Noise

Reprinted from
The Tenth Annual Report of the
Council on Environmental Quality

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FOREWORD

Noise is everywhere in modern society. As urban dwellers know, it can be irritating, annoying, and confusing. It can interfere with almost all aspects of life, from carrying on a conversation to going to sleep. Yet it is a difficult problem to address.

Noise is different from air and water pollution in several ways. Special monitoring devices are not needed to detect it. It is always near its source, whereas air and water pollutants can travel great distances. It does not necessarily remain for a long time.

Sound is not necessarily undesirable: witness the pleasure that we derive from the sound of wind in the trees or from a waterfall. Nor does any clearly identifiable quality of noise, such as loudness or repetition, necessarily cause problems, as anyone who has listened with pleasure to a rock concert, a Beethoven symphony, or the endless pounding of the surf can attest.

Yet noise—especially in urban areas—is a serious and growing problem. One survey showed that noise and crime are the two leading reasons people want to move out of their urban neighborhoods. Workmen's compensation payments for hearing loss are rising; states paid approximately $13 million and the federal government approximately $17.6 million for such claims in 1977. A study of grade-school children showed that noise in the home was having a greater impact on their reading performance than grade level, parents' educational background, or number of siblings. Studies of animals exposed to high noise levels show that noise causes a marked rise in blood pressure. There is even evidence that excessive noise exposure may be correlated to low birth weights in babies.

Originally published as Chapter 9 of *Environmental Quality—1979: The Tenth Annual Report of the Council on Environmental Quality*, this report explores the effects of noise, discusses how noise problems can be measured and what can be done about them, and describes actions now being taken at various levels of government to abate noise. We hope that it aids public understanding of the noise problem and stimulates support for measures which will improve our communities.

GUS SPETH, *Chairman*

CONTENTS

NOISE

I have wished a bird would fly away,
And not sing by my house all day;

Have clapped my hands at him from the door
When it seemed as if I could bear no more.

The fault must partly have been in me
The bird was not to blame for his key.

And of course there must be something wrong
In wanting to silence any song.

Robert Frost

In rural New England in 1928, Robert Frost found his concentration interrupted by one of nature's lesser creatures. Today this same setting might well include the noise of a power saw, jet airplane, or snowmobile. Most of us would agree with Frost that the song of a bird is part of the natural order of things, even if it occasionally annoys. The same cannot be said of the noise of modern, technological society, which can degrade the environment and the quality of our lives.

Noise and quiet are relative terms. The physical intensity of sound is measured objectively in decibels, but "noise"—unwanted sound—is also defined by subjective factors, such as setting and sources. To the poet or naturalist, for instance, quiet may mean the solitude of the wilderness, where the natural world lies undisturbed. To the urban dweller it may be relief from the perpetual barrage of city noises to be found in an apartment, home, or workplace, where noise from traffic, construction, industry, or aircraft cannot penetrate.

Noise is acceptable at certain times, within certain bounds, and at appropriate levels. Depending on the setting and source, even a loud sound, such as the roar of Niagara Falls, may be pleasurable. Noise at tolerable levels is an integral part of every vibrant city; the activities that contribute to the health of the city also generally produce noise. But in the past several decades, urban noise levels have increased at a dramatic rate and are contributing to urban decay.

Nearly half the U.S. population is regularly exposed to levels of noise that interfere with such normal activities as speaking, listening, and sleeping. Many people are subjected to high levels of noise in their homes or at work. The suburbs near urban centers are beginning to experience levels of traffic and industrial noise once confined to the cities. And even deep in the country's parks and forests, quiet is often shattered by the noise of motorcycles and airplanes.

Noise is primarily an urban problem, however. According to a recent Gallup poll, urban residents consider quiet one of the most important qualities in an ideal neighborhood, along with friendly people, good housing, and low crime rates. Quiet placed ahead of cleanliness, good schools, nearby shopping, and low traffic on the list of qualities respondents valued.[1]

The annual Bureau of the Census survey, conducted for the U.S. Department of Housing and Urban Development (HUD), has found in recent years that noise is the most frequently mentioned undesirable neighborhood condition in central cities (see Figure 9-1). Every year of the survey, approximately one-half of the respondents identified noise as an undesirable condition in residential neighborhoods. Also, noise was one of the two leading reasons given by people who wanted to move from their neighborhoods because of undesirable conditions; the other was crime. In the 1976 survey, noise was mentioned as an undesirable feature of the neighborhood three times as often as crime.[2]

Noise is a major environmental factor adversely affecting the quality of people's lives. More than that, noise is also a health problem. The next section explains the biomedical effects of noise, followed by a discussion of the nature and growth of noise sources in America, and what can be done—and is being done—by municipalities and states to control noise, as well as the federal role in assisting them. The chapter ends with a critique of the present national noise abatement effort and how it could be improved.

HEALTH AND WELFARE EFFECTS

HEARING LOSS

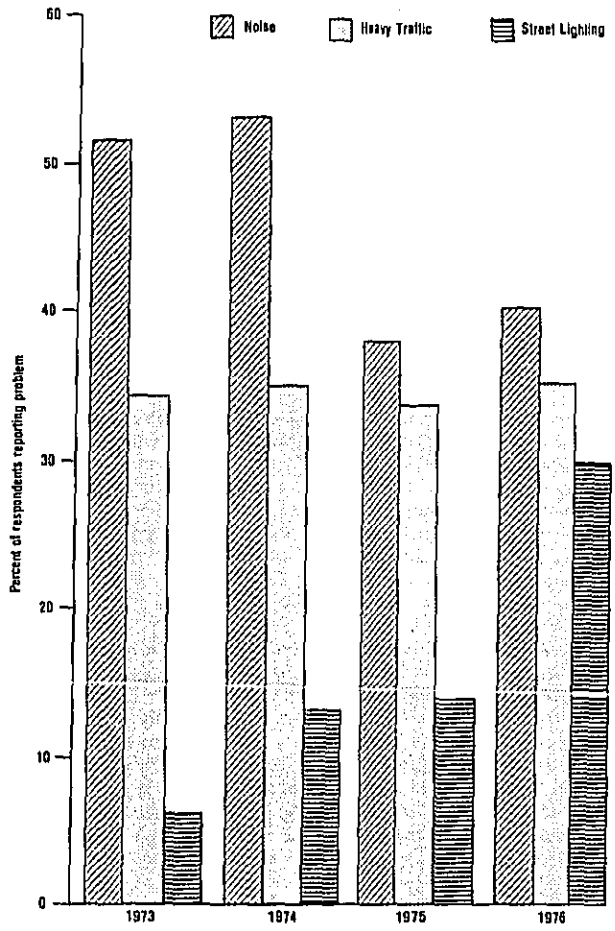
Perhaps the most serious consequence of noise exposure is its effect on hearing. Because the number of high-level noise sources has increased sharply in recent years, potentially harmful levels of noise are found in many cities and urban areas. It is estimated that as many as 20 to 25 million people—about 1 in 10 in the United States—are exposed to noises of duration and intensity sufficient to cause a permanent reduction in their ability to hear.[3] Of these, 10 to 15 million are estimated to be workers exposed to excessive noise on the job.[4] These include agricultural workers, construction workers, mine workers, and truck drivers, as well as factory workers.

Hearing loss due to noise exposure usually occurs gradually so that considerable deterioration may occur before one is aware of the

Figure 9–1

Undesirable Neighborhood Conditions in the United States, 1973–76

(sample size 69,337–74,005)



Source: U.S. Department of Housing and Urban Development Annual Housing Survey, 1973–1976.

damage. The damage is irreversible. When the highly specialized cells needed for hearing are destroyed by excessive exposure to noise, they do not regenerate and cannot be repaired.[5] If hearing continues to deteriorate, it becomes a handicap for which there is no cure.[6]

Hearing loss has a profound effect on the victim's life by interfering with speech, distorting sounds, preventing use of the telephone, and creating a depressing sense of isolation.[7] Hearing aids do not restore noise-damaged hearing, although they can be of limited help to some people.

INTERFERENCE WITH ACTIVITIES

An estimated 102 million Americans—virtually half the nation's population—are exposed to noise levels that may interfere with everyday activities.[8]

Noise and Sleep Noise can make it difficult to fall asleep, and can interrupt sleep by causing shifts from deeper to lighter sleep stages.[9] Although the apparent effects may only be a feeling of fatigue the next morning, repeated interruption of sleep over long periods of time, such as those experienced by many people living near highways and airports, may have more serious effects. The elderly are usually more easily awakened by noise.[10]

Communications Interference Noise is an obvious hindrance to communication. It is of particular concern in education and in situations where safety may depend on hearing the spoken word or other auditory warning signals. But the effect of noise interference on the quality of activities at home—conversations, TV watching, reading, or other activities—should not be ignored. At least 40 million Americans—or nearly one in five—are affected.[11] Even people with normal hearing who live in noisy places tend to reduce their communication with others and avoid social interaction. They tend to simplify their communications, talk only when absolutely necessary, and repeat themselves frequently.[12]

Effects on Work Performance Excessive noise seems to hinder work efficiency even when communication is not necessary. In some cases, particularly when close concentration is required, the accuracy of work suffers.[13] Studies also suggest that high noise levels during a task contribute to fatigue.[14] If the home itself is noisy, the worker may not find relief from the day's accumulated stress during nonworking hours. In the words of Leonard Woodcock, former president of the United Auto Workers, "They (auto workers) find themselves unusually fatigued at the end of the day compared to their fellow workers who are not exposed to as much noise. They complain of headaches and inability to sleep and they suffer from anxiety. Our members tell us that the continuous exposure to high levels of noise makes them tense, irritable, and upset." [15]

A 1977 Quality of Employment survey by the U.S. Department of Labor showed that 30 percent of the 2,300 workers surveyed in all types of employment considered noise in the workplace a problem of

some degree. Of those reporting the problem, 20 percent of the workers said that excessive noise was a major problem, another 20 percent said it was a sizable problem, and 50 percent said it was a slight problem.[16]

NOISE AND STRESS-RELATED PROBLEMS

The idea that people become totally accustomed to noise is a myth. Although we may get used to constant low-level noise, the human body will make automatic and unconscious responses when exposed to either sudden sounds or loud sounds.[17] Noise creates physiological stress. Although most noise does not mean danger, our bodies still react as if these sounds were a threat or a warning. In effect, the body involuntarily shifts gears. Adrenaline is released. Blood pressure rises, and muscles tense.[18] If the noise is sudden, it does not even have to be particularly loud for these reactions to occur.

Growing evidence strongly suggests a link between noise and cardiovascular problems, especially hypertension. Because noise is only one of several environmental causes of stress, researchers cannot say with confidence that noise alone causes the heart and circulatory problems they have observed. What they can point to, however, is a statistical relationship apparent in a number of field and laboratory studies. Epidemiological studies, which have attempted to take other factors into account, indicate that workers in noisy industries have a significantly higher rate of cardiovascular problems than those in quiet industries.[19] It could be that other factors, such as higher levels of toxic substances in the noisier factories, contributed to the higher disease rates. But the studies strongly suggest that at least an association with noise exists. Further research is necessary on this relationship.

In one research project, rhesus monkeys were exposed to the kinds of noises heard by the typical factory worker. The animals' systolic blood pressure jumped by 43 percent during 3 weeks,[20] and tended to remain high when the noise was shut off.[21] A similar increase in human blood pressure would mark the difference between a normal person and one with hypertension. Some of the noises the monkeys listened to each day were the ring of an alarm clock, the buzz of an electric razor, street traffic noise, and 8-hour recordings of factory noise.[22]

It may be that the generalized stress response to noise is also responsible for effects on reproduction. Before birth, the developing child is responsive to sounds in the mother's environment. Particularly loud noises have been shown to stimulate the fetus directly, causing changes in the heart rate.[23] Although definitive cause and effect relationships have not been established, studies of babies born to women living in noisy areas have shown evidence of a significantly higher incidence of low birth weight.[24] Such low birth weights are a statistically reliable indicator of increased susceptibility to many serious health problems for the newborn.[25]

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Noise-related stress is associated with emotional problems as well as physiological symptoms. Noise can trigger extreme behavior, as stories in newspaper files and police records indicate. For example, a man shot a boy who refused to stop making noise outside his apartment.[26] Repairmen have been threatened with guns [27] and motorboat operators shot at [28]—all because of the noise they were making. Noise can also inhibit or reduce helping or cooperative behavior. For example, in an outdoor study, a person with an arm in a cast dropped an armload of books while walking past a lawnmower. People were considerably less likely to stop and help pick up the books when the lawnmower was running.[29]

EFFECTS ON CHILDREN

The effects of noise on children are a matter of longstanding concern. The effects discussed so far could be still more serious if they interfere with normal childhood development. No one knows for sure whether children are particularly susceptible to noise-induced hearing loss, but there are indications that hearing loss among children is increasing.[30] Among the more serious recent findings is the preliminary conclusion that grade school children exposed to aircraft noise in school and at home had higher blood pressures than children in quieter areas. The exact implications for their health are not known, but certainly this finding is cause for serious concern.[31]

In addition, there are effects of noise on learning to consider. In the early 1900s, "quiet zones" were established around many of the nation's schools to reduce noises believed to interfere with children's learning. Today, researchers have rediscovered that learning difficulties are likely byproducts of noisy schools, play areas, and homes. Because they are just beginning to learn, children have more difficulty understanding language in the presence of noise than do adults. If children have to speak and listen in a noisy environment, they may have difficulty developing an essential skill such as distinguishing the sounds of speech.[32]

Reading ability also may be seriously impaired by noise. A study of reading scores of 54 children in grades two through five indicated that the influence of noise in the home was a more significant factor affecting reading performance than the grades the youngsters were in, the parents' educational background, or the number of children in the family. The longer the children had lived in a noisy environment, the more pronounced the reading impairment.[33]

Noise in the school can also have a detrimental effect. In a school located next to an elevated railway, students whose classrooms faced the tracks scored significantly lower on reading tests than did similar students whose classrooms were farther away.[34] In Inglewood, Calif., the effects of aircraft noise on learning were so severe that several new schools had to be built in quieter locations. As a school official explained, the disruption of learning went beyond the time wasted waiting for noisy aircraft to pass over. Considerable time had to be

spent after each fly over refocusing students' attention on what was being done before the interruption.[35]

NOISE SOURCES AND TRENDS

NOISE SOURCES

In the past 2 decades there has been a dramatic increase in the number of noise sources. There are more cars, trucks, motorcycles, and other vehicles on our highways than ever before. There are more office typewriters, more houses equipped with air conditioners and noise producing "labor-savers," and more industrial plants. One finding of the Urban Noise Survey, conducted by the U.S. Environmental Protection Agency (EPA) in 1976, is that no single noise stands out

SOME WAYS TO MEASURE NOISE

Instantaneous Measurement Sound is measured in decibels (dB). However, sounds of the same intensity (level) can differ in the frequencies of which they are composed. Sound level meters have several scales that electronically filter high and low frequencies in slightly different ways to produce single-number measures of the overall level at a given instant. The "A scale" is most often used to measure environmental noise. Its filtering (weighting) causes it to respond to sounds in much the same way as the human ear responds. All sound levels in this chapter are A-weighted.

Equivalent Sound Level (L_{eq}) Because many sounds fluctuate from moment to moment, it is desirable to have some kind of average level to describe the noise environment. L_{eq} is an energy average of sound levels during a given period of time. It is not the same as an arithmetic average because "peak" levels contain much more energy than the corresponding "valley" levels. Thus, in Figure 9–2, the L_{eq} is about 58 dB.

The major virtue of L_{eq} is that it correlates reasonably well with the effects of noise on people, except when the time of occurrence (day or night) is relevant.

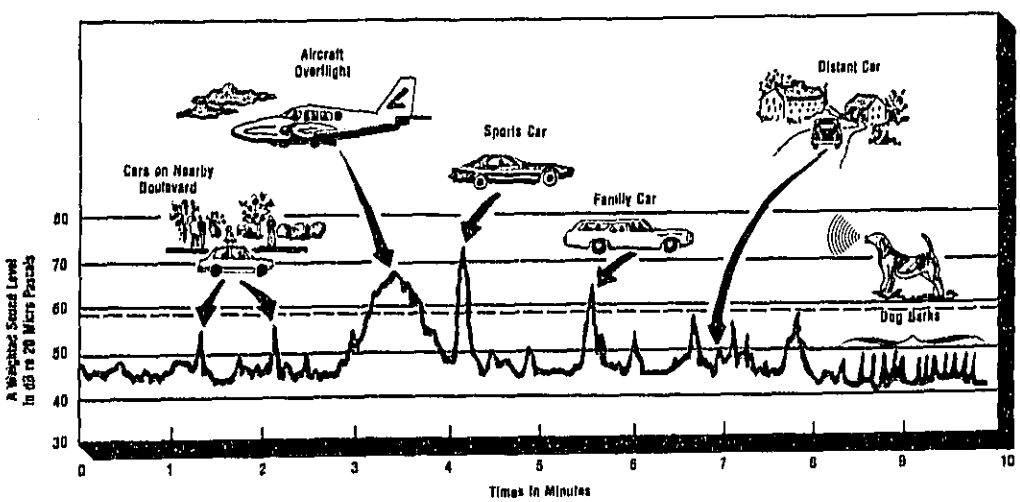
Day-Night Sound Level (L_{dn}) L_{dn} is an L_{eq} for a 24-hour period with a 10 dB penalty imposed on sound levels occuring at night (10 p.m. to 7 a.m). A typical use is for the characterization of noise in residential neighborhoods. Examples are shown in Figure 9–3.

Maximum Sound Levels Another frequently encountered measure is the maximum noise produced by a particular noise source. For example, regulatory limits on noise emissions from products are frequently specified in terms of some maximum allowable noise level, as measured at a standard distance, while the product is operated in a way that produces maximum or near-maximum noise. Obviously such levels cannot be compared meaningfully with L_{eq} or L_{dn} values.

Source: Adapted From *Protective Noise Levels*, EPA 550/9–79–100, November 1978, pp. 4–9.

∞ Figure 9–2

Typical Outdoor Sound Measured on a Quiet Suburban Street



Source: U.S. Environmental Protection Agency, *Protective Noise Levels*, EPA 550/9-79-100, November 1978.

LEVELS IDENTIFIED TO PROTECT AGAINST EFFECTS OF NOISE

EPA has identified noise levels, which, if not exceeded, should protect against some of the worst effects of noise.[30] They include:

To protect against hearing loss:	L_{eq}(24 hours) = 70dB or less (equivalent to L_{eq}(8 hours) = 75dB)
To protect against activity interference and annoyance:	L_{dn} = 55 dB or less, outdoors L_{dn} = 45 dB or less, indoors

The L_{dn} levels specified are yearly average values. These levels include a margin of safety and were derived, as directed by Congress, without considering the technical or economic feasibility of achieving them. Therefore, they should not be viewed as EPA-recommended regulatory goals, but rather as long-range environmental goals.

in people's minds. In areas not directly exposed to freeway or aircraft noise, most people think of community noise as a general din, made up of many sources rather than one or two. But of the noise sources cited by those surveyed, vehicle noise sources ranked highest, particularly motorcycles, large trucks, and cars. Table 9-1 ranks noise sources for areas with different population densities.

Although certain noise sources are perceived as more annoying than others, it is the combination and total number of sources that determine a community's noise levels. Figure 9-3 gives examples of sound levels that are roughly typical for different locations. It also shows the tremendous range of sound intensities that are compressed into the logarithmic decibel scale. Every 10 dB increase represents a tenfold increase in physical intensity[37] and approximately a doubling in loudness as perceived by people.[38]

Outdoor noise levels are a function of population density. In the medium and large cities of the nation, with populations greater than 100,000 and/or population density greater than 2,500 persons per square mile, noise is definitely of increasing public concern. Objective measures confirm that noise levels are generally higher in cities with greater population densities.

Figure 9-4 shows a mathematical (regression) line constructed from a large number of studies showing the typical correlation between outdoor noise level and population density. The scatter shows that it is not possible to predict accurately the noise levels for a particular area from the population density alone. But for a large number of areas, or the entire urban United States, it is possible to use the regression formula to estimate statistically the various local levels of noise.

Since 1970, population growth in rural counties has surpassed that of urban areas. However, the absolute numbers of people living in metropolitan areas have continued to increase.[39]

Table 9–1

Noise Sources Considered "Highly Annoying"

(In areas away from the direct impact of freeway or aircraft noise)

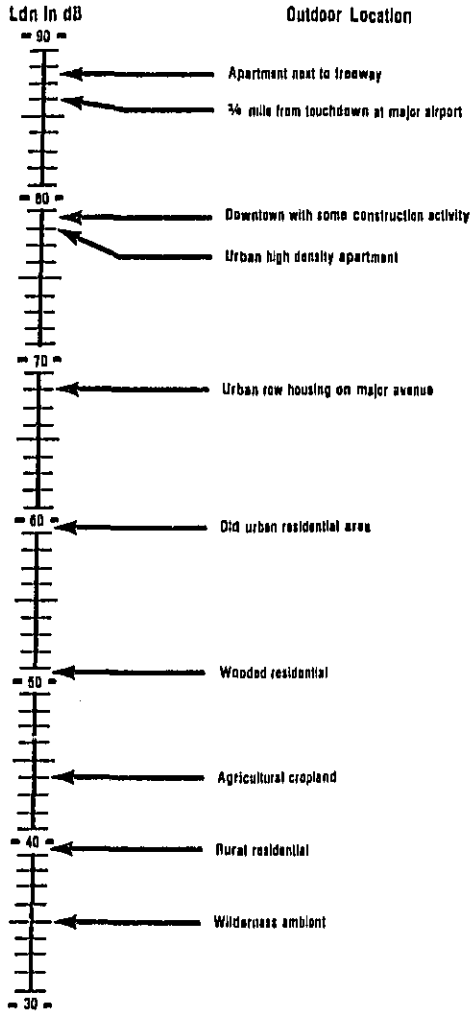
$p \leq 3{,}000$ (37%)			$3{,}000 < p < 20{,}000$ (51%)			$p \geq 20{,}000$ (12%)		
Rank	Source	%H.A.	Rank	Source	%H.A.	Rank	Source	%H.A.
1	Motorcycles	9.4	1	Motorcycles	13.2	1	Motorcycles	12.7
2	Helicopters	5.3	2	Large trucks	10.0	2	Autos	9.4
3	Autos	4.2	3	Autos	7.4	3	Large trucks	7.3
4	Construction	3.7	4	Construction	7.2	4	Construction	6.5
5	Airplanes	3.2	5	Sport cars	7.0	5	Sport cars	5.9
6	Sport cars	3.1	6	Constant traffic	5.5	6	Constant traffic	4.7
7	Large trucks	2.6	7	Small trucks	4.1	7	Buses	4.7
8	Power garden tools	1.8	8	Buses	3.5	8	Small trucks	4.1
9	Small trucks	1.5	9	Airplanes	3.4	9	Helicopters	3.9
10	Constant traffic	1.5	10	Helicopters	3.1	10	Airplanes	3.5
11	Buses	1.1	11	Power garden tools	2.1	11	Power garden tools	1.2
		55.9			62.2			66.0

p = population density in people per square mile.
% H.A. = percent of respondents highly annoyed by source.
Rank = rank order of noise sources that highly annoy respondents.

Source: U.S. Environmental Protection Agency, *The Urban Noise Survey* (Washington, D.C.: U.S. Government Printing Office, August 1977), p. 38.

Figure 9--3

Examples of Outdoor Day-Night Average Sound Levels in dB Measured at Various Locations

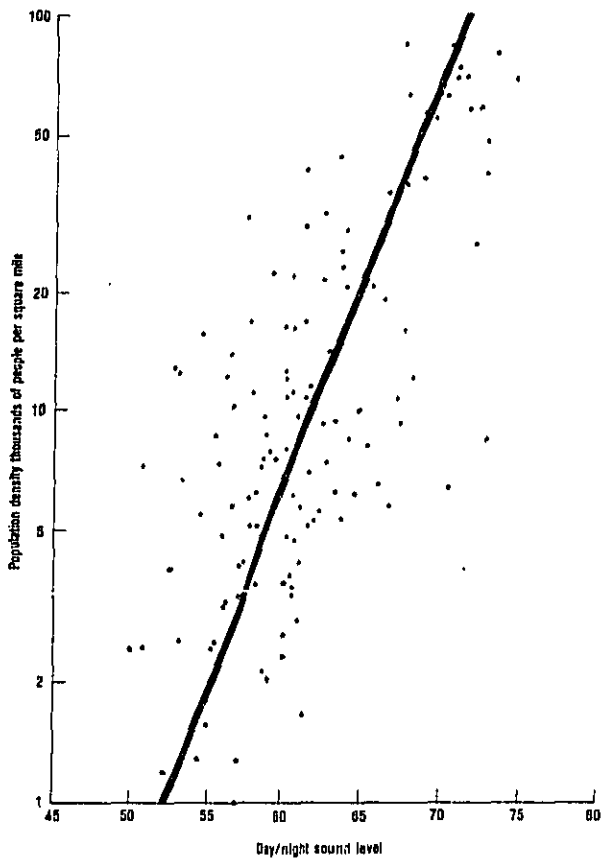


Source: U.S. Environmental Protection Agency, *Protective Noise Levels*, EPA 550/9-79-100, November 1978.

Table 9–2, based on 1970 population densities in urban areas, provides estimates of the numbers of people exposed to various levels of outdoor noise; the estimates are conservative because freeway and aircraft noise are excluded. For example, at least 93 million peo-

Figure 9–4

Day/Night Sound Level as a Function of Population Density



Source: U.S. Environmental Protection Agency, *Population Distribution of the United States as a Function of Outdoor Noise Levels*, June 1974, p. 15.

Table 9–2

Estimated Exposure of U.S. Population to Various Levels of Environmental Noise According to the Urban Noise Model

(excluding freeway and airport noise)

	Urban Only	Total Estimate (Rural Estimate Added to Urban Model)		Urban Only	Total Estimate (Rural Estimate Added to Urban Model)
L_{dn}	Millions of people exposed	Millions of people exposed	L_{dn}	Millions of people exposed	Millions of people exposed
34	134	180	59	67	67
35	134	179	60	59	59
36	134	177	61	51	51
37	133	174	62	44	44
38	133	170	63	37	37
39	132	168	64	30	30
40	131	165	65	24	24
41	130	161	66	19	19
42	129	158	67	15	15
43	128	153	68	12	12
44	126	150	69	9	9
45	124	149	70	7	7
46	122	145	71	5	5
47	120	140	72	4	4
48	118	135	73	3	3
49	116	130	74	2	2
50	113	123	75	1	1
51	110	118	76	0.889	0.889
52	107	112	77	0.559	0.559
53	103	108	78	0.332	0.332
54	99	100	79	0.187	0.187
55	93	94	80	0.093	0.093
56	88	88	81	0.039	0.039
57	81	81	82	0.012	0.012
58	74	74	83	0.002	0.002
			84	0	0

Source: W. J. Galloway, K. Mck. Eldred, M. A. Simpson, prepared for the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *Population Distribution of the U.S. as a Function of Outdoor Noise Levels*, 1974, pp. 25, 28.

ple—all in urban areas—are regularly exposed to outdoor noise levels of L_{dn} of 55 or more. At least 59 million people are exposed to levels of L_{dn} of 60 or more, and at least 7 million live in an urban environment where outdoor noise levels of L_{dn} of 70 or more are the rule.[40]

Table 9–3 shows the number of people exposed to various levels of noise (including aircraft and freeway noise) in the community, by the source of noise. Urban traffic and aircraft noise are the overwhelmingly important sources of all community noise levels for L_{dn} levels greater than 60 dB. The situation in other industrialized nations is similar, with traffic noise an even worse problem. An estimated 40 percent of the U.S. population is exposed to L_{dn} of 55 or more, versus 22 percent in Norway, 50 to 70 percent in most of Europe, and 80 percent in Japan. But aircraft noise is relatively worse in the

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Table 9–3

Number of People in the Community Exposed to Various Levels of Noise by Noise Source

(number of people in millions for each noise category)

L_{dn} (dB)	Urban Traffic	Rural Traffic	Aircraft	Rail	Agricultural	From Industrial Sites	Home Appliances
80	0.4		0.3				
75	2.0		0.8				
70	7.1	0.2	2.5				
65	21.6	1.0	7.9	0.4			
60	54.1	2.8	19.9	1.1		1.6	
55	102.1	4.8	50.0	2.4	0.1	6.3	15.0

Source: Bolt, Beranek, and Newman, Inc., prepared for U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *Noise in America* (Washington, D.C., 1978), p. 45, C-17.

United States: 13 percent of the population is exposed to L_{dn} levels greater than 55, whereas only 3 percent is exposed to those levels in Japan and Europe.[41]

As previously mentioned, an estimated 15 million Americans regularly work in potentially hazardous noisy environments. Many of these workers are becoming increasingly concerned about the health risks of working in such noisy conditions. According to an insurance industry study, noise-induced hearing loss is the occupational health hazard that affects most workers and for which financial compensation claims are greatest—nearly $200 million since 1969 for federal employees alone.[42]

TRENDS

Compensation Payments for Work-Related Hearing Loss The number of compensation payments has been escalating, especially in those industries with the noisiest machinery.[43] Although union activity and heightened worker awareness have partly influenced this trend, the claims do not yet reflect the extent of the problem. The amount of compensation that can be awarded to workers for hearing loss varies considerably depending on the state,[44] but the size of the claims is generally increasing.[45]

The number of annual hearing loss claims from federal workers alone rose from 200 in 1966 to more than 8,000 by 1975.[46] In 1977, there were more than 6,000 claims at the state level, resulting in awards of approximately $13 million. At the federal level there were approximately 2,300 claims amounting to awards of $17.6 million.[47] Most of these claims, however, are not fully compensated due to restrictive filing criteria.[48] The response of states to these claims varies considerably. Only nine states compensate almost all of the nonfederal hearing loss claims.[49] The prospect is that the number of claims and amount of awards will increase rapidly in the next 10 years. The cumulative state and federal benefits paid from 1977 to 1987 could easily

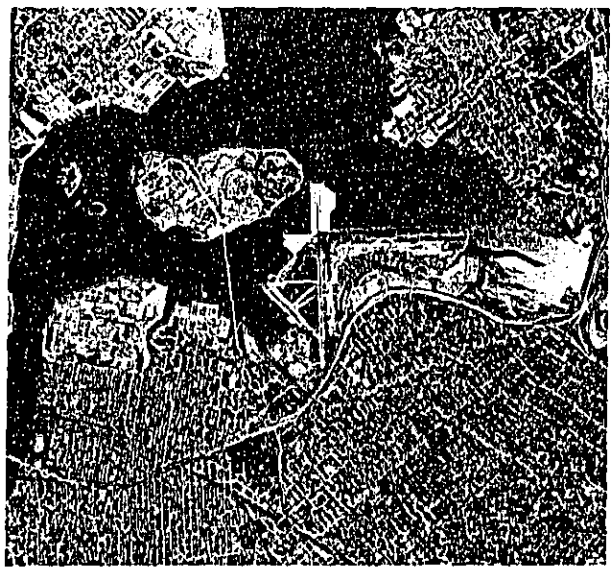
reach $0.8 billion. Given the rapid recent increase in the rate of claims, this estimate seems based on rather conservative assumptions (7 percent annual cost of living increase in benefits; 10 percent annual increase in numbers of claims).[50]

Road Traffic Noise Noise from road traffic is continuing to increase. According to the EPA's Office of Noise Abatement and Control, by the year 2000 noise levels will increase significantly and so will the number of people exposed to these levels. Even now an estimated 13.5 million people in the United States are exposed to an outdoor L_{eq} of 75 dB or greater from transportation or recreation vehicles,[51] a level sufficient to cause risk of permanent damage to hearing.[52] Even after federal noise regulations take effect, overall noise from cars, trucks, buses, and motorcycles will increase over time because of the anticipated increase in the number of vehicles.

According to one projection, the number of automobiles may increase from 84 million in 1977 to 130 million by 1985; and trucks from 17 million to 28 million.[53] Another source estimates that automobiles in use will increase by 0.6 to 0.7 percent each year through the year 2000.[54] Compounding the problem is the fact that the average levels of automobile noise are likely to go up with the increased sales of both 4-cylinder gasoline-engine and diesel-engine automobiles. These engines are noisier than the V-8 gasoline engines, which currently make up more than half the auto market.[55] The number of buses of various types (intercity buses, school buses) also is expected to continue to increase.[56] Various projections may not agree exactly on rate of growth, but they all agree that the number of noise sources is increasing.

Noise Emissions From Aircraft If current regulations controlling noise emissions from aircraft are implemented, and if special takeoff procedures are used, the land area exposed to aircraft noise L_{dn} levels of 65 or greater will decrease from 2,169 to 1,304 square miles by 1985. The number of adversely affected people is expected to decrease from about 6 million to about 3.6 million by the year 2000, although it then may grow again with increasing air traffic.[57] For those affected, aircraft noise will remain a major problem. These conclusions assume moderate growth of the airlines, i.e., a doubling of the number of planes between 1980 and 2000.

Noise From Rail Rapid Transit This is not currently an extensive problem in the United States because most cities do not now have rail transit. But for the ones that do, the noise problem can be serious. In New York City alone, an estimated 500,000 people are exposed to rapid transit noise between 85 and 100 dB inside their homes.[58] By the year 2000, 325 miles of track will be added to the existing 570 miles of rail rapid transit in the United States, and 2,000 new rapid transit cars will be added to the present fleet of 10,000. The new cars and track will be quieter than existing stock. However, many systems will be using existing noisy cars on new track or new cars on old track. In either case, without application of more noise abatement technology, noise levels will remain high.[59]



Six million people are exposed to noise levels of 65 L_{dn} or greater from U.S. airports. New York's La Guardia Airport affects one million of these people.

NOISE CONTROL AT THE LOCAL LEVEL

What can be done to control the widespread and rapidly growing problem of noise? The federal government is issuing regulations to reduce noise emissions from some of the major offenders. But, for the most part, these regulations apply only to new products and only solve part of the problem. The major impetus for successful noise reduction must be initiated and carried through at the local level, where noise problems and solutions are most apparent.

Although noise problems are often complex, many of the issues of greatest concern to the community can be solved through imaginative planning and coordination of existing resources. Communities around the country are employing a variety of measures, including in-use controls, operational restrictions, land use planning, and regulations on newly manufactured products.

SURFACE TRANSPORTATION NOISE

In-use controls apply to existing products already in use, as opposed to controls on newly manufactured products. In one case, the user or

owner is responsible for obeying the regulation; in the other, the manufacturer or seller is responsible. In early 1979, 164 local communities and 10 states had performance or in-use requirements for automobiles. These programs range from enforcement of existing local, state, or federal regulations to stringent local laws that require periodic inspection of vehicles.[60] Chicago, for example, designates two special vehicle enforcement teams to monitor motor vehicle noise from preselected sites around the city. The Department of Environmental Control has approved sites, based on measurement specifications that require a clear area within a 100-foot radius of the noise meter in order to get accurate readings. The biggest enforcement problem is being able to prove that somebody exceeded the noise limit. Improper measurement techniques can result in different readings from the same vehicle at different measurement sites because sound is reflected from buildings or other obstructions. When a violation occurs, the measurement team notifies a police car to apprehend the offender.[61]

Colorado Springs has a particularly vigorous noise control program, which focuses primarily on in-use control of motor vehicles. City patrolmen, certified as noise technicians, work chiefly on noise control, although they are qualified to perform normal police duties. A vigorous enforcement system with stringent penalties for violators, combined with the support of the community, the City Attorney's Office, and the municipal judges has resulted in a highly effective program.[62]

Area and time restrictions have also proven to be effective operational controls. Routing trucks away from residential or high traffic areas is a common measure that also applies to safety and general traffic management.[63] Both Denver and Colorado Springs restrict noisy trucks from traveling in certain areas during night and early morning hours. Chicago does not allow garbage collection at these times.

Land use restrictions and urban planning to reduce noise are proving among the most effective and cost-efficient local alternatives. However, where serious problems already exist, such as heavy traffic noise on a highway adjoining a school or hospital, noise barriers can be constructed. For instance, in Portland, Oreg., noise barriers will be built along a major street to protect nearby residents. In addition, some houses and apartments will be purchased by the city and the residents relocated to quieter areas.[64]

Advance planning for mass transit and road development should include noise control measures. Many cities are designing mall transit systems to provide quick and efficient transportation into and around the city. Buses are the predominant users of these transit malls, which concentrate bus traffic in a single corridor. When the malls are located adjacent to pedestrian malls, or in business or residential areas, high levels of noise exposure often result. Portland, Oreg. was recently faced with such a problem, and is now experimenting with retrofitting of buses to make them quieter.[65] New York City is currently designing a bus/pedestrian mall—the Broadway Plaza

Project—and is incorporating noise control into its plans. The purpose of the project is to clean up the Times Square area and to reduce vehicular noise by rerouting traffic. The bus-boarding areas will be at the edge of the mall, which features shops, restaurants, and theatres.[66]

Local governments may apply noise regulations to a wide range of newly-manufactured products. Chicago has established noise limits on newly-manufactured vehicles, construction and industrial machinery, and some equipment used in residential areas.[67] Although many state and municipal governments are currently regulating the noise levels of new products, EPA is charged with developing uniform national noise emission standards for certain products it determines are harmful to the public health and welfare. EPA is drawing on the data and experiences provided by states and localities in developing the federal regulations. EPA intends these regulations, when they go into force, to preempt all existing state and local noise emission laws that are not identical to the federal standard, which should eliminate the problems manufacturers would otherwise face with an assortment of state or local noise level requirements. State and local governments would not be preempted from imposing additional sale or in-use restrictions on the same products.

AVIATION NOISE

As airports and air traffic continue to increase, the progress made in aviation noise control will ultimately be in danger of being reversed. Aviation noise is a complex and controversial issue involving a variety of jurisdictional responsibilities, regulations, and laws. No easy solutions exist, particularly where airports are already surrounded by hundreds of thousands of people, as the pictures and Table 9-4 illustrate. However, some remedies can be achieved through effective planning and cooperation.

Table 9–4

The 10 U.S. Airports With the Largest Populations Exposed to L_{dn} of 65 or More

Airport	People Exposed to L_{dn} of 65 or More	Airport	People Exposed to L_{dn} of 65 or More
New York—La Guardia	1,057,000	Los Angeles	292,000
Chicago—O'Hare	771,000	Miami	260,000
New York—JFK	507,000	Denver	180,000
Boston—Logan	431,000	Cleveland	128,000
Newark	431,000	San Francisco	124,000

Source: U.S. Department of Transportation, *Aviation Noise Abatement Policy* (Washington, D.C.: U.S. Goverment Printing Office, 1976), p. 20.

The Federal Aviation Administration (FAA) has primary responsibility within the federal government for civil aircraft noise and has established noise emission standards for most types of nonmilitary aircraft ("newly-certificated aircraft"), as listed in greater detail later in this chapter. Despite the standards, aircraft noise will remain a major national problem in the future because of the growth in operations. Because airport noise is also a local problem, it must also be ameliorated through local actions by airport proprietors.

For airports not already located in developed areas, planning to achieve land use compatibility is an option available to local officials for containing excessive aircraft noise within the airport's boundary or in areas with compatible land uses near the airport. For instance, development at an airport can be planned to reduce the effects of future noise growth. The location of runways, terminal buildings, access roads, and other facilities influence the amount and location of future noise sources.

State and local governments and urban planning agencies can plan and control compatible land use activities near airports through zoning, and limiting the number of sewer or water approvals and building permits. Soundproofing schools, hospitals, and other buildings, and requiring insulation of apartments, homes, and public buildings near airports may be feasible alternatives, although they are less effective.[68]

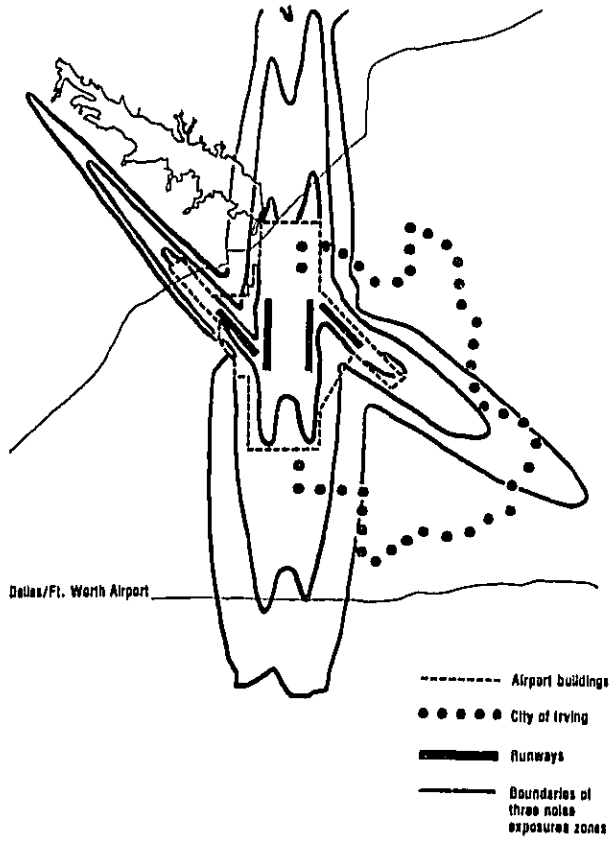
If financial resources are available, the airport and local authorities can buy adjacent land areas to insure their use for compatible purposes such as industrial or recreational development. Buying air rights or easements is another option that compensates the owners of the noise-affected land, but on a one-time basis, without eliminating noise damage.[69] Zoning is another alternative, but it is subject to change due to the pressure of urban expansion.[70]

Airport noise exposure often transcends zoning jurisdictions, causing additional problems.[71] The construction of the Dallas-Fort Worth Regional Airport is considered to be an example of successful land use planning involving multiple jurisdictions.[72] In spite of the airport's huge size and extensive buffer areas, planners determined that there would still be substantial noise exposure beyond the airport's boundary (see Figure 9-5). One of the planning strategies involved rezoning the affected area, which had originally been designated for residential development. A compatible land use study indicated that the land had high potential as an airport-related industrial park, not only because it would be compatible with the adjacent airport, but also because it would provide a higher tax base for the city. As a result of the findings, a new zoning district was written into the city's existing zoning ordinance.[73]

But, as the Dallas-Fort Worth case illustrates, these solutions are never permanent. As the area surrounding the airport is developed and land values increase, pressure builds to develop the area further. For example, the city of Irving, next to the airport, recently rezoned

Figure 9–5

Dallas-Fort Worth Regional Airport and Environs



Source: Adapted from U.S. Department of Transportation, Airport Land Use Compatibility Planning, AC 150/5050-6, 1977, Appendix 4, p. 9.

industrial areas to allow residential construction. Thus noise exposure may become a problem despite initial land use planning.[74]

Dulles International Airport, near Washington, D.C., is an example of what can happen around an airport—even a new airport with plenty of growing room—when there are no strict land use controls or accurate forecasts of projected growth in air traffic. Since 1973, pro-

jections of areas that would be affected eventually by aircraft noise were increased on several occasions.[76] These revisions put additional pressure on the 1972 policy of a nearby county to ban residential development from areas considered "generally unacceptable." The county recently modified its policy to permit new residential construction in an area expected to have noise levels by 1995 ranging from "generally unacceptable" to "intolerable," by HUD and VA standards. The new policy will prohibit residential construction only in the "intolerable" zone. In the other areas, classified as "generally unacceptable," builders will be required to install acoustical insulation in houses and to give buyers a warning.[77]

Airport proprietors have the authority to impose certain operational controls to reduce noise, such as scheduling engine run-ups at times of least annoyance or establishing landing fees based on aircraft noise characteristics or time of day. The proprietor can also make improvements in airport design, land acquisition, and other restrictions on airport use (within appropriate cost, safety, and efficiency limitations). The proprietor may take further measures, such as using preferential takeoff and landing flight tracks that avoid noise-sensitive areas, or requiring that aircraft land farther down runways away from residential areas.[77]

The Huntsville-Madison County Jetport in Alabama is a good example of combining land use and operational controls to contain aircraft noise. Although the airport was built in an open countryside essentially free of noise compatibility problems, expanding urbanization in the area led to the development of a land use plan. Operational controls were designed to keep jet aircraft away from residential areas after takeoff. Controls on new development were also established to encourage commercial and industrial uses of the areas facing heavy exposure.[78]

The Huntsville Jetport is one of approximately 600 airports certified for air carrier operations that transport passengers or cargo on federally approved routes. About 7,000 airports have no air carrier operations and are used only by general aviation traffic.[79] The general aviation airports have fewer FAA restrictions and afford more opportunity for locally initiated noise control measures.

The citizens of Torrance, Calif., encouraged various noise control measures, beginning in 1977, to abate noise from small planes. Noise contours and appropriate data were collected for several years. Data revealed that almost 98 percent of all operations remained below single-event maximum levels of 82 dB at the airport property line. This level was determined to be a reasonable limit for all aircraft operations. Furthermore, the number of operations at the airport's flying school (where student pilots practice takeoffs and landings) was restricted, thereby reducing the number of operations. A curfew with reasonable exemptions was also enacted to limit night flights. In addition, night flights had to meet a more restrictive 76 dB limit at the airport boundary.[80]

Pilots who cannot meet the 82 dB limit are sent notification letters. Most of these pilots have responded and cooperated. Because some pilots had difficulty operating their planes within the specified noise limit, a California court ruled that it would be discriminatory to impose fines for all violations. But when there are violations of the curfew or the restrictions on practice landings, fines may be imposed. Of the 28 pilots cited for violations to date, most were fined an average of $100 plus court costs. With grant assistance from the FAA, the airport is currently conducting a study to quantify the degree of noise control achieved.[81]

OTHER LOCAL GOVERNMENT ACTIVITY

In the past decade the number of local noise control ordinances has increased dramatically. In 1972 only 59 municipalities had some type of noise law. By 1977 that number had grown to 1,067.[82] Today, more than 50 percent of the U.S. municipal population lives in localities having some degree of noise legislation.[83]

Most cities and local governments use a number of tools for noise control, with varying degrees of success. Vehicular noise control, property line standards, building codes, soundproofing, site planning, zoning, public education, and noise abatement planning are several components of effective community noise control programs.

Most prevalent is the property line standard, which is designed to protect people from their neighbors' noise at the property line. These standards are relatively easy to incorporate into a municipal zoning ordinance and are generally effective. They usually apply to nonvehicular noise sources such as power plants, rail yards, factories, construction sites, or air conditioners on commercial or residential property. The majority of property line standards establish a maximum noise level that is enforced at the property boundary of the offending source.[84] They are usually enforced on a complaint basis.

Construction noise is usually regulated by restricting work activity to daytime hours, generally 7 a.m. to 6 p.m. Often specific types of equipment have maximum allowable noise levels, measured from a distance of 50 feet. EPA is proposing standards for several pieces of equipment, such as pavement breakers (or jack hammers) and rock drills,[85] which will alleviate part of the problem, especially if localities help enforce them. A federal standard limiting noise from newly manufactured portable air compressors is already in effect.[86] But source regulations will not be sufficient to contain construction site noise in many cases. Many communities will need to continue to use some form of property line standard and require noise barriers or other measures to control excessive site noise.[87]

Communities seldom use building codes for noise control, although specifications for new construction and renovation of older buildings can significantly reduce noise in the finished buildings.[88] Although the construction industry may be generally knowledgeable in noise control techniques involving building materials, this knowledge does

not always translate into action at the level of the individual worker. Also, most local jurisdictions lack personnel with knowledge of noise measurements and controls to enforce the codes.[89]

Some municipalities are establishing energy requirements for building construction that can have the added benefit of reducing noise. For example, the Housing Insulation Act in California has led to more effective building codes in the state. In San Diego, where a general review of all building plans is required, noise prevention measures have been successfully enforced.[90]

Site planning is another effective tool minimizing noise exposure of a building from some outside source. The amount of cumulative noise in an area is influenced by arrangement of buildings and structures in future development plans; distance from railroads, expressways, and industrial areas; and the type of terrain and vegetation.[91]

Despite the apparent increase in the number of noise control laws, few cities have comprehensive noise laws and even fewer have effective noise control programs. Most local noise ordinances address only a few noise problems and do not consider noise a multisource problem, with each source contributing to the total noise level. For example, there are fewer than 80 cities that have quantitative, comprehensive noise limits regulating land use, motor vehicles, and construction.[92] Most municipal officials consider noise a growing problem in the community, but may underestimate it because they rely heavily on complaints for their perception.[93] Without the support of local elected officials, community residents will not receive the benefits of comprehensive and effective noise control.

Although more cities are establishing noise control programs, there is a severe lack of funding available to implement them. Some of the largest programs, such as New York's and Chicago's, have experienced significant budget reductions.[94]

One effective program, launched and maintained on a modest annual budget of about $0.57 per capita, is the community noise control program in Salt Lake City.[95] After an unsuccessful attempt to institute a program that was too broad and unenforceable, a more specific program was developed that focused primarily on vehicular and property line standards. The city is also assisting seven neighboring communities in noise control efforts.

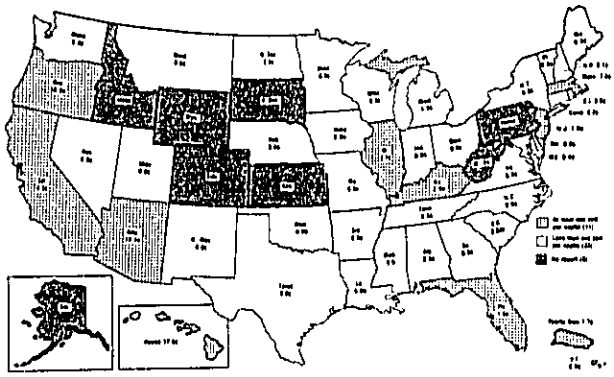
STATE NOISE PROGRAMS

State programs are also underfunded, which generally means that ordinances or other regulations cannot be implemented. In 1977, 27 states had enacted noise legislation, but only 20 states had budgets to support this legislation (see Figure 9-6). Only 11 states were spending more than $0.01 per capita per year on noise control programs.[96]

Furthermore, most of these states have provisions to regulate only one or two categories of noise sources, usually motor vehicles and recreational vehicles (particularly snowmobiles). Only four states—

Figure 9–6

State Noise Expenditures per Capita



Source: U.S. Environmental Protection Agency, *State and Local Noise Control Activities, 1977-1978*, May 1979, p. 4-17.

California, Maryland, Oregon, and Washington—have legislation regulating as many as three or four types of noise sources.[97]

Despite the limited resources available, states are in a unique position to take a leadership role in such matters as providing technical support to localities or establishing statewide regulations. Statewide regulations, such as noise limits for vehicles and land use zones, together with state assistance in implementation, provide localities with the opportunity for low-cost noise control. In California, the State Vehicle Code preempts all local vehicle noise laws and restricts the amount of noise that can be produced by both new and older vehicles. The state enforces noise controls on sales of new vehicles. Enforcement of in-use regulations is shared, with the California Highway Patrol covering state highways and localities covering the other roads. In some cases, such as regulations aimed at faulty muffler and exhaust systems, enforcement requires only an officer's professional judgment that the system has deteriorated. Palo Alto has been enforcing such a law for several years and has experienced a dramatic decrease in the number of noisy vehicles operating in the city.[98]

Illinois used California's experience with statewide vehicle regulations as a model in developing its own standards. The objective of the Illinois program was not only to reduce the general level of road noise but also to control the few vehicles emitting excessive noise. The rulemaking process included four public hearings, detailed studies of noise control alternatives, and cost estimates.[99]

The Illinois law regulates motor vehicles by weight, with an extra allowance for snow tires, so that each type of vehicle is as quiet as

practical. License plate code letters, which are based on gross vehicle weights, assist in enforcement of truck standards. Several other provisions contribute to ordinance enforcement, such as stationary testing at weighing stations and monitoring noise levels from many roadside locations.[100] The Illinois regulations require adequately maintained exhaust systems on all vehicles. Although vehicles with faulty mufflers make up only a small percentage of the total vehicle population, they are the noisiest vehicles on the road.[101]

There is much that states can do for newly-manufactured products, within the framework of federal preemption. Federal noise regulation of newly manufactured products preempts all similar state and local laws. Such uniform national regulation of major noise problems at the source is a key element in the national noise strategy. But state regulations can fill an immediate need in areas where federal involvement is several years away, and they can regulate products not covered by federal standards by demonstrating that certain levels are feasible. Some state action has influenced manufacturers so effectively that federal standards may not be needed. For example, by establishing noise limits on new snowmobiles sold within their boundaries, 14 states helped induce the snowmobile industry to adopt a 78 dB limit for *all* the newly manufactured machines, compared

After 14 states adopted noise limits for snowmobiles, the industry itself set a 78dB limit for all new machines. Several years ago, noise levels from some new snowmobiles went as high as 100dB. Photographer: Cecil W. Stoughton.

with noise levels from these machines as high as 100 dB several years ago.[102]

When federal regulations have already been issued, states are aiding the enforcement process by adopting identical standards and vigorously enforcing them. For instance, all states with in-use truck regulations have adopted the EPA-enacted Interstate Motor Carrier Regulation.[103] Because the U.S. Department of Transportation's (DOT) Federal Bureau of Motor Carrier Safety, which is responsible for enforcing the regulation, has limited resources, states and localities need to help enforce the regulations.

The Federal Aid Highway Act of 1970 requires that noise control be part of the planning and design of all federal-aid highways, or the Federal Highway Administration (FHWA) will not approve highway construction.[104] The 1973 and 1976 amendments to the act allow federal funding of noise abatement along existing highways. FHWA also requires that state highway agencies furnish localities with information on noise and land use.[105]

The construction of noise barriers is the most common noise abatement method used in the highway system today. In Minnesota, more than 50 such projects have already been approved, resulting in more than 20 miles of noise barriers. Funding for the program was initiated by an amendment to the 1975 gas tax legislation providing that 1 percent of the state's annual gas revenues would be spent on noise abatement along the interstate highway system. The federal government provided 90 percent matching funds, for a total of roughly $12 million.[106]

However, it is estimated that it would take thousands of miles of highway barriers to bring noise levels down from the 70 to 75 dB range to the 60 to 65 dB range. Furthermore, the high cost of barriers means that they should not be relied upon as a general cure for highway noise.[107]

The example of Cerritos, Calif., shows how state requirements for land use planning can help communities handle their noise problems. Three major highways are aggravating noise exposure in this rapidly growing suburban Los Angeles community. State law, which requires all communities to include noise control in comprehensive planning, has enabled this community to act forcefully in addressing the problem of highway noise. The local government, backed by strong state and public support, has endorsed stringent noise requirements for new residential construction. Through a permit process, developers are required to incorporate noise control into the architectural design, to use soundproofing construction materials and techniques, and to erect noise barriers.[108]

California has also taken the lead in the area of aviation noise, as the first state with airport noise limits. Regulations adopted under a 1969 law impose limits on total airport noise, and include a variance provision with annual hearings and renewals to insure progress toward eventual compliance.[109]

Illinois is considering a statewide noise regulation that would require airport operators to meet specified day-night average noise levels (L_{dn}) using whatever means necessary. The proposed regulation could have a significant impact on O'Hare International Airport, which might require a night curfew on flights or some form of waiver in order to comply.[110]

Maryland has recently enacted legislation to control airport noise impacts by proposing "noise zones" around its airports that would become more stringent as new, quieter aircraft are introduced. Maryland is the only state that owns its major airport, which gives it wider options in influencing the situation.[111]

Virginia has started to implement statewide land use regulations, including a provision for land use around airports. The state is providing technical assistance and devising methods to achieve compatible land use around existing airports, including Dulles.[112]

THE ROLE OF THE FEDERAL GOVERNMENT

NOISE STANDARDS FOR NEWLY MANUFACTURED PRODUCTS

The Noise Control Act of 1972 [113] directs EPA "to promote an environment for all Americans free from noise that jeopardizes their health and welfare." It specifies that EPA shall regulate new products in commerce that are "major sources of noise" and shall establish noise labeling requirements for noisy products and for products designed to reduce noise. In 1978, Congress amended this legislation with the Quiet Communities Act [114] to encourage the development of noise control programs on the community and state level. The amendments provided a necessary link and balance between the federal regulatory program and local noise control activities.

EPA began the rulemaking process by examining transportation and construction noise, the primary concerns of most local communities. The agency studied various products—such as trucks, motorcycles, and jack hammers—and considered a broad range of factors, including the absolute magnitude of the noise emitted in typical environments and whether the product is used in combination with other noisy products. EPA's principal objective was to improve the health and welfare benefits to the public by lowering noise emissions from products identified as major noise sources. This was the central theme of the 1972 Act. Also considered was the available technology and the costs to both the manufacturer and the consumer of reducing the noise levels of these products.

Since 1972, EPA has identified 10 products as major noise sources: medium and heavy trucks, motorcycles, buses, garbage trucks, wheel and crawler tractors (used in construction), portable air compressors, pavement breakers (or jack hammers), rock drills, power lawnmowers, and truck refrigeration units (see Table 9-5).

Table 9–5

Federal EPA Product Regulations (Noise Emission Limits on Newly Manufactured Products)

	1976	1977	1978	1979	1980	1981	1982	1983
Portable air compressors	F		E	E				
Medium and heavy trucks	F		E				S	
Wheel and crawler tractors		P		F*				E*
Garbage trucks (truck-mounted solid waste compactor)			P		F	E*	S*	
Buses—school			P		F*	E*		
city								
intercity								
Motorcycles				P	F*	E*		
Identified as Major Noise Sources: truck-transport refrigeration units, power lawnmowers, pavement breakers, and rock drills								
Under Consideration: light vehicles, tires, chain saws, construction equipment								

P=proposed.
F=final regulations issued.
E=rule goes into effect.
S=more stringent noise limits go into effect.
* Projected dates.

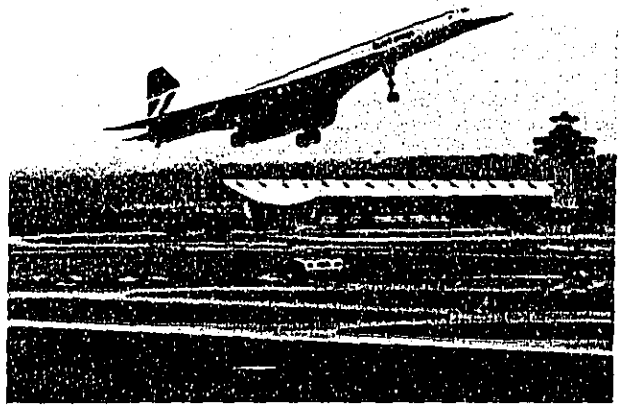
Source: U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *EPA Noise Control Program, Progress to Date* (Washington, D.C.: U.S. Government Printing Office, April 1979).

Besides standards on newly manufactured products, EPA has issued in-use regulations for locomotives and rail cars used in interstate commerce and has proposed them for other railroad equipment and facilities. These regulations are enforced by the Federal Railroad Administration of DOT.

Since 1975, interstate motor carriers also have been covered by EPA's in-use standards, which have proven effective in getting the worst noise offenders off the highways. The Bureau of Motor Carrier Safety of DOT actively enforces these standards.

FAA is responsible for issuing noise limits for new types of aircraft. The Federal Air Regulation (FAR) noise limits on new types of aircraft were established in 1969 [115] and in 1977, and now cover most types of aircraft including jet transports and propeller-driven aircraft.[116] There is also a "retrofit or replacement" rule requiring all existing subsonic jet transport aircraft to meet at least the 1969 limits by 1985. In 1979 FAA proposed noise limits for new helicopters.

An important development in 1978 was the resolution of the Concorde issue.[117] The original 16 Concordes were allowed to continue operating in the United States, although with various restrictions. The FAA did not rule on which airports they could use, but left that decision to the 13 individual airports identified in the environmental



The 16 Concordes operating in the United States at times exceed the noise levels allowed for subsonic aircraft. No more Concordes are expected to be built.

impact statement accompanying the FAA rule. Dulles (Washington, D.C.) and John F. Kennedy (New York) airports have received Concordes because they were part of FAA's original 16-month test program. The Concordes also use Dallas-Fort Worth and, in the near future, may use Atlanta. The FAA prohibited scheduling of Concorde flights to U.S. airports between 10 p.m. and 7 a.m. local time, and prohibited modifications to the aircraft that would increase their noise. FAA also issued new aircraft noise rules for all Concordes after the first 16; those rules are equivalent to the noise levels prescribed in 1969 for newly designed subsonic aircraft. The fact that only 16 of the first generation Concordes can operate in the United States limits the amount of noise impacts they can create; it will be up to local authorities to determine how the noise impacts are distributed among airports.

OCCUPATIONAL NOISE

The protection of workers from excessive noise on the job is an area of increasing public concern and controversy. The Occupational Safety and Health Administration (OSHA) is charged with developing and enforcing rules to prevent excessive noise exposure.

OSHA's mandate is that *no* employee should suffer material impairment of health or functional capacity even if the employee is regularly exposed to a hazard covered by an OSHA standard *for the period of his working life.*[118]

There has been a federal standard in effect for some time to protect workers from noise exposure. Maximum limits are a function of the exposure time. For example, an 8-hour exposure to 90 dB would constitute a maximum permissible daily exposure; so would 115 dB for 15 minutes. The level at which the standard should be set has been a matter of controversy. OSHA proposed a revised standard in 1974 that would keep 90 dB for 8 hours, but would tighten other parts of the existing regulation. This proposed revised standard has not yet been adopted. On the basis of research studies, EPA concluded that the 90 dB was not adequately protective. Under authority of the 1972 Act, EPA recommended that OSHA adopt a more stringent standard of 85 dB for 8-hour exposures, as well as a 3 dB or "equal-energy" rule instead of the present 5 dB rule for trading off duration for intensity.[119]

The economic costs associated with workplace noise regulations have been difficult to determine. One analysis has shown that U.S. industry would have to spend up to $10.5 billion to comply immediately with the 90 dB requirement and an additional $8 billion to comply with an 85 dB requirement. Substantially less would be required if the period allowed to achieve compliance were lengthened.[120]

Hearing protectors have sometimes been advocated as an all-purpose alternative to engineering controls of noise, but they are an inferior alternative. It is true that hearing protectors are by far the least expensive method for reducing noise exposure, but there are several disadvantages. The main problem is that workers resist wearing them, either because they need to hear the sounds around them for reasons of safety or communication, or because the devices are uncomfortable. In addition, their effectiveness in practice is limited. A recent study by the National Institute for Occupational Safety and Health surveyed 168 workers wearing earplugs on the job. It revealed that half of the workers tested were getting less than one-third of the decibel reduction specified by the manufacturer, either because they were using the wrong size earplugs or not inserting them properly.[121]

LABELING

For products capable of making noise that could adversely affect the public health and welfare, EPA is responsible for product labeling to provide information to the prospective user on how much noise a product generates or how well certain products, such as hearing protectors or acoustic tile, reduce noise exposure.[122]

EPA has proposed a rule for labeling hearing protectors[123] and expects to issue a final rule in 1979. The agency has developed mini-

mum standards for voluntary labeling programs that may be submitted to EPA for review and, if consistent with federal guidelines, may be adopted as an alternative to federal labeling requirements.

FEDERAL ASSISTANCE TO STATES AND LOCALITIES

Because federal standard-setting alone cannot achieve desirable community noise levels, state and local programs are an essential complement. The Noise Control Act as modified by the Quiet Communities Act provides the framework for a federal partnership with states and localities in achieving a balanced national noise control program.

One facet of this partnership is EPA's program for financial assistance to help communities launch noise control programs. This is not long-term assistance; instead it is designed to help communities identify their particular noise problems and build programs in response.[124]

Other federal agencies offering financial support for noise control include the Federal Highway Administration which, as mentioned, provides funding through states for noise barriers and other measures.[125] The FAA has an Airport Development Aid Program (ADAP) fund of approximately $500 million per year, part of which is available for land purchase and noise abatement measures around airports. As of December 1978, FAA has spent almost $22 million for noise control under this program. FAA has also given about $4 million to local airports for noise planning.[126] The Department of Defense has a program to reduce the impact of noise near its military airfields, which includes purchasing of land and easements around them. In Florida, for instance, the Navy's Cecil Field is surrounded by the city of Jacksonville. The Navy has spent $1.9 million to buy land interests for no-building zones at the end of the runways and has also encouraged compatible land use zoning by the city.[127]

HUD has a uniform policy, applicable to all forms of HUD assistance, that requires noise planning in new residential construction or in substantial rehabilitation of existing units with unacceptable noise levels.[128] The policy was updated in 1979.[129] Both VA and HUD have policies of not approving mortgage assistance for housing in excessively noisy areas.

Regional Technical Assistance Centers, provided by the Quiet Communities Act, will be established under EPA sponsorship at universities or other institutions with expertise to assist communities and states. EPA will fund at least one center through each of its regional offices.

In EPA's Each Community Helps Others (ECHO) program, communities share their experiences in noise control with other cities and towns, through community noise advisors. ECHO advisors are experienced in various aspects of noise control and serve on a volunteer basis to provide onsite assistance for particular noise problems.[130]

EPA is emphasizing the creation and strengthening of state noise control programs. States can assume much of the responsibility for providing technical assistance to communities, in the manner of the federal ECHO program.[131]

URBAN NOISE PROGRAM AND OTHER INTERAGENCY COORDINATION

One method for strengthening the national noise control effort is the coordination of federal programs. The pursuit of noise reduction can be combined with other urban improvement goals through better coordination of existing federal programs to:[132]

A quiet lawnmower, suitable for use on hospital grounds, was developed in EPA's cooperative federal-state-local "buy-quiet" program. Photographer: Bruce L. Wolfe.

- Combine soundproofing and energy "weatherization" of noise sensitive buildings, such as schools and hospitals;
- Promote quieter design in transportation projects affecting urban areas;
- Improve urban development planning so that housing will be located away from major noise sources;
- Establish "buy-quiet" programs in federal, state, and local governments to create an early market for quiet products; and
- Support neighborhood self-reliance efforts to identify and solve local noise problems.

Another opportunity for federal coordination is in noise effects research. During 1978, the Federal Agency Noise Research Panel on

SOME FEDERAL TOOLS AVAILABLE TO STATES AND COMMUNITIES

- "AICUZ" Studies—"Air installation compatible use zones." Reports have been completed on over 115 military airfields or facilities (DOD)
- *Model Noise Ordinance* (EPA)
- *Airport Noise Control and Land Use Compatibility (ANCLUC) Planning Under the Planning Grant Program*, 1977 (FAA 5900.4)
- *Airports—Land Use Compatibility Planning*, 1977 (FAA Advisory Circular 150/5050-6)
- *Community Strategy Guidelines* (EPA)
- The Federal Highway Administration methods to be used in predicting highway noise levels ("Procedures for Abatement of Highway Traffic Noise and Construction Noise," FHPM 7-7-73)
- *The Audible Landscape: A Manual for Highway Noise and Land Use* (The Federal Highway Administration guidance to localities for land-use planning near highways, reprinted 8/76)
- *Community Noise Assessment Manual* (Social Survey Workbook and Acoustical Survey Workbook) (EPA)
- ECHO Community Noise Advisors (EPA)
- Federal Highway Administration procedures for evaluating the noise reduction from barriers, elevated and depressed highway sections, and roadside structures. ("A Field Evaluation of Traffic Noise Reduction Measures," National Cooperative Highway Research Report 144)
- A one-week training course on highway noise and abatement. ("Fundamentals and Abatement of Highway Traffic Noise," Federal Highway Administration)
- *Noise Barrier Design Handbook* (Federal Highway Administration: FHWA-RD-76-58)
- Federal Highway Administration procedures for determining the acoustical insulation of planned or existing buildings against highway noise ("Insulation of Buildings Against Highway Noise," FHWA-TS-77202)
- Technical assistance from EPA Regional Offices

Noise Effects, the National Academy of Sciences Committee on Hearing and Bioacoustics, and the International Commission on the Biological Effects of Noise focused on the effects of noise on health. These groups agreed that further investigation is needed, particularly on the nonauditory effects of noise, including noise as it relates to cardiovascular disease, sleep disturbance, and reproductive effects; and interactive effects of other factors (such as chemical and physical agents) with noise.[133]

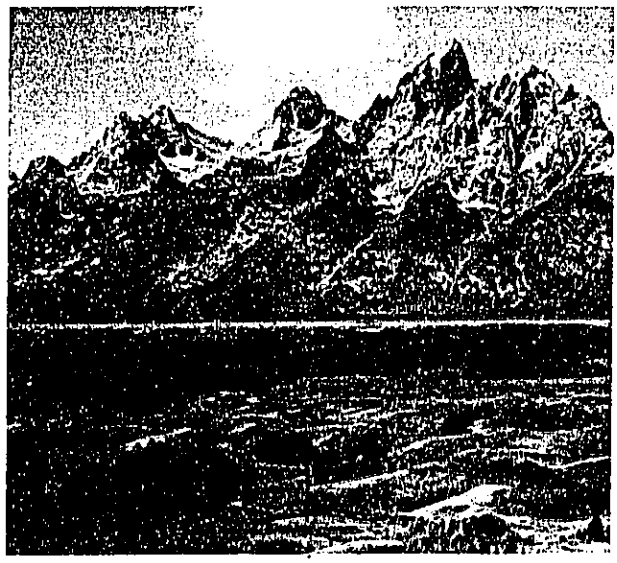
Research and demonstration projects in noise-control technology were emphasized in the 1978 Quiet Communities Act. Four interagency noise research panels have reviewed current and planned federal research, development, and demonstration programs in the areas of noise effects, surface transportation noise, machinery and construction noise, and aircraft noise. EPA concluded that the federal programs did not meet the needs for successful implementation of a national noise abatement strategy.

Research and technology demonstrations will assume an even more important role as noise levels continue to escalate. As better noise abatement technology becomes available, more stringent regulations will be practicable to attain more desirable noise levels. EPA's Quiet Heavy Truck Demonstration Program is an example of such a project. Five 1978 vehicles, representing all of the major truck and truck engine suppliers, will be modified to noise levels significantly below those required by current regulations. This demonstration program may be extended to include medium trucks and tires.[134]

QUIET IN WILDERNESS AREAS

A special issue is the preservation of lasting peace and quiet appropriate to wilderness areas where noises that would not be noticed in another environment can have a significant impact. For example, there has been a debate on the proper use of the Boundary Waters Canoe Area (BWCA) in Minnesota, where motorboats can be heard up to 2 miles away on a still night.[135] A compromise solution was reached with the passage of a federal law in 1978 that placed restrictions on the continued use of motorboats, snowmobiles, and logging equipment within the BWCA.[136] Under the law, during the next 15 to 20 years, motorboats will be restricted to using 25 percent of the BWCA instead of the present 60 percent. Use of snowmobiles will be phased out completely during a 5-year period, and logging operations, already restricted since 1972, will be halted permanently.

Wilderness quiet is also at stake in the Grand Tetons, where there have been repeated attempts to introduce commercial jet service into Jackson Hole Airport, the only airport located within the confines of a national park. Measurements there have shown that sound levels in the absence of aircraft noise are extremely low—as low as 20 dB—causing aircraft noise impacts to be greater than they would be in typical urban settings. Existing aircraft noise levels from private and commercial aircraft are already having a significant effect on the



Commercial jet service has been proposed for Jackson Hole Airport in the Grand Tetons National Park, Wyo., raising the issue of noise intrusion in national park and wilderness areas. Photographer: George A. Grant.

park's pristine values, but the introduction of the B–737 jet would increase the zone of impact still farther—from 31 square miles from existing propeller commercial service, to at least 140 square miles. The increased impact would be even greater in terms of encroachment of audible aircraft noise into areas where such noise is now inaudible.[137]

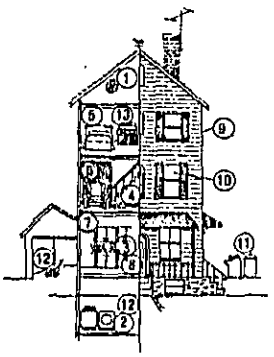
A related problem is the effect of noise on wildlife. There is evidence that noise may have adverse effects on some animal populations.[138] EPA is presently reviewing available information on this question.

PUBLIC AWARENESS AND PARTICIPATION

Public education on the national, state, and local levels is an important element of successful noise control. Citizens must be informed about the effects of noise on their health and welfare and about what they can do to minimize those effects. An EPA booklet, "Noise: A Health Problem," summarizes current information on the adverse health effects of noise.[139] The agency also distributes booklets to school children about hearing loss and how it can be avoided.

Figure 9–7

What You Can Do to Quiet Your Home and Protect Yourself From Noise



Inside

1. Install exhaust fan on rubber mounts
2. Use vibration mounts under electrical appliances like washer, dryer, and dishwasher
3. Put foam pads under blenders, mixers, and other small appliances (also your typewriter!)
4. Use wall to wall and stair carpeting with felt or rubber padding to dampen noise.
5. Use acoustical tile, spaced below ceiling
6. Install drapes to absorb sound
7. Buy quiet appliances
8. Install floor vinyl or thick linoleum to dampen sound

Outside

9. Eliminate noise leaks in walls by sealing holes or cracks
10. Caulk windows and install storm windows to cut down outside noise
11. Replace metal garbage cans with plastic ones

Protecting Your Ears

12. Wear ear protectors when you are using very noisy equipment or tools
13. Keep the stereo volume down

Source: Adapted from National Bureau of Standards Handbook 119, "Quieting—A Practical Guide to Noise Control, 1976".

The National Information Center for Quiet has been established as part of a coordinated education effort by a consortium of professional associations. The Center, located in Arlington, Va., will function as a national clearinghouse of information on noise abatement and control (see Figure 9–7) and will work with national voluntary organizations and civic groups.[110]

Public participation is also a key element of EPA's noise effort. Contributions are solicited in all phases of the rulemaking process from the public, state and local government officials, and manufacturers.

THE UNITED STATES AND ACTIVITIES IN OTHER COUNTRIES

Noise control activity has not been limited to the United States. The European countries and Japan have been very active. For example, they now regulate noise emissions at the source for a greater number of newly manufactured products than does the United States.[111] They also use most of the other approaches used here, and some different ones as well.[112] Many other countries, including the Soviet Union, also have numerous noise control regulations.[113] Major

efforts are now being made to standardize noise emission limits for new products so that they will not be a barrier to trade.[111]

CONTINUING PROBLEMS

Noise is a serious and enduring environmental problem. Surveys and national polls underscore the public's concern. Quiet is a highly valued commodity that we must take care to preserve. There are many important issues still to be resolved that demand immediate attention.

Learning more about the effects of noise on health should be high on the agenda. The evidence that suggests a link between noise and a wide range of health problems, in addition to hearing loss, suggests directions for research. Noise is suspected of contributing at least indirectly to cardiovascular disease, psychological and social problems, learning difficulties, and malfunction of a wide variety of bodily systems. These clues must be followed up, especially the possible link with cardiovascular disease.

Federal activity by itself will never be sufficient to maintain effective noise control; local resources will have to be tapped if U.S. citizens are to enjoy a quiet environment. Local noise control programs have made strides, but the task is often more complex than is at first apparent. Yet state and local officials are often lagging behind citizens in their concern about noise. The current trend is toward reduced municipal services, which may mean cutbacks in noise programs.

Although not as extensive as surface transportation noise, aircraft noise is perhaps the most acute problem outside the workplace. Reduction of aircraft noise at the source is beyond the control of local jurisdictions, but local communities and airports can still develop important noise abatement programs. There is no guarantee that future SST's will be even as quiet as today's subsonic aircraft, which are already too noisy for many of the nation's airports. However, reduction of aircraft noise is possible and essential for restoring and maintaining acceptable levels of quiet for millions of U.S. citizens.

The potential for state and local initiatives remains largely untapped and may be the deciding factor in developing effective noise control. It will be very important for states or localities to complement federal efforts by providing sale and in-use regulations for major noise sources. States can also help in such areas as offering technical support to localities or in establishing statewide regulations. They can serve as the link between federal and local efforts by insuring that federal regulations are adopted and adequately enforced and by taking a more active role in areas where local governments are unable to meet their responsibilities.

A revised OSHA occupational noise standard is needed as soon as possible to give better protection to the nation's workers. Noise is a 24-hour problem; workers do not put on a second set of ears when

they go home. Federal interagency cooperation is necessary in order to coordinate noise control programs. Better coordination of federal research is also needed. The Quiet Communities Act of 1978 re-emphasized the need for continued noise abatement technology research, including demonstration programs, to insure that future trends would not adversely affect the future environment. Yet the total amount of federal funds available for noise research has declined in recent years. Finally, low-noise areas are becoming rarer—both areas of relative quiet where people live, and areas of true quiet in remote wilderness areas. Low-noise areas should be protected so that people will have access to silence when they need it.

As the list of problems suggests, much work remains to be done on our national noise problem. Efforts to date have slowed, but not halted, the spread of noise. It is clear from the trends that the noise problem in the United States will continue to worsen unless continued federal activity is combined with expanded state and local programs for a broad national effort to control noise.

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