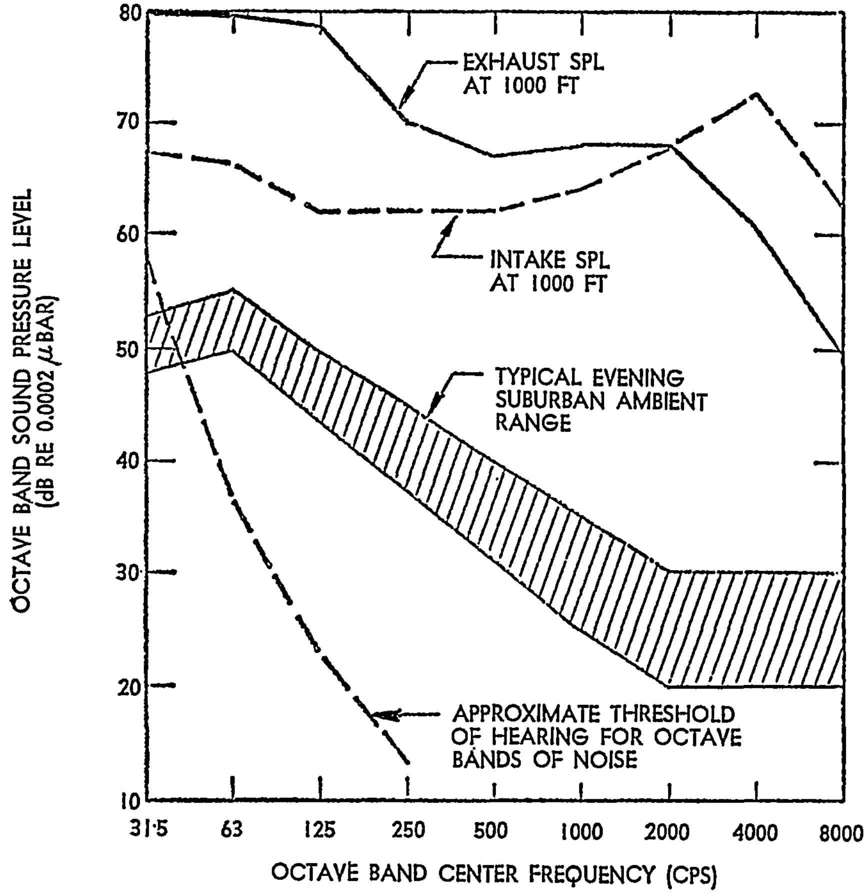
244. R. Hoover, The Law Frequency Sound of Gas Turbine, Electric Utility Installations, (paper presented at meeting of Acoustical Society of America, Miami, Fla., Dec. 1972).

245. Compliance is possible. One manufacturer of silencing units for peakers recommends for peakers noise in suburban neighborhoods limits as much as 11 dB more stringent than the Illinois C-to-A nighttime limits. The Acoustic Corp., Gas Turbine Silencing Requirements.

246. IPCB OPINION IN R72-2, *supra* note 22, at 43.

FIGURE 7.

20 MW GAS TURBINE SPL'S AT 1000 FT. COMPARED TO AMBIENT RANGE



some silencing treatment and were in conformance with the C-to-A daytime limits. The Board estimated that an expenditure of approximately $4 million would be required to bring the remaining stations into compliance. It would cost considerably more to meet the nighttime standards.[247]

The Illinois responses to the problems of the electric utility companies were several. The regulation was written to incorporate a requirement that sound pressure level data could not be measured less than 25 feet from the noise source.[248] This provided a significant at-

247. *Id.*

248. IPCB Rules, *supra* note 135, Rules 202-07.

tenuation factor for pole transformers located on back easements in residential areas. It was made clear on the record that such transformers were to be treated as Class C rather than Class A noise sources. Farmland, other than the homestead, was lowered from a Class B to a Class C receiver; and, as discussed earlier, undeveloped lands were excluded entirely from protection. This eased the problem for the large power transformers in remote areas. In addition, a "floor" was included in the prominent discrete tone rule,[249] the effect of which was to qualify most transformers as broad band noise sources, since their typical discrete tone characteristics were below the "floor." This then was coupled with a "grandfather" clause, exempting all noise sources existing at the effective date of the regulation from the nighttime standards.[250] Further, the Board made clear that the installation of a new or different piece of equipment, like a transformer, at an existing site would not change the classification from existing to new. "The property-line-noise-source is, in general, being regulated, not individual pieces of machinery that may comprise the source."[251] In effect, the daytime standard became the applicable 24 hour standard for the majority of the industry's equipment.

It is not entirely clear how the other current systems dealt with the problems of the electrical generating industry. Neither Colorado nor New Jersey distinguishes between existing and new sources; the nighttime standards apply to both. On the other hand, the New York regulation, read literally, seems to exempt both existing and new sources from the nighttime standards; presumably the intent was to exempt only existing sources.[252] New York also has a prominent discrete tone rule, with a floor similar to Illinois;[253] neither New Jersey nor Colorado has a prominent discrete tone rule.

C. Oil Refineries

Noise from an oil refinery is perhaps more difficult to control than that from any other kind of industrial installation. A refinery includes hundreds of individual noise sources and, for reasons of size, safety, and heat dissipation, the entire facility cannot be enclosed.[254] Fur-

249. *Id.* Rule 207(b).
250. *Id.* Rule 208(e).
251. IPCB Opinion in R72-2, *supra* note 22, at 21.
252. N.Y. Proposed Regs., *supra* note 139, § 006.4(c).
253. *Id.* § 003.5.
254. *IPCB Hearings on R72-2, supra* note 6, at 924-25 (Testimony of John R.

ther, oil refining is a 24-hour-per-day process which cannot simply be shut down during nighttime hours. Therefore, if more stringent nighttime limits are applicable, they are the only relevant limits. For the most part, noise emitted by a refinery to adjacent properties is received as steady, broad-band noise, without impulsive sounds or prominent discrete tones. Among the major sources are furnaces, motor pumps, compressors, fin fans, and vents.[255]

New refineries can be designed to meet a maximum limit of between 40 and 50 dBA at the property line.[256] A study conducted in England indicates that the cost of noise control, to meet a level of 45 dBA at 1,000 feet from the center of a new single-process plant, is from 1 to 2 percent of total on-site investment. The percentage is less for multiple-process plants costing more than $100,000,000. Total cost of noise control will vary by a factor of 2 for each 5 dBA change, upward or downward, from 45 dBA.[257]

To meet the same standard at an existing plant, not originally designed to do so, would require retrofitting, the expense of which may be greater by a factor of 2 to 4 than the cost of achieving compliance at a new plant.[258] Acoustical consultants for the Clark Oil Company made a noise survey around its Blue Island, Illinois refinery. Although Clark previously had spent $127,000 to treat heaters and boilers with sound absorbtive plenums and silencers, achieving a noise reduction of between 8 and 11 dBA measured 1000 feet away, a house 25 feet away still was receiving 82 dBA, 31 dBA above the proposed nighttime limit; other residences 450 and 850 feet away were receiving 65 and 54 dBA, respectively.[259] The consultants estimated roughly that it would cost an additional $28 million, or 16 percent of total capital investment in the existing facility, to quiet it to 45 dBA (which was then being considered as a nighttime standard for nonabutting Class A land) at a distance of 500 feet.[260]

Shadley, of Bolt, Beranek and Newman, June 30, 1972) [hereinafter cited as Shadley Testimony].

255. *Id.* at 912.

256. *IPCB Hearings on R72-2, supra* note 6, at 311-12 (Testimony of George W. Kamperman, June 22, 1972) [hereinafter cited as Kamperman Testimony].

257. *Id., citing* Sutton, *Control of Community Noise From Petroleum and Petrochemical Plant*, THE CHEM. ENG'R, Apr., 1969.

258. Kamperman Testimony, *supra* note 256, at 314.

259. Shadley Testimony, *supra* note 254, at 921.

260. *Id.* at 925.

The exemption for existing noise sources from the nighttime standard, discussed in the preceding section, provided the oil refineries with significant relief. Even so, the evidence at the Illinois hearings was that of the nine major refineries surveyed, five were out of compliance. The largest of the five was located immediately adjacent to a residential community, and was as much as 24 dB over the applicable standard. The owner, Shell Oil Company, stated that it would take a minimum of five years for compliance due to the large number of noise sources to be controlled.[261] The Board concluded that this refinery was not typical and could be handled through a variance procedure. The others were given a two-year deferral in order to undertake and complete the necessary retrofit.[262]

D. Natural Gas Pipeline Compressor Stations

Natural gas pipeline compressor stations, like electric utility peakers, are powered by gas turbine engines; and, as in the case of oil refineries, safety precautions to prevent explosions and fire may militate against complete enclosure of the compressor stations.[263] Witnesses for natural gas pipeline companies confirmed that the major noise problem for turbines is at the low frequencies. While they could be silenced through use of mufflers or baffles so as to satisfy a 51 dBA limit at several hundred feet, compliance with demanding octave band limits is much more difficult.[264] Likely solutions to compressor station noise involve exhaust mufflers, sound barriers, and perhaps enclosures with forced air ventilation systems.

In order to provide opportunity for development of alternative technological solutions to individual problems where low frequency noise is a major problem, the Illinois regulations provide that, where the sound level at the three lowest octave band center frequencies exceeds the standard by 10 dB or more, a time delay of 18 months is allowed before compliance with the standard is required.[265] None of the other current systems make special provisions for problems of low frequency attentuation.

261. IPCB Opinion In R72-2, *supra* note 22, at 34.

262. IPCB Rules, *supra* note 135, Rule 209(i).

263. *IPCB Hearings on R72-2, supra* note 6, at 1922 (Testimony of Michael A. Porter, Nov. 9, 1972).

264. *Id.* at 1925.

265. IPCB Rules, *supra* note 135, Rule 209(c).

E. AUTOMOBILE AND MOTORCYCLE RACE TRACKS

During public hearings conducted by the Illinois Pollution Control Board, many citizens complained about noise from automobile and motorcycle race tracks. The objectionable sources included both vehicle engines and loudspeakers whose volume was very high to overcome the engine noise. In contrast to the situation at most other facilities, where noise reduction is viewed as a desirable though costly accomplishment, motor noise is viewed by some track operators as desired by racing spectators and therefore of positive value.

Techniques are available for reducing such sounds. They include (aside from turning down the loudspeakers) walling, baffling, or covering the track; acquisition of buffer land between the track and receiving properties; and modification or muffling of the vehicle engines. Probably the most satisfactory solution to noise from automobile and motorcycle race tracks is to locate the facilities away from any receiving land that might be affected by the activity.

But what of the existing tracks, where adversely affected land uses already are nearby? Probably the most that can be achieved at existing tracks in such circumstances, short of closing them down, is the erection of sound barriers and the muffling of vehicles so that they do not emit substantially more noise than regular highway vehicles. A race track in Maryland achieved a 5 dBA reduction at adjacent properties by erecting a 20-foot high plywood wall.[266] A more substantial barrier would achieve better results, so that a significant noise reduction should be possible if the vehicles also are silenced.

In Illinois, the Environmental Protection Agency—the enforcement agency—recommended that race tracks be exempted from the numerical standards. The Board rejected that recommendation, but allowed the tracks two years in which to come into compliance.[267] Colorado, New Jersey, and New York all exempted race tracks entirely from quantitative noise limitations.[268]

F. FORGING PLANTS

Industrial forging operations produce substantial environmental noise which is very difficult to control. The main problem is the impact

266. IPCB OPINION IN R72-2, *supra* note 22, at 46.

267. IPCB Rules, *supra* note 135, Rule 209(j).

268. COLO. REV. STAT. ANN. § 66-35-3(7) (Supp. 1971); N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.4(6); N.Y. Proposed Regs., *supra* note 139, § 006.4(a)(6).

noise of the forging hammers. One Illinois citizen testified that although his home was in a residential area, two blocks and 400 oak trees away from a forging plant, his family was terribly bothered by impulsive noise from the forge.[269] The state Environmental Protection Agency took measurements and determined that hammer noise, measured at the citizen's house, reached levels as high as 66 dBA.[270]

Since no technology exists for silencing such noise at the source—120 to 140 dBA at the point of hammer impact—barriers or building modification must be employed. Because of the intense heat from furnaces used in the forging process, forging operations usually are conducted in buildings with large windows and doors, most of which are kept open to provide natural ventilation and permit the heat to dissipate through openings in the roof.

Merely closing all the windows and doors at most plants should produce a noise reduction of 20 dBA.[271] Even greater reduction could be obtained by designing for that purpose, for example, by utilizing double brick walls with no windows. In either case, a forced air ventilation system probably would be needed. However, such measures pose economic problems for existing forges, many of which are located in old buildings with walls mostly of glass. An alternative technology would be to utilize parallel baffle silencers, which look like giant venetian blinds, installing them within the forging plant immediately adjacent to the hammers. This would obviate the need for closing windows and installing a mechanical ventilation system.[272]

At present it is doubtful whether existing forges can economically meet a standard of 61 dBA at nearby residences. Fifty-one dBA at nighttime is out of the question, so they simply must shut down at night.

The problem is aggravated by the fact that impulsive noise is a particularly annoying form of noise, warranting a penalty factor when setting standards.[273] Testimony by forging industry representatives at the Illinois hearings was to the effect that there was no known technology that could bring the impulsive noise of the hammers within the proposed limits. Testimony by the industry's technical consultants, however, was to the effect that given five years of effort, to which

269. *IPCB Hearings on R72-2, supra* note 6, at 3201 (Testimony of Ralph Horton, May 14, 1973).

270. Reid Testimony, *supra* note 42, at 3219.

271. Kamperman Testimony, *supra* note 256, at 3246.

272. *Id.* at 3328.

273. *See* discussion of the impulsive noise rule prototype, Section IV.E.1 *supra*.

the industry had committed itself, the technology needed to meet the standards would be ready for on-line application.[274] Considering the low level of funding that had been committed to the project (1/50th of 1% of the total capital investment of the industry), a shorter compliance period was deemed in order, and the Board gave the industry three years to come into compliance.[275]

G. RAILROAD MARSHALLING YARDS

The principal sources of environmental noise from railroad marshalling yards seem to be the impact of coupling cars; the action of retarders; diesel engine locomotives and refrigerator car motors; the interaction of steel wheels and rails; locomotive warning horns; and loudspeakers used for communication among yard personnel.[276] Some of these noises can be quite loud. For example, coupling noise measured 100 feet from impact at a Chicago marshalling yard had a sound level of 85 dBA.[277]

Since it is difficult to relocate existing railroad yards or, in many cases, to acquire buffer land around them, the most promising noise control techniques are the erection of sound barriers and the silencing of individual equipment items. Many railroad yards operate 24 hours a day, and it probably is not feasible to shut them all down during nighttime hours. However, in order to meet more stringent nighttime noise limits, managers may have to schedule noisy activities so that they occur at different times, rather than all at the same time, and so that they are conducted in areas of the yard farthest removed from residences.

Loudspeakers and warning horns would not seem to be serious problems. Both can be operated at lower volumes, and the loudspeakers can be replaced by two-way radios. Diesel locomotives can be muffled—most of them presently are not—and refrigerator cars and idling locomotives can be parked in areas of the yards remote from residences. Coupling noise, screeching from retarder rails, and sound from wheel-rail interaction can best be controlled at the present time through erection of noise barriers, either at the periphery of the yard or, in the case of retarders, immediately adjacent to the retarders. At

274. IPCB OPINION IN R72-2, *supra* note 22, at 33-34.

275. IPCB Rules, *supra* note 135, Rule 209(h).

276. *IPCB Hearings on R72-2, supra* note 6, at 1642-54 (Testimony of several citizens, Oct. 11, 1972).

277. *Id.* at 838 (Testimony of Steven Adik, June 30, 1972).

one Chicago yard of the Santa Fe Railroad an 8-foot-high wall not even designed as a sound barrier served to reduce retarder noise from 67 dBA at the top of the wall to 56 dBA 20 feet outside the wall. Further technological development is undoubtedly possible to achieve reduction at the source of noise from coupling, retarders, and wheel-rail interaction.[278]

The Illinois regulations give the industry time to develop and apply cushioning for coupling noise or some adequate substitute; the rule allows 3 years to bring the sound from coupling into compliance with the impulsive noise standards.[279] Otherwise, railroad yards are treated no differently from other Class C sources.

The power of state (and local) governments to control noise from railroad yards has been complicated by section 17 of the federal Noise Control Act.[280] The confusion will be clarified (or compounded) by the regulations to be promulgated by the federal EPA. Until then, reasonable state regulations would appear to be both proper and lawful. The scope of state regulation of rights-of-way presents similar problems. The prototype (and Illinois) regulations include yards but not rights-of-way, though subsequently proposed federal regulations would permit some state control of right-of-way noise.[281]

The Colorado act specifically regulates railroad rights-of-way, classifying them as industrial zones, and states that "the operation of trains shall be subject to the maximum permissible noise levels specified for such zone."[282] No mention is made of railroad yards. The Colorado act also contains a provision that the act is "not intended to apply to the operation of aircraft, or to other activities which are subject to federal law with respect to noise control."[283] Since railroad operations and facilities are specifically dealt with in the federal Noise Control Act, this provision may have invalidated the section on rights-of-way. New Jersey exempts railroads entirely from the scope of its regulations,[284] while New York's proposed regulations exempt "sounds created by the means of propulsion of railroad trains."[285]

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278. *Id.* at 3330-31 (Testimony of George W. Kamperman, May 14, 1973).

279. RULE 209(g), ILL. POLLUTION CONTROL BD., RULES AND REGULATIONS.

280. *See* Section III.A.2 *supra.*

281. *See* Section IV.C and text accompanying note 119a *supra.*

282. COLO. REV. STAT. ANN. § 66-35-3(6) (Supp. 1971).

283. *Id.*

284. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.4(11) (1973).

285. N.Y. Proposed Regs., *supra* note 139, § 006.4(a)(4).

H. Quarries And Strip Mines

Noise problems at quarries and strip mines primarily involve blasting and mobile equipment.

In a judicial appeal which challenges the Illinois noise control regulations as applied to its members, the Illinois Coal Operators Association is contending that many of the bulldozers, scrapers, power shovels, and other equipment used in surface mines are essentially identical to those used in construction work, and that therefore strip mines should have the same exemption granted to construction sites.[286] However, construction sites differ in two important ways: they are temporary, and they are frequently in close proximity to property already highly developed for residential and other purposes so that it is infeasible to provide buffer land and perhaps even to erect temporary sound barriers. These factors usually are not applicable to strip mines, for which land acquisition and the erection of barriers should be more feasible. Ultimately, some of the problem should be solved by the development of quieter equipment pursuant to federal or state noise standards for new products.

In light of these factors, the Illinois regulations include quarries and strip mines within their scope as Class C emitters, while excluding construction activities as previously explained.[287]

The noise from blasting at quarries and strip mines presents greater difficulties. The impulsive noise from explosive blasting at a quarry or mine anywhere near a residential area usually will far exceed any reasonable limitations which would be established for environmental noise. At present no technology seems to exist for reducing blasting noise, nor do there seem to be substitute techniques for achieving certain purposes of blasting. A consulting engineer for the Illinois Aggregate Association testified in Illinois that explosive blasting is the only feasible method known to fragment rock, that quarrying practices now incorporate the highest current state of the blasting art, and that there is no known technological way to keep blasting noise within the Illinois limits at quarry property lines, even when the adjacent property is industrial rather than residential.[288] Perhaps substitute methods eventually can be developed. In the meantime, one way to minimize the negative effects of explosive blasting is to confine it to certain hours

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286. Petitioners' Brief, Illinois Coal Ops. Ass'n v. IPCB, Civil No. 46413 (Illinois Supreme Court, May, 1974).

287. *See* Section V.A *supra*.

288. *IPCB Hearings on R72-2, supra* note 6, at 1908-09 (Testimony of Innocencio Bernardo, Jr., Nov. 9, 1972).

of the day (not night) and to require that persons intending to blast give prior notice to the community in order to minimize the shock or surprise resulting from sudden impulsive sound.

The Pollution Control Board took the position that:

> the current state of the art of blasting is unlikely to reflect much serious consideration of possible means to reduce environmental noise emissions, since their reduction has never before been required. For the same reason, the possibilities for fragmenting rock by other, quieter means have probably not received adequate study.[289]

The Board noted that use of blasting mats and acquisition of land for atmospheric attenuation were possible techniques for noise reduction. The Board concluded:

> Assuming, therefore that no way is currently known for blasting operations to meet the noise emission limits, the fairest course of action for the Board is to set a compliance date for them, with respect to Rule 206 daytime limits, further in the future than the date for operations for which solutions are now known; e.g., three years from adoption of the regulations instead of the usual one year. This approach simultaneously recognizes the difficulties faced by the quarrying industry and avoids relieving it of all responsibility, which would be unfair to other industries.[290]

The industry was given three years to bring sound from explosive blasting activities into compliance. But a further restriction was imposed: during this period, blasting could take place only between 8 a.m. and 5 p.m., and only at specified hours previously announced to the local public.[291] Both New Jersey and New York exempt blasting noise from their nontransportation noise source regulations;[292] Colorado does not deal with it.

I. Mobile Farm Machinery and Lawn Maintenance Equipment

A common noise problem associated both with mobile farm machinery and with lawn maintenance equipment, such as power mowers, is that

289. IPCB Opinion in R72-2, *supra* note 22, at 33.

290. *Id.*

291. IPCB Rules, *supra* note 135, Rule 209(f).

292. N.J. Dep't of Environmental Protection, Noise Control Regulations § 7:29-1.4(13) (1973); N.Y. Proposed Regs., *supra* note 139, § 006.4(a)(13).

when operated immediately adjacent to the property line, they produce sound in excess of the limits applicable for the protection of any adjacent residential property. Items such as tractors, combines, and power lawn mowers produce well in excess of 80 dBA.[293] Short of erecting a sound barrier at his property line or returning to horse-drawn or hand-powered equipment, there is no way in which a farmer or homeowner today can operate his equipment near the line without producing excessive noise at an adjacent residential property, that is, noise in excess of both the C-to-A and A-to-A Illinois daytime limits.

The most feasible measures to be taken at this time seem to be to preclude the use of such equipment near property lines during nighttime hours and to require up-to-date mufflers and other silencing devices on both new and used equipment. Ultimately a really acceptable solution must come from the development of new technology, forced by new product noise standards.

The Illinois solution to the problem was to exempt from the regulations "sound emitted from lawn care maintenance equipment and agricultural field machinery used during daytime hours," that is, from 7 a.m. to 10 p.m.[294] This did not prevent farmers from using their field machinery at night, a necessity during certain periods of the year in Illinois, but it may require some to schedule nighttime operations so that they occur in the interior of the property.

New Jersey and New York exempted agricultural operations entirely;[295] New York also exempted lawn care and maintenance equipment.[296]

J. HOME AIR CONDITIONERS

On typical small residential lots, where an air conditioner unit is located a few feet from the house next door, the noise at that house almost invariably exceeds the prototype A-to-A nighttime standard. For those who are on the inside, the benefits far outweigh any interior noise. For those on the outside, especially those who are without their own and cannot close windows to shut out the noise, the racket is mixed with resentment—a very annoying combination indeed.

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293. *See* Figure 1 in the text *supra*.

294. IPCB Rules, *supra* note 135, Rule 208(c).

295. N.J. Dep't of Environmental Protection, Noise Control Regulations, § 7:29-1.4(1); N.Y. Proposed Regs., *supra* note 139, § 006.4(a)(10).

296. *Id.* § 006.4(a)(14).

In the long run, the solution is new product standards at the federal or state level, compelling the development of quieter machines. In the short run, available silencing techniques for existing units are very limited. The Illinois Pollution Control Board took the position that the problem could best be dealt with at the local level—presumably through threatened enforcement of nuisance standards and other persuasive techniques—and exempted noise from sources classified as household units (code 110), mobile home parks or courts (code 140), other residential property not elsewhere classified (code 190), and religious activities (code 691).

As discussed more fully above, the New Jersey standards do not cover sound emissions from residential property,[297] and the proposed New York regulation simply exempts all "sounds that originate on residential property."[298]

K. Other Issues Not Previously Noted

In addition to the preceding problem areas with which a noise regulation must deal, there are a few others that should be noted.

1. *Delayed Compliance for Existing Noise Sources*

It seems reasonable to provide existing noise sources some period of time in which to assess their particular noise emission situation and to take whatever noise reduction actions might be needed. This would be true even for those sources for which on-the-shelf abatement technology exists. As noted in the preceding sections, it is even more true where technology must be developed.

The Illinois regulations provide a blanket deferred compliance date for all existing noise sources of 12 months from the effective date of the regulations.[299] Existing noise sources are defined as "any property-line-noise-source, the construction or establishment of which commenced prior to the effective date of this Chapter."[300] The 1 year period was based on testimony at the Illinois hearings on the availability of consultants, noise control materials, and noise control techniques, and on industry testimony that only 5 percent of business and industry in Illinois would not be able to comply with the daytime

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297. *See* text accompanying note 193 *supra*.
298. N.Y. Proposed Regs., *supra* note 139, § 006.4(a)(1).
299. IPCB Rules, *supra* note 135, Rule 209(b).
300. *Id.* Rule 101(f).

limits within one year. The Board felt that a longer delay in compliance for existing sources was not necessary except for the hard cases, most of which were discussed above.

New sources—that is, those established after the effective date of the regulation[301]—can be designed with noise control and abatement techniques built in at the start. No period for retrofit is needed, and no deferred compliance warranted. Under the Illinois regulations, unless a new source has one of certain problems discussed in the preceding sections and is thus entitled to a special compliance date for that problem—e.g., blasting at mines and quarries, railroad car coupling, oil refining operations, and automobile and motorcycle racing—compliance is required at the time the noise source is established.[302]

In its proposed regulations, New York took a similar approach. Since April 1, 1974, all noise sources have been required to "notify the Commissioner in writing," presumably of their existence.[303] Since June 1, 1974, no person has been allowed to "initiate installation of a sound source" that would violate the standards. This means all new sources must comply since that date.[304] Similarly, after January 1, 1975, modified sources must comply.[305] Finally, after July 1, 1975, all sound sources must comply.[306]

Neither Colorado nor New Jersey makes any differentiation between existing and new sound sources, although New Jersey achieves somewhat the same effect for its nighttime standards by having one standard effective immediately, and a somewhat more stringent standard effective January 1, 1976.[307]

2. *Measurement Methodology*

There are a number of technical organizations which publish standard procedures for making various types of noise measurements. Since the measurement technique and type of instrumentation used can affect the numerical reading from a given sound, it is important that the regulatory levels be related to known measurement practices.

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301. *See id.* Rule 101(h).
302. *Id.* Rule 209(a).
303. N.Y. Proposed Regs., *supra* note 139, § 116.1(a).
304. *Id.* § 006.1(b).
305. *Id.* § 006.1(c). Modification is defined in § 001.1(t).
306. *Id.* § 006.1(d).
307. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.2(a)(4) (1973).

Colorado attempted to do this through specifying in its statute the particular publications of the technical organizations to be used as references. Predictably, the Act has had to be amended several times to update the citations. The Illinois Pollution Control Board delegated to the state's Environmental Protection Agency the authority to specify the measurement procedures, consistent with the standards and recommended practices of the American National Standards Institute, Inc. (ANSI) and the Society of Automotive Engineers, Inc. (SAE).[308] Under the New Jersey system, primary enforcement of the state regulations (including measurement) may be at the local level. The Department of Environmental Protection was delegated the authority to establish standards governing test equipment methods and procedures.[309] New York, on the other hand, spelled out in some detail its test procedures in the basic regulation.[310]

CONCLUSION

The reader may have concluded by now that if state regulation of nontransportation noise sources is this complex and difficult, it may not be worth the effort. The authors would offer for rebuttal the words of Mrs. Early, describing her situation after noise abatement steps were completed by the adjacent factory:[311]

> *The noise was tolerable, what I mean by that, it was something I could live with. It was so different from what it had been a year ago. It was still noise, I mean the noise had not been completely eliminated, but it is tolerable.*
>
> *It is something you can live with and not make you so nervous that you cannot hardly stand it.*
>
> *I can contend with it. I would like it quieter, but what we have now is livable.*

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308. IPCB Rules, *supra* note 135, Rule 103.

309. N.J. DEP'T OF ENVIRONMENTAL PROTECTION, NOISE CONTROL REGULATIONS § 7:29-1.5 (1973).

310. N.Y. Proposed Regs., *supra* note 139, pt. 004.

311. *IPCB Hearings on R72-2, supra* note 6, at 1119 (Aug. 17, 1972).