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NOISE POLLUTION

J. M. FOWLER AND K. E. MERVINE

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PREFACE

This is the third of a projected six Environmental Resource Packets produced under a grant from the Exxon Education Foundation. It is the first of the set of four for which prepaid orders of \$3.00 have been collected.

The first two packets of the series, "Energy and the Environment" (published January 1973, 62 pages, including a review article and 46 reviews of references) and "No Deposit, No Return: Municipal Solid Waste Management" (published April '73; 78 pages, including a review article, 69 reviews of references, and an appendix on sources) are out of print. We now have a sufficient number of additional requests to justify reprinting them. Since we have exhausted our funds for printing and mailing we must charge \$1.00 per packet for these and enclose an order form with this mailing for your convenience.

As we have become more expert at this business of packet production we have greatly broadened our search procedures and thus increased significantly the amount of material we must read, select, and review. This has delayed production of Noise Pollution well beyond our expected publication date, but as you see this is our most ambitious packet to date.

The topics chosen for the remaining three packets are:

Urban Mass Transportation

The Automobile and Air Pollution

Technological Assessment

These will be mailed to those who have ordered them as soon as they are completed.

Negotiations are currently underway which may allow us to continue the ERPP activities. We are seeking funds to do the complete revision and updating of the "Energy and the Environment" packet that the last year's explosion of information suggests. We are also hopeful of receiving EPA support for some further packets; the first two of which will cover industrial and municipal water pollution. We will hope to announce such developments in the next mailing.

We remain as always appreciative of any comments on or suggestions for improvement in this or future packets and look forward to a continuation of our mutual activities to improve the basis of environmental education.

John M. Fowler
Project Director

ACKNOWLEDGEMENTS

We want first to express our appreciation to James Hildebrand and the Columbia Law Review for their permission to reprint "Noise Pollution: An Introduction to the Problem and an Outline for Future Legal Research", the review paper which introduces this packet. Several people have been most generous in providing assistance with this packet: Patrick Cunniff, Professor of Mechanical Engineering here at Maryland who, through his position this summer at the EPA Office of Noise Abatement and Control, was able to ease our access to numerous government publications and provide much needed advice and guidance; Barbara Aleshire, Department of Transportation publications officer, who met with us to review appropriate DOT publications; Senator John Tunney, whose staff was most cooperative in providing access to various Congressional and Committee reports; and Cecilia Campbell, of the Library of Congress Congressional Research Service, who graciously provided us with numerous CRS documents. Finally, we were assisted in the preparation of this packet by two individuals new to the ERP Project: Becky Cawley, who is responsible for much of the library research work here, and LaVeme Havelka, who patiently and cheerfully prepared this manuscript for publication.

KEM

NOISE POLLUTION: AN INTRODUCTION TO THE
PROBLEM AND AN OUTLINE FOR FUTURE
LEGAL RESEARCH**

JAMES L. HILDEBRAND*

I have long held the opinion that the amount of noise which anyone can bear undisturbed stands in inverse proportion to his mental capacity, and may therefore be regarded as a pretty fair measure of it. . . . Noise is a torture to all intellectual people.¹

INTRODUCTION

Noise is one of the scourges of the modern world. It is an unwanted product of our technological civilization, and is becoming an increasingly dangerous and disturbing environmental pollutant. There is a growing public awareness and even some progress in the fight against air and water pollution, but a third jeopardy—*noise pollution*—has only recently begun to gain attention. Since the industrial revolution the daily lives of people, particularly in urban environments, have been invaded by unwanted and disruptive sounds. Traffic noise, which has been generally accepted without complaint until recently, has become intolerably noticeable. Not only is the actual number of operating motor vehicles increasing annually (an increase of 11.5 million cars and trucks in 1969 alone),² but there is also an upward trend in speed and weight, plus an almost universal adoption of the diesel engine for commercial vehicle use. However, the greatest increase in the urban noise level has been brought about by the introduction of the turbojet engine into commercial airline operation. It can be argued that the antagonism evoked by aircraft noise has stimulated a more critical public attitude toward noise in general and has drawn attention to other sources of unwanted sound which were previously tolerated. The advent of the supersonic transport (SST) is creating a global dimension to what is already a major national noise problem.

Noise has always been with us, but it has never been so obvious, so intense, so varied, and so pervasive as it is today. Background noise³ has increased at a rate of one decibel⁴ a year on the A scale (a scale devised to

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The author is currently editing a selection of essays to be published in book form under the title *NOISE POLLUTION AND THE LAW* (J. Hildebrand ed.). All rights of future publication of this article are reserved by the author.

1. A. SCHOPENHAUER, *On Noise*, in 2 *THE WORLD AS WILL AND IDEA* 199 (H. Haldane & J. Kemp trans. 1844).

2. N.Y. Times, Jan. 11, 1970, § 12, at 18, col. 3. This figure is predicted to increase to 15 million annually by the end of the 1970's. *Id.* There are over 99.9 million motor vehicles in the United States today. See N.Y. Times, Apr. 26, 1970, § 1, at 22, col. 1.

3. See notes 28-31 and accompanying text *infra*.

4. The decibel is a unit measure of sound intensity and is calculated from the level at which sound becomes audible to the human ear. One decibel represents the lowest

give greater weight to high-pitched sounds, which are more annoying to the human ear than low-pitched sounds). If this increase continues at the same rate for the next 30 years as it has for the last 30, it could become lethal.⁶ Since the intensity of sounds doubles with every six decibels, it will take only six years to double the loudness of city noise. "The strength of the general noise background in some of our communities is now four times what it was in 1956, and 32 times what it was in 1938."⁶

Noise may affect one's health in subtle ways—both psychologically and physiologically. Dr. Samuel Rosen, clinical professor of otology (the science of the ear) at Mount Sinai School of Medicine and consulting ear surgeon at Mount Sinai Hospital in New York City, recently stated: "At an unexpected or unwanted noise, the pupils dilate, skin pales, mucous membranes dry; there are intestinal spasms and the adrenals explode secretions. The biological organism, in a word, is disturbed."⁷ Noise also causes a loss of nervous energy to the detriment of the health and well-being of the individual.

Moreover, noise pollution may be a major factor in creating individual cognitive dissonance as well as mass societal neuroses. As the noise level increases, man like other animals becomes more irritable and more prone to irrational and neurotic behavior.⁸ An interesting correlation might be made between our nation's increasing crime rate and increasing urban noise level. The problem has also become an economic one. The World Health Organization estimates that lowered efficiency and increased errors caused by noisy working environments result in a loss of \$4 billion per year to American industry.⁹ In 1961 a *Time* estimate placed the cost of noise to American

audible sound and each additional decibel represents a tenfold increase in volume. For a discussion of the physical properties and the measurement of sound see A. PETERSON & E. GROSS, JR., *HANDBOOK OF NOISE MEASUREMENT* (5th ed. 1963); W. BURNS, *NOISE AND MAN* 10-51 (1968); A. BELL, *NOISE: AN OCCUPATIONAL HAZARD AND PUBLIC NUISANCE* 58-61 (1966). The decibel measurement, however, cannot measure either the subjective impression of noise perceived or the degree of mental disturbance caused. For example, the 50 decibel change of intensity between the rustling of leaves and the sound of people talking is far less noticeable than the next 50 decibel increase from the sound of people talking to the roar of a jet plane. See generally notes 85-89 and accompanying text *infra*.

5. *Noises Takes Toll, Says Experts*, *TODAY'S HEALTH*, Oct. 1967, at 87, col. 1; see also Conn., *Our Noise*, *AMERICAN LEGION MAGAZINE*, Feb. 1968, at 30; Bailey, *The Sound of Madness: "Noise is a Slow Agent of Death,"* *N.Y. Times*, Nov. 23, 1969, § 6 (Magazine), at 46.

6. Conn. *supra* note 5, at 30. Many noise levels encountered in urban areas today exceed standards found injurious in industry. Dougherty & Welsh, *Community Noise and Hearing Loss*, 275 *NEW ENGLAND J. MEDICINE* 759 (1966); See DEP'T HOUSING AND URBAN DEVELOPMENT, *Noise in Urban and Suburban Areas*, *TECHNICAL STUDIES PROGRAM OF FEDERAL HOUSING ADMINISTRATION* (1969); Ostergaard & Donley, *Background Noise Levels in Suburban Communities*, 36 *J. ACOUST. SOC. AM.* 409 (1964); STEVENS, *Community Noise and City Planning*, in *HANDBOOK ON NOISE CONTROL* 35-1 (D. Harris ed. 1957).

7. *Noises Takes Toll, Say Experts*, *TODAY'S HEALTH*, Oct. 1967, at 87, col. 1.

8. See notes 28-49 and accompanying text *infra*.

9. Mecklin, *It's Time to Turn Down All That Noise*, *FORTUNE*, Oct. 1969, at 133. For a discussion of one company's early attempts at combating industrial noise, see Scholtz, *Combating the Traumatic Effects of Industrial Noise*, 7 *CLEV.-MAR. L. REV.* 260 (1958). See also Miller, *Case Histories of Machine and Shop Quieting*, in *NOISE*

industry—for compensation, lost hours, and decreased efficiency—at \$2 million a day.¹⁰

The present state of affairs leaves little room for man to be sanguine. But how did we get into such a situation? The primary reason is the same as in other areas of environmental pollution—social and legal measures were not taken to prevent it, and for the failure to act in time the public authorities bear the major responsibility. The increase in noise has been accepted as a natural process, as a price to be paid for our technological progress. Law, justice, and public authorities all have capitulated to technology.

Yet, it is perhaps unfair to make modern technology the scapegoat of all our social and ecological ills. The pessimistic attitude—that technology has become an end in itself, that it subjects man to its demands rather than serves human needs, that it is inherently destructive of personal freedom, and that it will make the world totally uninhabitable or at least deprive it of all hope and beauty—is based upon a vast oversimplification. The converse—that technology is a universal solvent which has not only liberated Western man from the bondage of poverty and disease but will assure global prosperity and universal happiness for future generations if only applied vigorously—is likewise simplistic.¹¹ There is a more rational and balanced attitude somewhere between the two extremes:

Between these two extremes lies the view of those who recognize that benefit and injury alike may flow from technology, which, after all, is nothing more than a systematic way of altering the environment. They recognize that the quality of life has been greatly improved by technological advance and would deteriorate rapidly in a period of technological stagnation; that a technological culture, already adopted by one third of the human race and eagerly sought by much of the remaining two thirds, could be abandoned only at the cost of relegating hundreds of millions of human beings to suffering and death. The choice, from this perspective, is not between the abandonment of technology as a tool of human aspiration and the uncontrolled pursuit of technology as though more tools invariably meant a better life. *The choice, rather, is between technological advance that proceeds without adequate consideration of its consequences and technological change that is influenced by a deeper concern for the interaction between man's tools and the human environment in which they do their work.*¹²

REDUCTION, 571-98 (L. Beranek ed. 1960); Karplus & Bonvallet, *A Noise Survey of Manufacturing Industries*, 14 AM. INDUS. HYG. ASS'N Q. 235 (1953).

10. TIME, Jan. 2, 1961, at 29.

11. HOUSE COMM. ON SCIENCE AND ASTRONAUTICS, TECHNOLOGY: PROCESSES OF ASSESSMENT AND CHOICE, REPORT OF THE NATIONAL ACADEMY OF SCIENCES 2 (July 1969). For a discussion of these and other oversimplified views about technology, see Mesthene, *The Role of Technology in Society: Some General Implications of the Program's Research*, in HARVARD UNIVERSITY PROGRAM ON TECHNOLOGY AND SOCIETY, FOURTH ANNUAL REPORT 1967-1968, at 41-43 (1968). See generally E. MESTHENE, TECHNOLOGICAL CHANGE: ITS IMPACT ON MAN AND SOCIETY (1970).

12. TECHNOLOGY: PROCESSES OF ASSESSMENT AND CHOICE, *supra* note 11, at 2-3.

The stimulus necessary to provoke such a deeper concern for man's environment is often lethal. When air and water pollution was shown actually to kill people, there was action. Fortunately or unfortunately, a direct cause and effect relationship between excessive noise and death cannot yet be shown.¹³ However, the bell that is tolling is a loud one, and it is getting louder. If complete environmental deterioration is to be avoided, we must view the world, in Barbara Word's terminology, as a *spaceship Earth* which is capable of carrying only so much cargo and whose environmental level must be qualitatively maintained.¹⁴

Existing legal remedies have proved grossly inadequate to meet the expanding needs for effective noise control. Common law nuisance remedies and outdated municipal noise ordinances are not sufficient to protect individual rights and public health and safety from the damages caused by noise pollution. Even recent legislation, embodying modern scientific audiometric concepts, has had only limited success. Ultimately, the quieting process will not gain impetus until individual outlooks are changed. We must first realize that noise is not just an unpleasant annoyance, which must be endured as part of the price of progress. Once individuals realize that unwanted noise is a threat to health, not too dissimilar from air or water pollution, and that determined efforts are needed to keep it within reasonable bounds, then market pressures can be brought on manufacturers of noise-producing items and public pressure can become an effective catalyst for securing particularized legal regulation of specific noise-producing sources.

The purpose of this article is to provide an introduction to the practical problems surrounding noise as an environmental pollutant. The continuing deterioration of man's habitat demands a reevaluation of the present approaches to ecomanagement,¹⁵ and it is hoped that the discussion of the physiological, behavioral and psychological effects on the physical and mental well-being of our society and its members will emphasize the current need for legislative as well as judicial regulation. The article will also discuss the various sources of noise pollution and what can be done to ameliorate their disruptive influences. Finally, an outline for future legal research to meet the needs of

13. It is rumored, however, that the latest exotic weapon for military use in Vietnam is a siren capable of emitting 200 decibels—a sound intense enough to literally "boil" the inner ear. Dreher, *It's Getting Noisier*, THE NATION, Sept. 18, 1967, at 238-39.

14. In the last few decades, mankind has been overcome by the most fateful change in its entire history. Modern science and technology have created so close a network of communication, transport, economic interdependence—and potential nuclear destruction—that planet earth, on its journey through infinity, has acquired the intimacy, the fellowship, and the vulnerability of a spaceship.

B. WARD, *SPACESHIP EARTH* vii (1966).

15. Ecology is the science of the relations between organisms and their environment. Ecomanagement can be defined as the public management of all natural resources, including space and air. See J. MAYDA, *ENVIRONMENT AND RESOURCES: FROM CONSERVATION TO ECOMANAGEMENT* (1968).

planned and rational ecomanagement in the area of noise pollution will be suggested.

I. THE EFFECTS OF NOISE POLLUTION

As in other areas of environmental pollution, the adverse effects of noise pollution are multivariate and interrelated. While it can be shown empirically that exposure to excessive noise causes loss of hearing, it is more difficult to show the subjective effects of noise on individual and societal mental well-being. Man's ability to adapt to the deterioration of his environment further complicates attempts to measure the effects of noise pollution in any objective fashion. "It is possible to become 'acclimatized' to some noises, although only to the extent that one may become less aware of their subjective effects. However, the reverse may also occur and the noise become more noticeable."¹⁶ For simplification, this discussion will divide the effects of noise pollution on the human organism into physiological effects—including hearing loss, occupational deafness, and noise-induced diseases—and psychological and behavioral effects—including annoyance, speech interference, fatigue, psychosomatic disorders, tension-related diseases, sleep interference, and mental illness. The effects of infrasound and ultrasound and the effects of noise pollution on other animals and on our nation's wilderness areas will then be discussed.

A. *Physiological Effects*

The most severe and noticeable effect of exposure to excessive noise is loss or impairment of hearing. In the United States alone, 11 million adults and 3 million children suffer some form of hearing loss.¹⁷ Airborne sound is

16. A. BELL, *supra* note 4, at 33.

17. Brower, *Noise Pollution: A Growing Menace*, SATURDAY REVIEW, May 27, 1967, at 17. There are several types of deafness: (1) nerve deafness, sometimes called inner-ear, perceptive, or neurosensory deafness, in which noise is the usual cause; (2) conductive hearing loss, in which there is interference with the conduction of sound to the inner-ear; (3) additive or mixed hearing losses due to a combination of the above; and (4) functional deafness, which is due to psychological factors or to malingering. A. BELL, *supra* note 4, at 22. See generally J. BALLANTYNE, DEAFNESS (1960); H. DAVIS & S. SILVERMAN, HEARING AND DEAFNESS (1961). On the mechanism of hearing, see T. LITTER, THE PHYSICS OF THE EAR (1965); I. WHITFIELD, THE AUDITORY PATHWAY (1967); A. GLORIG, NOISE AND YOUR EAR (1958).

Until recently it was generally thought to be a physiological effect of aging that the ability to hear high tones gradually diminishes starting at about age 32 for men and age 37 for women. However, it is now believed by some doctors, including Dr. Samuel Rosen, consulting ear surgeon and clinical professor of otology at New York's Mount Sinai Hospital, that this hearing change, called presbycusis, is not a natural hearing loss but rather is caused by the general noise level in our society. See Rosen, *Presbycusis: Study of a Relatively Noise-free Population of the Sudan*, 71 ANNALS OF OTOLARYNGOLOGY & LARYNGOLOGY 727 (1962); Rosen, *Hearing Studies in Selected Urban-Rural Populations*, 29 TRANSACTIONS OF THE N.Y. ACADEMY OF SCIENCES 9 (1966). Of course, it is possible that factors other than noise cause a loss of hearing which correlates with age in Western society. Dr. Roy Sullivan has suggested that atherosclerosis and hypertension are two other possible factors, and he warns that Dr. Rosen's findings should be interpreted "with caution, in light of cultural, hereditary, diet and other environmental differences between the [Sudan and Western] societies." 113 Cong. Rec. H670 (daily ed. Jan. 26, 1967). See generally A. BELL, *supra* note 4, 41-43; W. BURNS, *supra* note 4, at 17-18.

a variation in normal atmospheric pressure,¹⁸ and the response of the ear is proportional to such pressure. There are numerous ways that noise can damage hearing. The most common effect of excessive noise on hearing is nerve deafness, which occurs when noises damage the hearing mechanism to a point where the sensory nerve function is depressed. In the process of hearing, sound waves are transmitted to the inner ear's cochlea, a shell-like chamber which is lined with hair-like sensors. Sounds are analyzed by the ear in this chamber. Prolonged exposure to excessive noise can cause marked changes in the cells of the hair-like sensors, causing a hearing loss which may be permanent.¹⁹ A more exceptional hearing damage, called acoustic trauma, or blast trauma, is caused when a sudden burst of noise, such as gunfire, ruptures the eardrum or disrupts the chain of small bones that transmit the sound within the ear to the auditory nerve. Explosive noise may also affect the inner ear, producing cochlear damage and permanent nerve deafness.²⁰

Not only the intensity of noise but such factors as duration of exposure, distance from the source, and frequency must be considered when assessing the probability of both correctable and irreparable hearing damage. Obviously, the longer the exposure the greater the damage. The intensity of sound diminishes over distance, with a progressively greater reduction as the frequency increases. Moreover, higher frequency sounds, such as that created by a turbo-prop airplane, are more disagreeable and dangerous than those of lower frequencies.²¹

18. A. PETERSON & E. GROSS, JR., *supra* note 4, at 3. Sound can be defined as a mechanical disturbance or an oscillation in pressure, stress, particle displacement, particle velocity, etc., propagated in an elastic medium, of such character as to be capable of exciting the sensation of hearing. By extension, the term sound is sometimes applied to any disturbance, irrespective of frequency, which may be propagated as a wave motion in an elastic medium. The medium in which the source exists is often indicated by an appropriate adjective, e.g., airborne, waterborne, structureborne. Sound can also be defined as the sensation of hearing excited by mechanical disturbance. Disturbances of frequency too high to be capable of exciting the sensation of hearing are described as ultrasonic. Hypersonics is the name given to ultrasonic disturbances in a medium, whose wavelength is comparable with the inter-molecular spacing. Disturbances of frequency too low to be capable of exciting the sensation of hearing are described as infrasonic. *See id.* at 213; BRITISH STANDARDS INSTITUTION, BS661, GLOSSARY OF ACOUSTICAL TERMS (1969). For a discussion of the physical properties of sound, see W. BURNS, *supra* note 4, at 10-51; W. HALL & O. MATTHEWS, SOUND (2d ed. 1965); L. KINSLER & A. FREY, FUNDAMENTALS OF ACOUSTICS (1962); R. STEPHENS & A. BATE, ACOUSTICS AND VIBRATIONAL PHYSICS (1966).

19. *See* W. BURNS, *supra* note 4, at 69; Brower, *supra* note 17, at 17; discussion in note 21 *infra*.

20. Lehmann, *Noise and Health*, UNESCO COURIER, July 1967, at 26.

21. *Id.*

Two physicians, Dr. John D. Dougherty of the Harvard School of Public Health and Dr. Oliver I. Welsh, chief of the Audiology Unit of the Veterans Administration Outpatient Clinic in Boston, made a study of loss of hearing in the high frequencies. Their report was published in the New England Journal of Medicine [Vol. 275, No. 14, Oct. 6, 1966, at 759]. In the process of hearing, they explained, sound waves are transmitted to the inner ear's cochlea, a shell-like chamber which is lined with hairlike sensors. High-frequency sounds are analyzed by the ear at the front of this chamber, while the low-frequency sounds are dealt with all along the path of the inner cochlea. Consequently, there is persistent wear in that one small area where the high-frequency sounds impinge; this area wears out first. The two physicians also noted marked tissue changes in the hair cells during noise exposure. According to Dr. Dougherty, "the hair

Loss or partial impairment of hearing is not the only physical damage that can be caused to the human organism by noise pollution. There is a growing concern that other serious physical difficulties may be caused or aggravated by the increasing noise in the urban environment.²² At a recent meeting of the American Association for the Advancement of Science, it was asserted by Dr. Lester W. Sontag that the human fetus may be damaged by noise pollution either directly by such violent noise as sonic booms, or indirectly by the mother's psycho-physiological reaction to excessive noise.²³ On the adult level, physicians have reported a causal relationship between exposure to excessive noise over a period of time and the incidence of heart disease and cardiovascular dysfunction,²⁴ migraine headaches, gastrointestinal disorders, and allergies, as well as endocrine and metabolic effects.²⁵ A recent report by the Federal Council for Science and Technology has stated that "[i]ncreasing numbers of competent investigators believe that [prolonged exposure to intense noise] may adversely affect other organic, sensory and physiologic functions of the human body."²⁶ Dr. Vern O. Knudsen, a physicist, a founder of the Acoustical Society of America, and former Chancellor of the University of California, did not overstate the problems when he said: "Noise is a slow agent of death."²⁷

B. Psychological and Behavioral Effects

Noise can be defined simply as one or a group of loud, harsh, nonharmonious sounds or vibrations that are unpleasant and irritating to the ear.²⁸

cells regenerate themselves after noise exposure; but after long-term exposure, it is entirely likely that they will wear out altogether."

Brower, *supra* note 17, at 17.

22. See, e.g., *Hearings on Noise: Its Effect on Man and Machine, Before the Special Investigating Subcomm. of the House Comm. on Science and Astronautics, 86th Cong., 2d Sess. (Aug. 23-25, 1960)* [hereinafter cited as *Hearings on Noise*]; AMERICAN ASS'N FOR THE ADVANCEMENT OF SCIENCE, *Symposium: Physiological Effects of Audible Sound*, Boston, Mass., Dec. 28-29, 1969 [hereinafter cited as AAAS Symposium], discussed in Welch, *Physiological Effects of Audible Sound*, 166 SCIENCE 533 (1969); N.Y. Times, Dec. 29, 1969, at 1, cols. 4-5. The papers presented at the AAAS Symposium are scheduled to be published later this year by the Plenum Press.

23. Sontag, *Effects of Noise During Pregnancy Upon Foetal and Subsequent Adult Behavior*, at AAAS Symposium, *supra* note 22, discussed in N.Y. Times, Dec. 29, 1969, at 1, cols. 4-5, and 25, col. 2.

24. Rosen, *Noise, Hearing and Cardiovascular Function*, at AAAS Symposium, *supra* note 22; Rosen, *Hearing Loss and Coronary Heart Disease*, 82 ARCHIVES OF OTOLARYNGOLOGY 236 (1965); Rosen, *Relation of Hearing Loss to Cardiovascular Disease*, TRANSACTIONS AM. ACAD. OPHTHALMOLOGY AND OTOLARYNGOLOGY 433 (1964). See also N.Y. Times, Mar. 19, 1967, § 1, at 42, col. 1 (report of Dr. Samuel Rosen at Conference on Noise Control, New York); Ragon, *Impact*, WORLD HEALTH, Feb.-Mar. 1966, at 26-28.

25. N.Y. Times, June 23, 1967, at 22, col. 2 (report of Professor Lee E. Farr to American Medical Ass'n Convention); Blum, *Noise: How Much Can We Take?*, McCALLS, Jan. 1967, at 113. See generally AAAS Symposium, *supra* note 24.

26. REPORT OF THE COMM. ON ENVIRONMENTAL QUALITY OF THE FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY, *NOISE: SOUND WITHOUT VALUE* 3 (1968) [hereinafter cited as *NOISE: SOUND WITHOUT VALUE*], discussed in N.Y. Times, Nov. 10, 1968 at 42, col. 1.

27. Quoted in Bailey, *supra* note 5, at 131.

28. Noise is any undesired sound. By extension, noise is any unwanted disturbance within a useful frequency band, such as undesired electric waves in any

"Whether a sound becomes noise—whether it is wanted or unwanted—whether it is injurious—in many instances is all in the point of view."²⁹ The degree of annoyance is not necessarily related to the intensity of the sound; it may often be influenced by subjective factors, such as familiarity and personal attitudes. Very loud music may still be considered beautiful by an appreciative listener,³⁰ whereas even minute scratching and extremely weak sounds can be a disturbing noise. Since annoyance is largely an individual response, and varies with persons and situations, it can be said that what makes a sound a noise is a matter of *psychology* rather than acoustics.

A sound which we associate with something pleasurable is far less likely to be considered as a noise than one with unwelcome connotations. We always tend to underrate the noise of our own car, for example, and the children next door always seem to make more noise than our own. So whether a sound is regarded as a noise and how noisy it is depends also on who causes the noise and his relationship with the person who hears it.³¹

In determining whether a sound is a noise, mental attitude and environment are of major importance,³² and it is interesting to note that groups of people with different backgrounds of work experience have differing annoyance thresholds.³³

As in other areas of psychological and behavioral reaction, there is no objective method of measuring annoyance as such. By asking a sufficient number of people about their reactions to noises, it is possible to obtain some

transmission channel or device Noise is an erratic, intermittent, or statistically random oscillation If ambiguity exists as to the nature of the noise, a phrase such as "acoustic noise" or "electric noise" should be used Since the above definitions are not mutually exclusive, it is usually necessary to depend upon context for the distinction.

A. PETERSON & E. GROSS, JR., *supra* note 4, at 210.
29. AMERICAN MEDICAL ASS'N, *Noise and Its Health Effects*, HUMAN DEVELOPMENTS IN ACTION, May-June 1967, at 23.

We shall apply the term noise to describe sounds which are unwanted and possibly also loud and objectionable. The criteria are thus subjective. The very nature of these definitions presupposes a very wide range of reactions by different people to the same sound, but if the sound is sufficiently loud or long-lasting, or both, or if it has some peculiarity in quality or time pattern, it will be found disagreeable by some people. By and large the louder the noise the greater the number of people who will find it objectionable; with certain noises, a larger proportion of those exposed will be likely to object strongly.

W. BURNS, *supra* note 4, at 7-8.

30. Even desired sound can be damaging, whether you call it noise or not: In Melbourne, Australia, noise researcher R. F. Burton set out to discover why he was noticing "tender ear" in two or three percent of teen-agers. He went to a rock'n roll teenage dance and clocked 114 decibels of sound, a dangerously high level for the ear to tolerate. He came away predicting that many teen-agers who subject themselves to this wanted noise will lose their hearing earlier in life than usual, and many will be deaf at 40.

Conn, *supra* note 5, at 32. See also *Medicine, Going Deaf from Rock'n'Roll*, TIME, AUG. 9, 1968, at 47; *Not Exactly Music to Your Ears: High Sound Levels of Rock-and-Roll Music*, CONSUMERS REPORT, July 1968, at 349; *Rock Physically Unsound*, SCIENCE DIGEST, June 1968, at 67.

31. Lehmann, *supra* note 20, at 26.

32. A. BELL, *supra* note 4, at 33.

33. See Kryter, *Noise Control Criteria For Buildings*, 3 NOISE CONTROL, Nov. 1957, at 14; *Noise: Sound Without Value*, *supra* note 26, at 2.

indication of the general degree of annoyance or distress. On the statistical basis of replies to specific questions concerning annoyance caused by noise, "together with a knowledge of the relevant noise environment, some quantitative indication of the way in which noise interferes with people's lives can be obtained."³⁴ It can be generally said that the louder the noise and the higher the pitch of its components, the greater the annoyance is likely to be; other factors are the characteristics of the sound and the modulation of loudness and pitch.

Another behaviorally disruptive effect of noise is its interference with speech communication. This is probably the best understood of the non-auditory effects of noise. This aspect of noise pollution is important for industry where the ability to communicate by speech is vital, and its interference may cause inconvenience, disruption of work, inefficiency, and accidents. The consonants convey most of the information content of speech, and because they are articulated in higher frequencies and are weaker in intensity than the vowels, they are more readily drowned out by other noises.³⁵ The interference with speech communication caused by noise is basically a masking process.³⁶ Background noises increase an individual's threshold of hearing, and the extent to which the hearing threshold is increased is called the speech interference level and can be expressed in decibels. "Discontinuous or impulsive noises often produce less interference than expected because speech that is partly masked may be complemented by interpolation or gesture to make good the gaps in what is actually heard."³⁷ The necessity to talk loudly or the extra effort caused by misunderstandings due to speech interference may cause fatigue. However, because of differing individual reactions it is not easy to prove that employees become more tired working in noisy surroundings than in quiet ones.³⁸

34. W. BURNS, *supra* note 4, at 101.

35. See Grimm, *Perception of Segments of English-Spoken Consonant-Vowel Syllables*, 40 J. Acoust. Soc. Am. 1454 (1966); Fairbanks & Miron, *Effects of Vocal Effort Upon the Consonant-Vowel Ratio Within the Syllable*, 29 J. Acoust. Soc. Am. 621 (1957); Kryter, Williams & Green, *Auditory Acuity and the Perception of Speech*, 34 J. Acoust. Soc. Am. 1217 (1962).

36. See Webster, *Speech Communications as Limited by Ambient Noise*, 37 J. Acoust. Soc. Am. 692 (1965). For a discussion of masking, see note 52 *infra*.

37. A. BELL, *supra* note 4, at 31. For a discussion of non-verbal communication, see Rosenthal, *Unintended Communication of Interpersonal Expectations*, 10 AMERICAN BEHAVIORAL SCIENTIST 24 (Apr. 1967); *Communication: What's in a Glance?*, TIME, Oct. 17, 1969, at 74; N.Y. Times, Sept. 28, 1969, ¶ 1, at 53, col. 1. See also Bacon, *The Man Who Reads Nature's Secret Signals*, NATIONAL WILDLIFE, Feb.-Mar. 1969, at 4.

38. A. BELL, *supra* note 4, at 35, citing Pugh, *Noise—Noxious or Nice*, 15 AM. INDUSTR. HYG. ASS'N Q. 127 (1954). Similarly, the claim that noisy working environments cause a loss of employee morale is a matter difficult to assess objectively. "In general, morale is related more to the degree of ego involvement in one's work than to noise levels or other disturbing conditions." A. BELL, *supra* note 4, at 35, citing Felton & Spencer, *Morale of Workers Exposed to High Levels of Occupational Noise*, 22 AM. INDUSTR. HYG. ASS'N Q. 136 (1961). Because of psychological considerations, often resulting from the participation of employees in noise-effect investigations, employee work performance may improve temporarily under simulated noisy conditions. See discussion and citations in A. BELL, *supra* note 4, at 34.

Psychiatrists and psychologists have recently noted the connection between excessive undesired noise and mental disorders. Drs. Rosen and Knudsen suggest that loss of hearing may in fact be the *least* serious impairment to the human organism caused by noise pollution. Both of these doctors point out that one no longer has to work in a boiler factory to suffer noise-induced psychological and physiological damage. Day and night most of us are exposed to a general racket. These noises are now being recognized as a major factor in the celebrated "tensions" of modern living; they contribute and aggravate all of the tension-related diseases—from stomach ulcers, neuroses, and mental illness to allergies and cardiovascular and circulatory diseases.³⁹

Dr. Knudsen calls the total effect of the background roar of modern life "*decibel fatigue*," and says that millions of Americans suffer from it. Dr. Rosen believes that medical science will one day recognize an entire "*noise syndrome*"—a family of symptoms related to unwanted or unexpected noises. He and others already cite dilation of the pupils, dry mucous membranes, skin paleness, intestinal spasms and glandular secretions as candidates for membership in the full "*noise syndrome*" when it is recognized.⁴⁰

Similarly, the late Dr. Fabian Rouke reported to the New York Committee for a Quiet City:

One of the insidious aspects of excessive noise is the fact that an individual may be unconsciously building up nervous tension due to noise exposures. This may cause a person thus exposed to noise suddenly to be catapulted into an act of violence, or mental collapse, by some seemingly minor sounds which drive him beyond the point of endurance. Many persons who are using tranquilizers may be treating the symptoms rather than the disease.⁴¹

Persons exposed to unwanted noise easily become irritable and unsociable: "Studies show that workers in noisy jobs tend to be more quarrelsome at work and away from it (at home, for example) than those doing equivalent jobs, but who are not subjected to similar noise stresses."⁴² There is evidence of increasing concern relating to the effect of noise on the efficiency, performance, and concentration of factory workers and office employees. It has been reported that astronauts subjected to a reproduction of the 145 decibel sound of a jet engine at full thrust experience difficulty in carrying out simple arithmetical operations, and tended to put down any answer in order to end the experiment.⁴³ "In many cases, [people working

39. See notes 22-36 and accompanying text *supra*. For additional citations, see A. BELL, *supra* note 4, at 34.

40. Conn, *supra* note 5, at 31-32 (emphasis added).

41. COMMITTEE FOR A QUIET CITY, INC., FINAL REPORT & RECOMMENDATIONS, July 7, 1960, at 24.

42. Lehmann, *supra* note 20, at 30-31.

43. A. BELL, *supra* note 4, at 34.

in a noisy environment] make more mistakes and their thinking gets slow and fuzzy. Often they carry a burden of resentment and irritation, have more 'social conflicts' at home and on the job than workers in quieter surroundings."⁴⁴ Obviously, unwanted noise that is deleterious to an individual's well-being and that also decreases working efficiency will add significantly to the costs of production and industry. As noted above, these costs caused by lowered efficiency and increased errors have been estimated to result in an annual \$4 billion loss to American industry.⁴⁵

One of the most disruptive effects of noise pollution, both physically and mentally, is loss of sleep. Even when the sleeping area is quiet a person may be kept awake by a ringing sensation in the ears, called tinnitus, which may have been caused by exposure to excessive noise several hours earlier. Adequate sleep is a physiological necessity, and noises which prevent sleep can be said to be prejudicial to physical health.⁴⁶ Victims may also "develop psychotic symptoms because their dreams are interrupted."⁴⁷ Because of the individual and personal peculiarities in the reaction to noise with respect to interference with sleep, it is virtually impossible to lay down rules of a practicable nature for preventing such disturbance. Maximum permissible noise levels for sleeping accommodation can be suggested,⁴⁸ "but an additional factor is that of intermittent noise, such as that from passing road or air traffic, and attempts must be made to account for the consequent individual disturbances on the basis of their frequency of occurrence. This factor is of particular importance in the case of aircraft noise."⁴⁹

C. Effects of Infrasound and Ultrasound

"Sound" may damage body and mind even though it cannot be heard. Studies have only recently been started by the French National Centre for Scientific Research in Marseilles concerning infrasound, which has a pitch or frequency of below 30 cycles per second and is thus inaudible to the human

44. Manchester, *Rising Time of Noise*, 53 NAT'L CIVIC REV. 418, 419 (1964). See also Broadbent, *Effects of Noise on Behavior*, in HANDBOOK ON NOISE CONTROL, *supra* note 6, at 10-10.

45. See Mecklin, *supra* note 9 at 133. For a discussion of one company's early attempts at combating industrial noise, see Scholtz, *supra* note 9.

46. See W. BURNS, *supra* note 4, at 100; Thiessen, *Psychological Effects of Noise During Sleep*, at AAAS Symposium, *supra* note 22; Lukas & Kryter, *Awakening Effects of Simulated Sonic Boom and Subsonic Jet Noise*, at AAAS symposium, *supra* note 22. See also Atherly, Hempstock & Noble, *Study of Tinnitus Induced Temporarily by Noise*, 44 J. ACOUST. SOC. AM. 1503 (1968).

47. TRIAL, Aug.-Sept., 1966, at 6 (summarizing testimony of Dr. Julius Buchwald, psychiatrist, New York State Medical Center, before the Mental Hygiene Commission of the New York State Assembly. See Mendels, *Sleep and Depression*, at AAAS Symposium, *supra* note 22.

48. It has been suggested that 35 decibels is the threshold for optimum sleeping conditions. See Bragdon, *Noise—A Syndrome of Modern Society*, 10 SCIENTIST & CITIZEN 29, 33 (1968).

49. W. BURNS, *supra* note 4, at 101.

ear, but which is still capable of harming the human organism. "Industrial cities abound in infrasound, generated by many kinds of machines and motors that turn at a slow rate. Even infrasound of weak intensity can penetrate houses and become the unsuspected cause of such ills as dizziness and fatigue."⁵⁰ Infrasound is blamed for feelings of malaise and discomfort sometimes experienced by airplane passengers,⁵¹ and for this reason most airlines cancel out or "mask" such infrasound with music while the engines are idling.⁵² Persons affected by infrasound experience physiological effects similar to those caused by low-frequency mechanical vibration. Vertigo and nausea are attributed to the excitation of the semi-circular canals, and infrasound may also cause resonances of internal organs producing intense irritation, visual disturbances, and interference with intellectual activity.⁵³

At the other end of the frequency scale are the ultrasounds which are also inaudible to the human ear but which may have other serious effects on the human organism. In an extensive survey of the auditory and subjective effects of industrial ultrasonic sources made in 1967, it was found that unpleasant subjective effects, including headache, nausea, tinnitus, and fatigue, were experienced by some persons and that temporary threshold shift occurred.⁵⁴ However, the conclusion of this report suggested that the effects were probably due to noise in the high but audible frequency range which also occurred in the industrial machine noise, and was not necessarily due to the ultrasonic components as such.

50. *The Danger of Sounds We Cannot Hear*; UNESCO COURIER, July 1967, at 28. See also discussion in note 18 *supra*.

51. *Id.*

52. It is common experience to have one sound completely drowned out when another, louder noise occurs. For example, during the early evening when a fluorescent light is on, the ballast noise may not be heard, because of the usual background noise level in the evening. But late at night when there is much less activity and correspondingly less noise, the ballast noise may become relatively very loud and annoying. Actually, the noise level produced by the ballast may be the same in the two instances. But psychologically the noise is louder at night because there is less of the masking noise that reduces its apparent loudness.

Experimenters have found that the masking effect of a sound is greatest upon those sounds close to it in frequency. At low levels the masking effect covers a relatively narrow region of frequencies. At higher levels, above 60 [decibels], say, the masking effect spreads out to cover a wide range, mainly for frequencies above the frequencies of the dominating components. In other words, the masking effect is asymmetrical with respect to frequency. Noises that include a wide range of frequencies will correspondingly be effective in masking over a wide-frequency range.

A. Peterson & E. Gnos, *supra* note 4, at 20-21.

53. W. Burns, *supra* note 4, at 249, citing Gaveau, Condat & Saul, *Infra-sons: Générateurs, Détecteurs, Propriétés Physiques, Effets Biologiques*, 17 ACUSTICA 1 (1966). Another very important study in this area is Mohr, Cole, Guild & von Gierke, *Effects of Low Frequency and Infrasonic Noise on Man*, 36 AIRSPACE MEDICINE, No. 9, at 817 (1965).

54. Aclon & Carson, *Auditory and Subjective Effects of Airborne Noise from Industrial Ultrasonic Sources*, 24 BRIT. J. INDUSTR. MED. 297 (1967). See also Parrack, *Effect of Airborne Ultrasound on Humans*, 5 INTERNATIONAL AUDIOLOGY 294 (1966). For a discussion of temporary and permanent threshold shift, see note 82 *infra*.

D. *Effects of Noise Pollution on Other Animals and on Wilderness Areas*

Man is not the only animal affected by noise pollution. Mink farmers can lose a majority of their animals in the killing frenzy the female minks undergo after being startled by a sonic boom.⁵⁵ "The laboratory exposure of animals to short loud sounds can cause diverse effects, such as a temporary rise in breathing and heart rates, a rise of blood pressure, or a lessened flow of gastric juice; but these responses quickly subside when the noise ceases."⁵⁶ Laboratory experiments have also demonstrated that sound with an intensity of 150 to 160 decibels is fatal to certain animals. The animals suffered from burns, spasms, and paralysis before dying.⁵⁷ Sport fish are believed to be hypersensitive to sound,⁵⁸ and research is also being undertaken to determine the effects of noise on commercial oyster beds.⁵⁹ Guinea pigs exposed to short periods of above-normal but supposedly tolerable noise have developed swollen inside-the-ear membranes, and vital auditory ear hair cells have been destroyed. Prolonged exposure to excessive noise has made rats lose their fertility, turn homosexual, and eat their young. If loud enough (150 decibels) the noise eventually kills them through heart failure.⁶⁰

America's wilderness areas and national parks, which to date have remained out of hearing range of urban and industrial noise, will soon be subjected to a new menace--sonic booms from supersonic transport (SST) planes flying overhead.⁶¹ Serious damage connected with sonic booms has been observed and reported in the Canyon de Chelly National Monument in Arizona, Bryce Canyon in Utah, Mesa Verde National Park in Colorado, and elsewhere.

At the Canyon de Chelly an ancient Indian dwelling was demolished when a large portion of an overhanging cliff fell following a sonic

55. *The Minneapolis Tribune* reports that Zack Taylor, a mink farmer at Frazee, Minnesota, was recently awarded \$37,490 in damages resulting from an Air Force sonic boom in 1965. The farmer said his minks "exploded" simultaneously from their nest boxes and crashed against the ends of their cages with all four feet, then became quiet. Later, he found dead kittens in the boxes and cages, some partially devoured, and concluded that the frenzied mothers had eaten many of their young. In 1966 his herd produced less than half the expected number of kittens.

NATIONAL PARKS, Aug. 1968, at 21. See Bond, *Effects of Noise on the Physiology and Behavior of Farm Animals and Farm-raised Mink*, in AAAS Symposium, *Supra* note 22. See also Heinemann, *Effects of Sonic Booms on the Hatchability of Chicken Eggs*, at AAAS Symposium, *supra* note 22.

56. A. BELL, *supra* note 4, at 35. See N.Y. Times, Feb. 8, 1970, § 1, at 83, col. 5 (report on experiments by Dr. Joseph Buckley, chairman and associate dean of pharmacology, University of Pittsburgh).

57. *Echoes from Our Noisy World*, UNESCO COURIER, July 1967, at 22, 23.

58. See N.Y. Times, Oct. 27, 1968, § 5, at 28, col. 2.

59. See Cleveland Plain Dealer, Mar. 16, 1968, at 10, col. 1. See also A. PETERSON & E. GROSS, JR., *supra* note 4, at 21.

60. Bailey, *supra* note 5, at 131. See also *Rocket Blasts and Guinea Pigs*, SCIENCE DIGEST, Oct. 1968, at 63. Ecological studies have shown that rats exposed to excessively loud noise exhibit a marked decline in the pregnancy rate. *Echoes from Our Noisy World*, *supra* note 57, at 23.

61. See generally text accompanying notes 126-132 *infra*.

boom. Rare sandstone formations in Bryce Canyon have been severely damaged. A rockfall of 66,000 tons occurred recently in Mesa Verde after the passage of two jet planes traveling at supersonic speeds. A rock slide from a canyon wall of the Navajo National Monument in Arizona has just been reported. In the Death Valley National Monument (California and Nevada), 323 sonic booms were counted in a six-month period ending in February 1968, with 68 of these considered to be serious enough to cause weakening and demolition of geologic features.⁶²

The future does not appear promising. "In a hearing before a congressional committee on May 22, 1967, Secretary of Transportation Alan S. Boyd said that it was probable that certain routes over thinly populated areas could be worked out in order to avoid booming the cities."⁶³ This means, of course, that special efforts will be made to find routes over our nation's wilderness and national park areas for the supersonic jets. If such efforts are successful, the tranquility and solitude of these sanctuaries will be destroyed by the persistent cannonade of sonic booms.⁶⁴

Increasing the threat to our parks and wilderness areas is the opinion of some government officials that these areas provide the only "feasible and prudent alternative" for locating the new SST jetports. The first of such airports was scheduled to be built, and construction was begun in the Everglades National Park in Florida. Six months after the project had begun, and after \$13 million had been spent on the construction of a landing strip for training flights, the international jetport was banned by a joint federal and state agreement.⁶⁵ When finished, the jetport would have covered 39 square miles in the middle of the Great Cypress Swamp, which supplies 38 percent of the water flowing into the park. Conservationists contended that the interruption of this flow would have upset, if not totally destroyed, the ecological balance in what has been regarded as the last refuge of solitude along the Eastern Seaboard. The construction of the flight training landing strip has already endangered the fragile and unique ecology of the park.⁶⁶

62. Editorial Comment to Graves, *Sonic Booms and Wilderness*, *TIME LIVING WILDERNESS*, Winter 1967-68, at 17, 18. See also *N.Y. Times*, Dec. 1, 1968, § 1 at 73, col. 4 (discussion of sonic boom damage to Mesa Verde National Park, Colorado); 113 Cong. Rec. H352 (daily ed. Jan. 18, 1967).

63. Graves, *supra* note 62, at 19.

64. The magnitude and range of the noise created by the new SST's are, to say the least, awesome. On its maiden flight, the Anglo-French Concorde was heard 20 miles away. Boeing's SST will generate noise above the threshold of pain. Soucie, *The Everglades Jetport—One Hell of an Uproar*, 54 *SIERRA CLUB BULLETIN*, July 1969, at 4, 7. See also *SST: Noise Reduction Sideline Noise Viewed as Major Problem by Boeing 21 AEROSPACE TECHNOLOGY*, May 20, 1968, at 53.

65. *N.Y. Times*, Jan. 16, 1970, at 1, cols. 6-7; *N.Y. Times*, Feb. 1, 1970, § 10, at 1, cols. 1-4.

66. See Soucie, *supra* note 64, at 7. See also Editorial, *A Jetless Everglades*, *N.Y. Times*, Sept. 7, 1969, § 4, at 14, col. 1; Pennkamp, *Disaster in Everglades National Park*, 50 *SIERRA CLUB BULLETIN*, Oct. 1965, at 4.

Another aspect of our ecological crisis is that pollution problems are not only multivariate but they are also interrelated—where there is big-league noise pollution, there invariably will be air and water pollution. The construction and expansion of our nation's

II. SOURCES OF NOISE POLLUTION—AND WHAT WE CAN DO ABOUT THEM

The sources of noise pollution are infinite in number and diversity. If the average person were to stop for ten minutes and attempt to identify all the unwanted sounds he hears, he would find it impossible to even list them in that amount of time. We have already defined noise as any unwanted or disruptive sound. Noise control can be defined as the technology of achieving an acceptable noise environment consistent with economic and operational considerations.⁶⁷ There are three approaches to the problem: One solution is to reduce the noise level at its source; the second solution is to dampen or insulate the places where we live and work; the third alternative is to "mask" unwanted noises with other more pleasing sounds.⁶⁸ For purposes of this discussion the sources of noise pollution will be divided into four general categories: (1) household appliances; (2) industry and construction; (3) traffic; and (4) aircraft noise and the sonic boom.

A. Household Appliances

The kitchen is the noise center of the modern home. An electric blender can produce 98 decibels, as compared with 95 by a subway and 107 by a loud power motor.⁶⁹ When the exhaust fan, the dishwasher, and the garbage disposal operate simultaneously, as much as 100 decibels may result. The situation has reached such proportions that Dr. John D. Dougherty of the Harvard School of Public Health has cited the kitchen as a major contributor to the increasing deafness of the general population.⁷⁰

The household roar, indoor and out, is multiplied not only by increasing the number of appliances but also by increasing the size of their power sources. Fifteen years ago, the typical, self-propelled power mowers had one horsepower engines, while today the "economy" models are equipped with engines three times that size; riding mowers and home tractors may have as much as twelve horsepower.⁷¹ Vacuum cleaners often will have more than two horsepower motors, and it is exceptional to find one with less than one horsepower.⁷² Music reproduction has undergone a similar, and perhaps unreason-

airports not only means an increase in pollution from jet sound, but also pollution from jet contrails and from the attendant on-ground sewage and industrial waste. It was estimated that the proposed Everglades jetport would have added 9,000 to 72,800 tons of carbon monoxide, 4,150 to 6,000 tons of nitrogen oxides, 13,000 to 40,250 tons of hydrocarbons, 1,000 tons of aldehydes and 1,260 to 3,250 tons of particulates to the surrounding atmosphere when it reached the projected operational level of 900,000 flights a year. Soucie, *supra* note 64, at 7.

67. Harris, *Noise*, ENVIRONMENTAL SCIENCE & TECHNOLOGY, April 1967, at 292.

68. See note 52 *supra*.

69. *That Noise You Hear May be Pollution*, BUSINESS WEEK, Apr. 22, 1967, at 42, 43.

70. See Brower, *supra* note 17, at 17; see note 21 *supra*.

71. Dreher, *supra* note 13, at 239.

72. Of course, another problem is changing personal attitudes—millions of dollars have

able, increase in power size. A stereo amplifier for home use will commonly produce 120 watts, or 60 watts of audio power per channel. The advantage is supposed to be that momentary peaks will be accommodated without distortion. The acoustic output of a 100-man symphony orchestra, however, seldom rises above 10 watts.⁷³

One approach to the problem of household appliance noise is to require manufacturers to rate their products on a numerical decibel scale so that consumers can compare relative noise levels of the products before they buy. Similarly, houses and apartments could be rated by city inspectors for noise so that prospective buyers and tenants will have some concept of how noisy the physical location actually is. Many noise levels encountered in community areas now exceed the safety standards found in industry.

"Sound absorbing materials, drapes, curtains and carpets which deaden noise, quieter air-conditioners, ventilators and other household appliances, and sound-insulated ceilings, walls, doors and windows all help to make the home a quieter and more restful place."⁷⁴ Acoustical research at the Owens-Corning Fiberglas Corporation has brought forth several simple ways that household noise can be reduced.⁷⁵ Since uninsulated walls are useless in stopping airborne noise (voices, street sounds, appliances), it is recommended that the house or apartment be built with a double-wall system in which there is no direct path for the transmission of undesired sound. Wall studs should be staggered so that the same stud does not touch the inner surface of both walls. "Blankets" of heavy insulation can then be hung between the walls. Impact noise (slamming doors, footsteps, mechanical equipment) can be reduced by cushioning. Carpets and sound-absorbing ceilings and walls can also greatly reduce impact sounds. Plumbing noise, which is a major headache for homeowners, can be reduced by "wrapping" the pipes so that they do not touch any part of the building structure, and holes where pipes pass through walls can be stuffed with resilient materials. One relatively easy way to control noise from motorized home appliances is to place them on sound-absorbing materials, and, if possible, within sound-insulated rooms.

been spent on advertising so that housewives will prefer "powerful" sounding household appliances. While it is technically feasible to build a vacuum cleaner that is nearly silent, it may not sell very well because today's housewife has been conditioned to the sound of power. See N.Y. Times, Apr. 30, 1969, at 31, cols. 4-8.

73. Dreher, *supra* note 13, at 239.

74. Schenker-Sprüngli, *Down With Decibels*, UNESCO COURIER, July 1967, at 4, 7.

75. *Solutions to Noise Control Problems in the Construction of Houses, Apartments, Motels and Hotels*, Owens-Corning Fiberglass Corp. (undated); discussed in NOISE: SOUND WITHOUT VALUE, *supra* note 26, at 23, 26-28. For a comprehensive 420 page report which analyzes the basic causes of noise problems in buildings and recommends corrective measures for their alleviation, see U.S. DEP'T HOUSING & URBAN DEVELOPMENT, REPORT NO. ST/TS-24, GUIDE TO AIRBORNE, IMPACT AND STRUCTURE-BORNE NOISE CONTROL IN MULTIFAMILY DWELLINGS (Jan. 1968). See also *Noise Control in Architecture: More Engineering than Art*, ARCHITECTURE RECORD, Oct. 1967, at 193; *Some Particular Problems of Noise Control*, ARCHITECTURE RECORD, Sept. 1968, at 185.

There is some indication that "sound conditioned" houses sell more rapidly than those in which noise-absorbers have not been installed. At a meeting of the National Association of Home Builders, in Washington, D.C., Charles McMahon, a spokesman for the association, reported that in a housing development in Birmingham, Alabama, 11 sound conditioned houses were built. These houses sold more quickly than similar homes in which the anti-noise features were not installed, despite the fact that the sound conditioned homes cost from \$600 to \$800 more. The homes included such special equipment as "a 'super-quiet toilet,' sound-proofed air-conditioning and heating units, sound-absorbing tiling and staggered stud construction in the walls."⁷⁶ In an attempt to develop low-cost methods and materials to reduce noise transmission between housing units and the intrusion of noise from outside sources, the United States Department of Housing and Urban Development has entered into a \$160,000 contract with Wyle Laboratories of Segundo, California, for an 18-month study. The findings of this study will be published as a guide to architects and builders.⁷⁷

Great Britain, Germany, Sweden, the Netherlands, and the Soviet Union have all developed strong building codes containing comprehensive noise-control provisions.⁷⁸ In the United States, building codes are being used to regulate noise in new apartment and office buildings. The New York City Council has drawn up a code calling for the reduction "of airborne noises traveling from one apartment to another through wall partitions or floors or coming from a public hallway; for the quieting of machinery such as central air conditioning; and for limitations on noises transmitted through ventilators, shafts, ducts, and outlets, as well as noises emanating from a neighboring building."⁷⁹ The New York City Board of Estimate recently withheld approval of Tracey Towers apartments in the Bronx until the builder agreed to include certain noise abating structures.⁸⁰ It is encouraging to note that the Federal Housing Administration has set impact-noise ratings in its minimum property standards.⁸¹ While such codes have inherent limitations, it can be hoped that they will have some effect in reducing the amount of acoustical garbage seeping from one apartment to another.

76. N.Y. Times, June 23, 1967, at 22, col. 2.

77. Cleveland Plain Dealer, July 13, 1969, § E, at 23, col. 7.

78. Editorial, *City of Noise*, N.Y. Times, Nov. 26, 1967, § 4, at 12, col. 2.

79. Brower, *supra* note 17, at 19. See also Note, *Urban Noise Control*, 4 COLUM. J.L. & Soc. PROB. 105, 108-14 (1968); Waterhouse, *Noise Control Requirements in Building Codes*, HANDBOOK ON NOISE CONTROL, *supra* note 6, at 40-1.

80. N.Y. Times, Nov. 22, 1968, at 45, col. 1 (city ed.).

81. U.S. DEPT HOUSING & URBAN DEVELOPMENT AND FEDERAL HOUSING ADMIN., REPORT NO. 2600, MINIMUM PROPERTY STANDARDS FOR MULTIFAMILY HOUSING, (Nov. 1963); discussed in NOISE: SOUND WITHOUT VALUE, *supra* note 26, at 25. See also FEDERAL HOUSING ADMIN. REPORT NO. 760, IMPACT NOISE CONTROL IN MULTIFAMILY DWELLINGS (1963).

B. Industry and Construction

Since the 19th century it has been recognized that workers in noisy surroundings suffered hearing loss earlier in life than other people. Today, hearing loss resulting from excessive noise is recognized in most countries as an occupational disease with financial compensation based on the extent of loss of hearing.⁸² The scope of such occupational deafness has reached impressive proportions. "Claims for compensation for hearing loss on the job now run at about \$2 million a year, while it has been estimated that 4 1/2 million American workers who don't file claims might win them if they would."⁸³ The Federal Council for Science and Technology, in a report issued in September 1968, estimated that the number of United States workers experiencing noise conditions unsafe for hearing to be in excess of 6 million and perhaps as high as 16 million.⁸⁴

A leading acoustical engineer, Dr. Leo L. Beranek,⁸⁵ has observed that men of 30 who have been exposed to a work environment with an average noise level of 90 decibels for periods as short as 10 years probably can hear no better than men in their 60's and 70's who have worked in a quiet environment.⁸⁶ The danger limit for most individuals is somewhere between 80 and

82. See Lehmann, *supra* note 20, at 26, 30. The most common result of excessive exposure to noise is a temporary shift in an individual's threshold of hearing, in other words, for the affected individual to hear clearly sounds must now be louder. By definition temporary threshold shift refers to any loss of hearing from which the ear recovers, however long this takes. If no recovery occurs, then there is said to have been a permanent threshold shift—an important factor in determining a workman's compensation. See Nelson, *Legal Liability For Loss of Hearing*, HANDBOOK OF NOISE CONTROL, *supra* note 6, at 38-1.

83. Conn, *supra* note 5, at 32. See also Brower, *supra* note 17, at 17.

84. NOISE: SOUND WITHOUT VALUE, *supra* note 26, at 32. See N.Y. Times, Nov. 10, 1968, at 42, col. 1; A. GLORIA, *supra* note 17, at 133.

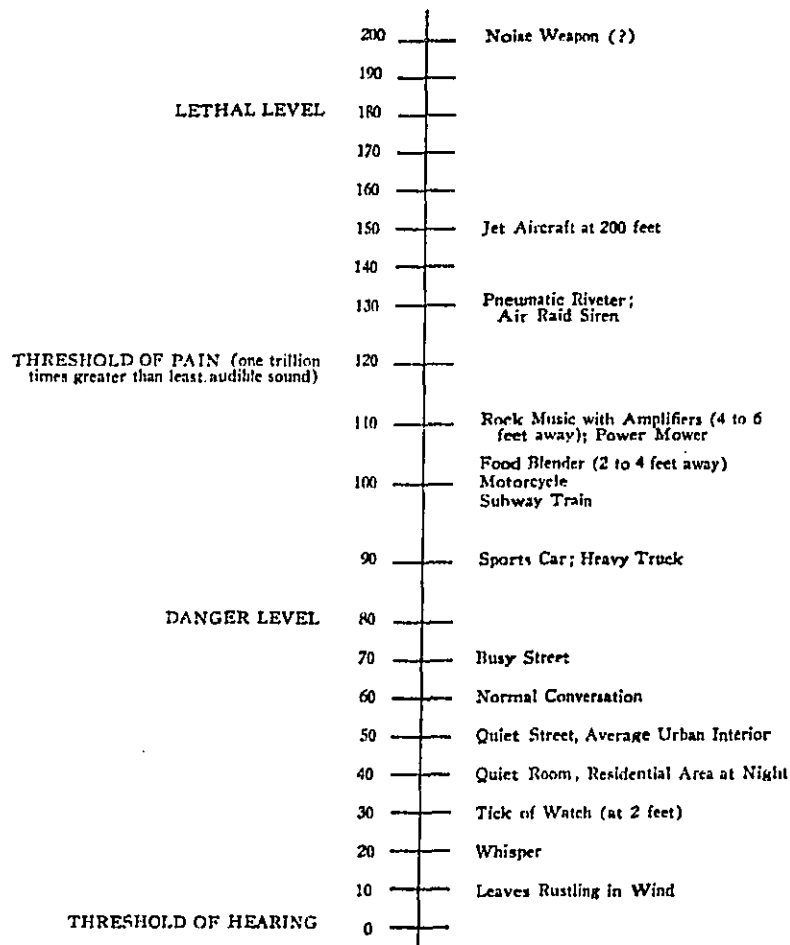
See generally SURCOMM. ON NOISE OF THE COMM. ON CONSERVATION OF HEARING AND RESEARCH CENTER, GUIDE FOR CONSERVATION OF HEARING IN NOISE (1964); cf. Address by William H. Stewart, Surgeon General, Public Health Service, U.S. Dep't of Health, Educ. & Welfare, Health and the Urban Environment, Medical Symposium on Biological Effects of Air Pollution, Oct. 28, 1966 (Public Health Service Reprint). Much of this research has been financed by affected industries. See Blum, *Noise: How Much More Can We Take?*, McCALLS, Jan. 1967, at 113. Industry has traditionally looked on the problem from a defensive position. Not only is industry the defendant in claims for occupational hearing loss, it is often the object of attack by irate citizens claiming that a factory or industrial plant is a public noise nuisance. A "classic" in this area is the article by William H. Lloyd, *Noise as a Nuisance*, 82 UNIV. PA. L. REV. 567 (1934). See also Note, *Nuisance and Legislative Authorization*, 52 COLUM. L. REV. 781 (1952); Note, *Nuisance—As a "Taking" of Property*, 17 U. MIAMI L. REV. 537 (1963); Prosser, *Private Action for Public Nuisance*, 52 VA. L. REV. 997 (1966).

85. Dr. Leo L. Beranek is a leading American specialist on problems of acoustics. He is a lecturer at the Massachusetts Institute of Technology, Cambridge, Massachusetts, where he was formerly associate professor of communications engineering, and is president of an American noise research and consulting firm. See L. BERANEK, *ACOUSTICS* (1954); L. BERANEK, *NOISE REDUCTION* (1960).

86. Dreher, *supra* note 13, at 239.

85 decibels.⁸⁷ The United States Air Force, the largest single employer with an inescapably noisy environment for most of its personnel, has settled on 85 decibels as the level where ear protection is mandatory.⁸⁸ Long-term exposure to noise with a decibel rating of over 80 is a generally accepted cause of hearing loss, and investigations have shown that some degree of hearing loss

87. RELATIVE NOISE LEVELS IN DECIBELS:



Compiled from the following sources: Schenker-Sprüngli, *supra* note 74, at 6; Dreher, *supra* note 13, at 241; *Medicine, Going Deaf from Rock'n Roll*, TIME, Aug. 9, 1968, at 47; Brower, *supra* note 17, at 17-18.

88. U.S. AIR FORCE REGULATION 160-3:5, *Hazardous Noise Exposure* (1956).

may occur at levels which are well below those commonly encountered under all sorts of contemporary conditions. Temporary deafness can be caused by short exposure to levels between 100 and 125 decibels. Listening becomes painful in the range of 125 and 140 decibels, and at 150 decibels the ear can be permanently damaged even with only short exposures.

Industrial noise is also a source of irritation for the general community. Mayor John Lindsay of New York City has been quoted as saying:

This city has an obligation to protect its citizens against all forms of violence, including assault by decibels In a modern industrial civilization, I suppose we have to be prepared to tolerate some increase in the sound level, but I see no reason why this city or its people should have to put up with battering, shattering noises.⁸⁹

This statement holds true for every other American city as well as for our nation as a whole.

With liability on their minds, it is not surprising that industries are searching for quieting processes. A relatively quiet pile-driver and air compressor are already on the market,⁹⁰ and it would take little research to develop similar less noisy industrial and construction equipment. The silenced machines are usually enclosed in a solid plastic housing lined with sound-deadening material. Furthermore, some noise reducing progress could be made if silencers and adequate mufflers were attached to present equipment, or if this equipment were properly isolated, screened, or enclosed. Techniques are being developed to permit economical and effective noise reduction where it was once considered too difficult or too expensive. Industries should be encouraged to seek suitable noise control measures, "and where large numbers of persons are exposed to a severe noise hazard, governments should encourage research and provide, directly or indirectly, the necessary financial assistance."⁹¹ Since noise control measures which are economically impossible today may become feasible or mandatory tomorrow, the problems must be kept under constant review.

Laws which allow unlimited construction noises between 7 a.m. and 6 p.m. in New York City and elsewhere should be re-evaluated. There is little reason why millions of people should be awakened by drills and jackhammers at 7 a.m. if these tools can be effectively quieted. Even the noisy garbage collectors celebrated by Carl Sandburg can be made more quiet by the use of rubber or plastic containers or by placing rubber bumper-rings around the garbage cans.

To a great extent the problem of controlling needless construction noise

89. Quoted in Brower, *supra* note 17, at 19.

90. *Id.* at 19; *Muffling the Clamor of Urban Construction*, BUSINESS WEEK, Dec. 14, 1968, at 168. For a discussion of European efforts to abate construction noises, see Schenker-Sprüngli, *supra* note 74, at 7.

91. A. BELL, *supra* note 3, at 62.

is a legal one. The typical municipal zoning ordinance or anti-noise regulation is more or less capable of regulating the neighborhood nuisance potential of *fixed* industrial installations, but there is virtually no legal restriction on how much noise temporary or transient construction companies can make in any neighborhood they invade. "If complaining citizens attack them as public nuisances, courts will generally rule that if even the noisiest construction project serves a social purpose, it isn't a public nuisance—and of course construction serves a social purpose."⁹² The logical result of the absence of legal control is that existing methods of abating construction noise are not applied. Air compressors and jack hammers, riveters, paving breakers, cement mixers, auxiliary engines, and pumps are all used amidst stores, homes, and office buildings with little or no muffling. Sometimes, the engines are surrounded with metal sheets that only act as sounding boards. In their vicinity conversation and rational thought are impossible. The answers to these problems must be in the form of new laws and law enforcement to reduce the volume of construction and demolition noise as much as possible. Noise control is expensive, and it is as unreasonable as it is naive to ask sympathetic construction firms and industries to invest in noise control measures voluntarily, only to let the unsympathetic companies underbid them on jobs by avoiding noise control costs.⁹³

C. Traffic Noises

Traffic noise is one of the major irritants contributing to our environmental noise pollution. Inter-city expressways, which extend for hundreds and thousands of miles, are bringing the din of the city to the country. Passenger car traffic, however, need not necessarily be irritating; many new car models are being equipped with better exhaust silencers and specially designed quiet tire treads. Furthermore, city and highway planners have it in their power to choose (and the public can demand) quieter road surfaces.⁹⁴

The more blatant violators of our relative urban peace and quiet are

⁹² Conn. *supra* note 5, at 33-34.

⁹³ On May 16, 1969 the United States Department of Labor, under Secretary George P. Shultz, took an unprecedented step forward in the battle for noise control by promulgating new standards for industrial noise. These standards, known as the Walsh-Healy Health and Safety Regulations, 34 Fed. Reg. 7948 (1969), became effective on May 20, 1969 and apply to all industrial firms which have federal contracts of \$10,000 or more during the course of one year. These new regulations establish a maximum allowable level of 90 decibels measured on the A scale for a continuous eight hour per day exposure; as the permissible noise level exposures increase in decibels, the duration per day and per number of exposure hours decreases. The new regulations will benefit some 27 million workers in about 70,000 plants. However, the \$10,000 minimum, and the fact that the standards apply only to government contractors means that millions of other workers will not be covered by these safety regulations. Furthermore, the regulations establish a maximum noise level of 90 decibels which is 5 to 10 decibels higher than most experts regard as safe.

⁹⁴ See, Beranek, *Street and Air Traffic Noise—And What We Can Do About It*, UNESCO COURIER, July 1967, at 12, 14. A brief biography of Dr. Beranek appears in note 85 *supra*.

trucks, buses, motorcycles, sports cars, and passenger cars with loud or faulty mufflers. In general, the average truck at 60 miles per hour is about twice as noisy as a steady stream of automobile traffic. Truck noise is also more irritating because it is sporadic. Sports cars, motorcycles, and buses create similar disruptions. The obvious remedy for this aspect of the noise pollution problem is to require adequate shielding and noise-insulation on all engine compartments and exhaust systems. It is encouraging to note that the new air pollution control mufflers are quieter than the regular exhaust mufflers. The organized parts of the trucking industry, such as the large fleet owners, have openly recognized their fast-growing contribution to national noise pollution. Generally, these large trucking concerns have encouraged reasonable laws and fair enforcement; they want truck noise control to be more legal than voluntary so that the "gypsies" will have to conform to the same noise standards as the fleets.

Traffic noise may be abated through technology in a number of ways. One solution is to place major thoroughfares in "ditches"—that is, building the roads in troughs which are 15 to 20 feet below the normal land surface. This approach is especially needed where the high-speed roads are extended into the heart of major cities. Some futuristic architects have predicted the use of covered tunnels for all city vehicular traffic.⁹⁵ Even lining streets and highways with trees, shrubs, fences, earth banks, and so forth, helps to insulate and to protect the surrounding area from the noise.

Ultimately, or from the long-term viewpoint, it can be hoped that other forms of propulsion may alleviate or at least alter the noise created by road vehicles. One such development is the Wankel engine which, while still an internal combustion engine, employs a rotor in a casing rather than the more common piston in a cylinder.⁹⁶ A gas-turbine powered bus is being currently tested in New York City, but General Motors has indicated that a production model of the bus would not be available for another two years.⁹⁷ The gas-turbine vehicle engines have been praised for their low noise levels—"the engine gives off a subdued canine whine, instead of the familiar feline purr that turns into a roar when the diesel engine accelerates."⁹⁸ Since gas-turbine produce a different type of noise, albeit quieter, than that of piston engines, road engineers and vehicle designers are likely to continue to face noise problems in the future. The most attractive possibility for the reduction of noise is some form of electric engine. A dual-mode transit system has been devised by Dwight M. Baumann, a professor at the Massachusetts Institute of Tech-

95. See Sullivan; N.Y. Times, Dec. 31, 1967, § 4, at 7, cols. 1-7. See also text accompanying notes 165-66 *infra*.

96. W. Burns, *supra* note 4, at 133. The only commercially available passenger vehicle with a Wankel engine is the German NSU Moter's "Ro-80." See Chinitz, *Rotary Engines*, SCIENTIFIC AMERICAN, Feb. 1969, at 90.

97. N.Y. Times, Dec. 20, 1969, at 61, cols. 1-5.

98. *Id.* at col. 1.

nology, which uses special buses and cars, equipped with both internal combustion engines and electric motors. The conventional engines would be used on city streets and highways. "On specially built transit corridors, however, they would be operated by electric motors and be guided by a retractable side arm that would swing out and touch an electric rail along the transit way. The rail would provide the power and guidance and control speeds."⁹⁹

Still a third solution would be to encourage a shift from individual automobile transportation to mass transportation. Indeed, there is some indication that Americans may be reaching the end of their long romance with the automobile.¹⁰⁰ In many cities the planner's dream has become the commuter's nightmare. In New York, for example, it is virtually impossible to cross Manhattan in the rush hour, either with a car or without one. The suffocation and immobilization of the cities by the automobile has been encouraged greatly by the federal government since the Eisenhower Administration. At that time, the powerful lobbying interests of the oil and automobile industries persuaded Congress to set up a huge self-perpetuating highway trust fund which is financed from a tax imposed on all sales of gasoline. The money can only be used for building new interstate highways. In a futile effort to abate city congestion, large multi-story car parks have been built in the midst of the metropolitan areas—and the effect of their presence has been to encourage more motorists to drive into town.

The public has finally begun to react against this lunacy. The city authorities in San Francisco, for example, flatly refused to cooperate with the state and federal governments in permitting a huge new highway, which would have destroyed one of that city's loveliest parks. Other cities, including Cleveland, New Orleans, and Memphis, are now putting up similar fights.

In addition, the new National Environment Policy Act of 1969¹⁰¹ may have a revolutionary effect on projects affecting the environment, including highway construction. This landmark legislation attempts to establish a national environmental policy and an independent body of environmental advisors within the executive office of the President. Besides the important declaration of a national policy for a better environment, the Act requires agencies of the federal government to consider environmental impact in deciding on project development, and gives the Council of Environmental Advisors surveillance over proposals. Oscar S. Gray, acting director of the Department of Transportation's Office of Environmental and Urban Systems

99. N.Y. Times, Nov. 26, 1969, at 90 cols. 1-3.

100. See Boyd, *The Transportation Dilemma*, 54 VA. L. REV. 428 (1968); J. MEYER, J. KAIN & M. WOHL, *THE URBAN TRANSPORTATION PROBLEM* (1966); C. PELL, *MEGALOPOLIS UNBOUND: THE SUPER-CITY AND THE TRANSPORTATION PROBLEM* (1966).

101. Pub. L. No. 91-190, 83 Stat. 852 (1970). See Sive, *Some Thoughts of an Environmental Lawyer in the Wilderness of Administrative Law*, 70 COLUM. L. REV. 612 (1970).

Research, has stated recently that among the factors to be evaluated in the early stages of highway planning will be such environmental concerns as recreation, parks, aesthetics, neighborhood character, erosion, wildlife, noise, and air and water pollution.¹⁰² It remains to be seen, however, if these federal guidelines will be followed on the state level.

Yet if transportation by automobile is to be discouraged, one must substitute a viable alternative in the form of fast, efficient, and quiet mass transportation. The rapid public transit systems have been sadly neglected. New York's subway system, which was designed at the beginning of the century, has had no new lines added to it for 40 years, despite a tremendous population increase in the areas it serves. The railroads, which used to be the major carriers of freight and passengers, have suffered and many have died. There are at least two states today (Maine and Vermont) where all passenger trains have stopped running, making the residents almost entirely dependent upon automobiles. Moreover, city subways and rail lines are presently one of the most important sources of urban noise pollution. "The San Francisco Bay Area Rapid Transit District, the Montreal subway and a few other urban-suburban railroads have taken pains to reduce noise, but most of the major systems, like that of New York City, seem to be operated on the basis that noise is unimportant."¹⁰³ It would seem that the well-known and perfectly feasible engineering measures for abating rail noise are "a refinement to which the users of public transportation are not entitled."¹⁰⁴

There is some indication that a new generation of mass transportation trains, capable of operating at speeds up to 250 miles an hour, may help to entice travelers and commuters off the busy highways. "Two developments have made such trains possible; the air cushion that replaces wheels and virtually eliminates friction, and the linear electric motor that pulls the train in almost complete silence."¹⁰⁵ Low noise levels are unquestionably a great advantage of such municipal transit vehicles; other high speed trains, propelled by jet or propeller engines, would be too noisy for use in urban and residential areas.

The conversion to swift, silent, and exhaust-free mass transport systems will not be easy. Not only will it require a tremendous capital investment in new equipment, but it will also mean the sacrifice of already-existing invest-

102. Boston Globe, Jan. 22, 1970, at 4, cols. 3-4.

103. Dreher, *supra* note 13, at 239.

104. *Id.* at 240. It is encouraging to note that: "The Washington [D.C.] area's planned \$2.5 billion transit system will boast . . . quiet-gentle track curves to avoid screech, continuous welded rails, sound-absorbing carpet between tracks, rubberized insulation of vehicle components, acoustical treatment of stations." *The Boom Nobody Wants*, NATION'S BUSINESS, Sept. 1968, at 76, 78.

105. N.Y. Times, Dec. 14, 1969, § E, at 14, cols. 1-3. The United States has recently let a \$3 million contract with Gruman Aerospace Corporation for the designing of a similar transit vehicle. N.Y. Times, Mar. 18, 1970, at 73, cols. 1-4.

ments in conventional modes of transportation. Ingenuity must be applied to make the new systems as compatible as possible with existing rights of way. It is imperative that the costs of pollution control be accepted by industry and by the public in general in the same way that costs for other safety measures are accepted.

Most states have motor vehicle statutes or codes requiring mufflers on automobiles, trucks, and buses to prevent excessive or unusual noise.¹⁰⁶ However, these statutes usually do not establish maximum decibel levels, and are, therefore, extremely difficult to enforce. Recognizing that the reduction of traffic noise through technology may be a long way off, two states (New York and Connecticut) as well as several foreign countries have at least attempted to limit traffic noise through comprehensive anti-noise legislation establishing maximum decibel noise levels for motor vehicles. In New York State, vehicles on toll ways and public highways are limited by law to a decibel count of 88.¹⁰⁷ Enforced along the Thomas E. Dewey Thruway at Larchmont by state police using portable decibel meters at toll booths, the law has substantially reduced truck and automobile noise.¹⁰⁸ The State of California has recently adopted comprehensive anti-highway noise legislation that would prohibit noise levels in excess of 82 decibels for passenger cars and 92 decibels for trucks and buses at posted highway speeds.¹⁰⁹ As an additional means of noise abatement,

106. For a compilation of state and local ordinances on noise control, see 115 Cong. Rec. E9031-E9112 (daily ed. Oct. 29, 1969). See also Yerges & Weisler, *Anti-Noise Ordinances*, in *HANDBOOK ON NOISE CONTROL*, *supra* note 6, at 39-1.

107. N.Y. VEH. & TRAFFIC L. § 386 (McKinney Supp. 1968-69):

1. No motor vehicle, other than an authorized emergency vehicle or a vehicle moving under special permit, which makes or creates excessive or unusual noise, shall operate upon a public highway.

2. A motor vehicle which produces a sound level of eighty-eight decibels or more on the "A" scale shall be deemed to make or create excessive or unusual noise.

(a) Sound pressure levels in decibels shall be measured on the "A" scale of a standard sound level meter having characteristics defined by American Standards Association specification S 1.4-1961 "General Purpose Sound Level Meter." Measurements of sound pressure level shall be made in accordance with applicable measurement practices outlined in the Society of Automotive Engineers Standard J672 "Measurement of Truck and Bus Noise" as approved January, nineteen hundred fifty-seven. The microphone shall be placed at a distance of fifty feet plus or minus two feet from the center of the lane in which the vehicle is traveling.

(b) Measurements of sound pressure level shall be made at speeds of less than thirty-five miles per hour.

(c) No arrest shall be made in cases where the noise limit is exceeded by less than a two decibel tolerance.

In *People v. Byron*, 17 N.Y.2d 64, 268 N.Y.S.2d 24, 215 N.E.2d 345 (1966), the court stated that section 375 prohibiting the operation of vehicles with excessively noisy mufflers and requiring each motorist to minimize the noise in his particular vehicle was unaffected by section 386 which set up limits beyond which no vehicle noise could go. *Id.* at 69, 268 N.Y.S.2d at 28, 215 N.E.2d at 348 (1966).

108. Brower, *supra* note 17, at 19. For a discussion of the New York experiment with decibel laws, see Note, *supra* note 79, at 111-14.

109. CAL. VEH. CODE § 23130 (West Supp. 1969):

(a) No person shall operate either a motor vehicle or combination of vehicles of a type subject to registration at any time or under any condition of grade, load, acceleration or deceleration in such a manner as to exceed the following noise limit for the category of motor vehicle based on a distance of 50 feet from the center of the lane of travel within the speed limits specified in this section:

California now restricts the sale of new motor vehicles which exceed established noise levels.¹¹⁰ In Connecticut the state police have begun to use a new electronic system to record the noise levels from passing vehicles and to photograph each car or truck exceeding a certain decibel level.¹¹¹ Microphones record each vehicle as it passes. If the emitted noise from the passing vehicle reaches a certain level, the system trips a camera which photographs a noise-level gauge in a corner of the photograph of the offending vehicle. A signal is then automatically relayed to a state police cruiser so that an immediate warning or arrest can take place. This system can be used to provide evidence for court cases in states and communities that outlaw noise over an established

	Speed limit of 35 mph or less	Speed limit of more than 35 mph
(1) Any motor vehicle with a manufacturer's gross vehicle weight of 6,000 pounds or more, any combination of vehicles towed by such motor vehicle, and any motorcycle other than a motor-driven cycle:		
(A) Before January 1, 1973	88 dbA	90 dbA
(B) On or after January 1, 1973	86 dbA	90 dbA
(2) Any other motor vehicle and any combination of vehicles towed by such motor vehicle	82 dbA	86 dbA

(b) The department shall adopt regulations establishing the test procedures and instrumentation to be utilized.

(c) This section applies to the total noise from a vehicle or combination of vehicles and shall not be construed as limiting or precluding the enforcement of any other provisions of this code relating to motor vehicle exhaust noise.

(d) For the purpose of this section, a motortruck, truck tractor, or bus that is not equipped with an identification plate or marking bearing the manufacturer's name and manufacturer's gross vehicle weight rating shall be considered as having a manufacturer's gross vehicle weight rating of 6,000 pounds or more if the unladen weight is more than 5,000 pounds.

(e) No person shall have a cause of action relating to the provisions of this section against a manufacturer of a vehicle or a component part thereof on a theory based upon breach of express or implied warranty unless it is alleged and proved that such manufacturer did not comply with noise limit standards of the Vehicle Code applicable to manufacturers and in effect at the time such vehicle or component part was first sold for purposes other than resale.

110. CAL. VEH. CODE § 27160 (West Supp. 1969):

§ 27160. Motor vehicle noise limits

(a) No person shall sell or offer for sale a new motor vehicle which produces a maximum noise exceeding the following noise limit at a distance of 30 feet from the centerline of travel under test procedures established by the department:

(1) Any motorcycle manufactured before January 1, 1970	92 dbA
(2) Any motorcycle, other than a motor-driven cycle, manufactured on or after January 1, 1970, and before January 1, 1973	88 dbA
(3) Any motorcycle, other than a motor-driven cycle, manufactured on or after January 1, 1973	86 dbA
(4) Any motor vehicle with a gross vehicle weight rating of 6,000 pounds or more manufactured on or after January 1, 1968, and before January 1, 1973	88 dbA
(5) Any motor vehicle with a gross vehicle weight rating of 6,000 pounds or more manufactured on or after January 1, 1973	86 dbA
(6) Any other motor vehicle manufactured on or after January 1, 1968, and before January 1, 1973	86 dbA
(7) Any other motor vehicle manufactured after January 1, 1973	84 dbA

111. N.Y. Times, Nov. 15, 1969, at 73, cols. 1-3.

level. A reading of more than 85 decibels is considered excessive in Connecticut,¹¹² and in a six-month study, which recorded the noise levels of 2,900 vehicles on the Connecticut Turnpike, 11 percent of the vehicles had decibel levels of 94 or higher from 25 feet away.

A British regulation requires that all passenger cars and trucks constructed after April 1, 1970 shall not produce more than 85 decibels; motorcycles and other mechanically propelled two-wheeled vehicles are limited to noise levels below 90 decibels.¹¹³ Maximum permissible noise levels in France, determined under the British testing procedure,¹¹⁴ are 83 decibels for passenger cars and small trucks, 86 decibels for motorcycles, and a maximum 90 decibels for large trucks and buses. In Switzerland the maximum permissible noise levels, measured laterally in an open field at a distance of seven meters with full engine power, are 80 decibels for passenger cars, 85 decibels for two-stroke motorcycles, large trucks, and buses.¹¹⁵ The "maximum noise level" scales established by the Swiss Anti-Noise Commission,¹¹⁶ have been of great value in providing points of departure for the anti-noise legislation of other countries.¹¹⁷

State decibel laws are a delayed step in the right direction for abating noise pollution from surface traffic. Perhaps truck noise and commercial vehicle noise should be federally regulated because of the heavy interstate

112. Connecticut's Motor Vehicles Law states in part: "(c) Each motor vehicle . . . shall be provided with a muffler or mufflers designed to prevent excessive, unusual or unnecessary exhaust noise, which muffler shall be maintained by the owner in good working order and in constant operation." CONN. GEN. STATS. ANN. § 14-80 (Supp. 1969).

113. *The Motor Vehicles (Construction and Use) Regulations 1969*, reprinted in THE BRITISH NOISE ABATEMENT SOCIETY, *THE LAW ON NOISE* 53-64 (1969).

114. The acoustical test for British automobiles requires measurement of the noise at a point 25 ft. from the centerline of the lane in which the vehicle travels for three different operating conditions: [1] constant speed of 30 mph in top gear; [2] starting from a steady speed of 30 mph and (beginning 32 ft. before passing the test microphone) accelerating as rapidly as possible over a distance of 65 ft.; and [3] maintaining a constant speed of 30 mph at full throttle with brakes applied. The highest noise level obtained under these three conditions of test is used to rate the vehicle.

Beranek, *supra* note 94, at 15.

115. Beranek, *supra* note 94, at 15.

116.

MAXIMUM NOISE LEVELS
(in decibels)

Established by the Swiss Anti-Noise Commission

Areas	Basic sound		Frequent peaks		Infrequent peaks	
	night	day	night	day	night	day
Recreational	35	45	45	50	55	55
Residential	45	55	55	65	65	70
Mixed	45	60	55	70	65	75
Commercial	50	60	60	70	65	75
Industrial	55	65	60	75	70	80
Main Traffic Arteries	60	70	70	80	80	90

Source: Schenker-Sprüngli, *supra* note 74, at 7.

117. *Id.*

traffic involved. Due to the increased costs of providing and maintaining adequate mufflers and engine covers, decibel laws may be ultimately effective only if they are national in scope and apply uniformly to all vehicles.¹¹⁸

D. *Aircraft Noise and the Sonic Boom*

In no other area of noise control are conflicting values more clearly seen than in the controversy over jet noise and the location and extension of airports.¹¹⁹ William F. McKee, Federal Aviation Administrator, has indicated that irritated citizens, protesting over aircraft noise, are the main obstacle to airport expansion.¹²⁰ The creation of any new airport or the enlargement of an existing one brings immediate protest from whole communities and chains of communities. Airlines and airports alter flight patterns and runways, while manufacturers attempt to minimize the noise problem on the ground by drastically altering airplane design. Recognizing the problem, federal agencies as well as private organizations are searching for means to control such noise.

Although quieter jet aircraft engines have been developed, the airline companies have been slow to change engines in mid-stream. Because of the increased costs of the new quieter jets,¹²¹ the public must exert economic and political pressure on the aircraft industry and the government. Many citizens are now demanding that their legislatures pass laws requiring all aircraft to

118. Bernnek, *supra* note 94, at 15.

119. The first comprehensive report on the growing aircraft noise problem was the Doolittle Report in 1952. *THE AIRPORT AND ITS NEIGHBORS, REPORT OF THE PRESIDENT'S AIRPORT COMMISSION (1952)*. Since then numerous other reports have been made. See, e.g., *NOISE: SOUND WITHOUT VALUE, supra* note 26, at 8-16; White House Press Secretary, *Aircraft Noise and Compatible Land Use in the Vicinity of Airports, Memorandum for Heads of Departments and Agencies (Mar. 22, 1967)*; *OFFICE OF SCIENCE AND TECHNOLOGY, ALLEVIATION OF JET AIRCRAFT NOISE NEAR AIRPORTS, REPORT OF THE JET AIRCRAFT NOISE PANEL (1966)*; *INVESTIGATION AND STUDY OF AIRCRAFT NOISE PROBLEMS, H.R. REP. NO. 36, 88th Cong., 1st Sess. (1963)*.

For a discussion of the legal aspects of aircraft noise, including noise litigation, claims, and theories of recovery, see Hill, *Liability for Aircraft Noise: The Aftermath of Causby and Griggs*, 19 U. MIAMI L. REV. 1 (1964); Munro, *Aircraft Noise as a Taking of Property*, 13 N.Y.L. FORUM 476 (1967); Spater, *Noise and the Law*, 63 MICH. L. REV. 1373 (1965); Tenzer, *Jet Aircraft Noise: Problems and Their Solutions*, 13 N.Y.L. FORUM 465 (1967); Tondel, *Noise Litigation at Public Airports*, 32 J. AIR L. & COMMERCE 387 (1966); Note, *Jet Noise in Airport Areas: A National Solution Required*, 51 MINN. L. REV. 1087 (1967). See also Nat'l Aircraft Noise Abatement Council *Aircraft Noise Litigation and Claim Survey* (June 1965); 115 Cong. Rec. E9031 (daily ed. Oct. 29, 1969) (remarks by Senator Hatfield).

120. N.Y. Times, Oct. 5, 1967, at 79, col. 1. See generally Tenzer, *supra* note 119; Note, *supra* note 119.

121. "Prior to the introduction of jet-powered commercial aircraft, an estimated \$50 million was spent on research and development by the industry to perfect in-flight sound suppressors for jet powerplants. By 1965, the industry had invested an estimated \$150 million in installation of in-flight suppressors." *NOISE: SOUND WITHOUT VALUE, supra* note 26, at 10, citing *REPORT OF PROCEEDINGS, NAT'L AIRCRAFT NOISE SYMPOSIUM, Jamaica, New York, at II-1 (1965)*.

On the federal level, Representative John W. Wylder introduced a bill during the second session of the 89th Congress which sought to amend the National Aeronautical and Space Administration (NASA) appropriations to include \$20 million for noise reduction research. Although this bill was defeated, NASA has since instituted research on jet noise reduction, with a budget of \$1.5 million. See Bragdon, *supra* note 48, at 31.

For a discussion of jet engine noise and its reduction, see W. Burns, *supra* note 4, at 209-14.

produce lower noise levels in residential areas. Such laws have little immediate effect, however, because most of today's jet aircraft cannot meet a substantially lower noise requirement. The proper approach to abating commercial aircraft noise is to impose noise limitations on all new aircraft entering the airlines' inventories. Then the process of quieting existing aircraft can begin. Federal requirements establishing acceptable noise levels before certification of new aircraft are the existing legal means available to accomplish this result. "Without such regulation, competitive pressures in both the manufacturing and operating industries will maintain the same lack of concern about noise as that which now exists from trucks."¹²² Municipal ordinances which attempt to ban excessive jet noise and sonic booms caused by airplanes flying over their territory may be invalidated, as was the case in *American Airlines, Inc. v. Town of Hempstead*,¹²³ on grounds of federal preemption.¹²⁴ But while local anti-noise ordinances may be ineffective, they at least give clear warning to the federal government and to the airplane industry that the public is very much disturbed by the problem and demands a solution.¹²⁵

The public has also made clear its impatience with the problem of sonic booms—"the loudest, most startling and most damaging noise yet made by any ordinary thing for routine peaceful human use"¹²⁶—which will be a part of the next generation of jet aircraft.¹²⁷ Any airplane flying faster than the speed of sound produces pressure or shock waves around the nose and around protruding parts of the plane, much like the waves created by a rapidly moving ship. These shock waves form a cone which encircles and follows the aircraft and intersects with the earth. "As the line of intersection with the earth advances with the movement of the airplane, people living within the width of the

122. Beranek, *supra* note 94, at 20.

123. 272 F. Supp. 226 (E.D.N.Y. 1966). Private action may be brought on theories of "taking of property" or public nuisance even though it is no longer a trespass to fly through the airspace over private property. See generally Spater, *supra* note 119; Munro, *supra* note 119; Hill, *supra* note 119; Tondel, *supra* note 119. See also Note, *Nuisance and Legislative Authorization*, 52 COLUM. L. REV. 781 (1952); Note, *Nuisance—As a "Taking" of Property*, 17 U. MIAMI L. REV. 537 (1963); Lloyd, *Noise As Nuisance*, 82 U. PA. L. REV. 567 (1934); Prosser *Private Action for Public Nuisance*, 52 VA. L. REV. 997 (1966).

124. See discussion in Note, *supra* note 79, at 117-18 & n.95; Spater, *supra* note 119, at 1381-96. Compare *Griggs v. County of Allegheny*, 369 U.S. 84 (1962), discussed in Hill, *supra* note 119.

125. See TIME, Oct. 6, 1967, at 67.

126. Conn, *supra* note 5, at 35. Concerning the damaging effects of the sonic boom on the human organism, see Nixon, *Human Response to the Sonic Boom*, at AAAS Symposium, *supra* note 22; Sontag, *Effects of Noise During Pregnancy Upon Foetal and Subsequent Adult Behavior*, at AAAS Symposium, *supra* note 22; see also N.Y. Times, Aug. 3, 1967, at 43, col. 2.

127. See U.S. DEPT OF TRANSPORTATION, SUMMARY OF SONIC BOOM CLAIMS PRESENTED IN THE UNITED STATES TO THE AIR FORCE, FISCAL YEARS 1956-1967 (1967); Baxter, *The SST: From Watts to Harlem in Two Hours*, 21 STAN. L. REV. 1 (1968); Orner, *Sonic Boom: Containment or Confrontation*, 34 J. AIR L. & COMMERCE 208 (1968); Note, *Sonic Booms—Ground Damage—Theories of Recovery*, 32 J. AIR L. & COMMERCE 596 (1966); Note, *Torts—Liability—Sonic Boom*, 36 J. AIR L. & COMMERCE 117 (1970); Katz, *The Function of Tort Liability in Technological Assessment*, 38 U. CIN. L. REV. 587, 655-61 (1969).

intersecting path usually hear two closely-spaced explosive sounds, known as the 'sonic boom,'¹²⁸ an explosive phenomena of the air caused by shock waves generated at supersonic flight speeds.¹²⁹ It is estimated that a single supersonic transport (SST) while flying across the nation will create a 50 to 80 mile wide noise carpet, or "bang zone," behind it that could startle as many as 20 million persons.¹³⁰ Furthermore, a fleet of 150 SST's in operation could cause an estimated \$1 million in damage every day to windows, plaster and other building materials.¹³¹ Unrestrained, the SST could change noise pollution from a local phenomenon to one of national and international proportions.¹³²

In an attempt to "afford present and future relief and protection to the public from unnecessary aircraft noise and sonic boom" the federal government passed the aircraft noise abatement law on July 21, 1968.¹³³ While this law will not solve all the problems involved in aircraft noise abatement, it can be an essential instrument in finding solutions and coordinating remedial research.¹³⁴

128. Beranek, *supra* note 94, at 20.

Measured outdoors, a typical sonic boom from a high-flying aircraft is a pressure wave that suddenly increases above normal atmospheric pressure by 0.5 to 2 pounds per square foot, then decreases somewhat more slowly to below normal atmospheric pressure by about the same amount, and finally jumps back to atmospheric pressure. The result is an N-shaped pressure wave less than half a second long. The lateral spread of the boom becomes greater as the altitude of the airplane increases, although the intensity of the boom decreases.

Id.

129. Roth, *Sonic Boom: A Definition and Some Legal Implications*, 25 J. AIR L. & COMMERCE 68 (1958).

130. N.Y. Times, June 18, 1967, § 1, at 60, col. 3 (statement by Harvard University physicist Dr. William Shureliff, Director of the Citizen's League Against the Sonic Boom); Brower, *supra* note 17, at 19. See generally W. SHURELIFF, *SST AND SONIC BOOM HANDBOOK* 50-56 (1970).

If the boom turns out to be seriously disturbing, by the time the prototype is built public resentment will collide head-on with the project. Some experts believe that by modifying the shape of the aircraft to reduce drag and hence the force of the boom, it can be kept within tolerable limits. If they prove wrong, there is little doubt that the SST will be barred from overland use. The economic consequences would be serious, but the public relations problem would be even worse. Either the technical problem will be solved, or the SST will be the first major casualty of the antinnoise movement.

Dreher, *supra* note 13, at 242. See also N.Y. Times, Sept. 28, 1969, § 4, at 8, cols. 7-8.

131. N.Y. Times, June 18, 1967, § 1, at 60, col. 3; see also Note, *supra* note 79, at 105. See *United States v. Gravelle*, 407 F.2d 964 (10th Cir. 1969), discussed in Note, *Parts—Liability—Sonic Boom*, *supra* note 125. Compare *Brown v. United States*, 230 F. Supp. 774 (D. Mass. 1964).

132. The application of international law to the SST is a serious question. Under existing treaties, overflights may be restricted or prohibited for reasons of public safety. See Huard, *The Roar, the Whine, the Boom and the Law: Some Legal Concerns About the SST*, 9 SANTA CLARA L. REV. 189 (1969); Hill, *supra* note 119, at 9-13; W. SHURELIFF, *supra* note 130, at 108-10. There is also a wide variety of foreign laws that might be applicable, including doctrines of strict liability. See Mankiewicz, *Airport Noise—Compensation of Adjoining Landowners under French Law: A Report on a Case and Some Further Considerations*, 35 J. AIR L. & COMMERCE 238 (1969); Mankiewicz, *Some Aspects of Civil Law Regarding Nuisance and Damage Caused by Aircraft*, 28 J. AIR L. & COMMERCE 44 (1958). Clearly, some new international convention regarding the SST will be necessary.

133. 82 Stat. 395 (1968); discussed in S. REP. NO. 1353, 1968 U.S. CONG. & ADMIN. NEWS 2688-98.

134. Statement of the Sec'y of Transportation, Alan S. Boyd, on Noise Abatement,

In amending Title VI of the Federal Aviation Act of 1958,¹³⁵ the law gives the Administrator of the Federal Aviation Administration, after consultation with the Secretary of Transportation, the power to fix standards for the measurement of aircraft noise and regulations for noise control and abatement.¹³⁶ This law forms a part of an overall noise control program encompassing eight basic areas: aircraft noise research, aircraft operations, sonic boom research, airport and land use, natural environment, legal, structures, and human response.¹³⁷ At the time of enactment it was intended that all federal efforts in these areas would be coordinated through an Inter-Agency Aircraft Noise Abatement Program to be established by the Department of Transportation.¹³⁸

Before the Transportation & Aeronautics Subcomm. of the House Interstate & Foreign Commerce Comm., Wednesday, Nov. 15, 1967 (U.S. Dep't of Transportation Reprint), at 6, discussed in N.Y. Times, Nov. 11, 1967, at 1, col. 7.

135. 49 U.S.C. §§ 1421-30 (1964).

136. Public Law 90-411, 82 Stat. 395 (1968) reads as follows:

Sec. 611. (a) In order to afford present and future relief and protection to the public from unnecessary aircraft noise and sonic boom, the Administrator of the Federal Aviation Administration, after consultation with the Secretary of Transportation, shall prescribe and amend standards for the measurement of aircraft noise and sonic boom and shall prescribe and amend such rules and regulations as he may find necessary to provide for the control and abatement of aircraft noise and sonic boom, including the application of such standards, rules, and regulations in the issuance, amendment, modification, suspension, or revocation of any certificate authorized by this title.

(b) In prescribing and amending standards, rules, and regulations under this section, the Administrator shall—

(1) consider relevant available data relating to aircraft noise and sonic boom, including the results of research, development, testing, and evaluation activities conducted pursuant to this Act and the Department of Transportation Act;

(2) consult with such Federal, State, and interstate agencies as he deems appropriate;

(3) consider whether any proposed standard, rule, or regulation is consistent with the highest degree of safety in air commerce or air transportation in the public interest;

(4) consider whether any proposed standard, rule, or regulation is economically reasonable, technologically practicable, and appropriate for the particular type of aircraft, aircraft engine, appliance, or certificate to which it will apply; and

(5) consider the extent to which such standard, rule, or regulation will contribute to carrying out the purposes of this section.

(c) In any action to amend, modify, suspend, or revoke a certificate in which violation of aircraft noise or sonic boom standards, rules, or regulations is at issue, the certificate holder shall have the same notice and appeal rights as are contained in section 609, and in any appeal to the National Transportation Safety Board, the Board may amend, modify, or reverse the order of the Administrator if it finds that control or abatement of aircraft noise or sonic boom and the public interest do not require the affirmation of such order, or that such order is not consistent with safety in air commerce or air transportation.

In November 1969, the Federal Aviation Administration issued a regulation intended to reduce by half the amount of noise produced by jet aircraft landings and take-offs. "The new rule, which sets maximum noise levels, will at first apply only to the big new jets scheduled to appear at airports within the next year. But it is expected that similar regulations will be ordered for current jet planes." Bailey, *supra* note 5, at 132. For a discussion of a similar British attempt to reduce jet aircraft noise, see W. BURNS, *supra* note 4, at 214-41.

137. Statement of the Sec'y of Transportation, *supra* note 134, at 4.

138. *Id.*

III. AN OUTLINE FOR FUTURE RESEARCH

The purpose of this article has been to provide an introduction to the practical problems and damaging effects of noise as an environmental pollutant. The solutions to these problems will only be found with the backing of informed public opinion and proper laws and regulations. As in other areas of environmental control, law-making and enforcement is a vital factor in any anti-noise campaign. The following outline for future research is an attempt to point out various areas where information, research, and understanding are needed. This outline does not pretend to be definitive in scope; rather its purpose is to indicate the inadequacies of existing legal remedies, to suggest some possible legislative solutions concerning noise pollution, and to emphasize the polycentricity of our ecological crisis.

A. Existing Legal Remedies

The legal responses to noise pollution, as to any problem, may be characterized as private or public remedies. Broadly stated, private remedies consist of individual law suits; public remedies consist of regulatory and remedial legislation. While these categories are obviously not mutually exclusive—a law suit brought under a public nuisance statute is both a public and private remedy—they do provide a convenient framework in which to analyze the adequacy of existing legal remedies and to suggest needed research.

1. *Private Remedies.* Private law suits are usually based on public nuisance statutes, or on the common law of nuisance, or on the constitutional theory of the "taking" of property.¹³⁹ Generally, these solutions, based as they are on economic and political theories developed during a period less technological and less complex than today, have proved inadequate to solve the problems posed by present-day noise pollution. Public nuisance statutes were not written with unwanted noise in mind.¹⁴⁰ Moreover, other legal and social problems limit the usefulness of the common law nuisance suit. In an urban environment, the most offensive noise is often the conglomeration of sounds caused by an almost infinite number of unidentifiable sources. The burden of showing causation, combined with the important requirement that the nuisance impair the enjoyment of the plaintiff's own property, can prove an insurmountable barrier to recovery.¹⁴¹ Finally, the constitutional theory of "taking"

139. See generally citations in note 123 *supra*. See also Note, *The Cost-Internationalization Case for Class Actions*, 21 *STAN. L. REV.* 383 (1969); cf. Juergensmeyer, *Control of Air Pollution Through the Assertion of Private Rights*, 1967 *Duke L.J.* 1126.

140. Of course, this defect is easily remedied by amendment. In the area of air pollution, the State Senate of Massachusetts is currently considering legislation which would allow private citizens to bring suit against anyone polluting the environment within that state. (Mass. Senate No. 907). The bill would allow judgments requiring that the pollution be stopped unless the costs of such action would threaten the existence of the polluting concern. See *N.Y. Times*, Feb. 4, 1970, at 19, col. 4.

141. Note, *supra* note 79, at 108.

of property requires governmental activity and does not reach the primary cause of noise pollution, that is private industry.

Certainly the damaging effects of noise as an environmental pollutant is a harm for which there should be an appropriate legal remedy. The physical damage to nerve receptors caused by excessive noise is not unlike that caused by a series of physical blows, and it may not be unreasonable to characterize excessive and deliberate public noise as a form of battery.¹⁴² Perhaps our developing law of the right of privacy, or, more appropriately, the right to sanity, should also encompass infringement by excessive noise.¹⁴³ These and other theories deserve exploration in the light of developing sociological and psychological studies of the effects of unwanted noise.¹⁴⁴

2. *Public Remedies.* While legislative solutions to noise pollution can be as broad and as varied as man's creativity, the response to date has fallen considerably short of that limit. Such laws as the federal aircraft noise abatement law¹⁴⁵ and the various schemes of limiting decibel levels have already

142. See generally citations in note 127 *supra*.

143. Under British common law, freedom from noise is considered essential to the full private enjoyment of a dwelling house. Noise alone may constitute a nuisance. *Crump v. Lambert*, L.R. 3 Eq. 409 (1867); *R. v. Smith*, 93 Eng. Rep. 795 (K.B. 1726). There are eight general principles relating to the common law of noise nuisance which have been established in the Chancery Division of the High Court, the Court of Appeal, and the House of Lords. These principles are: (1) *There must be material interference with property or personal comfort.* *Walter v. Selfe*, 64 Eng. Rep. 849 (Ch. 1851); *Betts v. Penge* U.D.C., [1942] 2 K.B. 154 (1942); *Rushmer v. Polsue & Alfieri Ltd.*, [1906] 1 Ch. 234 (1906). (2) *It is no defense for the defendant to show that he has taken all reasonable steps and care to prevent noise.* *Polsue & Alfieri Ltd. v. Rushmer*, [1907] A.C. 121, 122 (1907) (opinion of Lord Loreburn); *Halsey v. Esso Petroleum Co., Ltd.*, [1961] 1 W.L.R. 683 (Q.B. 1961). (3) *The noise need not be injurious to health.* *Vanderpant v. Mayfair Hotel Co.*, [1930] 1 Ch. 138 (1929); *Hampstead & Suburban Properties Ltd. v. Diomedous*, [1969] 1 Ch. 248 (1968). (4) *Temporary or transient noise will not generally be accepted as a nuisance.* *Andreae v. Selfridge & Co.*, [1938] Ch. 1 (1937); *Leeman v. Montagu*, E.R. 1677 (K.B. 1936). (5) *The courts do not seek to apply a fixed standard of comfort.* *Rushmer v. Polsue & Alfieri Ltd.*, [1906] 1 Ch. 234 (1906); *Colls v. Home & Colonial Stores Ltd.*, [1904] A.C. 179 (1904); *Halsey v. Esso Petroleum Co.*, [1961] 1 W.L.R. 683 (Q.B. 1961); *Sedleigh-Denfield v. O'Callaghan*, [1940] A.C. 880 (1940). (6) *It is no defense to show that the plaintiff came to the nuisance.* *Bliss v. Hall*, 132 Eng. Rep. 758 (C.P. 1838); *Sturges v. Bridgman*, 11 Ch. D. 852 (C.A. 1879). (7) *The courts will not interfere with building operations conducted in a reasonable manner.* *De Keyser's Royal Hotel Ltd. v. Spicer Bros. Ltd. & Minter*, 30 T.L.R. 257 (Ch. 1914) (dictum); *Andreae v. Selfridge & Co.*, [1938] Ch. 1 (1937); *Barrette v. Frankl Compressed Pile Co.*, 2 D.L.R. 665 (1954). (8) *Malice may be a significant factor.* *Christie v. Davey*, [1893] 1 Ch. 316 (1892); *Hollywood Silver Fox Farm Ltd. v. Emmett*, [1936] 2 K.B.D. 468 (1936). For a discussion of these and other cases, see *THE LAW ON NOISE*, *supra* note 113, at 13-19; *Spater*, *supra* note 119, at 1396-97.

144. As of yet, the possibility that light may be an environmental pollutant has been largely ignored. The increasing ocular barrage of neon signs and flashing lights, however, may soon become of greater concern. There is some indication that excessive light, like excessive noise, may produce physical and psychological damage to the human organism. See, e.g., *Gregory, Visual Illusions*, *SCIENTIFIC AMERICAN*, Nov. 1968, at 66; *Thomas, Movements of the Eye*, *SCIENTIFIC AMERICAN*, Aug. 1968, at 88. Assuming that light can be an environmental pollutant, then the plethora of legal problems being raised concerning noise pollution will also arise concerning unwanted and obtrusive light, and there is little hope that nuisance laws, our "taking" of property laws, or our right of privacy laws will provide adequate remedies. The suggestions in text, therefore, apply also to the probable future problem of light pollution.

145. See notes 133-38 and accompanying text *supra*.

been mentioned.¹⁴⁶ Other, as yet untried, possibilities suggest themselves. While it would be difficult to tax noise polluters directly,¹⁴⁷ tax incentives on the state and federal level could be employed to encourage noise abatement programs. A corporation might be given the option to treat expenditures for noise pollution abatement as a business expense in order to receive an immediate tax write-off without having to depreciate such expenditures over several years.¹⁴⁸ Federal or state governments could also make low-interest loans to companies unable to secure funds from traditional sources. Such loans might be limited to companies presently in existence and presently causing noise pollution without the means of abating it.

The reason for the failure of legislatures to grapple fully with the very real problems of environmental pollution generally and noise pollution specifically is probably the lack of understanding of both the problem and its possible solutions. There remains much to be done in the area of comprehensive anti-noise regulation on city, state, and federal levels. Studies in comparative law might attempt to evaluate various legislative solutions to noise control. Moreover, legislators and legal counsel for legislative bodies must be familiar with the scientific intricacies of noise pollution as well as the legal intricacies of anti-noise legislation.

B. *The Possibilities for International Action*

As business and transportation integrate on an international level, noise pollution, as with air and water pollution, becomes a problem of international control. It is obvious that international treaties and conventions are needed to resolve international environmental conflicts. There is growing concern over our global environment which transcends purely national interests, and it is foreseeable that in the near future a body of transnational environmental law will be developed.

1. *Education and Communication.* On the international level, the educational approaches to our environmental problems can assume various forms. They include international conferences and symposia, demonstrations, and scholarships. Because of its polycentric effects, a comprehensive educational program on noise must include architects, engineers, factory inspectors, health organization representatives, industrialists, insurance executives, lawyers, medical doctors, machine designers and manufacturers, politicians, and trade-union officials. Help from the World Health Organization and the Inter-

146. See notes 106-17 and accompanying text *supra*. See also discussion of the new Walsh-Healy anti-noise regulations in note 93 *supra*.

147. However, in the area of traffic noise one effective abatement solution would be for local governments to limit the use of private motor vehicles by means of increased taxation on private vehicle ownership or by means of "city entrance" tolls for all private vehicles. The revenue obtained by taxing motorists who insist on driving and parking in congested, noise and air polluted inner-city areas could be used to improve and subsidize quieter public transportation.

148. See INT. REV. CODE OF 1954 §§ 162, 167.

national Labor Organization should also be solicited. The aim of a comprehensive educational program should be to establish a body of experts in each country with a thorough knowledge of the subject, capable of stimulating the development of, and perhaps even directing, noise abatement activities.¹⁴⁹

Several international meetings devoted to noise have been held, but none of these have been planned specifically for public health and labor officials or for lawyers and legislators. Forums must be established where various national approaches to environmental problems can be compared. And the structure of model national and international noise control legislation is a matter of prime importance.

Among the legislative considerations are a general survey of the problem, including methods, instrumentation and standards; the definition of harmful noise levels by intensity, frequency and duration of exposure; specification of the persons, places and circumstances where the law applies; details of enforcement agencies and penalties for infringements; the principles and practice of engineering noise control; standards and methods for medical examination and action to be taken when noise-induced hearing loss is found; the qualifications of medical and engineering control staffs; and the types of ear-protector, with indications for their use.¹⁵⁰

2. *International Cooperation.* "Although increasing attention is being paid in many countries to health problems arising from noise, in only a few has there been any systematic attempt to assess the extent of the problem on a national scale."¹⁵¹ To date, no survey of noise pollution has been made on an international scale. However, there are indications of increased international cooperation in the area of environmental control. Plans are being drafted by a "task force" of specialists at the National Academy of Sciences for a global warning network on environmental changes which threaten life forms.¹⁵² The

149. A. BELL, *supra* note 4, at 111.

150. A. BELL, *supra* note 4, at 112. There is also a need for a wider and freer interchange of knowledge and increased communication between nations concerning our global environmental problems.

Apart from certain publications and periodicals of various organizations and societies, the International Occupational Safety and Health Information Centre of the ILO [International Labor Organization] has made a praiseworthy attempt to break down this isolation, but it has to cover a very wide field. A detailed up-to-date bibliography, including recommendations, standards and codes, would be most useful. . . . Since the volume of published material on acoustics is prodigious and spans many disciplines, there is considerable need for some international correlation and for the dissemination of sufficiently detailed abstracts on every aspect of the subject.

Id.

151. *Id.* at 113.

152. N.Y. Times, Feb. 12, 1970, at 1, cols. 6-7. See Kennan, *To Prevent a World Wasteland: A Proposal*, 48 FOREIGN AFFAIRS 401 (1970); N.Y. Times, Mar. 20, 1970, at 12, cols. 1-3 (city ed.).

The United States itself has taken a major step toward recognizing the desirability of encouraging international cooperation in preservation of world environment. Title I, section 102(E) of the National Environmental Policy Act of 1969 states:

The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2)

General Assembly of the United Nations has begun plans for an international conference in 1972 to explore the possibilities of cooperation to "eliminate the impairment of human environment" and to organize a worldwide defense against pollution.¹⁵³ In a similar attempt, the 22-nation Organization for Economic Cooperation and Development (OECD) has recently announced its intention to establish international tolerance limits for environmental pollutants.¹⁵⁴ Countries who exceed the limits would pay indemnities. Members of OECD include the United States, Canada, Japan, and 19 Western European countries. But the organization operates by voluntary compliance, and since there is no way of enforcing action on the independent governments, it cannot be assumed that all the members will adhere to the standards of environmental control.

C. Suggested Remedial Approaches

1. *Population Control.* Our exponential population explosion is the underlying cause for all our natural resources problems; there are simply too many people fighting over a limited supply of renewable and non-renewable resources.¹⁵⁵ The population problem is by no means limited to the "have-not" and underdeveloped nations. In November of 1967 the population of the United States was 200 million, by November 1969 it had exceeded 203 million and the average annual population growth rate was 1.3 percent (compared with 2.1 percent growth rate of underdeveloped nations and a world average population-growth rate of 1.8 percent).¹⁵⁶ Present projections put the United

all agencies of the Federal Government shall . . . (E) recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment; . . .

Pub. L. No. 91-190, 83 Stat. 853 (1970). See also *Sive, supra* note 101.

153. This conference will be the First International Conference on the Human Environment. See *N.Y. Times*, Mar. 30, 1970, at 34, cols. 2-6; *id.*, Dec. 4, 1968, at 18, col. 1. An eight-day symposium on international environmental problems, sponsored by the Standing Committee on Environmental Disruption of the International Social Science Council (a United Nations auxiliary body), was held in Tokyo, Japan, on March 9-16, 1970. Forty-five delegates, including social scientists from 13 industrial countries, exchanged views on environmental pollution at this meeting. See *N.Y. Times*, Mar. 3, 1970, at 18, col. 5 (city ed.).

154. *N.Y. Times*, Feb. 19, 1970, at 11, col. 1.

155. Exponentially viewed, it will not be long before the earth's surface is packed solid with humans, the whole mass standing in individual refrigerated capsules on a thick layer of immovable automobiles. Babies will issue from this mass in a constant stream to stand on the shoulders of their parents. Suddenly, atomic fusion is achieved by the central computer which runs this horror and the mass dissolves into a small exploding universe of positive and negative electrons, neutrinos and antineutrinos, baryons and leptons, all moving apart at relativistic speeds. Before this, of course, we shall have all killed one another off by the exponential rise in the crime rate, by radiation diseases, and, lacking all exercise, by dying shortly after birth from the ultimate pollution, namely, the inability to move away from our own excrement.

Cowan, *Law and Technology: Uneasy Leaders of Modern Life*, 19 *CASE W. RES. L. REV.* 120, 122 (1967).

156. See *TIME*, Nov. 24, 1967, at 70; *N.Y. Times*, Jan. 11, 1970, § 12, at 16, cols. 2-8;

States population at 308 million by the year 2000, and 374 million by the year 2015. The world population, which now stands at 3.5 billion, will be increased by at least another 3 billion in the next 30 years; and by 2050 the world population will exceed 15 billion unless extreme measures are taken.

One effective way of abating noise is to limit the number of noise-producers, beginning with the biggest noise-makers—the people themselves. Generally speaking, there are two approaches to controlling the population: first, by limiting the number of births, and second, by increasing the number of deaths through a comprehensive program of applied eugenics.¹⁵⁷ For moral and philosophical reasons, applied eugenics is not a viable solution; birth control is the only alternative.

The United States is becoming aware, as a nation, that a voluntary birth control program, as enunciated by President Nixon in July 1969, is an unrealistic and futile approach to the problem.¹⁵⁸ Direct controls, such as compulsory sterilization or abortion, would be too offensive. However, indirect economic incentives should be used to encourage the postponement of marriage and the limitation of births within marriage. The federal government should stop taxing single persons more heavily than married ones, eliminate tax exemptions for children, legalize abortions and sterilization, and levy a "child tax" on parents having more than one or two children. These suggestions are extreme, and yet the choice today is not between the ideal and the undesirable, but rather between the undesirable and the disastrous. If nothing is done, in 10 or 20 years, 50 to 100 million people may starve yearly.¹⁵⁹ Add to this the de-civilizing aspects of unwanted noise and the fact that the noise problem is becoming more acute with urbanization, and the undesirable aspects of the optimal alternatives become minimal.

2. *Expanding the "Decibel Limit" Concept.* As noted earlier, laws are being enacted on state and federal levels to define prohibited noise in terms of decibels, a measure of the intensity of sound.¹⁶⁰ Inherent in any anti-noise legislation based on the objective "decibel limit" concept are problems regarding standard-setting, enforcement, and constitutionality.

id., Nov. 24, 1968, § 4, at 5 (full-page ad sponsored by the Campaign to Check the Population Explosion).

157. See Golding, *Ethical Issues in Biological Engineering*, 15 U.C.L.A.L. Rev. 443 (1968); Grad, *Legislative Responses to the New Biology: Limits and Possibilities*, 15 U.C.L.A. L. Rev. 480 (1968); Wald, *The Evolution of Life and the Law*, 19 *CASE W. RES. L. REV.* 17 (1967); Hardin, *The Tragedy of the Commons: The Population Problem has no Technical Solution, It Requires a Fundamental Extension in Morality*, 162 *SCIENCE* 1243 (1968).

158. See, e.g., *N.Y. Times*, Oct. 5, 1969, at 51, col. 1; *id.*, Sept. 22, 1969, at 31, cols. 3-7.

159. *N.Y. Times*, Sept. 22, 1969, at 35, col. 4. See *Wall Street J.*, Dec. 3, 1968, at 20, col. 4; *N.Y. Times*, Dec. 15, 1968, at 55, col. 1; *Cleveland Plain Dealer*, Sept. 4, 1968, at 20, cols. 1-2 (Report of the 19th Annual Meeting, American Institute of Biological Sciences, at Ohio State Univ., Sept. 4, 1968); *Cleveland Plain Dealer*, May 23, 1968, at 53, cols. 1-8. See generally P. EHRLICH, *THE POPULATION BOMB* (1968); P. EHRLICH & A. EHRLICH, *POPULATION, RESOURCES AND ENVIRONMENT: ISSUES IN HUMAN ECOLOGY* (1970).

160. See text accompanying notes 107-117 *supra*.

In measuring [noise], three characteristics of sound are significant. First, sound cannot be separated from its environment. Therefore, when a noise-meter measurement is made, the one sound being measured cannot be isolated, and the reading is affected by all the sounds in the area. A meter reading is also affected by the physical nature of the surroundings and by atmospheric conditions. Second, since sound intensity is a function of distance, a decibel reading is meaningful only when the distance from the noise source to the microphone is reported. Third, the decibel is a limited standard of measurement; *i.e.*, it only registers the intensity of, or pressure created by, sound waves. Yet the offensiveness of noise varies with the frequency as well as with the intensity of sound. Thus, two noises which register the same number of decibels on a meter can sound louder or softer to the hearer, depending on pitch.¹⁶¹

The traditional type of anti-noise ordinance, which merely limits noise that is "excessive or unusual," may be attacked as unconstitutional on grounds of arbitrariness and vagueness. The new "decibel limit" laws, while establishing an objective standard and thus avoiding the vagueness problem, may provide additional problems of enforcement. It is almost impossible to conduct measurement tests on crowded highways because of noises from other vehicles and outside sources. More research is needed to determine the maximum noise levels for our modern urban environment, and the multitude of legal problems, outlined earlier, must be attacked before the decibel-limiting laws can become a truly viable solution.

3. *The Quieting Process.* In the area of noise pollution man has two alternatives: he can attempt to abate the unwanted and disruptive noise which pervades his habitat, or he can attempt to adjust and adapt to ever-increasing levels of noise. People become accustomed to a steady noise level or familiar sounds and tend to adjust themselves and their lives to these otherwise unwanted noises. Where convenient, chemical pollution—of the air, water, and food—noise pollution, and light pollution will be sufficiently controlled to prevent the kind of damaging effects that are immediately disabling and otherwise obvious. "Human beings will then tolerate without complaints concentrations of environmental pollutants (whatever their nature and origin) that they do not regard as a serious nuisance and that do not interrupt social and economic life."¹⁶²

However, man's ability to adapt to the "quality" deterioration of his environment has ominous implications. It is probable that continued exposure to even low levels of toxic agents and pervasive noise will eventually result in a great variety of delayed or latent pathological manifestations, creating physiological and psychological misery.¹⁶³ Behaviorally, a similar slow mental

161. Note, *supra* note 79, at 111-12 (footnotes omitted).

162. Dubos, *Adapting to Pollution*, 10 *SCIENTIST & CITIZEN* 1, 3, Jan.-Feb. 1968.

163. [T]he worst pathological effects of environmental pollutants will *not* be detected at the time of exposure; indeed they may not become evident until several decades later. In other words, society will become adjusted to levels of pollution sufficiently low not to have an immediate nuisance value,

disintegration may result from noise-induced cognitive dissonance, thus giving impetus to what has been characterized as the mass societal neuroses. Insanity and irrationality scales are based on *current* relative deviations from what is considered "normal" behavior. The frightening aspect of slow societal trends towards what at an earlier time would have been considered irrational is that typically neurotic behavior of an earlier time may slowly become the normal and therefore acceptable level of behavior of a current or future stage of civilization or de-civilization. What is *degeneratus* at Time One may be accepted as *sapiens* at Time Two.

One way for our society to maintain its relative long-term sanity is to shift to a completely controlled environment. The elephants at Windsor Park Zoo in London have been fitted and are wearing noise-mufflers on their ears.¹⁶⁴ Soon those members of our society that can afford them will be wearing "space-helmets" which can filter out toxic impurities in the air and control the amount of noise that enters the wearer's head. Automobiles in the United States are already being fitted with air purification systems and are so constructed as to minimize the intrusion of outside traffic noises. "The ultimate long-term objective in environmental control should be to manage society in such a manner that these products of its activities can be recycled so as to become useful again, instead of being wasted and thereby added to environmental pollution."¹⁶⁵ Such futuristic city planners as Dr. Athelstan Spilhaus have already designed smokeless, noiseless, and trafficless cities with completely controlled environments and recycling systems.¹⁶⁶

CONCLUSION

It is obvious that laws and their just application could provide an effective coercive force for noise pollution abatement. Zoning is an important part of urban environmental planning, and it is applicable to noise pollution as well as such other environmental noxae as air and water pollution.¹⁶⁷ Legal compensation for hearing loss, mental disturbances, and invasion of one's right of quiet can also stimulate change in the noise level of our urban and industrial environments. Moreover, our civilization has the technology and resources to abate disturbances from unwanted noise. The ineffectiveness of present solutions to the quality deterioration of our habitat nevertheless indicates the need for re-evaluating both the methods used and the goals desired in environmental law.

but this apparent adaptation will eventually cause much pathological damage in the adult population and create large medical and social burdens.

Id.

164. N.Y. Times, Oct. 17, 1969, at 45, col. 8; *id.*, Sept. 28, 1969, at 80, cols. 4-7.

165. Dubos, *supra* note 162, at 6, citing Spilhaus, *The Experimental City*, DAEDALUS, Fall 1967, at 1129.

166. See, e.g., N.Y. Times, Dec. 31, 1967, § 4, at 7, cols. 1-7; Spilhaus, *supra* note 165.

167. See A. BELL, *supra* note 4, at 103-105; C. W. Kosten, *Establishment of Zones and the Right For Quiet*, in PROCEEDINGS OF THE SECOND INTERNATIONAL CONGRESS FOR NOISE ABATEMENT, Salzburg, 1962.

Future environmental programs must be synoptic in their approach; no small facet of our complex cultural and technological system can be overlooked without incurring the hazards of latent dysfunctionality, the long-term disruptive and unwanted consequences of policies which attempt to solve polycentric problems and which otherwise, at least in the short-term, appear functionally viable solutions to immediate socio-economic problems.¹⁶⁸ Today many of the central ecological issues are essentially "legal" in nature, but the success of any legal policy for environmental control must ultimately be evaluated in terms of its long-term effects. To help make this evaluation, lawmakers must turn to the science of human ecology. Human ecology is still a young science where advancements "depend in part on mutual understanding and cooperation among social and natural scientists and humanists, and in part on the development of new methods for studying interacting processes in complex systems."¹⁶⁹ Lawyers and legal scholars can and must participate in this cooperation and development if legal solutions are to be successful.

The types of solutions necessary to avoid the impending environmental crisis will obviously place great strains upon basic political and economic axioms. Such concepts as zero population growth¹⁷⁰ and no "no-growth economy"¹⁷¹ require a shift in values away from quantitative and toward qualitative criteria. The most fundamental questions concerning our environmental crisis, therefore, are ethical ones: Will a national policy of negative population

168. "A problem is 'polycentric' when it involves a complex of decisions judgment upon each of which depends upon the judgment to be made upon each of the others." H. HART & A. SACKS, *THE LEGAL PROCESS: BASIC PROBLEMS IN THE MAKING AND APPLICATION OF LAW* 669 (tent. ed. 1958). For a legal example of latent dysfunctionality because of only unidimensional success in socially engineering a change in female mobilization in Central Asia, see Massell, *Law as an Instrument of Revolutionary Change in a Traditional Milieu: The Case of Soviet Central Asia*, 2 *LAW & SOC'Y REV.* 179, 221 (1968). See generally MERTON, *Social Problems and Sociological Theory*, in *CONTEMPORARY SOCIAL PROBLEMS* 697 (R. Merton & R. Nisbet eds. 1961); *FUNCTIONALISM IN THE SOCIAL SCIENCES: THE STRENGTH AND LIMITS OF FUNCTIONALISM IN ANTHROPOLOGY, ECONOMICS, POLITICAL SCIENCE, AND SOCIOLOGY* (D. Martindale ed. 1965).

169. *N.Y. Times*, Jan. 12, 1970, at 75, cols. 3-6. See also Hardin, *supra* note 157.

170. A population rate growth of zero occurs when the number of births equals the number of deaths. Obviously, any program to reach this end, would clash with the "right to propagate." Compare *Skinner v. Oklahoma*, 316 U.S. 535 (1942), with *Buck v. Bell*, 274 U.S. 200 (1926). Professor Kingsley Davis, director of international population and urban research at the University of California and an advocate of the zero population growth concept, has stated that such a drastic reduction in births would necessarily require not only a change in existing laws but also absolute government regulation of the size of families—a concept that most nations have found impossible to accept. "In a more Orwellian guise," writes Davis, "such control might include pressure through limits on availability of housing, manipulation of inflation to force mothers to work, increased city congestion by the deliberate neglect of transit systems, and increased personal insecurity through rigged unemployment." *TIME*, Nov. 24, 1967, at 70. See Davis, *Population Policy: Will Current Programs Succeed?*, 158 *SCIENCE* 730 (1967).

171. The concept of a "no-growth economy" was discussed extensively at a recent meeting of the United States Commission for UNESCO held in San Francisco, Calif., on November 24-28, 1969. Basically, the concept means of repudiation of the tenet of bigness and perpetual economic expansion for the more optimal and qualitative concern for the ultimate consumer and the environment in general. See *N.Y. Times*, Nov. 28, 1969, at 26, cols. 2-5; *id.*, Jan. 11, 1970, § 12, at 22, col. 1; *id.*, April 12, 1970, § 1, at 40, cols. 3-4.

growth or of negative economic growth enhance the freedom of human beings as individuals, and will it enhance justice for all human beings as members of society? "These two ethical ideals of individual freedom and distributive justice often are, or seem to be, more or less incompatible. The task of law-givers throughout history, however, has been to strike a workable balance between them."¹⁷² So it must be as we prepare to meet our environmental crisis.

Environmental destruction has always been an aesthetic problem, but today it also involves the survival of mankind as a species. In the area of noise pollution, we are not dealing only with the maintenance of our own sanity, but also with the mental well-being of our children and our society as a free and rational civilization. To paraphrase Arthur Schopenhauer,¹⁷³ the amount of noise which any civilization can bear undisturbed stands in inverse proportion to its mental capacity, and may therefore be regarded as a pretty fair measure of it. Our ability to meet our environmental crisis may be a test of our intelligence and ultimately a test of the survival of our species.

172. N.Y. Times, Jan. 12, 1970, at 75, col. 6. (Article by Dr. Roger Revelle, Richard Saltonstall Professor of Population Policy and director of the Center for Population Studies at Harvard University).

173. A. SCHOPENHAUER, *On Noise*, in 2 THE WORLD AS WILL AND IDEA 199 (H. Haldane & J. Kemp trans. 1844).

I. BASIC GENERAL REFERENCES

1. NOISE POLLUTION

Author: Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, United States Senate, 92nd Congress, March 24, 1972 and April 12 and 13, 1972.

Publisher: USGPO, Washington, D.C., Serial # 92-H35 (604 pp; \$2.50) 1972.

Level: Popular, for the most part, with some semi-technical papers submitted for the record.

Point of View: These hearings were held to gather background information on noise pollution. Testimony was taken from industry and consumer representatives and from academic researchers and government policy personnel.

Summary: Three noise pollution bills were under consideration by Congress at the time of these Hearings: S. 1016, "a bill to control the generation and transmission of noise detrimental to the human environment," introduced at the request of the Nixon Administration; S. 3342, "a bill to amend Title IV of the Clean Air Act", co-sponsored by Senators Tunney and Muskie; and H. R. 11021, "a bill to control the emission of noise detrimental to the human environment," passed in February, 1972 in the U.S. House of Representatives. The text of each bill is included at the beginning of these Hearings and much of the testimony which follows isolates and criticizes the various provisions associated with them. There are three main questions to which the legislation and, therefore, the Hearing testimony, is addressed: (1) Should the regulation of aircraft noise emission be in the hands of the Administrator of the FAA (as it has been to date) or the EPA; (2) Should the Federal government develop ambient noise criteria; and (3) Should Federal standards of new product noise emission preempt independent and possibly stronger legislation at the state or municipal level.

California, being markedly ahead of the rest of the nation in terms of noise pollution legislation, is the site of the first day's Hearing. Testimony is provided by Robert Moretti, Speaker of the California Assembly, briefly outlining California's progress in this area and concluding on a note that occurs again and again throughout the testimony of state and local officials: "Any language preempting California's enforcement role in noise pollution [should] be deleted from the legislation". Speaker Moretti is followed by Frank Lanterman, a member of the California legislature who has long been active in the area of noise pollution. Lanterman, speaking in support of S. 3342, strongly supports curtailment of Federal preemption and outlines several noise suppression considerations which have con-

fronted California's special technical advisory panel on motor vehicle noise. These include: the importance of keeping noise surveillance procedures simple and inexpensive, of coupling ambient noise standards with strong, effective, single-source standards, and of recognizing the basic fact that a standard is no better than the test which is used for enforcement. Noise from diesel trucks and vehicle tires is briefly discussed, as is the idea of a noise level emissions tax on motor vehicles as an alternative to new product standards.

A brief but useful document, "Quiet City Report", prepared by the Los Angeles Quiet City Committee, is included here. It contains a quick overview of the noise problems in cities, specific recommendations directed at urban noise control, a model noise ordinance, and a short discussion of airport noise. Among the appendices to the report are two of particular interest: a brief bibliography and an outline of the sources of noise pollution.

Testimony then turns to the issue of the psychological and physiological effects of environmental noise and includes remarks by two of the leading research scientists in this area: Dr. Karl D. Kryter, of the Stanford Research Institute, and Dr. Donald Belt, of the Stanford Medical Center. Dr. Kryter's testimony is focused on the need for establishing improved Federal guidelines as to the criteria for acceptable noise levels and Dr. Belt addresses the need for improved public education and the establishment of a large scale longitudinal study of hearing and environmental noise, such as that begun two years ago with the development of an audiological data bank at Stanford Medical School.

The California segment of the hearings concludes with remarks by State Deputy Attorney General Nicholas C. Yost, reiterating the dangers of Federal preemption in pollution control, and two testimonies addressed to the issue of aircraft noise: that of James K. Carr, director of Airports, San Francisco Airport Commission, and that of Randall L. Hurlburt, Environmental Standards Supervisor, City of Inglewood, California. Mr. Carr's testimony is in support of Federal preemption for regulation of aircraft engine noise and of retaining FAA preeminence in the setting and enforcement of such standards. Mr. Randall, on the other hand, urges establishing the EPA as the authority in the setting of aircraft noise standards and summarizes the feeling of many FAA critics with the remark that, "...making the FAA responsible is like putting the fox in charge of

1. "POLLUTION" (cont'd)

the chicken coop." Several papers prepared by the City of Inglewood, a city which is plagued with a serious aircraft noise problem, are included here: "Noise Control, Legislation, and Enforcement", "The Ten Point Action Program for the Alleviation of Noise Pollution in Inglewood, California", "Community Noise Control: Training Guide and Enforcement Manual", "Noise Control Experience in Local Government" and "Aircraft Noise Effects on Property Values". Brief testimony on motor vehicle and aircraft noise is given by various California State officials and a very good summary introduction to the problem of noise control, "A Report to the 1971 Legislature on the Subject of Noise....", is appended to this segment of the Hearings.

The remainder of the Hearings consists of two days of testimony in Washington, D.C., the first of which is given over to testimony by government agency officials and the second, to a day of testimony by representatives and lobbyists for the various industries which would be directly affected by Federal noise pollution legislation. By far the most important testimony of the first day's hearing in Washington is that provided by Thomas Carroll, Assistant Administrator for Planning and Management, EPA, and Dr. Alvin F. Meyer, Jr., Director, Office of Noise Abatement and Control. For the main part, their testimony is in support of the administration bill (S. 1016) and critical of the Tunney-Muskie bill (S. 3342). In particular, the EPA strongly supports Federal preemption in the area of noise pollution regulation and sides with the administration in contending that primary responsibility for setting, monitoring and enforcing aircraft noise standards should remain with the Administrator of the FAA and should not be transferred to the EPA. Appended to their testimony is a very useful paper, "Additional Information Supporting EPA Statement on Noise Control Legislation....," which reiterates the administration's position and provides point by point rebuttal to the critics of Federal policy in this area. A glossary of terms common in noise pollution literature is included. Representatives of the Environmental Defense Fund, the National Governors Conference, and the National League of Cities, U.S. Conference of Mayors, conclude the day's Hearings offering support for S. 3342, the Muskie-Tunney bill, and criticism of the administration's position.

Finally, the last day of Hearings is given over entirely to industry spokesmen, with representatives from each of the following groups appearing: International Snowmobile Manufacturers Association, Automobile Manufacturers Association, Engine Manufacturers Association, Rubber Manufacturers Association, Uniroyal Tire Company, Construction Industry Manufacturers Association, Airport Operators Council International, Heavy Duty Truck Manufacturers Association, International Harvester Company, and the Air Transport Association. Their testimony is uniformly in favor of Federal preemption and, where applicable to their industry, of retaining FAA control over aircraft noise standards. In addition, the various industry representatives are concerned that export products be excluded from any restrictive U.S. noise standards and that controls not be applicable to products manufactured prior to the date of legislative enactment. There is a wealth of correspondence included in support of their position.

Four particularly interesting documents appear in the appendix to these Hearings: "Aircraft and Noise: The Retrofitting Approach", a 1972 Library of Congress Congressional Research Service Report; a letter from Wm. O. Ruckelshaus, EPA Administrator, to Senator Randolph, outlining the EPA's views on S. 3342; the report of a UCLA study, "Jet Aircraft Noise Over Residential Areas", and a short paper prepared by the National Organization to Insure a Sound-Controlled Environment (NOISE) on "Aircraft Noise Pollution and the Need for Federal Legislation." All in all, this volume provides an excellent introduction to the issues and problems associated with noise pollution and is especially useful as a primer on the policy questions involved in trying to legislate in the area of environmental pollution.

2. REPORT TO THE PRESIDENT AND CONGRESS ON NOISE

Author: Report of the Administrator of the Environmental Protection Agency in compliance with Title IV of Public Law 91-604, the Clean Air Act Amendments of 1970, February 1972.

Publisher: USGPO, Washington, D.C. (400 pp; \$1.75) 1972. Senate Document No. 92-63; GPO Stock #5500-0040 (NTIS #PB-206716, \$6.00).

Level: Popular; Prepared as a background document for legislators at the Federal and local levels; illustrated; numerous tables.

Point of View: "Title IV of PL 91-604, signed into law on December 31, 1970 by the President, directed that the Environmental Protection Agency conduct a "full and complete investigation and study of noise and its effect on public health and welfare" and to report, within 1 year, the findings to Congress. To those ends, authorization was given to the Administrator to hold public hearings and to conduct research, experiments, demonstrations and studies.... The result of these extensive efforts is this report to the President and the Congress of the United States."

Summary: As a primer on noise pollution, this brief report has several factors to recommend it. One cautionary note is in order, however; generalities abound and, while the report provides a good overview of most facets of noise pollution, it is in no way a definitive or source document. What it does provide, and in a well organized, readable format, is a condensation of numerous EPA Technical Information Documents and a useful summary of the material presented in the series of eight national public hearings held by EPA in selected cities across the country. (Many of the

documents and, in fact, each of the hearings, are reviewed separately in this packet, making this a particularly useful report for our purposes here).

There are six chapters in all: Effects of Noise Pollution on Living Things and Property; Sources of Noise and Their Current Environmental Impact; Control Technology and Estimates for the Future; Laws and Regulatory Schemes for Noise Abatement: Government, Industry, Professional and Voluntary Association Programs; and An Assessment of Noise Concern in Other Nations. Three appendices follow, one providing a listing of the source documents used in preparing the report, another containing the text of "a proposed bill to control the generation and transmission of noise" (essentially, S. 1016 as debated in Ref. I-1) and the last providing a list of participants in the various Public Hearings on Noise. Finally, a brief but useful glossary of noise pollution terms is provided.

The chapter treatments are somewhat uneven, reflecting both the established areas of emphasis for research in noise pollution and, to a lesser degree, the quality of testimony provided in the individual hearings. Not surprisingly, the sections on aircraft noise and control technology (the main areas of noise investigation at the Federal level for some years) contain the most definitive data. Other areas, particularly effects on living things and industry efforts to quiet consumer products, point to areas where a great many basic questions remain unanswered. In sum, reading this report will serve two useful purposes: it will provide a good, general introduction to the "state of the art" in noise pollution and it will set in context many of the documents which form the core of this packet.

3. NOISE POLLUTION: THE UNQUIET CRISIS

Author: Clifford R. Bragdon, Environmental Specialist with the Bio-Acoustical Division of the U.S. Army Environmental Hygiene Agency and Associate Professor of City Planning at the Georgia Institute of Technology.

Publisher: University of Pennsylvania Press, Philadelphia, 1970 (280 pp; \$15.00).

Level: Semi-popular; numerous graphs and tables; bibliography.

Point of View: "The attitudes of society have allowed noise to become an environmental problem of sizeable proportion... Society, through its technology, has created

noise and has continued to tolerate it, with only sporadic attempts to control it... In a period of urban living where noisiness breeds noisiness, it is important to re-educate the population to the virtues of quiet."

Summary: There are really two books here: one, a very good introduction to the community noise problem and the means of measuring it, and the other a case-study report of a community noise study conducted by the author in and around Philadelphia, Pennsylvania. Altogether, it is a most satisfying combination and should prove a particularly useful handbook to the general reader, whether as "concerned citizen" or

3. "NOISE POLLUTION: THE UNQUIET CRISIS" (cont'd)

as a student of environmental engineering. Bragdon writes easily and clearly and demonstrates an attention to pedagogy that is generally lacking in the literature in this area.

Chapter 1, "Community Noise as a Social Problem" provides an excellent overview of the many factors which combine to create and sustain community noise pollution. Particular attention is paid to the shortcomings of Federal policy in this area and to the kind of government-industry interactions which tend to minimize environmental considerations.

In "What is Noise?" Bragdon examines the perception of noise and provides a remarkably clear and concise summary of the characteristics of noise and of the means of measuring it. It is a short chapter, but the reader will carry away from it a good, basic understanding of the difference between sound intensity and frequency, between Hertz units and decibels, and between the various scales and indices used for measuring particular sound sources. The figures, graphs and tables provided here are especially useful in establishing comparisons of the sound from various sources, and the equations and conversion mechanisms are clearly explained and exemplified.

Effects of noise pollution, "Nuisances and Hazards", are examined in Chapter 3. The main focus is on physiological effects and Bragdon briefly reviews the major research findings in this area. Some attention is paid to psychological effects and to the subtle interferences, invasion of privacy, task performance, etc., which are less well understood and researched. Finally, a section is directed to a discussion of the damage to physical objects and some interesting data is provided on the cost of sonic boom damage.

All of this material is introductory to the discussion of the Philadelphia noise survey which is really the central focus of Bragdon's book. The three chapters devoted to the survey (The Design of the Community Noise Survey; Analysis of Sound and Its Sources; and Community Response) provide an excellent and readable

summary of the kind of community noise analysis that is well within the range of current technology. The methodology is carefully outlined, research procedures are described in some detail and, perhaps most important, careful attention is paid to describing the measurement procedures and equipment. There is a wealth of useful information in these chapters. For the citizen who wants to know what can be done to quantize the noise problem in his area, or for the student interested in designing a community noise survey project, these three chapters are an invaluable resource.

Finally, in "Quieting the Crisis" Bragdon examines some of the possible solutions to the noise pollution problem. These range from proposing a new system for rating environmental health to an outline of new approaches to community noise management and a variety of architectural design recommendations.

Appended to the body of this document are several useful items. Appendix A contains the Community Questionnaire used in the Philadelphia Survey and Appendix B is an alternately humorous and maddening compilation of the noise control claims contained in the national advertising of various consumer products. (The automotive manufacturer claims are particularly interesting when compared to the actual test data provided by Bragdon in Chapter 1.) It is a well documented book, replete with informative chapter notes, but of particular value is a Bibliography, containing more than five hundred references arranged in six categories: Noise, General; Physical Effects; Psycho-Social Effects; Law: Noise Abatement; and Noise Sources. In short, it is an expensive book, but well worth the investment.

4. THE NOISE AROUND US

Author: Report of the Panel on Noise Abatement to the Commerce Technical Advisory Board, U. S. Dept. of Commerce.

Publisher: U. S. Dept. of Commerce (NTIS: COM 71 00147; 294 pp.; \$6.00) Sept. 1970.

Level: Popular; designed as background document for govern-

ment officials and primer for the general public.

Point of View: Policy oriented; the main charge to this Panel was to recommend potential Federal initiatives in the noise pollution area and the body of the report is simply support data for the Panel's suggestions.

Summary: As a background document, this report

4. "THE NOISE AROUND US" (cont'd)

suffers from the tendency to generalize and, in the process, lose clarity. For someone who knows little or nothing about the physiology of hearing, the rationale behind the various acoustical measurement scales, etc., the explanations here will really not be of much help. Many topics are touched on, but few are developed in a cohesive, instructive way. There is something in each of eight main areas: the nature of noise, causes of noise pollution, deleterious effects of noise, noise receivers, technology and application abatement and control, economics of abatement and control, legal aspects of noise pollution, and strategies for achieving noise abatement and control. There is some interesting descriptive material here, in particular those sections which deal with the technology and application of noise abatement and control and strategies for achieving that control, but much better coverage of that kind of material, is provided in Ref. I-2.

The report does have several strong points, however, and is a useful reference document, not so much for the body of the text, as for the material which is appended to it. In particular, a very useful bibliography, containing 674 references, has been included here. References are provided under ten main headings and the list includes a good sampling of government technical reports, journal articles, and papers addressed to rather specialized areas (i.e. effects of noise on task performance, impulse noise, annoyance and community response, etc.) not specifically covered in this packet.

Appendix A, which consists of excerpts from the Walsh-Healey Public Contracts Act "Relating to Scope and Duration of Occupational Noise Exposure", provides a very useful and time-saving service for anyone interested in a quick review of Federal legislation relating to industrial noise exposure

levels. The two remaining appendices focus on state and local noise ordinances, one providing a sampling of local ordinances classified as to their legislative sophistication, and the other detailing the California Motor Vehicle Code noise regulations, one of the strongest in the country.

Finally, this is essentially a policy document and its real focus is on the set of twelve recommendations which introduce the report. These are addressed to the following areas: Institutional changes to enhance interaction between noise producers and receivers; hearing conservation; research; development of criteria and measurement methodology prior to standard setting; and means to achieve quiet products and production processes. While there is nothing startling in all this, the report does conclude on a very positive, action-oriented note:

Noise abatement and control can be carried out, if the citizenry so desires, in order to create an improved quality of life. It is not necessary to prove that noise adversely affects health or welfare. Similarly, objective criteria for measurement of noise can be established in the absence of complete understanding of the subjective response to noise. Working standards can be implemented on the basis of existing knowledge and then refined, if necessary, when further research results have been obtained.

For an even more popularized summary of the Panel's report, the reader should see "The Noise Around Us: Findings and Recommendations" (USGPO: 24 pp; \$.50; Sept. 1970), an illustrated pamphlet prepared by the Commerce Department.

5. NOISE-SOUND WITHOUT VALUE

Author: Committee on Environmental Quality of the Federal Council for Science and Technology.

Publisher: USGPO, Washington, D. C. (56 pp.; \$.60) September 1968.

Level: Popular.

Point of View: "This report reviews the dimensions of noise in our society and the responsibilities of the Federal agencies concerned with noise abatement. The report has been reviewed by the agencies concerned and endorsed by the Federal Council for Science and Technology."

Summary: This is one of the first government documents to address the problem of noise pollution and, while it is written on a level which makes it of limited use as a reference document, it does reflect the kind of policy considerations that marked the Federal government's initial interest in this area. The discussion is divided into three areas: Outdoor Noise, Indoor Noise, and Occupational Noise. Little is provided in any area beyond a very general summary of the problems involved and the kinds of Federal activities which either are addressed to their solution or which the panel recommends should be initiated. References used in preparation of the report are cited in a brief bibliography, but most

5. "NOISE-SOUND WITHOUT VALUE" (cont'd)

of them are quite dated now. Perhaps the most interesting feature available here is the list of recommendations in the final section. These are grouped under five headings: Research, Federal Standards, Intergovernmental Actions, Education, and Federal Coordination. In short, this is a useful reference for the general reader who wants a quick, popular level summary of the issues involved in the

noise pollution problem. It is not, however, aimed at a thorough review of the subject and, while it appears without exception in noise pollution bibliographies, it should not be looked to as a substantial reference work in this area.

6. INDUSTRIAL NOISE MANUAL

Author: American Industrial Hygiene Association.

Publisher: American Industrial Hygiene Association, 14125 Prevoist, Detroit, Michigan 48227 (171 pp; \$15.00) Second Edition, 1966.

Level: Semi-Technical; numerous graphs and illustrations; references at end of each chapter.

Point of View: The Noise Committee of the AIHA prepared this manual as a guide for the industrial hygienist in the implementation of a comprehensive hearing conservation program. The focus is on three areas: (1) the physical measurement of noise; (2) the medical evaluation of persons exposed to it; and (3) the control of noise exposure.

Summary: This is by far the most technical of the background references reviewed here and, as an operating manual for the industrial hygienist, it necessarily also has a markedly narrower focus. Designed to provide a basic background in the technology of noise control, the manual contains much information not easily available elsewhere, but it does so at the expense of excluding such pertinent topics as policy, economics, etc. Nonetheless, this is a valuable document for the reader desiring a review of the engineering technology currently available in noise control programs.

There are twelve chapters in all, the first five of which deal with the various aspects of the measurement of sound: Physics of Sound, Instruments for Sound Measurement, Technique of Sound Measurement, Noise Surveys, and Vibration. A fairly sophisticated mathematical background is assumed and close attention is paid to the details of actual measurement procedures and to the specifications of the various instruments involved. Photographs of the basic equipment are provided.

The medical aspects of noise in industry are examined in the next four chapters: Anatomy and Physiology of

the Ear, Effects of Noise on Man, Hearing Measurement, and Medical Aspects of Industrial Hearing Conservation. This section is particularly well-illustrated and contains much useful data on various exposure levels, criterion curves, etc.

The remaining chapters, by far the bulk of the book, focus on noise control. In "Personal Protection," the authors provide both a discussion of maximum attenuation criteria and a guide to the selection and fitting of the various protective devices (earplugs, earmuffs, etc.) available. "Engineering Control" then examines the broader area of designing for quiet in plant construction and modification of noise sources in existing buildings. Examples of several modifying techniques are provided along with several tables showing data on sound transmission loss of general building materials and structures, sound absorption coefficient of materials, etc. Almost all of the equipment discussed is shown in photographs or illustrations and the measured quieting effect of each is displayed in accompanying graphs and tables. Finally, in "Legal Aspects of the Industrial Noise Problem", a very brief discussion of workmen's compensation is provided and a paragraph or so is directed to an explanation of each of several legal issues, such as impairment vs. disability, factoring for loss of hearing with age (prebycusis), accidental injury vs. disease, allocation of liability, etc. A short appendix includes a few guidelines on meter reading, a four-place logarithmic table, and a brief but useful glossary of terms.

7. NOISE

Author: Leo L. Beranek, Chief Scientist and founding partner of Bolt, Beranek and Newman Inc., a consulting, research, and development firm involved in environmental engineering.

Publisher: Scientific American 215: 66-76, December 1966.

Point of View: "It is clear that the basic problem is essentially incurable; noise is an unavoidable price we must pay for a machine civilization. But if we cannot eliminate the noise of modern technology, we can at least control it to minimize its effects."

Level: Popular; several graphs and illustrations.

Summary: Noise control is really the main focus of this article, but in setting the framework for a discussion of abatement technology, Beranek first provides a brief summary of the magnitude of the noise problem, its effects on man, and the methods of noise measurement which enable engineers to assess noise levels and intensity.

Known effects of noise on hearing capacity are reviewed in terms of noise standards and frequency levels, and a useful graph of comparative noise intensities of a variety of common sounds is provided. The problem of determining measurable psychological effects from noise exposure is briefly discussed and Beranek concludes by noting that, while psychological effects are the most difficult to standardize, "We should not minimize the annoyance effect of noise. Some physiologists assert that annoyance is a biological protective mechanism (like the discomforts of fatigue, hunger, or cold) that impels the organism to avoid noise as it does other signals of disturbance."

The body of the article then deals with what has been done to control noise and what might be done in the

future. The need to set standards for tolerable noise levels is again underscored, and Beranek reviews the levels suggested by the American Standards Association and compares them to some existing industrial noise levels and to those proposed by the Council of State Governments. Finally, a scale developed at Bolt, Beranek, and Newman, Inc., the speech-interference level (SIL) is described and the criteria derived from using that scale applied to an examination of background noise levels in the home and office.

Building noise, vehicular noise, and the potential impact of the SST on the noise environment are reviewed in separate sections, each of which contains a brief summary of the kinds of controls, Federal and State, operating to regulate these noise sources. Beranek concludes the article with the admonition that, "We could improve the quality of our environment enormously by allocating a portion of our energy and wealth to controlling noise. . . It appears that we shall have to pay these costs if we are to make a tolerable adaptation to the noises of civilization."

8. NOISE IN THE ENVIRONMENT

Authors: Peter A. Franken and Daniel G. Page, Bolt, Beranek and Newman, Inc.

Publisher: Environmental Science and Technology 6 (2): 124-129, February, 1972.

Point of View: "...Noise can be controlled, and much of the technology required for noise control is presently available. By properly applying existing technology, advance planning, and appropriate considerations in designing vehicles, machines, and buildings, a substantial amount of relief from noise

could be provided at relatively small cost."

Level: Popular; illustrated.

Summary: For the most part, this is a discussion of noise control, but it does contain sufficient interesting information on such other aspects of the noise pollution problem as effects, land use, and measurement, to make it a valuable general reference. A brief discussion of the trend toward increased noise pollution introduces the article, followed by several paragraphs addressed to the problem

8. "NOISE IN THE ENVIRONMENT" (cont'd)

of understanding the various units and scales used in noise measurement. In "Effects of Noise", the authors deal briefly with noise exposure levels and stress the importance of speech interference as a criterion. A table showing the noise intensity of various community sources is provided. Land use planning is put forward as "one of the most appealing approaches to the community noise problem", and the discussion of its potential includes a brief treatment of acoustic planning tools and the kind of improvements that can be made in community noise levels by using noise forecasting techniques in the siting of highways and airports. The advantages of this approach are briefly outlined and the obvious limitation is cited: "it does not improve the existing situation." The authors believe that there are ways to improve the current state of

noise pollution, however, and the next section of the article deals with specific improvements that could be made in several areas: vehicles, aircraft, residential noise, construction equipment, etc.. Finally, regulatory steps are examined and existing ordinances in several cities are evaluated. The limitations of such legislation are briefly noted and the authors conclude by re-affirming their argument that the technology for noise control exists: "What is primarily needed now is to begin applying, on a broad scale, the knowledge that is already available."

9. SOUND POLLUTION: ANOTHER URBAN PROBLEM

Author: Peter A. Breysee

Publisher: The Science Teacher 37 (4): 29-34, April, 1970.

Point of View: "A major effort will be required to solve the noise-abatement problem. It will be mandatory that many facets of our society--private, industrial, governmental, educational and technical--assume greater responsibility in the quest for a quieter city."

Level: Popular; several graphs.

Summary: This is a much more quantitative article than the other journal articles here and its value lies in the attention the author has paid to explaining, though very briefly, the physics of sound and the various measuring scales used in noise monitoring. Several useful graphs accompany this section of the article. With that background established, Breysee then moves to a discussion of the effects on man of exposure to noise and briefly notes both the psychological and physical problems that have been substantiated by research. Aircraft noise is isolated as a particularly serious aspect of the problem and brief attention is paid to the implications of proposed SST flight. The concluding paragraphs here are addressed to the question of what can be done about noise. Several common aspects of nuisance and zoning laws are examined and the author notes that "a review of most of these codes and laws indicates that they are usually ineffective or unenforce-

able." Several recommendations are then offered and the article concludes with the following admonition: "Community noise must be recognized and accepted as a major factor in urban planning and development. For this to be accomplished, it would be necessary to establish uniform standards and criteria for evaluating and controlling noise. . . . Appropriate local, state, and federal legislation must be forthcoming in order to support and effect compliance with standards; the manufacturers of mechanical equipment for all phases of use, domestic and industrial, must be made aware of the need to produce quieter equipment; construction costs must also recognize the need for acoustic treatment in homes and buildings."

II. LEGISLATION AND POLICY

1. LAWS AND REGULATORY SCHEMES FOR NOISE ABATEMENT

Author: Prepared by the Program of Policy Studies in Science and Technology of The George Washington University under EPA Contract 68-04-0032.

Publisher: USGPO, Washington, D.C. (NTID300.4; 409 pp.; \$5.50). NTIS #PB-206719; \$9.00.

Point of View: "...the primary task of the PPS/GWU Study Group was to conduct a survey of the existing regulatory structure and to make a tentative assessment of the effectiveness with which such regulations are administered and enforced. However, in sections 2, 3, and 4 certain provisional suggestions are made which should provide guidance in the further development of environmental noise abatement programs at the Federal, State and local levels."

Level: Non-technical; mostly descriptive with some sections providing a listing of various noise codes as they appear in the law.

Summary: As a basic reference tool in the area of noise legislation there is nothing to compare with this volume for clarity and comprehensiveness. There is certainly much more here than might be needed by the non-professional, but the authors have gone to great effort to assure good organization and careful annotation of all their material.

Several introductory pages outline the rationale and procedure of the study, summarize the significant findings and conclusions and point out, for brief exposition, the most persistent problems in the regulation of environmental noise. As an organizational device, the basic assignment, and hence the report, was divided into four areas or "sub-tasks": (1) Current Governmental Noise Regulatory Schemes; (2) Analysis of Existing Legal Regulatory Structure for Noise Abatement and Control; (3) The Effectiveness of Existing Noise Control Regulation; and (4) Proposals and Problems in the Regulation and Abatement of Noise. In a further attempt to add to the usefulness of this document, an analytical framework, the "Illustrative Regulatory Matrix for Environmental Noise Abatement and Control", was developed to facilitate the analysis of judgement questions inherent in the problem of controlling environmental noise: i.e., what noise can best be abated at the source; what noise can best be regulated through reduction of effects, etc.

The body of the report then focuses on specific areas

within the first two "task" sections. Subsections within Section 1, "Current Governmental Noise Regulatory Schemes", provide an excellent summary of existing Federal policy and legislation. This general policy outline is followed by specific treatment of each of the major noise sources (transportation, industry and construction) and the Federal regulations applying specifically to them. Trends and gaps in the Federal program are then briefly summarized. Finally, the same noise-source breakdown is used to outline detailed discussions of noise sources regulated at the state level (with specific state codes cited) and noise sources regulated at the regional level.

Section 2, "Analysis of Existing Legal Regulatory Structure for Noise Abatement and Control", examines the authority behind existing legislation and provides a generic framework for a close examination of the various regulatory schemes. Several "illustrative" cases are provided, with the main focus in this section being on the question of distribution of authority among Federal, State and Local jurisdictions. Aircraft noise regulations are then examined in some detail and a concluding sub-section lumps all the non-aircraft noise together for an examination of the kind of rationale behind regulatory schemes at the private and community action level.

The effectiveness of all this Federal, State and local regulation is examined in Section 3. Again, aircraft noise regulations come under particularly close scrutiny, with most of the State discussion focused on California legislation. Highway noise and occupational noise are also dealt with separately. The local level sub-section provides a useful review of general noise laws along with some discussion of zoning ordinances and building codes.

Finally, Section 4 addresses "Proposals and Problems in the Regulation and Abatement of Noise." Separate sub-sections deal with aircraft, vehicular, construction, and domestic noise. Within each area the major continuing problems are identified and recommendations made toward their alleviation. An Appendix to the report provides a fold-out series of pages illustrating with charts existing Federal, regional, state and local noise regulations.

2. ENVIRONMENTAL NOISE CONTROL ACT OF 1972

Author: Report of the Committee on Public Works, United States Senate, Together with Minority Views, to accompany S. 3342.

Publisher: USGPO, Washington, D.C., September 19, 1972 (Report #92-1160; 54 pp.; not for sale.)*

Point of View: "Noise - unwanted sound - is increasing in urban areas at a rate which may double the average person's exposure to it within 10 years. Testimony before the Subcommittee on Air and Water Pollution indicates clearly that the impact of noise goes well beyond mere unpleasantness, stress, and other psychic effects. It in fact may cause serious physiological effects on the human body ranging from deafness to enhanced risk of cardiovascular disease to alteration of fetal nervous systems."

Level: Popular; reports such as this are routinely provided to the Congress to accompany a Committee's endorsement of pending legislation.

Summary: This is clearly an advocate document, prepared to support the Committee on Public Works in its recommendation for passage of the bill, "to amend Title IV and to add a new Title V to the Clean Air Act". As such, however, it provides a convenient summation of the arguments and support data which detail the need for Federal legislation to curtail the noise pollution problem. Much of this report is, in fact, a brief summary of the testimony provided the Committee during the 1972 hearings on this and related bills (See Ref. 1-1). The body of the report, however, is focused on section-by-section analysis of the pending legislation in terms of its rationale and provisions and a discussion of logistical factors, such as the cost of the proposed legislation. An opening "General Statement" briefly outlines the magnitude of the noise pollution problem and stresses the need for Federal regulation of the problem. In "Major

Provisions", those areas which were hotly contested during the Hearings (i.e., preemption, standards, and authority over aircraft noise regulation) are gone into separately and the final resolution explained. Finally, in the "Minority View" section, dissenting opinions are aired, in the form of a brief essay on the shortcomings of the bill (as provided in a very interesting paper contributed by Senator Muskie) and in a collection of correspondence from industry representatives, etc. While there really is no substitute for a thorough reading of the Hearings themselves, this report does provide a summary of the main issues surrounding noise control legislation and a quick review of the arguments supporting Federal intervention in this area. As for the value of the legislation itself, after some twenty pages of strong support for the Senate bill, there is Senator Muskie's closing comment: "But the Administration wants a bill. Environmental Protection Agency Administrator, William P. Ruckelshaus, told the Committee on Public Works in executive session in September of this year, that he was not interested in the merits or the demerits of noise pollution legislation which might be forthcoming. He said the Administration wants a bill and he did not care what provisions that bill included."

3. NOISE CONTROL ACT OF 1972

Author: 92nd Congress

Publisher: USGPO (Public Law 92-574; 17 pp.; \$.15) October 27, 1972.

Point of View: "The Congress declares that it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare. To that end, it is the purpose of this Act to establish a means for effective

coordination of Federal research and activities in noise control, to authorize the establishment of Federal noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products."

Level: Non-Technical; this is simply the text of the Federal legislation.

*See Appendix B, Paragraph 4.

3. "NOISE CONTROL ACT OF 1972" (cont'd)

Summary: Passed in February of 1971, this first comprehensive noise control law empowers the Federal government to establish emission standards for all noise sources that the Administrator of the EPA "determines to be a threat to the public health and welfare." Other provisions of this legislation include a citizen suit clause (identical to those in the Clean Air Act), EPA authority to require labeling of products as to their noise generation characteristics, and the establishment of the EPA as the coordinator for all Federal noise programs. This includes aircraft noise initiatives, but only in so far that the EPA can recommend regulations which the FAA may, after proper consideration (public hearings, etc.), "either adopt, modify or reject. . . consistent with FAA's mission to ensure the highest degree of safety in air commerce." Funds totaling \$21 million, distributed over a 3 year

period, are authorized to carry out the provisions. The following categories are dealt with separately under the wording of this legislation: Findings and Policy, Definitions, Federal Programs, Identification of Major Noise Sources, Noise Criteria and Control Technology, Noise Emission Standards for Products Distributed in Commerce, Aircraft Noise Standards, Labeling, Prohibited Acts, Enforcement, Citizen Suits, Records Reports and Information, Research, Technical Assistance and Public Information, Development of Low Noise Emission Products, Judicial Review: Witnesses, Railroad Noise Emission Standards, and Motor Carrier Noise Emission Standards. (A condensation of this act, "Summary of Noise Control Act of 1972" (EPA 335) is available free of charge from: US EPA, Office of Public Affairs, Washington, D. C. 20460).

4. SUMMARY OF NOISE PROGRAMS OF THE FEDERAL GOVERNMENT

Author: Several; compilation of reports submitted to EPA by the various Federal agencies having noise programs.

Publisher: USGPO, Washington, D.C. (NTID300.10; 400 pp.; \$3.75) December 31, 1971.

Point of View: "It is recognized that this document represents information collected in response to a specific inquiry and is basically a byproduct of the much broader report to the President and Congress. However, in view of the varied and qualitative nature of the collected data, this report was prepared to better inform representatives of government and the private sector as to the significant achievements and directions of Federal noise programs."

Level: Semi-technical; varies from report to report; some graphs and tables.

Summary: In addition to the EPA, there are seventeen Federal agencies with at least minor programs in the area of noise abatement and control. What this document provides is a basic introduction to which agencies are doing what, the size of the various programs, and some detail as to the specific problems as they are addressed on an agency-by-agency basis. Though not particularly inspiring reading, the basic data is here, making this a useful reference document on how individual agencies perceive their own programs. Some of the highlights of each agency program are identified in the opening section, "Efforts of Other Agencies" and

the text of this summary is further summarized in an accompanying table, which provides a quick guide to the budget for the programs in the various agencies. As the material for this document was gathered in response to a standardized questionnaire, data from each agency falls into roughly the same categories: Organizational, Functional (program objectives, procedures, etc.), Fiscal (current program, personnel, contracts and grants, etc.), and Regulation and Certification (authority and responsibilities, actions taken to implement regulation and certification requirements.) Several of the attachments appended to the various agency reports are of particular interest: "Guidelines to the Department of Labor's Occupational Noise Standards", "Operational-Procedural Noise Reduction Flight Program", "Transportation Systems Center Technical Progress Report", etc. In short, while this is not the most readable document in the EPA noise series, it is clearly a valuable reference work for the reader seeking an overview of the role of the individual agencies which share responsibility for the Federal noise program.

5. NOISE POLLUTION AND THE LAW

Author: James L. Hildebrand, Editor

Publisher: William S. Hein and Co., Inc.,
Buffalo, New York (354 pp.; \$25.00) 1970.

Point of View: "It is hoped that this selection of articles will not only provide a valuable source of reference for private individuals, students and teachers, as well as public and local authorities who are concerned with noise pollution and its abatement, but that it will also stimulate those who are authorized to deal with the increasing nuisance caused by noise to acquaint themselves with the problem and with the legal means to effectively remedy intrusions by this new environmental pollutant."

Level: Semi-technical; the articles in this collection have been taken from various law journals.

Summary: As the author notes in the preface, this is the first book concerning noise pollution and the law to be published in the United States. It contains thirteen articles which have been reprinted from assorted law journals and grouped under three headings: Noise and the Law, Aircraft Noise, and Sonic Boom. Throughout, the quality of the writing is consistently good, with the articles within each section progressing from a rather general nature to a specific treatment of one aspect of the noise problem, a progression which reflects the overall organization of the book itself.

Part I is introduced by "The Noise Crisis", a very general but useful article by Donald Antrop which provides a characterization of the noise problem; what it is, where it comes from, and how it's measured. "Noise and the Law" (George Spater) follows, providing a summary of court cases to date and a close look at the important question of the apparent immunity of government-authorized entities from legal action for objectionable noise. "Urban Noise Control" then looks at the problem on the municipal level and provides a review, first of the various effects of noise pollution, and then of the existing remedies and legislative solutions as provided under the two standard types of city ordinances: general anti-noise or nuisance codes and the more quantitative decibel laws. Finally, "Noise Control: Traditional Remedies and a Proposal for Federal Action" (James Kramon) examines three areas of federal involvement: public contracts, federal-aid highways, and public buildings. Kramon concludes by stating that "... thoughtful remedial steps can encourage responsive technological developments and thereby reduce the need for reliance on remedies that have proven to be ineffective."

Section 2, "Aircraft Noise," again provides, first, a general overview of the problem, and then four articles which examine specific elements of the problem: "Aircraft Noise - as a Taking of Property", "Liability for Aircraft Noise: The Aftermath of Causby and Griggs", "Noise Litigation at Public Airports", and "Jet Noise in Airport Areas: A National Solution Required." Issues addressed in this group of articles include the problem of setting aircraft noise standards, regulation of airline glide paths, compensation to landowners affected by aircraft noise, and the formidable constitutional question of compensation for the "taking of property" by the intrusion of aircraft noise. The articles in "Sonic Boom", the third and final section in the book, deal with sonic boom as an inevitable source of noise litigation and attempt to outline several approaches which might be taken to establish clear legal provisions before the problem reaches too great proportions. The first article in this section, "Sonic Boom: Containment or Confrontation" (Anthony Ortner) reviews the results of the series of tests conducted by the U.S. government between 1961 and 1965 and provides a concise summary of the technical problems involved in the control of sonic boom. Four legal aspects are examined: strict liability, trespass, nuisance and taking, damage and proof of cause, and unknown defendant. Several recourses are briefly noted and the conclusion drawn that, "... legislation is needed to identify government as the responsible control agency, responsible for damages and empowered to settle claims."

A particularly clear, well-illustrated discussion of what a sonic boom is and how it is produced, is provided in the next article: "The SST: From Watts to Harlem in Two Hours." Effects on people and property are described, again with the aid of numerous illustrations, and the article concludes with a summary of the legal aspects involved and a series of fairly explicit recommendations regarding the regulation of sonic boom. In "Sonic Booms: Ground Damage and Theories of Recovery", H. Lloyd Relley examines the guidelines for recovery under the Federal Tort Claims Act and under existing insurance coverage provisions. Potential suits against commercial airlines are discussed in terms of possible legal avenues for compensation and the author concludes that: "Since supersonic transports will cause certain inevitable damage, the airlines should be required to pay their own way. Since the traveling public is demanding supersonic aircraft, it should bear the ultimate cost for the actual physical damage to property, which inevitably follows, through the increased

5. "NOISE POLLUTION AND THE LAW" (cont'd)

fares which the airlines will be forced to charge on supersonic flights."

The final article, "Sonic Booms: Tort Liability", is focused on the various theories of recovery open to claimants under the Federal Tort Claims Act (FTCA); negligence, trespass, nuisance and unconstitutional taking. The significance of the United States v. Gravelle decision is discussed and the author concludes that: "In view of the general principle that operators of ultra-

hazardous activities are held strictly liable, the operators of supersonic aircraft should stand as insurers for all damages proximately caused by sonic booms." The text of "Control and Abatement of Aircraft Noise and Sonic Boom" (P.L. 90-411) and of Senate Report No. 1353, a report prepared to accompany that bill, are included as chapter 14.

6. COMMUNITY NOISE ORDINANCES: THEIR EVOLUTION, PURPOSE AND IMPACT

Author: Clifford R. Bragdon, Associate Professor, Department of City Planning, Georgia Institute of Technology, Atlanta, Georgia Institute of Technology, Atlanta, Georgia, 30332.

Publisher: Paper presented at the 74th National Meeting of the American Institute of Chemical Engineers, New Orleans, Louisiana, March 13, 1973. (To be published in Proceedings of the Meeting).

Point of View: "In the United States most municipal noise ordinances initially regulated street activities, however, these early provisions were generally non-quantitative and consequently unenforceable. . . . Today more comprehensive ordinances are evolving and these regulations are the basis for expanded municipal noise control programs. Their impact has varied due to the quality, content and administration of these ordinances. Recently approved Federal noise legislation (Noise Control Act of 1972) will have a profound influence on the quality and quantity of municipal ordinances."

Level: Non-technical.

Summary: This is a very readable, well-documented summary of the role of community noise ordinances in the control and abatement of noise pollution. A brief history is provided at the outset of the major, precedent setting ordinances, dating from the 1938 motor vehicle control ordinance adopted by Memphis, Tennessee. Noting that, ". . . the majority of city governments have no noise provisions, and many of those enacted are generally non-specific and vague", Bragdon briefly analyzes those

which do exist as either nuisance type laws or performance type (zoning regulations). Their impact is then assessed in terms of annual expenditure, in money and man-hours, and incidence and type of citizen complaints registered. Data to support the generalizations made in this section is provided in a two-page table, one detailing municipal noise abatement expenditures and the other providing a breakdown of noise complaints, based on data from the Department of Environmental Control of Chicago, Illinois. Federal impact on the quantity and content of local noise laws and programs is then examined, and NEPA (the National Environmental Policy Act) is isolated as having the greatest influence in this area. Two appendices are provided: one charting city noise control regulations by type, as to acoustical criteria, and one providing a quick summary of the provisions of the 1972 Noise Control Act.

7. COMPILATION OF STATE AND LOCAL ORDINANCES ON NOISE CONTROL

Author: Hon. Mark Hatfield, U.S. Senator from Oregon.

Publisher: Congressional Record 115: 32178-32259, October, 29, 1969.

7. "COMPILATION OF STATE AND LOCAL ORDINANCES ON NOISE CONTROL" (cont'd)

Point of View: "...the pollution of our land, air, and water has become such a problem that we are now faced with a situation which, if not met immediately and with all of the creativity and ingenuity of our age, could mean the extermination of all forms of life in many areas of our planet. As yet, noise has not reached this proportion, but given the present noise increases in our environment the same threat could soon prevail in noise pollution that does in air and water contamination -- and by soon I mean within our lifetime."

Level: Non-technical

Summary: For the most part, this is precisely what the title says it is -- simply a straightforward listing of the noise ordinances as they appear in the various state and local laws. The compendium is introduced, however, by a paper titled, "The Legal Aspects of Noise Control", by James J. Kaufman, a New York lawyer long active in the noise pollution area. It is a very useful reference in itself, containing a detailed discussion of airport noise legislation, an analysis of Federal involvement in noise litigation (particularly the FAA), and a good, general summary of

existing state and local noise legislation. A brief concluding section summarizes the impact of current legislation and provides a set of six recommendations for the direction of future policy decisions. The "Point of View" quoted above is taken from the remarks of Senator Hatfield prior to introducing both the Kaufman paper and the ordinance compendium into the record. Regrettably, there has been no attempt to categorize the various statutes in any way and the reader is left with a very lengthy alphabetical listing by state, which makes for forbidding reading. It is a very useful reference document, however, for anyone seeking quick information of the statutes operating in a particular state. Hatfield also included two useful reprintings from earlier issues of the Congressional Record: one, the Federal Occupation noise exposure regulations and the other, the text of the FAA "Noise Standards: Aircraft Type, Certification".

CROSS REFERENCES

1. "Laws and Regulatory Schemes for Noise Abatement", in "Report to the President and Congress on Noise", (Ref. I-2).
2. "Legal Aspects of the Industrial Noise Problem", in Industrial Noise Manual, (Ref. I-6).
3. "It's Time to Turn Down All That Noise", (Ref. I-11).
4. "Noise Control", (Ref. VIII-10).
5. "Recommended Standards for Occupational Noise Exposure", (Ref. VIII-11).
6. "Interstate Motor Carrier Noise Emission Standards" (Ref. VIII-12).
7. "Legal and Institutional Analysis of Aircraft and Airport Noise", (Ref. V-2).
8. "Community Noise Problem: Factors Affecting Its Management", (Ref. VII-1).
9. "Toward a Quieter City", (Ref. VII-3).

III. ECONOMICS

1. ECONOMIC ASPECTS OF NOISE POLLUTION

Author: Irwin Feller and Jon P. Nelson, Center for the Study of Science Policy, Institute for Research on Human Resources, University Park, Pennsylvania.

Publisher: USGPO (159 pp.; \$6.00; NTIS #DOT TST-73-3) April 1973.

Point of View: "This report is directed at (1) assessing recent developments in the theoretical discussion of externalities, particularly as they relate to the formation of public policy concerning aircraft noise; (2) developing a micro-economic framework for noise as a commodity; (3) evaluating existing empirical studies on the costs of aircraft noise; and (4) evaluating the applicability of the theoretical and empirical literature to emerging public policy on aircraft noise, as reflected in existing federal legislation."

Level: Technical; some tables and graphs; references.

Summary: Essentially, this is a technical examination of the considerations which enter into benefit-cost analysis economics. It is a complex, scholarly paper, clearly written to the understanding of fellow economists. Also, in consideration of the scope of this packet, it is a somewhat narrow reference, dealing only with aircraft noise. Despite these limitations, however, this is an extremely valuable reference and well worth the

time required for its reading.

The report begins with a "summary and conclusion" section, which provides a state-of-the-art assessment of the theoretical and empirical literature on the economic aspects of noise. Recommendations are offered for potential policy formulations, given the limitations of knowledge in this area. The general nature of externalities is the subject of the next chapter, and the focus is on the various issues relating to how an economic system can respond to these externalities in terms of efficiency and equity criteria. The "simple" model of externalities provided here is useful in that it represents the analytical framework that has been employed in most public political analyses of environmental issues.

Chapters 4, 5 and 6 provide a micro-economic framework for treating noise as a purchasable commodity, a discussion of "Empirical Studies of Pollution and Property Values", and further elaboration on traditional welfare economics. A number of useful tables and figures appear throughout the report, along with many suggestions for further reading.

2. THE ECONOMIC IMPACT OF NOISE

Author: The National Bureau of Standards, under inter-agency agreement.

Publisher: USGPO, Washington, D.C. (NTID 300.14; 104 pp.; \$1.00) December 31, 1971. NTIS #PB-206726; \$3.00.

Point of View: "A study has been undertaken to survey the economic impact of noise. Data available on the entire subject of noise and its abatement are so rudimentary that they do not lend themselves to even the most primitive economic analysis."

Level: Non-technical; numerous tables and graphs appended to the report.

Summary: Several factors recommend this as a particularly useful reference on the economics of noise pollution. To begin with, it is a document based on fact, not speculation, and a careful reading will not only tell you most of what is known about the economics of noise pollution, but will suggest as well reasons for the scarcity of data and areas where research is most needed.

In the first section, a brief assessment of the state-of-the-art in noise pollution economics is provided and the authors suggest several reasons for there not being better data available: the nature of noise itself (rapid "decay"), the fact that effects associated with noise exposure are

neither as dramatic nor immediate as those associated with other pollutants, and the existence of a public attitude that seems to view noise as nothing more than the "price of progress."

An examination of the growth rate of environmental noise is provided in Section II and it is clear from the data discussed that noise pollution is growing at an alarming rate, both in terms of a rapid percentage growth rate and in terms of increases in the absolute number of noise sources. These various sources are examined separately in the next three sections. Aircraft noise receives the most attention, partly because that is where the research has been done and, therefore, where the best data exists, and partly because that is the area where citizen complaints and law suits have been focused.

In an effort to examine the magnitude of the aircraft noise problem, several aspects of the problem are examined in some detail: cost, as reflected in specific airport case studies; costs of easements as compensation to property owners; awards made as a result of litigation against airports, the growth rate of suits against aircraft noise, construction and relocation costs for schools effected by noise from aircraft, etc. Various schemes for abating aircraft noise are briefly discussed and an estimate is provided of the potential savings which could be

2. "THE ECONOMIC IMPACT OF NOISE" (cont'd.)

realized by controlling aircraft noise. It is recommended that, when all the cost data available is considered, the best approach to aircraft noise control is to focus on means to reduce noise at the source.

Ground transportation and residential equipment are then analyzed as noise sources and one of the main problems isolated in this discussion is the lack of definitive data to support noise control measures. Several studies of individual noise sources within each category are noted and it is clear that, to date, most of what is known is applicable only on a product by product basis.

"Spending on Noise Abatement" is one of the more enlightening sections of the report and provides a summary of data on expenditures by both government and private sources. The data on private expenditures is extremely spotty, but it is suggested that one reason for that is simply that not much has been done to date. As to government spending, it is almost exclusively aircraft

related (95% in 1970 and 85% in 1971) with very little money being spent outside the NASA "quiet engine" program and attempts to quiet the SST.

Several recommendations are included at the end of the report as to areas where research is most needed: analysis of effects of noise standards on the competitive position of US products in foreign markets, effects in terms of product quality and quantity, effects on property value, estimates of the economic costs and benefits of alternative means of measuring noise and alternative means of enforcing allowable noise standards. An extensive appendix, containing data on growth rates of various products and associated noise generation, is provided along with a brief but useful bibliography.

3. TECHNOLOGY AND ECONOMICS OF NOISE CONTROL

Author: Public Hearings on Noise Abatement and Control (Vol. VIII), conducted by the EPA Office of Noise Abatement and Control, Washington, D. C., November 9-12, 1971.

Publisher: USGPO, Washington, D.C. (515 pp.; \$2.00) 1971 (Stock No. 5506-0056).

Point of View: "Under the Noise Pollution and Abatement Act of 1970... the EPA, through the Office of Noise Abatement and Control, is required to hold public hearings. A series of eight of these hearings was conducted in selected cities to aid the Office of Noise Control and Abatement in compiling information relevant to its investigation of the problem of noise pollution. Further, these hearings present an opportunity for the public and industry to express their viewpoints on the general subject of noise control."

Level: Popular; some tables and graphs.

Summary: This is a fairly impressionistic treatment as far as the actual economics of noise pollution is concerned. Most of the testimony here falls into one of two categories: either private citizens and citizen groups pleading for some governmental action to quiet the environment, or industry representatives (mostly engine and equipment manufacturers) explaining why it is so difficult to control noise and how costly such attempts would probably be to the consumer.

It is clear that there simply isn't enough known about the costs of noise abatement to enable anyone to make a definitive statement about what could reasonably be done in this area.

Again, the best data relates to aircraft noise, but the record here is spotty and, at times, bewildering. Representatives from the Boeing Company, Pratt and Whitney, American Airlines, and the Northrup Corporation provide testimony outlining their R and D efforts in the area of aircraft noise abatement and providing some figures as to what it all has cost. Part of the problem, as they describe it, is that existing antitrust laws prohibit their working together to seek a solution to the noise problem. Their results on a company by company basis have been disappointing, at a cost that is impressive, but difficult to really pin down as it's not clear exactly what is included in their bookkeeping for "noise research". What is clear is that, left to their own devices, the airline industry is going to move reluctantly in this area, and at great expense. What incentive there is will have to come from the FAA, an agency often accused of taking it's mandate to foster commercial aviation with an enthusiasm that overlooks such problems as aircraft noise. At any rate, one need only read the testimony provided by the Boeing Company to realize what a complex and frustrating task it will be to get any real progress in the control and abatement of aircraft noise.

3. "TECHNOLOGY AND ECONOMICS OF NOISE CONTROL" (cont'd)

Motor vehicle noise, which includes diesel trucks, motorcycles, and passenger cars, is another large chunk of the noise problem addressed in these hearings. There are no uniform, Federal standards in this area, making enforcement of any industry noise regulations close to impossible. What incentive does exist seems to be in the PR value of selling "quieter" cars, but that quiet is relative only to those inside the car, while the real problems are left relatively untouched. Some states, like California, have fairly sophisticated noise codes which control things like motorcycle noise, but as the representatives from Harley-Davidson and American Honda make clear, the motorcycle industry sees noise as a consumer, not a manufacturer problem. They claim to be making reasonably quiet products and contend that the problem is in the purchaser making modifications to the product, modifications, however, which are often made by using "racing" equipment produced by these same manufacturers. The engine manufacturers argue that placing noise standards on engines is prohibitive to noise control efforts as it reduces the flexibility available to those who must work to quiet the entire end-product, the car or tractor or whatever the engine is to become a component of. Several industry lawyers testify to the unreasonableness of asking manufacturers to comply with "arbitrary and ad hoc" standards and at least one testifier, from General Testing Lab, notes that the incentive to quiet products must come externally; there simply isn't sufficient incentive within the various manufacturing industries to support noise control R and D. The agricultural equipment people take a slightly different tact, maintaining that they have their own industry-wide

standards, through things like the Nebraska tractor testing program, and the EPA needn't involve itself in their business. In the end, it all comes down to everyone agreeing that motor vehicle noise is a serious environmental problem, but everyone seeing it as someone else's problem and not one that warrants Federal standards being applied to their products. While the feeling expressed here is a sort of intuitive one that the cost of noise abatement will be prohibitively expensive to the consumer, it is clear that there really isn't sufficient data available to make any reliable estimate in that area possible.

Several individual papers included here provided particularly useful information: "The Economics of Noise Pollution" (pp. 18-30), "Some Sources of Noise from Motor Vehicles and Possible Action for Control" (pp. 71-78); "Summary, Noise Reduction Research and Development" (pp. 117-143); "Truck Tire Noise" (pp. 365-437); "Economics of the Construction Industry" (pp. 451-464) and the statement of the President of the American Institute of Planners on land use planning as a means to control environmental noise. All in all, these hearings make for interesting, but often frustrating, reading and, while they fail to provide much in the way of useful data on the problem of noise pollution control and abatement, they do capture the complexity of the problem of determining where the responsibility for general research initiatives and monies in this area lies.

4. THE COSTS AND ECONOMIC IMPACTS OF ENVIRONMENTAL IMPROVEMENT

Author: Report of the Council on Environmental Quality

Publisher: Chapter 8 (pp. 269-309) in Environmental Quality, the third annual report of the Council on Environmental Quality (Washington: USGPO) August 1972.

Point of View: "Like any reallocation of resources, the investment to achieve environmental quality will bring about short-run adverse impacts, i. e., higher prices, temporary unemployment, and plant dislocations. Matched against these negative results are the investments' dividends, such as decreased health bills, increased recreational opportunities, diminished damage to materials, and better maintenance of the ecological balance necessary for human survival."

Level: Popular; several tables and diagrams.

Summary: The importance of this article is not that it has any definitive data on the economics of noise control

and abatement (it doesn't), but that it provides an overview of the economic assumptions and methodology into which noise data will eventually be fitted for analysis. Noise, in fact, is viewed here as a very small element in the overall pollution picture. Most of the economic studies that have been done to date on environmental pollution have focused on three areas: air pollution, water pollution, and solid waste. Noise is but one of the "other" environmental pollutants, estimated to be no more than 3% of the cumulative environmental impact problem. In fact, the Council notes that: "There are no comprehensive estimates of the cost of lowering noise to more environmentally acceptable levels. Such costs will vary depending on the levels established and the classes of noise sources included."

What the Council has provided here, however, is a fairly detailed description of the kind of economic analysis that has led to the establishment of environmental cost

4. "THE COSTS AND ECONOMIC IMPACTS OF ENVIRONMENTAL IMPROVEMENT" (cont'd)

estimates in other pollution areas, most notably air and water pollution. It is clear that, for the near future at least, this same methodology will be carried into the analysis of other cost estimates, noise pollution included, and for that reason it is useful to have some familiarity with the procedures outlined here. The report begins with a discussion of the costs of environmental controls, total and incremental, and of the impact of control costs on the economy. The main focus, however, is on an analysis of the series of economic impact studies conducted by the EPA "to begin to develop a better understanding of the nature and order of magnitude of the adverse impacts of environmental regulations on the economy as a whole and on individual industries and segments within the economy". There are twelve studies in all: eleven "microeconomic" studies and one "macroeconomic" study. The cost definitions and assumptions associated with each are briefly described and a summary of the findings in each study provided. The overall conclusion reached by the Council, and one

which has clear implications for the future of noise control and abatement, is that the economy can absorb the costs of pollution control without any serious loss. The microeconomic studies, in fact, are summarized as indicating that "none of the industries studied would be severely impacted in that the long-run viability of no industry is seriously threatened solely by the pollution abatement costs estimated" and the macroeconomic study" indicated that the national economy will not be severely impacted by the imposition of pollution abatement standards."

In short, while there is no definitive analysis yet available of the cost impact of noise pollution abatement and controls, it is possible to see from these studies on related areas the kind of factors and assumptions which will effect the future of noise pollution policy.

CROSS REFERENCES

1. "Economics of Noise Abatement and Control", in The Noise Around Us, (Ref. I-4).
2. "It's Time to Turn Down All That Noise", (Ref. I-11).
3. "The Concorde SST", (Ref. VI-4).
4. "Public Hearings on Noise Abatement and Control: Construction Noise", (Ref. VII-8).
5. "Aircraft Noise Effects on Property Values", in (Ref. I-1), Noise Pollution.
6. "Effects of Noise Pollution on Property", in Report to the President and Congress on Noise, (Ref. I-2).
7. "Economic Aspects of Noise Abatement", in Report to the President and Congress on Noise, (Ref. I-2).
8. "Summary of Noise Programs of the Federal Government", (Ref I-4).
9. "Manufacturing and Transportation Noise", (Ref. IV-6).

IV. SOURCES OF NOISE POLLUTION: GROUND TRANSPORTATION

1. TRANSPORTATION NOISE AND NOISE FROM EQUIPMENT POWERED BY INTERNAL COMBUSTION ENGINES

Author: Prepared by Wyle Laboratories under contract for the EPA Office of Noise Abatement and Control.

Publisher: USGPO, Washington, D.C. (NTID. 300.13 370 pp; \$3. 75) NTIS #PB-208660; \$6.00) 1971.

Point of View: "This report has been prepared by Wyle Laboratories for the Environmental Protection Agency in response to the directives contained in the Clean Air Amendments Act of 1970, specifically, section 401, "Noise Pollution and Abatement Act of 1970." It forms part of the major study accomplished by the Office of Noise Abatement and Control, of the EPA, which is summarized in its report to Congress."

Level: Semi-Technical; numerous graphs and tables; extensive bibliography; technical background material appended.

Summary: This is an excellent overview reference on transportation noise, written in a readable, concise manner with careful attention to background data and documentation. To provide a clear understanding of the significance of noise from the various sources, several aspects of each are considered: nature and economic significance of the industry associated with the source; basic noise characteristics of each type of source; environmental noise attributes of each type of source; past and present efforts toward reducing noise; and estimated potential noise reduction for the future with today's technology.

Aircraft noise is examined first, with separate sections focusing on commercial aircraft, V/STOL aviation, and general aviation aircraft. The whole chapter runs to nearly 100 pages and there are numerous graphs, tables and illustrations included to supplement the text.

Briefer chapters follow on highway noise, rail systems, ships and recreational vehicles. The same general cut is taken through the available data as was done with aircraft noise and the reasons which operate to impede industry efforts to control vehicle noise are carefully summarized. The sections on rail, ship and recreational vehicles are particularly useful as data on these sources is much harder to come by than is that for motor vehicles and aircraft. Rapid rail transit is handled separately from conventional, locomotive rail noise and some very useful data is included on noise levels being achieved in the newer metro systems. Ship noise is treated rather briefly, mostly because the only significant noise environment is the area within the ship itself and levels

there have long been kept at an admirable "Lower than 65dB(A) level." "Recreation vehicles", however, provides a rather lengthy treatment of some of the favorite culprits in the environmental noise area: motorcycles, pleasure boats, snowmobiles, and several off-road vehicles. The growth rates here, both in terms of noise level increase and number of source units sold per year, are alarming, but numerous alternatives are suggested as means to alleviate this problem while it is still of controllable size.

The remainder of the report deals with various devices powered by small internal combustion engines (generators, lawn care equipment, chain saws, model airplanes, etc.) and the discussion here ends on an encouraging note: "The combined effort by the public in demanding quieter products powered by internal combustion engines and successful response to this demand by the manufacturers, should provide a substantial decrease in annoyance from this equipment."

With the background data on noise characteristics and reduction potential established in these first three chapters, the report is then directed to a consideration of the environmental impact associated in an overall way with transportation vehicles and small internal combustion engines. The relative contribution of each of the source categories is estimated and their relative contribution to the outdoor noise level in average urban residential areas is assessed. Some data is then provided as to potential impact of each source on the community and the potential hazard, in terms of hearing damage and speech interference, associated with each source. All of this is presented in a readable, well-illustrated section which runs to some fifty pages and a detailed discussion of the methods and sources of data used in carrying out this impact analysis is presented in Appendix B. Appendix A provides a useful summary of various noise standards (FAR-36, SAE, California Code, etc.) and appendix C reviews noise generator characteristics for jet engine noise, propeller and rotor noise, internal combustion engine noise, and tire noise. An extensive collection of references is scattered throughout the report and a brief "Conclusion and Recommendations" section provides a useful summary of four areas of the environmental noise problem: noise impact on people, interaction between public and industry, Federal action to reduce source noise, and recommendations for noise reduction. All in all, this is an excellent reference document on transportation noise, well-suited for use by professionals and non-professionals alike.

2. TRANSPORTATION NOISES: A SYMPOSIUM ON ACCEPTABILITY CRITERIA

Author: James D. Chalupnik, Assoc. Prof. of Mechanical Engineering, University of Washington, Editor.

Publisher: University of Washington Press, Seattle, Washington (362 pp; \$14.50) 1970.

Point of View: This book is based on a symposium entitled "Evaluating the Noises of Transportation" held at the University of Washington, March 26-28, 1969, sponsored by the Office of Noise Abatement, Department of Transportation.

Level: Varies from paper to paper, but technical, for the most part; numerous graphs and tables and bibliographies appended to several papers.

Summary: The list of symposium attendees appended to this book reads like a who's who of acoustical research people. While the purpose of the symposium was to address the problem of establishing a uniform scale for evaluating transportation noises, in the process of discussion and analysis, just about every scientific-engineering aspect of the noise problem is touched on: Transportation Noise Sources (aircraft surface, and community noise levels); Scales for Expressing Noise Level (loudness, annoyance, damage risk, etc.); Laboratory Methods for Evaluating Human Response

to Noise; Methods for Evaluating Community Response to Noise; and Relation Between Laboratory Results and Community Response.

Each paper delivered during this symposium (there are 31 in all) is presented on the level of one professional to another and, while every symposium attendee's specialty is not transportation noise, they are, for the most part, the leading professionals in noise research - engineers, medical doctors, physicists, government noise program administrators, etc. In short, quite a sophisticated background in noise research is assumed in this book and it is not easy reading for one new to the area. It is, however, an excellent compilation of state-of-the-art analyses in some of the most important areas of noise control research and, while the hoped for consensus on a noise measuring standard was not achieved during this two-day meeting, what has resulted is an excellent exchange of information between professionals working on diverse aspects of the noise problem. This is a document rich in background data and procedural analysis, containing as well a very useful bibliographic guide to the research literature in the references noted at the end of the various papers.

3. LECTURES IN TRANSPORTATION NOISE

Author: Richard H. Lyon, Professor of Acoustics, Mechanical Engineering Department, Massachusetts Institute of Technology.

Publisher: Grozier Publishing, Inc., Warren Avenue, Harvard, Mass. 01451 (259 pp.; \$20.00) 1973. Available only by mail direct from the publisher.

Point of View: "The lectures approach transportation noise from a traditional noise analysis viewpoint, which considers the three elements: source, path, and receiver. . . it (this book) is intended to provide the reader with information that will help him to understand noise and its effects on people."

Level: Technical; intended for seniors and graduate students in various fields of engineering (numerous illustrations; glossary of symbols; index, appendix).

Summary: Originally presented during the 1970 Spring Term at MIT, the twenty-three lectures published in this volume provide an excellent introduction to the

acoustics of transportation noise. Part analytical, part empirical, the lectures range in approach from the calculation of wave equations to an examination of atmospheric attenuation using laboratory values in predicting propagation losses.

Basic acoustic theory, descriptions of physical concepts, and engineering formulas are dealt with in the first four chapters. While the mathematical background assumed in this section is rather sophisticated, the author notes that "the math is not really essential to much of what follows in later lectures and some readers may want to pass over the somewhat detailed derivations."

Aircraft noise is the subject of lectures 5 through 13, which provide an examination of the generation, propagation, and effects of this particularly important facet of transportation noise. The phenomena of speech interference and annoyance are briefly treated here, with special attention accorded psychoacoustic criteria for aircraft noise and various abatement schemes, such as land use planning.

3. "LECTURES IN TRANSPORTATION NOISE" (cont'd.)

Motor vehicle noise is examined in lectures 14 through 18, with particular attention to noise from automobiles, motorcycles and trucks. Included in the discussion is an examination of the effect of ground surface and topography and how these effects differ from those associated with aircraft.

Finally, the last five lectures, 19 through 23, focus on noise from rail vehicles, both rapid transit and main line rail. The main concern is with ground vibrations, their generation and propagation, and the criteria for their acceptability.

Numerous tables and graphs accompany each of these chapters, making this by far the best source for data on transportation noises, and a brief list of references is appended to each chapter. While there has been no attempt here to discuss transportation noise in an environmental context, this is a most valuable primary reference source on the problem of transportation noise itself and should be of interest to the reader with a science or engineering background.

4. THE EVALUATION OF NOISE FROM FREELY FLOWING ROAD TRAFFIC

Authors: D. R. Johnson and E. G. Saunders, Aerodynamics Division, National Physical Laboratory, England.

Publisher: Journal of Sound Vibration 7 (2): 287-309, 1968.

Point of View: "To determine the effectiveness of any limitations placed on individual vehicle noise output, it is necessary to establish the current levels of noise from road traffic as a reference against which improvement arising from noise restrictions can, in the future, be assessed. . . . Environmental features and differing roadway configurations will influence the observed patterns of noise. The way in which all these factors affect the noise levels in roadway environments needs to be known if valid comparisons of traffic noise are to be made. . . ."

Level: Technical; numerous graphs and tables; same illustrations; references noted.

Summary: Although not published until 1968, this article reports the results of roadside surveys made between 1963 and 1965. It is one of the earliest such studies reported in the literature and one frequently cited in articles and reports on motor vehicle noise.

Much of the first part of the article simply sets forth the procedures used for the study: scope of work, measurement sites and procedures, etc. A brief section deals with simple traffic flow analysis, suggested as a means to indicate the effect on sound intensity of traffic

density and of distance from the roadside. Against this background, extensive analysis is then provided of the survey results under the following headings: unification of multi-lane Traffic Flow, Effects of Velocity, Derivation of Empirical Law, Prediction Chart for Traffic Noise Levels, Corrections Due to Acoustical Environment, Effect of Heavy Commercial Vehicles, Effect of Gradients, Method for Predicting Mean Levels of Traffic Noise and, finally, Total Noise Exposure. The authors note in conclusion that: "Checks made using the present data suggest that the order of accuracy in determining noise exposure is as good as that achieved in predicting mean sound level. Thus, if the concept of total noise exposure embodied in the formula L_{eff} is acceptable, it is now possible to represent the traffic noise that will be produced under any envisaged operating conditions, as a single figure which takes both the factors of level and duration into account." Appendices to the body of the report deal with the mathematics of analysis of single line traffic flow and presentation of data to example traffic noise level prediction.

5. SURVEY OF MOTOR VEHICLE NOISE

Author: N. Olson, Division of Physics, National Research Council of Canada.

Publisher: Journal of Acoustical Society of America 52 (5): 1291-1306, 1972.

Point of View: "Transportation noise, and motor-vehicle noise in particular, account for the steady or slowly varying ambient noise level, particularly in urban areas. Being so numerous, motor vehicles can be treated statistically, and this establishes con-

5. "SURVEY OF MOTOR VEHICLE NOISE" (cont'd.)

sistent noise emission characteristics."

Level: Technical; this is the report of a motor vehicle noise study undertaken by the author; numerous graphs; brief bibliography.

Summary: This is one of the landmark studies on motor vehicle noise and provides data and data analysis on measured noise in the city of Ottawa from passenger cars, trucks, tractor trailers, intercity buses and motorcycles. For each source, a brief description is given of the conditions under which the noise measurements were made and the resulting data is displayed in accompanying graphs. A background knowledge of noise measurement techniques and standards is assured. The author concludes:

"On the basis of the preceding measurements of noise, the statistical properties of any given category of motor vehicle accelerator from a stop or cruising at speeds within a given range, are predictable. Speed and vehicle weight are important parameters governing the noise level. In the case of motorcycles, throttle-setting, rather than speed or weight, is the most important parameter."

Motor-vehicle traffic distributed over the whole

6. MANUFACTURING AND TRANSPORTATION NOISE

Author: Public Hearings on Noise Abatement and Control (Vol. II) Chicago, Illinois, July 28-29, 1971, USE

Publisher: USGPO, Washington, D.C., (300 pp.; Stock No. 5500-00085; \$2.10) 1971.

Point of View: "These hearings were directed ... by the U. S. Congress as part of an extensive effort to develop a record for the President and the Congress on the noise problem as it exists in the U.S. and what is being done about it and what can be done about it so that we may develop recommendations for further Federal action."

Level: Popular.

Summary: Testimony taking during this two day hearing focuses for the most part on two aspects of the noise problem: aircraft noise and to a consideration of the psychological and physiological effects of noise exposure, but only in a rather informal, sidelight way.

The hearings open with some interesting testimony on the noise code in Chicago, both the original 1957 version,

urban area is the major contributor to the ambient noise level at any given point of observation, which follows a more or less regular diurnal pattern in response to traffic. Intermittent noise, local or otherwise which rise above the ambient level, can be regarded as intrusive noises, which, because of the contrast, can be more annoying than the steady ambient noise. In many areas, ambient noise from all sources may be so high that individual sources are masked."

which was a landmark in this area, and the revisions that were made in 1971 after an extensive noise study undertaken by Bolt, Berenek and Newman. Because of Federal preemption in the area of aircraft noise, the Chicago code addresses itself exclusively to vehicle noise and provides a clear set of quantitative standards which auto manufacturers and operators must meet in that city. Aircraft noise, however, is a large part of Chicago's problem, with O'Hare Airport being one of the busiest, and therefore noisiest, airports in the country. This aspect of the noise problem is the focus for the remainder of the first day's hearings.

Five aircraft industry spokesmen provide testimony on the various aspects of the noise problems presented by airports and aircraft. The representative from GE provides a lengthy description of the "quiet engine" program they are participating in with NASA in the production of the CF 6 Engine. The Vice President for Development of American Airlines then provides testimony as to the complex economic, technical and time factors involved in quieting aircraft noise and argues at some length against retrofitting of jet engines as the best solution to the problem. He argues in-

V. SOURCES OF NOISE POLLUTION: SUBSONIC AIRCRAFT

1. CONFERENCE ON AIRCRAFT AND THE ENVIRONMENT

Author: Proceedings of a conference sponsored jointly by the Society of Automotive Engineers (SAE) and the U. S. Department of Transportation (DOT), February 8-11, 1971.

Publisher: Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York, 1001 (2 volumes; 402 pp; \$12/set) 1971. (Check NTIS)

Point of View: "It is the goal of the conference to show us (DOT) how air transportation can be a good neighbor to our social and natural surroundings."

Level: Varies; Semi-technical for the most part; illustrated; numerous graphs and tables; some bibliography.

Summary: These two volumes contain a very useful state-of-the-art summation on just about every aspect of the aircraft-environment problem. They are the product of a two day, joint SAE-DOT conference and reflect some of the best and, certainly, the most influential, thinking that has been addressed to this problem. As is often the case with such conferences, the conclusions and recommendations, requiring, as they do, consensus on short notice, are less than earth shaking. They should not, however, reflect on the value of the conference itself.

There are forty-four papers in all, dealing with every-

2. REPORT ON AIRCRAFT-AIRPORT NOISE

Author: Report of the Administrator of the EPA in compliance with Noise Control Act of 1972, Public Law 92-574.

Publisher: US EPA, July 1973 (To be available from USGPO late in 1973).

Point of View: Report of several studies undertaken by EPA in response to the directive of the 1972 Noise Control Act. These studies were designed to provide background information for setting of EPA regulations to provide such control and abatement of aircraft noise and sonic boom . . . as EPA determines is necessary to protect the public health and welfare."

Level: Non-technical; bibliographies appended to each section.

Summary: This report is part of EPA's response to

thing from the training of acoustical engineers through research on sonic boom, noise reduction operational procedures, engine and airplane design, water vapor pollution of the upper atmosphere, and into public health aspects of noise pollution, legislative remedies, and suggestions as to the role which the federal government should play in all this. In short, there is something and, more often than not, a rather definitive something on everything having to do with the aircraft-environment issue. All of it is well-documented, and much of it is accompanied by illustrations, graphs and tables which provide a quick summation of existing data and help to make this a most valuable reference.

section 7 of the Noise Control Act of 1972. Under that section, the Administrator of the EPA is directed to "conduct a study of the (1) adequacy of Federal Aviation Administration flight and operational noise controls; (2) adequacy of noise emission standards on new and existing aircraft, together with recommendations on the retrofitting and phase-out of existing aircraft; (3) implications of identifying and achieving levels of cumulative noise exposure around airports; and (4) additional measures available to airport operators and local governments to control aircraft noise."

Six task force groups were established early in 1973 and called together for two plenary sessions and four to six working meetings, the last of which was in June 1973. The report of the six groups, collected in this report and published in preliminary fashion in July 1973, are entitled:

2. "REPORT ON AIRCRAFT-AIRPORT NOISE" (cont'd)

- Legal and Institutional Analysis of Aircraft and Airport Noise and Apportionment of Authority between Federal, State and Local Governments
- Operations Analysis Including Monitoring, Enforcement, Safety, and Costs
- Impact Characterization of Noise Including Implications of Identifying and Achieving Levels of Cumulative Noise Exposure
- Noise Source Abatement Technology and Cost Analysis Including Retrofitting
- Review and Analysis of Present and Planned FAA Noise Regulatory Actions and Their Consequences Regarding Aircraft and Airport Operations

- Military Aircraft and Airport Noise and Opportunities for Reduction without Inhibition of Military Missions

This is entirely a descriptive report and includes little in the way of data analysis, graphs, or tables. The summations themselves, however, are quite useful and provide a concise overview of the issues that are central to the Federal aircraft noise abatement initiative. Excellent bibliographies are appended to each chapter. In sum, this is an extremely valuable reference document.

3. FOURTH FEDERAL AIRCRAFT NOISE ABATEMENT PROGRAM, FY 1972-73

Author: Report of the Office of Noise Abatement, Office of the Assistant Secretary for Systems Development and Technology, Department of Transportation.

and flight operational modifications procedures, A good summation of the Federal government's perceived role in aircraft noise abatement is provided;

Publisher: USGPO, Washington, D. C. (72 pp; \$.95) January 1973.

Point of View: "The purpose of this Fourth Federal Aircraft Noise Abatement Program is to assemble in one document brief descriptions of current work to reduce aircraft noise impact. The ultimate objective of the aircraft noise abatement program is the elimination of adverse impact from aircraft noise on airport neighbors."

... the Federal government is not assigning responsibility to determine what maximum aircraft noise levels will be permitted in local communities. Rather the Federal Government's prime effort has been to concentrate on prescribing standards for the measurement and control of aircraft noise in order that aircraft will be as quiet as possible within the constraints of technology and economic feasibility. ... It is not envisioned that the Federal Government will assume responsibility for monitoring aircraft noise in day-to-day operations; however, the Government may publish operating rules in conjunction with certification rules for noise abatement purposes."

Level: Non-technical; illustrated; bibliography.

Summary: This summary of subsonic noise and sonic boom research and development is published annually by the DOT "to provide the Congress and the Executive branch with a consolidated outline of programs and fiscal resources involved in government and industry efforts to reduce aircraft noise."

A brief, illustrated discussion of the sonic boom phenomenon follows and the continuance of FAA research in this area, despite the curtailment of the US SST development program, is explained as a means to provide standards for foreign SST's which might fly into the U.S. on a commercial basis.

An opening "historical background" section reviews the record of Federal involvement in noise abatement and briefly examines the kinds of administrative decisions which have determined authority over the various aspects of the aircraft noise problem. In "Aircraft Noise and the Urban Environment," a summary of progress to date in developing a methodology to evaluate the noise problem (DOT-NEF measure) is provided and a few paragraphs summarize progress in the area of land use alternatives

The body of the report consists of two sections, one providing brief descriptions of "Government Supported Subsonic Noise R and D Programs" and the other summarizing "Government Supported Sonic Boom

3. "FOURTH FEDERAL AIRCRAFT NOISE ABATEMENT PROGRAM, FY 1972-73" (cont'd)

R and D programs." Work undertaken on an agency by agency basis is explained in a paragraph or so for each project and a table showing a "Summary of Fiscal Data" provides quick reference to the magnitude of the Federal investment in the aircraft noise abatement field. Proposed subsonic noise R and D programs are briefly outlined and a short section contains a review of "Non-Government Supported Research," briefly describing projects underway at Boeing, GE, and McDonnell Douglas. Unfortunately, no fiscal data is provided on the non-government programs and it is difficult from the brief descriptions provided to assess the magnitude of the aircraft industry's commitment in this area. Proposed NASA and DOT Sonic Boom research

for fiscal 1973 is outlined and a glossary of terms and bibliography follow. Both are useful additions, but the bibliography is of particular interest as it provides a guide to several industry and government documents that would otherwise be difficult to reference.

4. NOISE STANDARDS: AIRCRAFT TYPE CERTIFICATION

Author: Federal Aviation Administration notice of proposed rule making.

Publisher: Federal Register 34 (8): 453-465, Saturday, January 11, 1969.

Point of View: "The FAA is considering the adoption of a new Part 36 of the FAA regulations prescribing aircraft noise standards for subsonic transport category airplanes, and for subsonic turbojet powered airplanes regardless of category."

Level: Semi-technical.

Summary: In July 1968 the Congress amended the Federal Aviation Act of 1958 to require noise abatement regulation, directing the Administrator of the FAA, in consultation with the Secretary of DOT, "to prescribe and amend standards for the measurement of aircraft noise and sonic boom."

With the publication of this "Notice of Proposed Rule Making" in the Federal Register, the FAA outlined its proposed standards and invited "interested persons to participate in the making of the proposed rule by submitting such written data, views or arguments as they may desire."

It is a lengthy and somewhat tedious exposition, reviewing on a paragraph by paragraph basis the rationale and legal implications behind each segment of the proposed aircraft and noise standards. Finally, on page 458, appears the heading "Part 36 - Noise Standards: Aircraft Type Certification," a delineation of the now famous FAR 36 regulations which became effective on December 1, 1969. These regulations prescribe maximum permissible noise levels for subsonic transport category aircraft and for sub-

sonic turbojet powered aircraft regardless of category. Three points of measurement are specified --- approach, take-off, and sideline -- and the Effective Perceived Noise Level, in units of EPNdB, is specified as the basis for compliance. The publication of these regulations represents the first positive step taken by the Federal Government to halt the escalation of aircraft noise. While this does not make for particularly interesting reading, it is a must for anyone wishing a full understanding of the sorts of standards now in operation, both in terms of their technical dimensions and legislative authority. A familiarity with this document will help put into perspective the data contained in the various EPA reports, conference documents, and hearings which are reviewed in this section of the packet bibliography.

5. AIRCRAFT NOISE ABATEMENT

Author: Hearings before the Subcommittee on Transportation and Aeronautics of the Committee on Interstate and Foreign Commerce, House of Representatives, 90th Congress, 1st and second Sessions.

Publisher: USGPO, Washington, D. C. (Serial No. 90-35; 203 pp.; Available from the Committee on request) 1968.

Point of View: "Today the Subcommittee on Transportation and Aeronautics, . . . commences hearings on H. R. 3400 and related bills. This proposed legislation would authorize the Secretary of Transportation to prescribe standards for the measurement of aircraft noise and sonic boom and to establish regulations for their control and abatement. The regulations could then be applied to aircraft certification procedures."

Level: Non-technical.

Summary: Compared to most hearings on environmental issues, this set is a disappointment. No background papers have been appended here, no definitive data is brought out, and very little in the way of substantive debate has taken place. What these hearings do substantiate is that aircraft noise is a very hot political issue. Most of the first two day's hearings, and substantial parts of the remaining sessions, are taken up by testimony from Congressmen who represent districts where aircraft noise is a pervasive problem. For the most part, however, they appear here simply to reiterate the need for Federal action in the area of aircraft noise control and to relay the complaints of their constituents.

The first substantive testimony occurs at the end of the second day with the appearance of the Secretary of Transportation, his general counsel, and the chief of the Office of Noise Abatement in the DOT. A brief review is provided as to what DOT has done to date in the area of aircraft noise abatement and the Secretary registers his support of the Bill under consideration, H. R. 3400. The general counsel assures the congressmen on the hearing committee that the proposed bill does not present any legal hazards to the Federal government and the Noise Abatement office chief discusses some of the technical problems in abating noise through operational modifications.

Day three opens with testimony from the general

counsel for the Air Transport Association of America, a group that represents most of the scheduled airlines. While noting that the airlines are agreeable to Federal certification for noise, the counsel provides an extensive criticism of the Bill under consideration and inserts in the record an alternative piece of legislation drawn up and proposed by the airlines themselves. The main points of contention relate to the limitations of H. R. 3400, in that it deals only with noise control at the source and says nothing about land use and operational modification alternatives, and the designation of authority, which the Congress would invest in the Secretary of Transportation and which the airlines would like to see in the hands of the administrator of the FAA. The counsel then describes the various industry supported noise abatement programs that have taken place without Federal pressure and reiterates that, because certification for noise is closely related to certification for safety, an FAA decision, the authority for that should be set in the FAA.

A representative from the Air Operators Council International follows and, to the annoyance of Representative Kuy Kendall, Congressman from Tennessee and firm ally of the airlines, contradicts several points made by the airlines' counsel. His testimony provides a well-reasoned argument as to the limitations of zoning as a solution and provides some needed moderation to the airlines' claims.

Several more congressmen appear at the opening of the fourth day's session, all of them recording their support of the Bill under consideration and emphasizing the need for immediate Federal action. The President of the Air Line Pilots Association puts in a brief appearance in which he criticizes the trend to see flight operation modifications as a long range solution to the aircraft noise problem. He argues that such procedures have been pushed as far as possible in terms of safety and that a better alternative would be for stronger zoning laws for land around airports and the cooperation of the FHA in refusing to mortgage homes in high noise impact areas around airports. This argument is seconded by testimony from the National Business Aircraft Association representative, speaking for the owners and operators of some 500 business and private jets. The hearings conclude with the appearance of several more irate congressmen, none of them adding anything new to the testimony record. About the best thing that can be said for all this is that the hearings do contain a good summary of the airline industry's feelings about Federal involvement in their affairs and, while little

5. "AIRCRAFT NOISE ABATEMENT" (cont'd)

in the way of new information is provided by the legion of congressmen who appear to testify, they do make the point that aircraft noise is a good political issue, a fact that will surely bear strongly

on the future of Federal control in this area.

6. ALLEVIATION OF JET AIRCRAFT NOISE NEAR AIRPORTS

Author: A Report of the Jet Aircraft Noise Panel, Office of Science and Technology, Executive Office of the President.

Publisher: USGPO, Washington, D. C. (167 pp.; \$1.25) March 1966.

Point of View: The basis for this report consists of papers presented to the OST Jet Aircraft Noise Panel in consideration of the rising number of citizen complaints about aircraft noise and the direct accountability which the Federal government has assumed in terms of responsibility for the regulation of aircraft travel. Specialists most likely to provide authoritative views were invited to join the Panel in a one-day discussion of the aircraft noise problem and to provide papers outlining their views.

Level: Semi-technical; varies from paper to paper; numerous graphs and tables; bibliography.

Summary: This is a classic reference on aircraft noise and represents the first Federal effort to examine this as an environmental problem. There are five main topics, with several papers being delivered by experts on each. Papers by Galloway and Kryter address "Physical and Psychoacoustic Measurements" in terms of the definition and execution of physical measurement of parameters relevant to individual and community reactions to noise, the development of standardized quantitative indices for various measurements, and definition of areas for further research in acoustics. "Developments in Engines, Airplanes, and Aircraft Utilization," contains two papers addressed to the general problem of engine design for noise generation reduction. Existing possible modifications are reviewed, potential reductions (in PNdb) and their cost are estimated, and the possibilities for developing new engines are discussed in terms of the technology and costs involved.

Airplane noise is examined in terms of the general design and development problem of making airplanes and engines to achieve lower generated noise levels. Emphasis in these papers (one from a Boeing representative and the other from a Douglas representative) is on possible future designs

for modifications on existing jets, development of new aircraft specifically designed to minimize noise generation, and the possibility, irregardless of cost, of producing in the near future a significantly quieter jet.

"Aircraft utilization" is addressed in papers by representatives from American Airlines and TWA. Specifically, developments in engines and aircraft are examined in terms of airline operations and economics, with some discussion of the SAE noise standardization problem.

Two operational procedures are then looked at in some detail: air traffic and flight procedures, for noise modification. Commentary is provided by representatives from FAA, the Airline Pilots Association, and a Vice President of TWA. Finally, general economic considerations, and utilization potential and legal problems in noise abatement are reviewed in separate papers on economics, problems in public regulation, and reports on experience in these areas at O'Hare, Kennedy, and Los Angeles Airports. In sum, while this is now a somewhat dated treatment of the aircraft noise problem, it remains a classic, often referenced document that provides an excellent review of the issues and alternatives involved.

7. AIRCRAFT NOISE IMPACT; PLANNING GUIDELINES FOR LOCAL AGENCIES

Author: A HUD Planning Guidance Report, prepared under contract by Wilsey and Ham and Bolt, Beranek and Newman.

Publisher: USGPO, Washington, D. C. (274 pp.; \$3.50) November 1972 (GPO Stock Number 2300-00214).

Point of View: "This manual is an attempt to interpret the information developed in the MANAPS (Metropolitan Aircraft Noise Abatement Policy Studies) reports and other case studies of aircraft noise abatement and present it in a form that provides a practical tool for the local planner, local government and others in developing a comprehensive aircraft noise abatement policy and program."

Level: Non-technical; numerous flow diagrams, tables and illustrations; annotated bibliography.

Summary: In order to relate the costs of land use planning and redevelopment strategies to other means of dealing with airport noise, DOT and HUD funded studies of four U.S. airports. These reviewed the existing local noise situation and investigated the costs of specific abatement programs under the conditions at the study airports. Reports of these studies were issued in 1971 and this document, published one year later, is an attempt to synthesize the information in those original reports and make the findings understandable to concerned planners. Five aspects of the problem are discussed in separate sections: The Planning Context (limitations of airport planning,

recent legislative trends, etc.), Defining the Noise Problem (nature and effects of aircraft noise), Options for Reducing Noise Conflicts (noise source changes, path changes, feedback and control mechanisms, etc.), Developing a Planning Program for Aircraft Noise Abatement, and The Future of Noise Abatement Policy. Each chapter is well illustrated with drawings, graphs and tables, and is written on a relatively non-technical level, with straight forward explanations provided of technical terms or engineering concepts as they arise. Technical appendices, running to some 80 pages, provide backup for the chapter discussions and contain data on various noise calculations, technical considerations in noise insulation, HUD noise standards, proposed Air Force standards, etc. Finally, a fairly extensive bibliography and supplementary list of reports available from the National Technical Information Service (NTIS) are provided. While many of the problems under discussion are given only brief textual treatment, the data contained in the many tables and graphs here is extremely useful and the overall effect is to provide a most interesting, quick summary of some very complex problems. It is the kind of document which should be most useful to anyone interested in an overview of the complexities which govern land use policy decisions as they relate to airport sitings and operations.

8. OUTDOOR NOISE AND THE METROPOLITAN ENVIRONMENT; CASE STUDY OF LOS ANGELES WITH SPECIAL REFERENCE TO AIRCRAFT

Author: Los Angeles City Planning Commission, Los Angeles, California (60 pp.) 1970.

Point of View: "Cities are faced with growing noise pollution from more trucks, aircraft, motorcycles, and new kinds of powered equipment. With noise already a serious problem along freeways and around airports, expanding air traffic will extend noise pollution over entire communities unless it is controlled. It is this noise from aircraft which is a primary concern of this study, not only because of its widespread effects today and for tomorrow, but because it is not too late to control it without severe economic disruption."

Level: Non-technical; numerous tables, graphs and illustrations; bibliography.

Summary: This is the report of a study undertaken in 1969 by Dale Beland, a member of the L.A. City Planning Commission, and a group of his students in the USC Graduate Program of Urban and Regional Planning. While the study was addressed to an examination of all major external sources of noise pollution in the urban environment, its main focus is aircraft noise. The body of the report provides a non-technical summation of the urban noise problem in general, the methodology of the study, and a close look at two areas of transportation noise: Freeways, Ground Vehicles and Powered Equipment (24 pp.) and Airports, Aircraft and Airways (24 pp.). Specific recommendations for the Los Angeles area are provided, along with some fairly generalized conclusions and recommendations directed at the urban noise problem

8. "OUTDOOR NOISE AND THE METROPOLITAN ENVIRONMENT: CASE STUDY OF LOS ANGELOS WITH SPECIAL REFERENCE TO AIRCRAFT" (cont'd).

on a broader scale. Supportive data and general background references are included in an extensive seven-part appendix. Throughout, useful illustrations accompany the text, many of them portraying comparisons of data

on various noise sources as existing in 1970 and projected to 1990. The bibliography is especially good and contains references under ten separate headings.

CROSS REFERENCES

1. "Aircraft and Noise: The Retrofitting Approach", a 1972 Library of Congress Congressional Research Service Report, reprinted in appendices to Noise Pollution, (Ref. I-1).
2. "Jet Aircraft and Noise Over Residential Areas", Report of a UCLA Study, reprinted in appendices to Noise Pollution, (Ref. I-1).
3. "Aircraft Noise Pollution and the Need for Federal Legislation", a short paper prepared by N.O.I.S.E. and reprinted in the appendices to Noise Pollution, (Ref. I-1).
4. "Aircraft Noise and Control Technology", in "Report to the President and Congress on Noise", (Ref. I-2).
5. "Environmental Noise Pollution: A New Threat to Sanity", (Ref. I-10).
6. Sections 2 and 3 of "Laws and Regulatory Schemes for Noise Abatement", (Ref. II-1).
7. "Operational-Procedural Noise Reduction Flight Program", appended to "Summary of Noise Programs in the Federal Government", (Ref. II-4).
8. "Aircraft Noise", Section 2, a collection of five law journal articles in Noise Pollution and the Law, (Ref. II-5).
9. "The Legal Aspects of Noise Control", and text of "Noise Standards: Aircraft Type and Certification", in (Ref. II-7).
10. "Aircraft Noise", in The Economic Impact of Noise, (Ref. III-2).
11. Chapters 33, 34, 37 in "Handbook of Noise Control" (Ref. VIII-1).
12. Chapter IIID and IVB in "Noise Assessment Guidelines; Technical Background" (Ref. VIII-6).
13. "Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines", (Ref. IV-1).
14. "Aircraft Noise" (Lectures 5 through 13) in Lectures in Transportation Noise, (Ref. IV-3).
15. "Manufacturing and Transportation Noise", (Ref. IV-6).

VI. SOURCES OF NOISE POLLUTION: SUPERSONIC AIRCRAFT

1. SST AND SONIC BOOM HANDBOOK

Author: William A. Shurcliff, Physicist, Harvard University, and Director, Citizens League Against the Sonic Boom.

Publisher: Ballantine Books, New York (153 pp.; \$.95) 1970.

Point of View: "Why should the public - 95% of whose members would never fly in an SST - be forced to provide billions of dollars for an inefficient, unnecessary plane that could destroy peace and quiet throughout much of the civilized world."

Level: Popular.

Summary: This is one of the best known products of the recent SST debate and provides, with laudable brevity and clarity, a most useful summary of the main arguments raised against American development of a commercial SST. Shurcliff has done an excellent job of gleaning the literature, particularly Congressional hearings testimony, for the kinds of facts and data which refute the wisdom of SST travel. Various chapters deal with the design of the proposed planes themselves, the problems encountered by the French, Russians, and Americans in their prototype models, results of the Air Force experience with sonic booms over populated

areas (including the Air Force Academy, where an over-zealous pilot boomed out \$50,000 worth of window glass on graduation day), measures of sonic boom effects on people, dangers and discomforts inherent in SST flight, degrading environmental effects, and the economic complexities of production, sales and government subsidy. All of this is further complimented by a series of appendices which include the text of the reports issued by the four working panels of the President's SST Ad Hoc Review Committee, a most interesting document, particularly in light of the President's decision to recommend going ahead with the SST project, despite the admonitions of the Panel. A good, though somewhat dated, bibliography is appended, with especially good references to government and popular literature. In short, this provides a very enjoyable and informative introduction to the problems of the SST development plans and is well-suited to a popular audience.

2. SONIC BOOMS FROM SUPERSONIC TRANSPORT

Author: Karl D. Kryter, Director of the Sensory Sciences Research Center, Stanford Research Institute, Menlo Park, California.

Publisher: Science 163 : 359-367, 24 January, 1969.

Point of View: "It is concluded that the sonic booms from the Concorde and Boeing SST's operating during the daytime sometime after 1975, at frequencies presently projected for long-distance supersonic transport of passengers over the United States, will result in extensive social, political, and legal reactions against such flights at the beginning of, during, and after years of exposure to sonic booms from the flights."

Level: Non-Technical; illustrated; graphs and tables; references.

Summary: Directed at an analysis of the effects of sonic booms on people, this is an excellent, brief summary of the potential severity of the problems posed by supersonic flight over populated areas. Kryter begins by reviewing the major arguments put

forward by SST proponents and provides rather detailed counter arguments to refute most of the claims made by industry and government spokesmen. He then turns to an examination of overland supersonic flights and notes that this will bring on a political response of some magnitude, certainly greater than anything experienced to date in terms of complaints and suits against subsonic aircraft noise. Kryter concludes that the data collected to date on the response of people to sonic boom exposure suggests that their reactions will prove prohibitive to overland flights. The final sections of the paper provide data on the intensity of sonic boom, acceptability of sonic booms, damage from sonic boom, and an analysis of relevant research studies, all of which support his contention. Kryter concludes: "Without a drastic reduction in number or length of anticipated supersonic flights, it is estimated that, in the United States after 1978 or so, tens of millions of people would be in a noise environment equivalent to a composite noise rating of 98 to 115 because of one to 51 daily occurrences of sonic booms from an SST."

3. THE EFFECTS OF SONIC BOOM AND SIMILAR IMPULSIVE NOISE ON STRUCTURE

Author: Report prepared by the National Bureau of Standards under Interagency Agreement.

Publisher: U. S. Environmental Protection Agency, Washington, D. C. (19pp.; \$.30; NTID 300.12; GPO Stock #5500-0048) December 31, 1971.

Point of View: "A brief discussion is given of the physical nature of sonic booms, and other impulsive noises, and the parameters, such as over-pressure, duration and mechanical impulse, which are used to characterize sonic booms. This is followed by an overview of the response of structures - particularly buildings - to sonic booms and a review of the damage history observed due to supersonic overflights."

Level: Semi-technical; illustrated; tables, bibliography.

Summary: This is the report of the sonic boom damage incurred during the series of government tests made between 1961 and 1966 over selected U. S. cities. The first few pages provide a brief, textbook-like discussion of the nature of sonic booms and other impulsive noises. This leads into an examination of the response of various structures to sonic booms and it is shown that the main vulnerable building components

are window glass and plaster, not an insignificant problem when one considers that some of the newer high-rise buildings have facades that are as much as 80% glass. Various building designs that might lead to the magnification of sonic boom damage are discussed briefly and actual test data on the financial damage to buildings in the various test cities is provided. A brief, concluding section takes note of the particular vulnerability of historical buildings and archeological structures and details damage done at several national park monuments by test booms. There is some mention of problems related to earth surfaces, avalanches, etc. but there is little in the way of reliable data on this aspect of the problem. A fairly lengthy bibliography is appended to the report.

4. THE CONCORDE SST

Author: Migdon R. Segal, Analyst, Science and Technology, Science Policy Research Division, Library of Congress.

Publisher: An internal report, available only through a member of Congress by request. (Report 72-257 SP) December 13, 1972.

Point of View: "Despite its technological success, the future of the Concorde remains a gamble due to economic and environmental factors. . . . Among the factors inhibiting Concorde sales are a relatively high selling price, uncertainty over operating costs, the recent recession in the airline industry, and the fear of environmental restrictions which might hamper Concorde operations."

Summary: This is one of many excellent documents prepared by the Library of Congress staff as background information for Senators and Congressmen. While one must be a member of Congress to have access to this and other Library produced documents, most Congressmen are more than willing to secure these papers for interested constituents, and this is a particularly

worthwhile one to request. Prepared prior to the Congressional decision to halt the U. S. SST development, this is essentially an evaluation of the Concorde program in terms of its production history, anticipated performance, market prospects, and environmental factors. A final "Outlook" section opens with this assertion: "The Concorde development and testing program is proceeding smoothly, and it seems likely that the Concorde will be ready for the world's aviation community by 1975. It remains to be seen, however, whether the world will be ready for the Concorde by that time." While this is a relatively short summary (20 pages) it is an extremely interesting one and full of valuable data on all aspects of the SST.

5. SONIC BOOM IN RELATION TO MAN

Author: The Special Study Group on Noise and Sonic Boom in Relation to Man, Report to the Secretary of the Interior.

Publisher: Scientist and Citizen 10: 223-229, November 1968.

Point of View: "... the Study Group has considered various aspects of the sonic boom, together with those effects on man which are to be expected from regular commercial flights of supersonic transport aircraft (SST's). The following conclusions and recommendations give our advice concerning the effects on man and his environment that need to be taken into account in deciding whether SST's should be allowed to operate at supersonic speed over the land area of our nation."

Level: Non-technical.

Summary: Excerpted and printed here are the conclusion and recommendation sections of what was the first officially sanctioned study to warn against the dangers of a commercial SST fleet. The main thrust of the study group's recommendations are that SST's not be flown over land, particularly over populated areas, in light of the results of public response, in terms of damage claims and complaint, to French, American, and British test flights. It is pointed out

that relatively few people will probably fly in SST's, compared to the numbers to be subjected to their sonic booms, and that the unknown consequences of the introduction of water vapor into the stratosphere by SST's could prove seriously damaging to the environment. The panel recommends that commercial SST flight be regarded as an "experimental technological development" and that more research into the problems of supersonic flight be immediately undertaken along with public hearings. Results of existing experiments on the effects of sonic booms on people are reported and projections given as to the possible magnitude of these problems to result from overland, commercial SST flights. Some data is provided on damage claims and complaints associated with SST test flights and particular attention is paid to structural damage done at several of the national monuments. A final section examines "Factors in Decision Making" and the Panel calls for extending the parameters of the decision beyond the confines of aviation progress and national prestige and recommends turning increased attention to the associated undesirable or adverse side-effects which inevitably accompany supersonic flight. The report ends on a rather prophetic note: "... every leader in the federal administration should be concerned that the decision making process be proper, because all probably will face similar situations in one way or another as the nation moves ahead."

6. SONIC BOOM

Author: Herbert A. Wilson, Jr.

Publisher: Scientific American 206: 36-43, January 1962.

Point of View: "The loud noises caused at the ground by an airplane flying faster than the speed of sound will have to be brought under control before supersonic transports can come into service."

Level: Non-technical; illustrated; graphs, tables.

Summary: This is an excellent, short, non-mathematical discussion of the physical phenomenon of sonic boom. It is extremely well illustrated, allowing the student to easily follow along visually with the straightforward text descriptions of shock waves and the various physical parameters which determine their magnitude. Various engineering alternatives which might mitigate the inevitable boom which accompanies all supersonic flight are briefly

discussed and the author concludes: "When the supersonic transport comes, it will boom. But it may be feasible to keep those booms from reaching the ground at an objectionable intensity. This will require careful design of the airliner, with special attention given to configuration and structure, and possibly an extra margin of engine performance. And it will surely require carefully laid out and strictly maintained flight plans in which sonic boom will become an integral factor, along with weather, visibility, and traffic in the increasingly crowded air."

7. SONIC BOOMS

Author: Harvey H. Hubbard

Publisher: Physics Today 21: 31-37, February 1968.

Point of View: "Because booms can startle people and shake buildings and their contents, there is serious concern for public acceptance of the sonic boom . . . There are those who would ban the supersonic transport altogether. . . Others are taking a more realistic approach. Consideration is being given to the development of advanced-design aircraft that would minimize the effects of sonic boom!"

Level: Semi-technical; illustrated; references.

Summary: This is a slightly more technical discussion of the physics of sonic booms and assumes some acquaintance with wave phenomenon. It is much more a traditional textbook treatment than is the Scientific American article and would probably be more appropriate reading for the science or engineering student. Some historical background

is provided here in a brief section which notes some of the early researchers into sonic boom phenomenon. The discussion then moves to point-source disturbances, aircraft disturbances (spectral content of bow waves, etc.) and a review of the nature and extent of sonic boom ground-exposure patterns (lateral spread patterns and overpressure). Finally, brief attention is turned to the effects of sonic booms, both in terms of subjective, human reactions and actual physical damage reports on structures. The author is clearly more skeptical of the degree of sonic boom disturbance than is Wilson and ends on a reassuring note as to the ability of scientists to cope with these kinds of problems.

8. SONIC BOOM RESEARCH

Author: Proceedings of a Conference held at the National Aeronautics and Space Administration, Washington, D. C., April 12, 1967.

Point of View: "The purpose of this meeting was to ascertain those areas of sonic boom research that are the most pressing from the standpoint of commercial supersonic transport (SST) operation and to determine whether or not all possible aerodynamic means of reducing sonic boom overpressures were being explored."

Level: Technical; illustrated; graphs and tables; references at end of each paper.

Summary: This is a compilation of five invited papers and seven contributed remarks directed toward a state-of-the-art survey of sonic boom research to 1967. While much of it is now dated and somewhat preliminary, the basic aerodynamics and many of the

proposed design features are comparable to existing technology. In fact, the concluding remark of one of the NASA participants proves, in retrospect, quite accurate: ". . . many of the participants seem to share my skepticism that there are any avenues which are not currently being explored that will lead to real aircraft configurations with substantially lower peak overpressures." At any rate, this is an interesting discussion of the technology of sonic boom aerodynamics and provides a quick reference to the kind of information available to the developers of the prototype commercial SST at Boeing. Some of the chapter reference listings are quite extensive and most of the papers are well-illustrated and full of useful data.

9. THE SUPERSONIC TRANSPORT

Author: Kurt H. Hohenemser.

Publisher: Scientist and Citizen 8: 1-10, April, 1966.

Point of View: "This report is an attempt to pre-

sent in simple terms the important public issues arising from the development of the SST. In keeping with the guiding principle of Scientist and Citizen, the issue will be formulated and its technological background presented without advising for or against a specific policy decision."

9. "THE SUPERSONIC TRANSPORT" (cont'd)

Level: Non-technical; illustrated.

Summary: This, the first of two articles that Dr. Hohenemser prepared for publication in this journal, is of particular interest as it pre-dates the real SST debate and provides one of the first, full-fledged analyses of the potential problems in the SST development program. Some background is provided as the role of the Federal government in this development program and the author briefly reviews some of the advantages and disadvantages that aviation development has brought us since Lindbergh's 1927 flight across the Atlantic. Several technical problems associated with the increased speed of the SST are then reviewed, including those associated with high surface temperatures, wing configuration, and atmospheric turbulence. Under "Environmental Problems of the SST", Hohenemser examines two problems: cosmic radiation and sonic boom. Far greater attention is paid to the phenomenon of sonic boom and a good, though necessarily quite simplified, explanation is provided of the physical dimensions involved. Two concluding

chapters deal separately with "Benefits vs. Costs" (shorter travel time promised vs. real savings in time, balance of payments problems, boom limitations on land overflights, etc.) and "SST Economics: An Added Note" which provides an updating of direct operating costs per seat mile for the transatlantic route, data taken from an article published just prior to this one going to press. All in all, this is a most useful summary of the kinds of problems environmentalists were trying to alert the public prior to the full-scale development of an American commercial SST. Were it not for the potential existence of French-British Concorde fleets and Russian SST flights, these might be considered arguments of historical interest only. As it is, they are quite timely still and, in this presentation, should be easily comprehended by a non-scientific audience.

CROSS REFERENCES

1. "Environmental Noise Pollution: A New Threat to Sanity", (Ref. I-10).
2. "The SST: From Watts to Harlem in Two Hours" and "Sonic Booms: Ground Damage and Theories of Recovery", "Sonic Boom: Containment or Confrontation", "Sonic Booms: Tort Liability", and "Control and Abatement of Aircraft Noise and Sonic Boom", in Section 3 of Noise Pollution and the Law; (Ref. II-5).
3. "Fourth Federal Aircraft Noise Abatement Program", (Ref. V-3).
4. Physiological Effects of Noise, (Ref. IX-6).
5. "Psychological Reactions to Aircraft Noise", (Ref. IX-9).
6. "Sonic Boom" in Noise and Man, (Ref. X-3).

VII. COMMUNITY NOISE: CONSTRUCTION, INDUSTRY AND HOME APPLIANCES

1. THE COMMUNITY NOISE PROBLEM: FACTORS AFFECTING ITS MANAGEMENT

Author: Clifford R. Bragdon (See Ref. I-3).

Publisher: Natural Resources Journal 10: 687-718, October 1970.

Point of View: "The noise associated with urban living is a growing environmental liability. Increasing numbers of the population are affected by this pollutant, making proper noise management vitally important. To provide a background for effective policy decisions, it is essential to identify those factors affecting community noise management. . . . The purpose of this article is to discuss each of these factors."

Level: Non-technical; documented.

Summary: Bragdon has written extensively and well on the problems of noise pollution and this is an excellent introduction to the quality of his work. It is aimed at answering the question that confronts every environmental issue: Why isn't more done about the problem? Specifically, Bragdon's interest is exploring the built-in factors which have kept noise pollution from being attacked in any concerted, large scale way. He isolates six specific problems for examination: auditory regression, human misunderstanding, adaptation, priority of concerns with respect to urban problems, institutional apathy, and ignorance. The examples which document the role which each of these factors has played are taken from a careful culling of the noise pollution literature, particularly government documents and

hearings testimony. Some if it is highly speculative, particularly the sections on auditory regression and adaptation, but for the most part, the evidence is impressive: the familiar equation of noise with power or "progress", the inability of government agencies to handle inter-disciplinary problems, the lack of incentive for industry achievement in quieter products, etc. Seen altogether like this, the catalogue of factors is impressive, sometimes amusing, but ultimately maddening. Knowing this, Bragdon concludes by noting the existence of several noise abatement organizations and the need for public education through journal articles geared to the general public. The whole tone here is one of positivism and Bragdon is careful to emphasize that the dimensions of these problems are amenable to change and improvement. Again, this fits into the category of political literature, in the broadest and best sense of the word, and should be required reading for any and all students of the noise pollution problem.

2. COMMUNITY NOISE

Author: Prepared by Wyle Laboratories under Contract for the U. S. EPA Office of Noise Abatement and Control.

Publisher: USGPO, Washington, D.C. (203 pp; NTIS #P8-207124, \$3.00) 1971.

Point of View: "This report addresses the part of the overall noise pollution problem which is associated with outdoor noise in the community. It attempts to provide a quantitative framework for understanding the nature of the outdoor noise environment and the reaction of people and community to its various aspects."

Level: Technical; numerous tables and graphs; illustrated; bibliography.

Summary: This is essentially a compilation of data on community noise put together for EPA in preparation for their Report to the President and Congress on Noise." The density of information is quite high, with the text supplementary to the numerous tables and graphs which appear throughout the report. An introductory section provides a brief but detailed review of the nature of sound and a discussion of statistical analysis of noise levels. The range of outdoor noise environments measured at 18 locations is examined, with particular attention to residual noise spectra, variance in noise levels with location, and relationships among various measures taken on the A-Weighted scale. The two basic types of noises which effect community noise levels, constant level noise intrusions and intermittent single event noise intrusions,

are then compared in terms of their relative importance to effects such as sleep and speech interference. Several scales developed specifically to examine community reaction to these types of noises are then described and applied to data on noise from aircraft, traffic, etc., to document the analysis of the EPA studies. All of this data is then put into perspective in a chapter which looks at the growth of noise pollution, in terms of both intruding noise and residual noise, and attempts to moderate the popular, environmentalist contention that noise could grow by 1 db per year, or 10 db per decade. Various changes seen in both these areas are documented and problems with earlier studies, some of which have been the partial basis for the 1 db per year estimate, are discussed. A rather extensive conclusions and

recommendations section closes the report suggesting, among other things, a nationwide community noise survey, creation of one or more metropolitan area-wide monitoring demonstrations, review and updating of existing analytical methods for predicting outdoor noise, and establishing noise quality goals for the indoor and outdoor environment. All of this is buttressed by an extensive series of appendices which include some fifty references, background data on the community noise survey (community descriptions, etc.), examples of typical noise spectra measured at some of the locations, and descriptive definitions of some of the principal terms used in the report.

3. TOWARD A QUIETER CITY

Author: Report of the Mayor's Task Force on Noise Control.

Publisher: Copies of this report may be obtained from the Mayor's Task Force on Noise Control, through the New York Board of Trade, 295 Fifth Avenue, New York, New York, 10016 (56 pp.; \$1.75) 1970.

Point of View: "... the Task Force believes that noise has reached a level intense, continuous, and persistent enough to threaten basic community life... Vehicular traffic, jet aircraft, subway trains, construction equipment and air conditioners, as major noise sources, degrade the health and well-being of New York residents."

Level: Popular; illustrated; numerous tables and graphs.

Summary: This is a remarkable report, assembled by a Mayor's Task Force that included everyone from Lewis Goodfriend and Norman Cousins to the public relations director of the New Yorker magazine. At any rate, it proves to be a winning combination and should serve as positive incentive to citizens considering a noise survey of their community. Granted, New York is a special case, one where it is possible to gather data on almost every noise abuse known to man. And it's all here, with particular emphasis on those arch villains, construction equipment and vehicle (especially truck) traffic. But this isn't just the usual cataloging of complaints, rather it is a

carefully documented and considered evaluation of the sources of city noise, their effects, and what, politically, economically and technologically, can be done to abate the problem.

The work behind this study was divided among five subcommittees, one each on Medical, Building, Legal, Technical and Public Relations factors. Their reports make up the body of this text and are replete with back-up data, most of it displayed in easy to read graphs and tables. The overall recommendations of the Task Force as a whole introduce the individual subcommittee reports and are mostly qualitative in nature. They range from specific recommendations regarding EPA's role in New York's noise problem to general summations of impending issues, such as STOL ports, and simple, what can be done now suggestions, including adopting some of the quieter construction equipment that has been available, but unused, for some time. All in all, it makes for interesting and informative reading, certainly a stimulating political document to recommend to citizen's groups preparing to undertake community action regarding noise pollution.

4. COMMUNITY NOISE STUDY

Author: Robert E. Gay, Environmental Standards Division, Planning and Development Department, City of Inglewood, California.

Publisher: Environmental Standards Division, City of Inglewood, Inglewood Civic Center, 105 East Queen Street, Inglewood, California, 90301 (75 pp.) August 1972.

Point of View: Report of a study undertaken to measure the 24 hour noise exposure at 35 locations throughout the City of Inglewood.

Level: Technical; illustrated; graphs and tables.

Summary: Inglewood has a special problem - it lies along the final approach to Los Angeles International Airport, surely one of the noisiest residential areas in the country. For the past several years, the citizens there have worked to document their problem and present their case to the Federal government in hopes of achieving some relief. To date, the problem remains a severe one, but a well documented one that should be brought to the attention of anyone studying community noise problems. This report is one of several documents published by the city's Environmental Standards Division and provides data on a 24 hour noise survey undertaken by the City in 1972. It is a useful document on several counts:

as a model community noise survey, as a particularly good study of the impact of aircraft noise on a community, and as an example of the kinds of measurement problems encountered in trying to quantify noise pollution in a residential community. There are four sections to the report: Data Acquisition (monitoring equipment, etc.), Data Evaluation, Data Correlation, and Conclusions and Recommendations (including evaluation of the efficacy of the techniques and parameters employed). Inglewood's problem is an extreme one, but it is one that is growing increasingly familiar, as numerous residents on Long Island could testify. In short, this is really too specific a document to recommend broadly, but it is certainly an important document of anyone interested in a close examination of existing techniques of community noise measurement or the specific problems associated with the impact of aircraft noise on a community.

5. URBAN PLANNING AND NOISE CONTROL

Author: Clifford R. Bragdon (See Ref. I-3).

Publisher: Sound and Vibration 8 : 26-32, May 1973

Point of View: "Noise represents a major environmental problem capable of being a nuisance or a hazard to the population. . . The future noise status of urban areas is dependent upon controls either initiated by or implemented by the urban planning profession."

Level: Non-technical; several graphs and tables; references.

Summary: This is one of several brief but quite useful articles on noise pollution which appear regularly in this journal. Directed to urban planning professionals, it provides a brief summary of the magnitude of the noise problem (in terms of dollars and damage) followed by a fairly detailed examination of planning strategy for environmental noise control. Bragdon notes the three components of the noise problem: the source, the path, and the ultimate receiver. He then looks at the kinds of techniques which can be applied in each of these areas in the interest of noise abate-

ment. Specifically, Bragdon points to the kinds of land use decisions which have been taken on the part of various cities in the past and which might now be taken as a means to shield the population from damaging levels of noise exposure. He concludes: "Beside comprehensive planning, zoning, and environmental design-site review, there are other urban planning techniques useful for controlling urban noise. These include subdivision regulations, housing and building codes, among others. The future success of urban development will depend in part on recognizing and solving environmental problems. . . The acoustical engineer and related noise specialists can play a major role in assisting the urban planner. . ."

6. INDUSTRIAL NOISE-IMPACT ON THE COMMUNITY

Author: Lewis S. Goodfriend and Frederick M. Kessler, Lewis S. Goodfriend and Associates, noise consultants.

Publisher: Journal of Environmental Sciences ; 18-22, September/October, 1972.

Point of View: "It appears that presently, noise due to construction job sites, surface transportation, and aircraft exceeds in importance the contribution of industrial plants to community annoyance. At some future date, when noise abatement efforts applied to the above primary sources successfully reduce their levels, the contribution of industrial plant noise to the community residual levels will rise in importance. . . using the present state-of-the-art in noise abatement, it is possible to control industrial noise and thus minimize the impact of industrial noise in the community."

Level: Semi-technical; several graphs and tables.

Summary: Goodfriend is a frequent and respected contributor to the literature on noise pollution and in this brief article he provides a useful summary of several facets of the industrial noise problem. Of particular interest is his opening discussion of criteria which make plant noise acceptable to "industrial neighbors". Goodfriend notes that it is likely people won't complain about industrial plant noise if the noise is within the following bounds; it is continuous; it does not interfere with speech communications; it does not include pure tones or impacts; it does not vary rapidly; it does not interfere with getting

to sleep; and it does not contain fear-producing elements. He adds, too, that transportation noise frequently acts to mask industrial noise.

What all of this really adds up to is that it is difficult for a community to isolate industrial noise from the ambient and set objective standards for its control so that, as long as it isn't startling in comparison to the ambient noise, communities will tolerate it. Goodfriend notes, however, that work is currently underway to develop a community noise descriptor to evaluate noise from different sources and that Federal laws will soon demand regulation of all community noise, industrial plant noise included. A typical data acquisition system which might be used to measure industrial noise levels outside the plant is described and two EPA surveys of this kind of noise are discussed in terms of their implications for future standard setting. Several rating systems used to assess the community noise impact of various noise levels measured on standard A-weighted scales are then described. Various community noise tolerance factors are then discussed, along with a brief summary of the kinds of noise control devices and systems currently available.

7. NOISE FROM CONSTRUCTION EQUIPMENT AND OPERATIONS, BUILDING EQUIPMENT, AND HOME APPLIANCES

Authors: Prepared for the U.S. Environmental Protection Agency by Bolt, Beranek, and Newman under Federal contract.

Publisher: US GPO, Washington, D.C. (323 pp; NTIS #PB 206717; \$6.00). December 31, 1971.

Point of View: "Given that noise is a serious environmental problem, some appropriate questions one might ask in seeking a comprehensive noise-control objective are: Precisely what are the sources of noise pollution? How many people are exposed to these sources and how are they affected? What can be done to control the noise output of offending sources? This report attempts to answer these questions for the specific categories of construction, home appliances, and building equipment."

Level: Non-technical; extensive graphs and tables; data and technical material concentrated in appendices; bibliography.

Summary: This is clearly the most valuable general reference on building, construction and appliance noise, providing a thorough, non-technical review of the problem in the body of the report and backing up that discussion with extensive data and technical information concentrated in the several appendices.

There are three main divisions to the report and each aspect of this particular noise area is discussed within each. "Source Characterization," the first division, deals with the definition of each particular noise source in terms of measured noise-scale readings, duration nature, cause and available and/or existing

7. "NOISE FROM CONSTRUCTION EQUIPMENT AND OPERATIONS, BUILDING EQUIPMENT, AND HOME APPLIANCES" (cont'd)

abatement techniques. Data is provided on actual A-scale readings for each source and the magnitude of the noise generated by that class of noise producing equipment is described. The second report division, "Impact", deals with the subtler problem of evaluating the perceived effect of each particular noise source. A brief discussion is provided of seven known effects of exposure to noise: hearing damage risk, speech interference, sleep interference, physiological stress, startle, annoyance, and task interference. Research data on each aspect is noted and the problems of measuring objectively in each category are noted. Finally, the third section of the report, "Industry Efforts", describes the history of industry response to pressure for quieter equipment and notes the

various factors which mitigate against heavy industry investment in noise control. A summary and conclusion section follows which includes a review of economic and social impact studies and outlines "A Program of Public Support Development." A brief bibliography and a series of three technical appendices, running to some fifty pages, complete the report.

8. PUBLIC HEARINGS ON NOISE ABATEMENT AND CONTROL: CONSTRUCTION NOISE

Author: Hearings conducted by the U. S. EPA.

Publisher: U. S. GPO, Washington (187 pp., \$1.25; Stock #550-0037) Volume I, Atlanta, Georgia, July 8-9, 1971.

Point of View: This is the record of the first of eight national public hearings held by EPA under requirement of the Noise Pollution and Abatement Act of 1970. The hearings were designed to "aid the Office of Noise Abatement and Control in compiling information relevant to its investigation of the Problem of Noise Pollution. Further, these hearings present an opportunity for the public and industry to express their viewpoints on the general subject of noise."

Level: Popular; illustrated.

Summary: As is the case with all of the hearings in this series, there is a great deal of interesting information here, but there is also a lot of repetitious testimony and a tendency to stray from the main topic of the hearing. The first day of testimony recorded here is very useful, however. There is an opening statement on the nature of hearing and hearing loss which is well-illustrated and succinctly stated. This is followed by testimony from several professionals -- engineers, architects, planners, etc. -- on various aspects of the construction noise problem. Several newly-developed "quiet" types of construction equipment are described and the whole area of incentive to make and use this kind of improved equipment is explored in some rather close questioning by the EPA Panel members. A common theme throughout this testimony is summarized by a manufacturer of silencing equipment who notes that while the tech-

nology to quiet equipment exists, it is not being used because "there is no economic incentive now to the construction industry, in fact, there is a penalty." There is much discussion throughout this first day of what kind of standards could be set to encourage the use of quieter equipment and the general consensus is that, if everyone in the construction field were forced to use quiet equipment, this would result in maintaining a uniform bidding level and no one contractor would be punished for his attempt to silence some of the needless noise of jackhammers, wrecking balls, etc. All of this exchange between the manufacturers, users, and panelists is most useful in demonstrating the complexity of urging "quality of living" type improvements on a profit-motivated industry. The questioning from the Panel, particularly that from Alex Baron, is exceptionally good and leads to clarification of several confusing issues.

There is a shift in emphasis for the second day's hearings, however, and very little is said here about construction noise. Part of the provision of these hearings is that they are open for input from the public on "the general subject of noise" and, as is the case with most of these hearings, whenever the discussion is opened in this way, it is the people who live around airports who appear to testify. There is, in short, very little mention of construction noise in the second day's testimony, but a lot of testimony as to the horrors of living near a major airport. And, as is generally the case, it is difficult to read this catalogue of abuse without marveling that so little has been done to alleviate the suffering of people living near airports. A new twist is added here with testimony about the annoyance of police helicopters making low passes over certain areas

8. "PUBLIC HEARINGS ON NOISE ABATEMENT AND CONTROL: CONSTRUCTION NOISE" (cont'd)

of Atlanta, apparently with some frequency, and several people annoyed with a proposed highway development project appear to demand that more study of the environmental impact of this construction be made. In short, the first day's hearings offers a useful compilation of information on construction noise, particularly in terms of available means to abate the

problem. The second day, however, serves to remind EPA that, while construction noise is synonymous with airports and, until something is done about that abuse of "peace and quiet", all else will be seen as attempts to skirt the real problem.

CROSS REFERENCES

1. Noise Pollution: The Unquiet Crisis, (Ref. I-3).
2. Industrial Noise Manual, (Ref. I-6) (last chapters).
3. Section 4 of "Laws and Regulatory Schemes for Noise Abatement", (Ref. II-1).
4. "Guidelines to the Department of Labor's Occupational Noise Standards", appended to "Summary of Noise Programs in the Federal Government," (Ref. II-4).
5. "Urban Noise Control", in Noise Pollution and the Law, (Ref. II-5).
6. "Community Noise Ordinances: Their Evolution, Purpose and Impact", (Ref. II-6).
7. Chapters 35, 36 in "Handbook of Noise Control" (Ref. VIII-1).
8. Chapters IIF, IIIB in "Noise Assessment Guidelines; Technical Background"(Ref. VIII-6).
9. "Transportation Noises: A Symposium of Acceptability Criteria", (Ref. IV-2).

VIII. NOISE MEASUREMENT AND CONTROL

1. HANDBOOK OF NOISE CONTROL

Author: Cyril M. Harris (Editor) Professor of Electrical Engineering, Columbia University.

Publisher: McGraw-Hill, N.Y. (1024 pp. \$27.00) 1957.

Point of View: A handbook covering all aspects of noise and vibration generation, propagation, transmission, reception, effect, and control.

Level: Technical but graded; each chapter begins with basic concepts and definitions and the handbook chapters proceed from basic introductory ones to the highly specialized.

Summary: If one were limited to a single reference work on noise measurement and control, this is probably the one most experts would recommend. Its forty chapters cover almost every aspect of noise and vibration. The editor, Cyril Harris, is an acoustical consultant and co-author of a book in architectural acoustics and all the separate chapters are authored or co-authored by appropriate specialists.

For the non-specialist the first seven chapters are the most useful; they cover (after an introduction to noise by Harris) the physical properties of noise, propagation of sound in air, the hearing mechanism, the loudness of sounds, techniques of audiometric testing, and hearing losses from noise.

Chapter 2, "The Physical Properties of Noise and Their Specification", Chapter 3, "Propagation of Sound in the Open Air", and Chapter 4, "The Hearing Mechanism," are of particular interest to the college science teacher as they provide many examples of the application of the basic sciences - physics in particular - to sound phenomena.

Chapter 5 deals with definitions and measurement of loudness level and loudness. The next two chapters deal with effects on hearing, with Chapter 6 providing a detailed description of audiometric testing.

Chapter 8 on ear protectors is followed by two chapters on the effects of noise on speech and behavior - and an unusual one on the effects of vibration on man which also provides some interesting facts about the mechanical structure of the human body. Chapters 12, 13, 14, and 15 deal with vibration control, isolation, damping, and measurement.

The next two chapters treat noise measuring instruments and techniques, and are followed by 17 chapters of a highly specialized nature which cover acoustical materials, noise transmission, and a host of control problems, such as Gear Noise, Bearing Noise, Fan Noise, etc., of interest to the non-specialist are Chapter 22, "System Considerations in Noise Cultural Problems", and perhaps the last four chapters of this group (31, 32, 33, and 34) which cover automobile noise, rail transportation noise, and aircraft noise sources and control techniques.

Chapter 35 and 36 are titled "Community Noise and City Planning" and "Community Reaction to Noise" and are of general interest providing quantitative data on noise levels from various sources and on community attitude toward noise.

The last four chapters deal with the legal aspects of noise and are of a less technical nature. The last two are of particular interest covering anti-noise ordinances and noise control requirements in building codes.

This book is of obvious worth to anyone wishing to know specific facts about any source of noise and suggestions for ways of controlling it. It is also, as has been said, recommended as an inclusive reference work for the non specialist interested in sound phenomena of noise pollution.

2. NOISE AND VIBRATION CONTROL

Author: Leo L. Beranek, Editor.

Publisher: McGraw-Hill Book Co. N.Y. (650pps. \$29.50) 1971.

Point of View: Emphasizes the application of noise and vibration control techniques to real life

situations.

Level: Technical. Like its predecessor, Noise Reduction (McGraw- 1960, Leo Beranek, Editor) this text is aimed at the graduate engineer. The material is graded in technical level, however, so that each section begins with simple concepts and proceeds

2. "NOISE AND VIBRATION CONTROL" (cont'd)

to advanced ones.

Summary: This book is a thorough revision and updating of the earlier text, Noise Reduction. It is aimed at the same audience - the practicing industrial or architectural engineer - and has the same limited usefulness for the non specialist. Since it is the more recent publication, it is the preferable reference.

The book has been shortened by 100 pages and re-organized; the number of specialized chapters has been reduced. The basic sequence of concepts, etc. is very similar: the first two chapters give basic introductions to sound waves and to levels, decibels, sound spectra etc. Both of these chapters will be valuable references to the non-specialist.

The measurement and analysis of noise is the overall theme of the next four chapters and they also will be useful to the non-specialist. Chapter 3, for instance, has a good, brief treatment of different microphones, Chapter 4 explains the systematic approach to field measurements, and Chapter 5 contains some important general techniques of data analysis.

The next three chapters, while they are highly technical, provide, at least in their introductory sections, a valuable review. These three deal with sound propagation in space -- outdoors, and in large and small rooms. The chapter (7), "Sound Propagation Outdoors" in combination with the last chapter (18), "Criteria for Noise and Vibration in Communities, Buildings, and Vehicles" are likely to be of most use to the amateur noise expert.

3. FUNDAMENTALS OF NOISE: MEASUREMENT, RATING SCHEMES AND STANDARDS

Author: National Bureau of Standards.

Publisher: U.S. Environmental Protection Agency, Office of Noise Abatement and Control (163 pps.; \$3.00; NTIS #PB - 206727)

Point of View: Objective and technical.

Level: "... an introduction to noise including the inter-relationship between physical measures and psychological responses. ... included are sample calculations of sound level, loudness level, and perceived noise for fine selected spectra."

Summary: The first four chapters are introductory in nature and deal with the physical principles of sound generation and propagation (the decibel scale

Chapters 10-16 are also highly specialized, dealing with sound transmission and absorption and with specific techniques of noise and vibration reduction. The most useful of these to the non-specialist are apt to be chapters 10 and 11, which deal with the acoustical properties of porous materials and the interaction of sound waves with solid structures.

The last two chapters cover Damage-Risk Criteria for Hearing (Chapter 17) and Criteria for Noise and Vibration in Communities, Buildings and Vehicles (Chapter 18). These chapters rank with the first two in potential usefulness to the non specialist. They give the biological, physical, and philosophical background to noise criteria. In them the interested teacher will find not only the quantitative data in acceptable and unacceptable levels for the various kinds of noise pollution and hearing damage, but also practical examples of measurements that can be made by teacher or student.

is described in detail) and some general statements about ultrasonic and infrasonic range are included. The basic instrumentation and techniques of physical sound measurement are provided, the equipment described, measuring practices are summarized and frequency of sound pressure curves are presented. The last of these introductory chapters deals with the correlations between noise and human response and the guidelines to various types of damage are discussed along with criteria for communication interference etc. Each of these topics is supported by graphic data presentation and the supporting physiological experimentation is summarized.

The second part, Chapter 5, presents sample calculations for sound level, loudness level, and perceived noise level. The example developed is the fly over

3. "FUNDAMENTALS OF NOISE^o MEASUREMENT, RATING SCHEMES AND STANDARDS" (cont'd)

of an executive jet airplane at 500 feet and two methods for calculating the loudness level (the Steven's method and the Zwicker's method) are applied. The different assumptions of these two methods and the difficulty of establishing a single rating system for loudness is explained.

Chapter 6 is a brief, two page summary of recommended practices in a real world situation and Chapter 7 is an equally brief treatment of sound transmission, which emphasizes the areas where knowledge is insufficient and more experimentation is needed. The last chapter is a compilation of the various applicable noise standards.

The remainder of the report consists of appendices which are (A) a glossary of terms, (B) a second real world example of sound measurement and data reduction and analysis -- this time of a test of truck tire noise. Appendices C and D provide specialized conversion data for earlier calculations and Appendix E addresses of relevant organizations. In short, this reference is of use mainly to teachers wishing to develop numerical examples or to set up actual noise measurements in a laboratory situation.

4. SOUND, NOISE AND VIBRATION CONTROL 5. NOISE ASSESSMENT GUIDELINES

Author: T. J. Schultz and N. M. McMahon, Bolt, Beranek and Newman, Inc.

Publisher: Urban Noise Abatement Research Program, U. S. Dept. of Housing and Urban Development (17 pp; \$.70; USGPO).

Point of View: Aimed at public involvement in noise assessment for housing sites.

Level: Popular, technical terms and concepts where they are used are explained in simple terms.

Summary: This is essentially a noise assessment workbook for housing sites. It contains detailed but simple step-by-step procedures for classifying the noise level at a given housing site into the following categories: "clearly acceptable, normally acceptable, normally unacceptable, clearly unacceptable". The three sources for which procedures are given are aircraft,

truck and automobile, and train. The assessments are to be based on onsite distance measurements and information obtained from official sources (which are listed) or calculable from data included in the workbook. Worked out examples and work sheets are included.

This workbook could be the base of student experimentation, a class project etc. Its simplicity will be a handicap, however, if the physical basis of the measurements and judgements are desirable. Such interpretation, however, could be made with the help of the "Technical Background Document". (Reference VIII - 5). In combination with this latter document, some interesting and quantitative projects could be designed.

6. NOISE ASSESSMENT GUIDELINES, TECHNICAL BACKGROUND

Author: Theodore J. Schultz, Bolt, Beranek and Newman.

Publisher: U. S. Dept. of Housing and Urban Development, Office of Research and Technology, (209 pps.; USGPO; \$2.00).

Point of View: Objective summary of noise abatement and control as it applies to housing siting.

Level: Variable; topics are introduced in non-technical terms but the report is complete with its technical descriptions and graphic displays.

Summary: This long report is divided roughly into four parts. The brief part I gives the sociological rationale for noise abatement, while part II, gives an introduction to sound and its measurement in the urban situation. Simplified treatments of both measurement techniques and the evaluation of results are provided. The third part, which takes up the major part of the report, is a complete summary of the technical background, including descriptions of the various rating systems and comparisons between them. In this section also are given the experience of various counties with urban noise and its psychological effects. It is in this section also that aircraft noise is separately

*Out of Order. See bottom of Page 48.

6. "NOISE ASSESSMENT GUIDELINES; TECHNICAL BACKGROUND" (cont'd)

considered. The correspondence between rating, measured levels, and the criteria of tolerable exposure are developed.

The final section provides the numerical calculations and assumptions that support the simple step-by-step procedures of the companion workbook.

This report is much too detailed a source for

any but the teacher who is interested in initiating a site evaluation project. Its other important use would be as a reference document for the many noise rating systems. The brief descriptions and discussions of interrelations make it valuable for this purpose.

7. GUIDELINES FOR NOISE AND VIBRATION CONTROL

Author: Lyle F. Yerges, Contributing Editor, Sound and Vibration.

Publisher: Sound and Vibration, 7; 18-21, August 1973.

Point of View: "...the technology to avoid or eliminate much of today's industrial noise nuisance already exists; in fact, most of it is already over 20 years old. ... industrial noise control will ultimately result in better, safer, and possibly more economical processes."

Level: Popular and general but with some quantitative rule of thumb data and equations provided.

Summary: This short article is aimed at industrial managers and seeks to convince them that industrial noise should be abetted and that it can be, often without great difficulty. It provides a general treatment of noise sources and of the ways of control-

ling noise at the source, through the transmission path and at the receiver. It is enriched by emphasizing the important general principles of control and by three tables which provide relevant and representative data on (1) effect of operating parameters (horsepower, speed, pressure, etc.) as sound power output (2) acoustical impedances of various materials, and (3) costs of various noise and vibration control options.

While the article is of most pertinence to the engineer or industrial manager faced with noise problems, it will be a useful reference for the amateur who wishes to have a general knowledge of industrial noise problems and the methods and costs of solutions.

8. MODERN-DAY ROCK AND ROLL MUSIC AND DAMAGE-RISK CRITERIA

Author: James M. Flugrath, Speech and Hearing Center, Memphis State University.

Publisher: The Journal of the Acoustical Society of America, 45 (3); 704-711, 1969.

Point of View: "The purpose of this paper, then, is to analyze the sound levels of modern day rock-and-roll music and to determine if they exceed the various established DRC."

Level: The measurements and their interpretations are technical but, overall, the level of explication is within the understanding of a non technical reader.

Summary: The study reported in this article is very

interesting for two reasons; it provides a very useful, real example of noise measurement and the interpretation of the measurements in terms of damage-risk criteria (DRC), and it sheds more scientific light on a prevalent controversy between parents and their teenage children.

For a more technical point of view Flugrath first had to decide what kind of noise--steady state, impact, continuous, or intermediate -- was produced by rock bands. Such a decision was necessary in order that an applicable DRC could be selected. He recorded 1/2 hour of music from each of ten bands which played in a local dance hall and then analyzed the results in several different ways, including a spectral analysis.

8. "MODERN-DAY ROCK AND ROLL MUSIC AND DAMAGE-RISK CRITERIA" (cont'd)

Several amusing results emerged from the study; one was that all bands peaked at 2000 Hz (which the author suggests was due to a guitar amplifier turned up to feedback volume - a situation that occurred for each band). He also found that high frequencies prevailed in all the bands. In spite of the apparent great fluctuations in songs, tones, instruments, etc., he characterized the music as essentially steady state over a long period of time.

The application of various DRC's to the music is instructive as well as amusing but it is somewhat sobering to find that, by any test, the music exceeds maximum permissible DRC's and should "be con-

sidered potentially damaging to the hearing of the participants."

This paper obviously has potential appeal to students and suggests as well as details the procedures for making similar measurements -- an attractive experimental project.

9. THE CONTROL OF VIBRATION AND NOISE

Author: Theodore P. Yui, Elastomer Chemicals Department, E. I. duPont de Nemours and Co.

Publisher: Scientific American 220: 98-106, January 1969.

Point of View: A new method of noise and vibration control.

Level: Semi-technical.

Summary: This article is mainly concerned with describing a new technique called constrained-layer damping, which provides important reductions in vibrations, and therefore noise, at the source.

The article does provide, in addition, a general

review of noise generation and propagation and the conventional methods of reducing it by isolation and absorption. The main focus is on the use of constrained - layer damping -- a thin layer of visioelastic material applied directly to the vibrating source and backed by a rigid material, usually sheet metal. The mechanical energy of the vibrations in the constrained layer is converted to heat. The physical properties of the visioelastic material are examined and some examples of actual noise reductions achieved in real life applications are described.

10. NOISE CONTROL

Author: Hearings before the Subcommittee on Public Health and the Environment of the Committee on Interstate and Foreign Commerce, House of Representatives, 92nd Congress, First Session.

Publisher: Printed for the use of the Committee on Interstate and Foreign Commerce (504 pp.; Serial No. 92-30) USGPO, Washington, D. C., 1971.

Point of View: Hearings on H. R. 5275, H. R. 923, H. R. 3364, H. R. 6986 and H. R. 6988, "bills to control the generation and transmission of noise detrimental to the human environment; to establish an office of noise abatement control within HEW; to require the disclosure of the operational noise level of machinery distributed in

interstate commerce, and for other purposes."

Level: Varies, from testimony to testimony, mostly non-technical; several tables and graphs.

Summary: Six bills are up for consideration in this set of Hearings, making for a rather complex agenda. The first ninety pages of this volume, in fact, contain nothing but the text of this legislation, and much of the testimony here is that of one Congressman or another endorsing one bill or another. There is some useful information here, however, and a selective reading should prove productive.

In the first day's session, the testimony of the Deputy

10. "NOISE CONTROL" (cont'd)

Director of the EPA, speaking in support of the Administration bill, is quite informative. It includes the text of an EPA "Summary Status Report (as of May 7, 1971)" which briefly outlines the scale and emphasis of EPA noise control efforts. Similarly useful testimony is provided on the second day, including a brief summary of various state noise control laws, a review of EPA research contracts in the area of noise measurement and control, a discussion and reprinting of a University of Tennessee research paper, "Non-Occupational Noise and the Effect Upon Hearing of Young Persons", and a particularly useful discussion of sonic boom, accompanied by the text of a U.S. Air Force, Department of Interior, FAA sponsored study, "Sonic Boom Effects" (pp. 183-230). Aircraft noise remains the focus of the remainder of testimony

on the second day and is carried into the third day with rather extensive testimony from various FAA representatives. Several important exhibits accompany this testimony, including the text of the FAR-36 regulations (See Ref. V-4), and topics covered range from retrofitting problems and STOL noise to problems with the SST. Also included here is the text of the FAA "Quarterly Status Report" (pp. 394-420) which briefly summarizes FAA noise abatement activities. The Hearings conclude with a brief discussion of motorcycle noise and some good, solid testimony from a U.S. Bureau of Standards delegation as to the problems of noise measurement and the setting of noise standards.

11. RECOMMENDED STANDARDS FOR OCCUPATIONAL NOISE EXPOSURES

Author: None indicated.

for Occupational Safety and Health. It will be useful to those who want definitions, exposure vs. duration limits, age correlations, etc.

Publisher: Sound and Vibration 7:35-41, Nov. 1972.

Level: Technical.

Summary: This brief article contains the technical contents of the Recommendations for a Noise Standard of the National Institute

12. INTERSTATE MOTOR CARRIER NOISE EMISSION STANDARDS

Author: EPA Notice of Proposed Rule Making.

carries the proposed EPA noise emission standards for interstate motor carriers. In addition to the proposed standards (which are for vehicles -- diesel trucks - weighing over 10,000 lbs), the brief article contains a summary of the sources of truck noises and some interesting analyses of the expected impact of this regulation on the trucking industry.

Publisher: Federal Register 38 (144): 20102-20107, Friday, July 27, 1973.

Point of View: "The EPA proposes to establish a new part 202 of Title 40 of the Code of Federal Regulations establishing noise emission standards for motor carriers engaged in interstate commerce."

Level: Semi-technical; statement of proposed standards and supporting rationale.

Summary: This issue of the Federal Register

* 4. SOUND, NOISE, AND VIBRATION CONTROL

Author: Lyle F. Yerges, Consulting Engineer

Point of View: "... to provide, in the idiom of the practicing architect and engineer, enough of the fundamentals of sound and vibration and their control to permit the professional to feel comfortable about the projects."

Publisher: Van Nostrand Reinhold Company, N. Y. (203 pps., \$10.95)1969.

4. "SOUND, NOISE, AND VIBRATION CONTROL" (cont'd)

Level: Technical -- however, the level of this book is considerably below that of Ref. VIII - 1, 2 and 3, and while it does contain many tables and graphs it does not include the mathematical presentations of these other references.

Summary: This is intended to be a "working guide" for the professional but because the materials are presented briefly and simply it will also serve as a summary of the principles of sound and vibration control in working and living areas for the non professional.

The book is divided into three parts: (1) a basic section in which the theory of sound and vibration and their effects are reviewed. (2) a section on the general principles of sound and vibration control and the materials, systems, and construction used for this purpose (3) a "checklist" section which provides data, drawings, troubleshooting guidelines, etc.

The first section of 16 pages could be used as student reading as the basic principles of sound propagation, transmission, and in the human response to sound. The second section of 66 pages begins with definitions of the terms used in noise measurement. The main attention is on the general properties of acoustical material and control techniques and it is followed by the "practical" Section III.

The value of this reference to the non-professional will come from, in addition to the review of basic principles, the brief descriptions of acoustical properties and control techniques which give quick insight into the practical side of noise pollution abatement.

CROSS REFERENCES

1. "What is Noise?", Chapter 2 in Noise Pollution: The Unquiet Crisis, (Ref. I-3).
2. "Excerpts from the Walsh Healey Public Contracts Act Relating to Scope and Duration of Occupational Noise Exposure", appended to The Noise Around Us, (Ref. I-4).
3. First five chapters of Industrial Noise Manual, (Ref. I-6).
4. "Sound Pollution: Another Urban Problem", (Ref. I-9).
5. "The Need for a Noise Pollution Abatement Act", (Ref. II-8).
6. "Transportation Noise: A Symposium of Acceptability Criteria", (Ref. IV-2).
7. Lectures in Transportation Noise, (Ref. IV-3).
8. "The Evaluation of Noise from Freely Flowing Road Traffic", (Ref. IV-4).
9. "Community Noise", (Ref. VII-2).
10. "Urban Planning and Noise Control", (Ref. VII-5).
11. The Effects of Noise on Man, (Ref. IX-1).
12. "Primer on Methods and Scale of Noise Measurement" in Noise as a Public Health Hazard, (Ref. IX-3).
13. Industrial Noise Manual, (Ref. I-6).
14. "Noise", (Ref. I-7).
15. "Noise in the Environment", (Ref. I-8).
16. "Outline for a Systematic Approach to Noise Abatement and Control", in Physiological and Psychological Effects, (Ref. IX-7).

IX . EFFECTS OF NOISE ON MAN

1. EFFECTS OF NOISE ON PEOPLE

Author: Prepared by Dr. James D. Miller, Central Institute for the Deaf, St. Louis, Missouri and reviewed and approved for publication by members of the NAS-NRC Committee on Hearing, Bioacoustics, and Biomechanics.

Publisher: USGPO, Washington, D. C. (153 pp; \$3.00; NTIS #PB206723) 1971.

Point of View: "It has not been demonstrated that many people have had their lives shortened by noise. While undoubtedly there have been accidental injuries and death when auditory warning signals were misunderstood or not heard because of the effects of noise, the prevalence of these has not been evaluated. Perhaps the stress of continued exposure to high levels of noise can produce disease or make one more susceptible to disease, but the evidence is not convincing. There are only hints of relations between exposure to noise and the incidence of disease. In other words, the effects of noise on people have not been successfully measured in terms of "excess deaths" or "shortened lifespan" or "days of incapacitating illness". The only well-established effect of noise on health is that of noise-induced hearing loss."

Summary: This is an excellent review of what is known about the effects of noise on people, and, more important perhaps, how it is known. Published

under the approval of the very prestigious NAS-NRC Committee noted above, it carries the sanction of some of the leading medical researchers in this area in the country.

There are seven subject sections: Ear Damage and Hearing Loss, Masking and Interference with Speech Communication, Interference with Sleep, Loudness Perceived Noisiness and Unacceptability, Annoyance and Community Response, Other Possible Psychological and Sociological Effects, and Transient and Possible Persistent Physiological Responses to Noise. In short, there is a definitive summary here of the state-of-the-art knowledge about every effect that has been proposed as being the result of noise impacting on people. Numerous studies are cited throughout the report, but their findings are always summarized in non-technical terms and the interested reader is provided full citation in the list of references which appears at the end of the report. The emphasis here is on the inconclusiveness of the data on every effect except noise-induced hearing loss. The clear implication is that a great deal of research remains to be done in this area.

2. THE EFFECTS OF NOISE ON MAN

Author: Karl D. Kryter, Stanford Research Institute, Menlo Park, Calif.

Publisher: New York, Academic Press (633 pp., \$25.00) 1970. A publication in the Environmental Sciences Interdisciplinary Monograph Series.

Point of View: "An attempt has been made to provide a critical and historical (dating from 1950) analysis of the relevant literature in the field and, as warranted, to derive new or modify existing techniques for the evaluation of environmental noise in terms of its effects on man."

Level: Technical; numerous tables and graphs; bibliography.

Summary: Dr. Kryter's name has become synonymous with research into the effects of noise on man and it is

most unusual to find a bibliography in this area that is not dominated by his work or a national hearing to which he is not called to provide testimony. With the publication of this book, he has assimilated much of the material published in the research journals (some 4,000 articles) and presented it in a form which should enable the non-specialist to obtain a good, scholarly review of research in this area. This is clearly a book directed at fellow professionals, and a rather sophisticated science and mathematics background is assumed.

Part I, "Auditory System Responses to Noise" contains six chapters dealing with the fundamentals of sound and hearing: Analysis of Sound by the Ear, Masking and Speech Communication in Noise, The Aural Reflex, Audiometry, Damage Risk from Exposure to Noise, and Proposed Procedures for Estimating Damage Risk to Hearing. Part II, "Subjective Responses to

2. "THE EFFECTS OF NOISE ON MAN" (cont'd)

Noise", extends the examination of the nature of sound and the means for its evaluation. There are five chapters here: Loudness, Perceived Noisiness (Annoyance), Environmental Noise and Its Evaluation, Summary of Methods of Predicting Certain Responses to Noise, and Proposed Procedures for the Evaluation of Environmental Noises. It is in this latter section that Kryter explains the measuring scale that he contributed several years back and which has become a standard in noise measurement, the Perceived Noise Level (PNL). Finally, Part III contains an introductory section and two chapters dealing with man's nonauditory system responses, including such things as work performance, sleep, feelings of pain, vision, and blood circulation. Kryter notes in the preface that: "It is clear that some of the more complex and perhaps more important, from a health viewpoint, effects of noise have to do with these somewhat second-order reactions." A three-page summary, Part IV, concludes the book and contains a useful table of "basic physiological and psychological responses of man

to habitual environmental noise." It also includes the following paragraph, which capsulizes Kryter's evaluation of the data on noise effects to date: "A possible teaching of much of the data presented in this book is that, other than as a damaging agent to the ear and as a masker of auditory information, noise will not directly harm people or interfere with psycho-motor performance. Man should be able, according to this concept, to adapt physiologically to his noise environment, with only transitory interference effects of physiological and mental and motor behavioral activities during this period of adaptation. This concept, or its converse, is difficult to substantiate by scientific research and must be recognized as being hypothetical at this time." An extensive list of references, one of the best in print, is appended.

3. NOISE AS A PUBLIC HEALTH HAZARD

Author: W. Dixon Ward and James E. Fricke, Editors.

Publisher: Proceedings of the June 13-14, 1968 Conference on Noise as a Public Health Hazard (Washington: American Speech and Hearing Association) February 1969. (Available for \$5.00 from: Director, Public Information, American Speech and Hearing Association, 9030 Old Georgetown Road, Washington, D. C., 20014).

Point of View: "The Conference . . . was organized in an effort to present the best evidence available bearing on the general question: To what extent is noise a public health hazard? An attempt was made to secure speakers who would present a broad picture of the noise problem: speakers who would not only summarize the relevant facts and theories dealing with noise and hearing loss, and discuss psychological reactions to intense noise and community complaints about sonic booms, but also explore opinions and prejudices that influence psychological reactions of individuals to those noises that could not conceivably affect their hearing."

Level: Technical; graphs and tables; references.

Summary: This is something of a landmark Conference, representing the first time that noise, as a health factor, was the subject of a national meeting convened by a governmental agency in partnership with a national asso-

ciation. Noting this in his keynote address, William Stewart, then Surgeon General, compares the 1968 attitude toward noise pollution with that which characterized 1958 thinking about air pollution. In short, a lot of basic research existed but, for the most part, people were working independently of each other and there was no concerted national effort to deal with noise as a public health hazard. The rationale behind this Conference was to bring together the research people and the government people and attempt to assess something about the current state-of-the-art in noise research and to propose something about where it was all leading and where future emphasis should be placed.

As a concession to the non-specialists present at the Conference, the first paper here, "Primer on Methods and Scales of Noise Measurement," is a very useful review of the methods used to measure the physical and psychological attributed of sound. Careful attention is paid to terminology, concepts, and their definitions, and the result is a paper which should prove first priority reading for anyone interested in understanding the basic acoustics behind research into noise effects.

The body of the report consists of papers presented by members of each of six panels: Effects of Noise on Man, Industrial Noise and the Worker, Noise in

3. "NOISE AS A PUBLIC HEALTH HAZARD" (cont'd)

the Community, Special Problems of Recent Technological Development, Community Noise Control, and Discussion and Summary. Many of the men cited in the EPA summaries of noise research are present as speakers here and the papers delivered are full of useful data, most of it presented in graphs and tables. In addition, many of the papers are docu-

mented with lengthy bibliographies. As a reference document on the health effects of noise pollution, these Proceedings are invaluable and should head the reading list of anyone seriously interested in this aspect of the noise problem.

4. A BASIS FOR LIMITING NOISE EXPOSURE FOR HEARING CONSERVATION

Author: Compiled by J. C. Guilnard, University of Dayton Research Institute.

Publisher: Joint EPA/USAF Study, Prepared for the EPA and distributed by NTIS (#AMRL-TR-73-90; EPA-550/9-73-001-A) July 1973 (169 pp.; \$3.00). To purchase copies write: National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22151.

Point of View: "The goal of this document is three-fold: (1) it attempts to arrive at a consensus regarding the effects of noise exposure upon human hearing; (2) it evaluates the principal factors affecting the incidence of noise-induced hearing loss in various populations; and (3) it makes recommendations concerning noise exposure levels for the purpose of hearing conservation."

Level: Technical; numerous tables; bibliography.

Summary: This is a straight-forward report providing a compilation of data, with references to published work, which represents the present state of knowledge concerning the effects of continuous and impulsive noise on hearing. Background and summary remarks are pro-

vided in the five sections which comprise the body of the report: Introduction, Definitions, Effects of Noise on Hearing (Continuous Noise and Impulsive Noise), Factors Influencing Incidence of NIPTS, and Conclusions and Recommendations. Hearing danger represented by both occupational and non-occupational noise exposure is considered and data are included or cited "which enable quantitative predictions to be made of the risk to hearing in the American population due to noise exposure in any working or living context." The remaining one hundred and forty pages consist of a series of appendices which provide data on and discussion of relevant aspects of noise measurement, the physiology of hearing, and theories explaining the effects of noise on the ear. An extensive bibliography is included.

5. PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE

Author: Prepared for issuance by the Administrator of the EPA under the signature of Alvin F. Meyer, Jr., Deputy Assistant Administrator for Noise Control Programs.

Publisher: Unpublished; available from the Office of Noise Abatement and Control, U.S. EPA, upon request. Date of issue, July 27, 1973. To be published by USGPO and distributed by NTIS.

Point of View: "The Noise Control Act of 1972 requires that the Administrator of the EPA develop and publish criteria with respect to noise. These criteria are to "reflect the scientific knowledge most useful in indicating the kind and extent of all identifiable ef-

fects of noise on the public health and welfare which may be expected from differing quantities and qualities of noise." This document meets that requirement."

Level: Semi-technical; numerous tables and graphs; extensive references.

Summary: Criteria here means "descriptions of cause and effect relationships" so that what is provided in this document is an attempt to appraise the available knowledge relating to the health and welfare effects of noise pollution. In preparing this assimilation, the EPA searched the general professional literature and the support documents prepared to accompany the

5. "PUBLIC HEALTH AND WELFARE CRITERIA FOR NOISE" (cont'd)

"Report to the President and Congress on Noise" such as Ref. IX-4). In addition, the EPA sponsored an International Conference on Public Health Aspects of Noise and the proceedings of that conference have been applied to the preparation of this document. This, then, represents the most complete EPA statement on the health and welfare implications of noise pollution.

Information is presented here under twelve headings: Noise and Noise Exposures in Relation to Public Health and Welfare, Rating Schemes for Environmental Community Noise, Annoyance and Community Response, Normal Auditory Function, Noise-Induced Hearing Loss - Temporary and Permanent, Masking and Speech Interference, Additional Physiological and Psychological Criteria, Effects of Noise on Performance, Interaction of Noise and Other Conditions or Influences,

Effects of Noise on Wildlife and Other Animals, and Effect of Noise on Structures. Within each category, extensive documentation is provided of existing studies and the various measurement and standards scales applied to each aspect of the noise problem are delineated. Each section is also briefly summarized and extensive references are provided. A Glossary is appended to the report, as is a brief bibliography.

6. PHYSIOLOGICAL EFFECTS OF NOISE

Authors: Edited by Bruce L. Welch and Annemarie S. Welch, Friends of Psychiatric Research, Inc., Maryland Psychiatric Center and the Johns Hopkins University School of Medicine.

Publisher: Plenum Press, New York (365 pp.; \$19.50): 1970.

Point of View: This volume is based upon papers presented at an international symposium on the Extra-Auditory Physiological Effects of Audible Sound, held in Boston, Mass., December 28-30, 1969, in conjunction with the annual meeting of the American Association for the Advancement of Science.

Level: Technical; numerous graphs and tables; references.

Summary: This symposium was originally titled "Assessing the Impact of Technology: Example and Precedent of the SST-Sonic Boom" and was organized "to fill the obvious need to encourage an adequate advance evaluation of the probable effects upon health of this dramatic environmental change." In the introduction, provided by an official of the U.S. Public Health Service, the magnitude of the noise problem is noted and contrasted with the relatively sparse data as to health effects beyond hearing loss. The text of 25 papers presented at the Symposium follow, organized under nine major headings: Adaptation, Resistance to Disease, Endocrine and Metabolic Function, Cardiovascular, Reproductive, Neurological,

Biochemical and Pharmacological, Sleep, and Studies of the Effects of Sonic Booms from Supersonic Aircraft. For the most part, these are highly technical reports of laboratory experiments done on animals, although several papers report work done with human subjects. All are accompanied with extensive data and citations of related research. This is clearly a document directed to an audience of non-specialist and fellow-specialist research scientists and extensive references from the research literature are provided for those who seek additional information. The list of contributors to this volume is an impressive one and includes scientists from U.S. universities, government laboratories and private research institutes along with representatives from several foreign countries. A brief summary of the volume is provided along with additional references of the various topics, a list that runs to some ten pages.

7. PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS

Author: Volume VII of the Public Hearings on Noise Abatement and Control, Boston, Mass., October 28 and 29, 1971.

Publisher: U.S. GPO, Washington, D.C. (352 pp; \$1.50; GPO # 5500-0056) 1971.

Point of View: "These hearings are designed to provide to the Government information regarding noise in several areas: (1) Public attitudes and concern relating to the problem; (2) the capabilities of industry to deal with the problem; and (3) the views of the professions concerned with noise and acoustics, as to the severity of the problem and what also may be done about it. . . . The hearing today and tomorrow is a scientific hearing dealing primarily with the problems of physiological and psychological response to noise."

Level: Varies, for the most part, non-technical; graphs and tables; some illustrations.

Summary: As with most of the Hearings in this series, there is a great deal of interesting information here, but due to the nature of public hearings, it is somewhat difficult to get quick access to it. Often in the midst of testimony, or in response to a question put by a panelist, someone will offer the kind of summary statistic that speech writers are always on the lookout for, but you almost have to read this volume cover-to-cover to get at those numbers. And that can be a bit frustrating, as there is also a lot of repetitious information here, particularly in the first day's testimony which consists mostly of papers provided by the political representatives of the state, the Mayor, state senators, U.S. senators, etc. Interspersed with these are the testimonies of several Boston residents as to the effects of living adjacent to

Logan Airport, testimony which provides needed perspective in light of some of the research summaries which follow later in the Hearings.

Beginning with day two of the Hearings, testimony is provided by various scientists working in the area of physiological and psychological response to noise. For the most part, they simply relate the kind of experiments they are involved in and report the results they have achieved to date. There is some good questioning of these experiments by the people on the EPA panel and most of the researchers testifying have useful data to provide, often in graph or tabular form. In addition to this kind of testimony, there are also several interesting papers submitted for the record. Three are especially interesting: "Physiological, Psychological, and Economic Effects of Sonic Booms" (pp. 144-167); "Special Report on Recent British and American Noise Surveys" (pp. 185-201) and "Outline for a Systematic Approach to Noise Abatement and Control" (pp. 298-352), an impressive offering from two MIT civil engineers. In short, the value of this document varies greatly from one testimony to another, but there is a lot of interesting information here for anyone who will take the time to weed through it.

8. HAZARDOUS EXPOSURE TO INTERMITTENT AND STEADY-STATE NOISE

Authors: K. D. Kryter, Stanford Research Institute, W. Dixon Ward, University of Minnesota, James D. Miller and Donald H. Eldridge, Central Institute for the Deaf, St. Louis, Missouri.

Publisher: Journal of the Acoustical Society of America 39: 451-464, 1966.

Point of View: This document was prepared by Working Group 46 of the NAS-NRC CHABA (Committee on Hearing, Bioacoustics, and Biomechanics) in response to a request from the Office of the Surgeon

General, U.S. Army, for specific damage-risk criteria for exposure to sound.

Level: Technical; numerous tables and graphs; references.

Summary: This is one in a series of papers dealing with damage-risk criteria prepared by the National Academy of Sciences in response to a request from the Armed Services. This particular paper, however, is something of a classic in the literature and appears as the primary reference on this subject in several

8. "HAZARDOUS EXPOSURE TO INTERMITTENT AND STEADY-STATE NOISE" (cont'd)

bibliographies. A brief introductory section, outlining the history of this effort and the approach of the Working Group, is followed by background information presented under four headings: Damage Risk Criterion, Bases for Specification of Tolerable Exposure to Sound, Variability in Susceptibility to Threshold Shift, and Hearing Conservation and Monitoring Program. Section five, Graphic Representation of Damage-Risk Contours, provides numerous graphs

plotting "Noise Burst Duration in Minutes" against "Necessary Intervening Recovery in Minutes". Discussion of this data is provided in section six and a final section, "Physical Measurement of Sound", comments on a "general rule of thumb" for determining whether a sound contains a strong narrow band of energy of a certain width. An extensive bibliography is included.

9. PSYCHOLOGICAL REACTIONS TO AIRCRAFT NOISE

Author: Karl D. Kryter (See Ref. VIII-2)

Publisher: Science 151: 1346-1355, 18 March, 1966.

Point of View: "Possible methods of evaluating the acceptability of the noise from aircraft are presented."

Level: Semi-technical; graphs and tables; references.

Summary: The discussion here focuses on the basic psychological attributes of sound, behavioral reactions and auditory fatigue from exposure to noise, and community reaction to the noise from jet aircraft. Kryter first briefly reviews what is known about sound and general behavioral reactions to noise, a discussion that includes numerous references to the research literature and several

tables and graphs of support data. He then makes some general observations about the particular nature of community reaction to jet aircraft noise, noting that it is a matter of statistics, relative importance in light of the noise environments as a whole and, third, a matter of equities, "of opinion concerning the rights of individuals to be protected from nuisances, and the welfare of the community as a whole." The remainder of the paper briefly examines these three aspects of the noise problem more closely and looks quickly at several criteria of unacceptability of community noise environment, and at one potential noise problem, the sonic boom.

CROSS REFERENCES

1. "Effects of Noise Pollution on Living Things and Property", in "Report to the President and Congress on Noise," (Ref. I-2)
2. "Nuisances and Hazards", Chapter 3 in Noise Pollution: The Unquiet Crisis, (Ref. I-3).
3. "Deliterious Effects of Noise", in The Noise Around Us, (Ref. I-4).
4. Chapters 7, 9, 10, 11, 36 in "Handbook of Noise Control" (Ref. VIII-1).
5. Chapter 17 in "Noise and Vibration Control" (Ref. VIII-2).
6. Chapter 4 in "Fundamentals of Noise: Measurement, Rating Schemes and Standards" (Ref. VIII-3).
7. Chapter III D in "Noise Assessment Guidelines; Technical Background" (Ref. VIII-6).
8. "Recommended Standards for Occupational Noise Exposure" (Ref. VIII-11).
9. "Physical and Psychoacoustic Measurements", (Ref. V-6).
10. "Sonic Boom in Relation to Man", (Ref. VI-5).

X. STUDENT READING

1. NOISE POLLUTION

Author: Donald F. Anthrop, Assoc. Prof. of Environmental Studies at California State University, San Jose.

Publisher: Lexington Books, Lexington, Mass. (159 pp.; \$12.50) 1973.

Point of View: "The same factors which have brought us air and water pollution in crisis proportions, namely increasing population, urbanization, industrialization, technological change, and the usual relegation of environmental considerations to a position of secondary importance relative to economic ones, have also brought us a crescendo of noise."

Level: Semi-technical; numerous graphs and tables; bibliography.

Summary: There are several factors to recommend this text as an excellent resource for the undergraduate student exposed for the first time to acoustics. To begin with, there has been careful attention to pedagogy in the preparation of this text and each equation or calculation which appears has been brought into the discussion for good reason and is fully explained through reference in the text and accompanying graphs or diagrams. The mathema-

tics, ~~in fact~~, have been kept to a minimum and quantitative relationships are rarely described without an accompanying qualitative description. The chapters evolve in a logical way, beginning with a discussion of the dimensions of the noise pollution problem and the physical nature of noise before moving on to discuss each of four major noise source problems: noise in dwellings, construction noise, motor vehicle noise, and aircraft noise. In each of these latter chapters, data is provided on the magnitude of the problem, the scales used to measure noise from that particular source, legislation which currently sets regulations on that kind of noise, measure effects of noise from the particular source, and finally, a brief look at the potential, technological and political, of abating the noise. In short, this is a well documented, carefully prepared text, well-suited for use with undergraduate students, especially those with little mathematical sophistication.

2. FUNDAMENTALS OF ACOUSTICS

Authors: Lawrence E. Kinsler and Austin R. Frey, Professors of Physics, U.S. Naval Postgraduate School, Monterey, Calif.

Point of View: "One purpose of this book is to present, in as simple and concise a form as possible, the fundamental principles underlying the generation, transmission, and reception of acoustic waves. A second purpose is to apply these principles to a number of important fields of applied acoustics."

Level: Technical; graphs and tables; references.

Summary: This has long been a classic among acoustics texts for use in advanced physics and engineering courses. The following excerpt from the preface to the second edition provides a summary which really needs no elaboration.

"One purpose of this book is to present, in as simple and concise a form as possible, the fundamental principles underlying the generation, transmission, and reception of acoustic waves. A second

purpose is to apply these principles to a number of important fields of applied acoustics. . . .

" our primary aim has been to familiarize the student with the fundamental concepts and terminology of the subject and with the analytical methods that are available for attacking acoustical problems. The first nine chapters of the book provide an analysis of the various types of vibration of solid bodies, and of the propagation of sound waves through fluid media. These nine chapters will suffice for a one-semester course in the fundamentals of theoretical acoustics, and they may also be used for the first semester of a full-year course in theoretical and applied acoustics. The remaining six chapters are concerned with a limited number of applications of acoustics. Those discussed have been selected either because of their outstanding importance, as concrete illustrations of the practical application of mathematical techniques developed in the earlier chapters, or because adequate treatments are not readily available in other books. Since each of these last six chapters is an independent, self-contained unit, an instructor presenting a two-semester

2. "FUNDAMENTALS OF ACOUSTICS" (cont'd)

course may omit any one or more of these chapters and substitute material from the more specialized textbooks of acoustics.

One factor that has been kept in mind in writing this book is the close association that exists between acoustics and electrical engineering...

The book may be studied with equal facility by advanced undergraduate or graduate students in Physics, Electrical Engineering, Electronic Engineering, and similar disciplines. The essential requirements are a knowledge of the fundamental principles of mechanics and electricity and an understanding of the methods of calculus, including partial derivatives. Since this book is intended primarily as a textbook for classroom use, rather than as an encyclopedic reference work, no attempt has been made to include a complete bibliography, although numerous references are given, either where the treatment is necessarily incomplete or to provide an interested reader with a source of more detailed information. We have attempted to derive each important equation from the fundamental laws of physics and to show in some detail not only the mathematical steps but also the logical processes involved in these derivations. The derivations of a few of the less important equations have been intentionally omitted and are, instead, included as exercises for

the student among the problems given at the end of each chapter.

Considerable attention has been paid to the selection of a comprehensive set of problems, for the ultimate check on the student's understanding of the subject is his ability to apply his knowledge to new situations. In order to assist those engaged in self-study of this book, answers are provided in the appendix for the odd-numbered problems. Tables of physical constants and functions are given in the Appendix.

As far as possible, the recommended standards of acoustical terminology of the American Standards Association have been used throughout this book, and a glossary of symbols is incorporated in the Appendix as a further aid in clarifying the confusion that might result from the multiplicity of physical quantities represented by certain of the more commonly used symbols."

Publisher: New York, John Wiley and Sons
(524pp; \$15.95) 2nd edition, 1962.

3. NOISE AND MAN

Author: William Burns, Professor of Physiology at the University of London at Charing Cross Hospital Medical School.

Publisher: J. B. Lippincott Company, Philadelphia (336 pp; \$11.00) 1968. (Revised 1973).

Point of View: "There is at present growing concern about the occurrence of unwanted sounds, commonly called noise, and their possible effects upon man. Despite frequent conferences and symposia, and the existence of an extensive literature on noise, the necessary information is to some extent elusive. This introduction to the subject of noise and its effects on man attempts to provide the basic information and point the way to fuller treatments of the several aspects of the subject:"

Level: Semi-technical; illustrated; graphs and tables; bibliography.

Summary: This is a text to which you will see reference

on almost every bibliography of noise literature. Published in 1968, it is one of the first textbooks to break away from traditional acoustics and treat noise as an environmental problem posing potential health hazards to man. As with all "environmental" topics, the noise pollution literature has mushroomed so rapidly since the publication of this text that much of the data included here is now somewhat dated.* Nonetheless, the discussion of the physical properties of sound which introduces the text is a good one, although probably of much more interest to the science than the non-science student. "Types of Sounds" examines frequency, periodic and non-periodic waveforms, velocity of sound waves, and standing waves. This is followed by a chapter on the measurement of sound which, like the others in this introductory section of the book, contains good, basic physics and some fairly sophisticated mathematics. The next three chapters deal with hearing and the first of these, "Mechanism of Hearing", is one of the most interesting offerings in this text. Chapters on the measurement of hearing and on normal hearing and deafness complete

* Revised edition just published.

3. "NOISE AND MAN" (cont'd)

this section. More discussion of physical effects and an introduction to the psychological effects of noise exposure are dealt with in the next four chapters: Annoyance, Measures to Reduce Interference Effects, Temporary Effects of Noise on Hearing, and Permanent Effects of Noise on Hearing. Burns then examines hearing preservation, its objectives and procedures, and discusses both existing noise standards and those that might come into effect in the near future. Finally, two major sources of noise pollution, aircraft noise and impulse noise (sonic boom) are examined in separate chapters. Some discussion is also provided in this final section of industrial and community noise, but it is in these last two sections of the book, effects and sources, that one is most aware of the fact that an awful lot of data has been published on all this since 1968. The turbofan engine, for instance, source of much of today's aircraft noise problem, had not

even gone into service at the time this book was published. Despite the need for updating in much of the "state-of-the-art" material here, however, the physics and mathematical content is well done and this should be a useful reference book for science and engineering students. There is much helpful technical data in the appendices and the list of references provides a good guide to pre-1968 technical publications.

4. ENVIRONMENTAL ACOUSTICS

Author: Leslie L. Doelle, Acoustical Consultant, Assoc. Prof., School of Architecture, University of Montreal.

Publisher: McGraw-Hill Book Company, New York (246 pp.; \$18.50) 1972.

Point of View: "This book . . . is based upon several years of concurrent teaching at three Canadian schools of architecture and on the large number of acoustical problems solved in a private practice of over 20 years. Although intended for the architect and the architecture student, the book also will be useful to engineers, interior designers, builders, contractors, promoters, developers, and in general anyone whose occupation involves him in problems of environmental acoustics."

Level: Semi-technical; illustrated; numerous graphs and tables.

Summary: This is a most interesting book, with something on everything from the history of acoustical ideas to noise control in specific types of buildings and even rooms. Along the way, Doelle manages to fit in a remarkable amount of material under four main divisions: terminology, room or space acoustics, environmental noise control, and the execution, supervision, and checking of acoustical works. The mathematics involved in such calculations as acoustical phenomena in enclosed spaces is presented clearly and concisely. Excellent tables, graphs and illustrations appear throughout the text, not just as decoration but as actual enhancements to

the discussions they accompany. The focus clearly is on designing for quiet in buildings, public and private, but Doelle approaches his main interest from a broad based dealing with the physics of sound, the properties of various sound-absorbing materials, acoustical requirements of various activities, and existing noise criteria for specific types of buildings. Three appendices provide technical data on sound absorption coefficients and sound-insulation values of floors. A brief bibliography of architectural texts serves as a fourth appendix. In short, this is a most readable, up-to-date review of the state-of-the-art of architectural acoustics and should be of interest to many readers outside of the architecture profession.

5. NOISE

Author: Rupert Taylor, British noise consultant.

Publisher: Penguin Books, Baltimore, Md. (268 pp.; \$1.85) 1970.

Point of View: "Though not deadly, noise ever present, ever irritating, can change men's lives and even their personalities. Probably vastly more serious than the measurable physiological effects of noise are the immeasurable psychological effects. . . The priority is without doubt to put an end to the confusion and lack of knowledge."

Level: Non-Technical. Illustrated; glossary of acoustical terms, appended.

Summary: This is a refreshingly relaxed and straightforward little book, with no gimmicks and a great deal of respect for the capacity of the reader to interest himself in an area about which he probably knows very little. Taylor's intended audience is the interested layman and his approach is exemplified by this from the forward: "I am not an academic. I have tried to condense the knowledge gained in six years of controlling noise into a book for fellow non-academics. . . I have tried to say nothing that cannot be justified in simple English, and have tried to justify some things which would normally be done mathematically." He also notes, and correctly, that there is not much mathematics here and that, what there is,

can be overlooked without missing the meaning of the text. Despite this disclaimer to the academic approach, however, the density of information here is quite high and, with the aid of excellent drawings and diagrams, Taylor is able to explore in an interesting way topics which can, in the traditional approach, be deadly to the non-science reader. Included here are chapters on air waves and sound, on the dimensions of sound (based on Taylor's interest in music), and on the various sound sources and means for their abatement and control. A glossary of acoustical terms, appears at the end of the book and a series of six appendices provide some interesting background data and a short bibliography of acoustics text books. In short, while it is unlikely that anyone browsing through a bookstore would settle on this as an afternoon's reading project, it is quite likely that, as a textbook in a course for non-science students or a suggested reference to a student seeking an introduction to acoustics, this would prove most satisfying.

6. NOISE

Author: Laurent Hodges, Dept. of Physics, Iowa State University.

Publisher: Chapter 7 (pp. 112-125) in Environmental Pollution (New York: Holt, Rinehart and Winston, Inc.) 1973. (\$7.95).

Point of View: "Noise has come to be regarded as an important type of urban pollution, capable of causing annoyance and hearing loss, and perhaps even adverse physiological and psychological effects."

Level: Semi-technical; aimed at undergraduate students and educated laymen; illustrated; references.

Summary: This is a brief but valuable chapter out of one of the best "environmental reader" texts on the market today. Hodges begins with a quick summary of "Sound and Hearing", providing an examination of sound waves and the logarithmic scale used for

measuring intensity level and sound pressure level. Decibel readings of various common sounds are provided and contrasted to the sorts of extreme noise associated with occupational noise exposures and hearing damage. "Public Noise Exposures" looks at the effects of noise on humans, both physiological and psychological. The main sources of environmental noise are described briefly in terms of their relative importance and several noise abatement and control mechanisms are briefly noted. A final section deals briefly with sonic booms, mostly as a physical phenomena, and some useful illustrations accompany this discussion. A short but selective list of references is appended to the chapter which, while not the most complete in the book, nonetheless demonstrates the same attention to pedagogy which makes this a useful reader in undergraduate courses.

7. NOISE

Author: Melvin A. Bernarde, Associate Professor, Dept. of Community Medicine, Hahnemann Medical College and Hospital, Philadelphia, Pa.

Publisher: Chapter 12 (pp. 220-243) in Our Precarious Habitat (New York: W. W. Norton and Co., Inc.) 1970. (\$3.95)

Point of View: "Although noise, within limits, is a necessary and probably unpreventable adjunct of our machine civilization, it would appear that unless definite steps are taken to reduce the present inordinate levels in industry and in the community generally, increasing numbers of the population may become auditory cripples."

Level: Popular; illustrated; several graphs and tables.

Summary: This is always an interesting book to turn to for treatments of the various environmental problems as Bernarde, being a medical doctor, takes a slightly different cut through this material than do most of the traditional authors of environmental literature. Predictably, his main concern here is with the health hazard aspects of noise pollution, but he approaches it through a carefully

developed analysis of the essential characteristics of sound, interpretations of readings on the various sound measurement scales, limits of human hearing and a good, brief description of the workings of the human ear. With this background, Bernarde moves into a discussion of noise-induced hearing loss, providing an examination of threshold levels and the various kinds of hearing problems that occur in man. Particular emphasis is placed on hearing loss through exposure to excessively high noise levels and summaries of several recent studies in this area are provided. Extensive data is provided on measured effects of excessive noise and on the moderating effect of various abatement techniques, including use of ear plugs, et. The final paragraphs in this chapter introduce sonic boom, only in a very qualitative way, and contain Dr. Bernarde's strong, personal admonitions against a value system which places development of the SST above dealing with many of the societal problems currently faced by this country.

8. SOUND FROM MOTOR VEHICLES: AN EXERCISE IN NOISE POLLUTION

Author: Joseph Priest, Dept. of Physics, Miami University.

Publisher: Chapter 7 (pp. 266-284) in Problems of Our Physical Environment (Reading, Mass: Addison-Wesley Publishing Company) 1973. (\$10.95).

Points of View: "Noise, though not particularly in nature, is a by-product of motor vehicle operation and is increasingly regarded as a pollutant because of its magnitude and its potential effect on human health and well being."

Level: Semi-technical; illustrated; graphs, tables, references; problems at end of chapter.

Summary: Motor Vehicle noise is really used here simply as a timely application for a fairly traditional treatment of the physics of sound. This is, in fact, a textbook prepared for use in "Physics and the Environment" a course offered by the Miami University physics department for students needing distribution requirements in the physical sciences. The focus, therefore, is in getting across some of the basic physical principles involved in the study of sound and wave phenomenon. The first half of the

chapter deals with the physical properties of sound, energy and power of a sound wave, the human ear as a receiver and noise measurement and standards. Numerous graphs, tables, and illustrations accompany this discussion and the mathematics involved is explained in a straightforward manner with little in the way of mathematical background assumed. Unfortunately, as with many so-called "environmental" texts, the actual discussion of the problem noted in the title, namely, motor vehicle noise, is left to the final two paragraphs of the chapter with very little evidence that the author has troubled himself with the literature in this area at all. In short, this is not a treatment of motor vehicle noise, rather it is a fairly traditional introductory level discussion of the physics of sound aimed at the "non-science" student. It is, however, a well-done treatment, with useful data in the accompanying graphs and some of the problems at the end of the chapter might prove interesting to students in a general, physical science course.

9. THE FIGHT FOR QUIET

Author: Theodore Berland, free-lance journalist.

Publisher: Prentice-Hall Inc., Englewood Cliffs, N. J. (305 pp; \$2.95) 1970.

Point of View: "Besides the toll which noise imposes on our bodies, our emotions, and our hearing, there is the physical mayhem and destruction it wreaks. For noise not only shocks us, maddens us, distresses us, and deafens us, it physically wrecks our surroundings as well."

Level: Popular.

Summary: There are three parts to this book: What Noise Is and Does, Where Noise Comes From, and What You Can Do About It. By far the most interesting section is the first, where Berland has done a particularly good job of summarizing in a popular way the nature of sound and the effects of noise on man. By comparison, "Where Noise Comes From", is less useful, although there is some interesting, catchy data here on noise levels from various sources and in particular places in the home and office. Finally, "What You Can Do About It" records the history of citizen efforts to quiet noise and evaluates some of the more touted industry efforts to

produce quieter products. A good, brief summary of the kind of design features available for quieting buildings is provided and tribute is paid to those whose efforts have materially added to suppression of noise in everything from construction projects to aircraft engines. Berland ends on a familiar note, calling for citizens to organize and bring the weight of their influence to bear on government at all levels. Of the popular level books available on the subject of noise, this is by far the best researched and the most inclusive. It is in no way a complete treatment of the noise problem, however, and touches only superficially on some very complex aspects of the nature of noise and the potential for its control.

10. THE TYRANNY OF NOISE

Author: Robert Alex Baron, founder, Citizens for a Quieter City.

Publisher: Harper and Row, New York (294 pp; \$2.75) 1970.

Point of View: "It may be true that the meek shall inherit the earth, but that will be because it won't be livable, and the noisemaker will be living on other planets. Whether under geodesic domes or under water, the goal for our cities must be as quiet an environment as necessary for human comfort and well-being. This goal is achievable if we end our passive acceptance of industry's acoustic waste products."

Level: Popular, bibliography.

Summary: Mr. Baron is an interesting figure in the small circle of individuals identified with the fight against noise pollution. A recent convert to the severity of the problem, having sustained several months of agony living side-by-side with a City construction project, he has come on like the proverbial gang-busters, appearing as a citizen-

witness at numerous government hearings and actively promoting, through Citizens for a Quieter City, the cause of noise control in general and, more specifically, the need for strong controls on the noise emission levels of manufactured products. He is no way an "expert" on acoustics, nor does he pretend to be. Leaving the technical explanations to the scientists, Baron focuses on those aspects of the noise problem which most impact on the average citizen: the price in health, the price in dollars, and the price in environmental quality. Unfortunately, in his missionary zeal, he makes some rather sweeping judgements as to the good guys and the bad guys, leading to generalizations like the following: "Scientists who work in the field of noise are fatalists. They equate noise with progress, and the future with noise. They believe advancing civilizations will create more noise, not less." In short, this is a political book, designed for maximum impact, and it has obvious biases and, at times, the sorts of generalizations that don't really lead to an understanding of the problem. It is quite readable, however, and may bring the problem of noise pollution to the attention of many readers who would be turned off by a discussion of the physics of sound or measurement scales.

APPENDIX A

Suggested Bibliographies

A. General

1. The Environment Index (New York: Environment Information Center) Annual volumes in print, 1971 to date
2. Applied Science and Technology Index (New York: H. W. Wilson Co.) Annual volumes in print, 1958 to date (also monthly issue).
3. Science for Society: A Bibliography (Washington: American Association for the Advancement of Science) Annual volumes in print, 1970 to date.
4. Selected U.S. Government Publications (Washington: USGPO) Issued bi-monthly at no charge by the U.S. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
5. Books in Print, a Xerox Education Publication (New York: R. R. Bowker and Co.) Published yearly in two volumes: Title and Publisher Index and Author Index.

B. Noise Pollution

1. "Noise Pollution: An Overview", Ann L. Pray, Council of Planning Librarians Exchange Bibliography #213 (Monticello, Ill.: Council of Planning Librarians) August 1971. (Write: Mrs. Mary Vance, Editor, Post Office Box 229, Monticello, Illinois 61856. Send check or money order for \$1.50 per copy.)
2. "Noise: Effects and Problems of Control; Selected, Annotated References, 1966-1972", Jewel H. Ogonji and Shirley Loo, Library Services Division, U.S. Library of Congress, August 18, 1971. (Available by request through your Congressman or Senator; do not write directly to the Library.)
3. "Noise: Potential Danger to Man, An Indexed Bibliography, 1960-1972", Virginia S. DeHaan, December, 1972. Available from: Information Center for Hearing, Speech, and Disorders of Human Communication, The Johns Hopkins Medical Institutions, 310 Harriet Lane Home, Baltimore, Md. 21205. Send check or money order for \$3.00.
4. "National Noise Study: Bibliography, 1956-1969" (Cincinnati, Ohio: U.S. Bureau of Occupational Health and Standards) 1971.
5. "Aircraft Noise and Sonic Boom - Selected References, 1966-1969" (Washington: U.S. Dept. of Transportation) 1969. (Bibliographic List #2).
6. "An Annotated Bibliography on Noise, Its Measurement, Effects and Control" (Pittsburg: Industrial Hygiene Foundation of America, Inc.) 1955.
7. "Environmental Pollution: Noise Pollution - Airplane Noise" (Alexandria, Va.: Defense Documentation Center) 1970. (AD 724 850; DDC - TAS - 71-21-1). Available from NTIS.
8. "Environmental Pollution: Noise Pollution - Noise Effects on Human Performance" (Alexandria, Va.: Defense Documentation Center) 1970 (AD 729 850; DDC-TAS - 71-31-vol. 1). Available from NTIS.
9. "Noise Control", E. B. Magrab, CRC Critical Reviews in Environmental Control, pages 61-83, August 1972.
10. Noise Facts Digest, U.S. EPA, June 1972.

APPENDIX B

Availability of Government Reports

All of the government reports included here should be available for circulation through the Regional Government Library in your Congressional district. Should you desire to obtain personal copies of these documents, there are five main sources:

1. The United States Government Printing Office. Orders may be sent by mail or, for faster service, phoned in to the Order Desk in Washington. When ordering a document, be sure to give the GPO Stock Number and to include a check or purchase order for the amount required. The Mailing address is:

Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

In addition to this main office, there are 12 bookstores located outside of Washington (see last page of this Appendix).

2. National Technical Information Service (NTIS)

Many of the government reports which used to be available free of charge are now distributed through NTIS. When this is the case with documents referenced here, the NTIS order number is provided along with the price of the document, which is usually \$3.00 to \$6.00. For NTIS documents, give order number and send check to:

National Technical Information Service
Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151.

3. Environmental Protection Agency, Office of Noise Abatement and Control

Numerous pamphlets, workshop reports, and internally prepared documents are available only from the Office of Noise Abatement and Control. Requests should be addressed to:

Publications Director
Office of Noise Abatement and Control
Environmental Protection Agency
Washington, D. C. 20460

4. Congressional Committees. Several of the hearings documents included here were printed solely for distribution by the Committee concerned and are not available through the GPO. Requests for these documents should be addressed to the Publications Officer of the Committee noted under "author" in the write-up.

5. Your Representatives to Congress

Requests for Library of Congress publications must be made by a representative to Congress; there is no public access to these internally produced reports. As a rule, Congressmen are eager to provide constituents with any assistance possible and they frequently are able to provide free copies of Congressional Hearings and background documents. Requests should be made as specifically as possible (publication date, order number, etc.) and you should allow several weeks time for response.

APPENDIX B (cont'd)

SOURCES OF INFORMATION ON NOISE POLLUTION

Acoustical Society of America
c/o Mr. Eugene Kone
A. I. P.
335 East 45th Street
New York, New York 10017

Citizens Against Noise
2729 West Lunt
Chicago, Illinois 60645

Citizens for a Quieter City, Inc.
P. O. Box 7777, Ansonia Station
New York, New York 10023
ATTN: Mr. Robert A. Barom

National Council on Noise Abatement
1626 K Street, N.W.
Washington, D. C. 20006
ATTN: Mr. William D. Hurley, Pres.

Mayor's Committee on Noise Abatement
Philadelphia Department of Public Health
500 South Broad Street
Philadelphia, Pennsylvania 19108

Sierra Club Headquarters
1050 Mills Tower
222 Bush Street
San Francisco, California 94104
ATTN: Angeles Chapter Noise Committee

National Organization to Insure a Sound-
Controlled Environment (N.O.I.S.E.)
Executive Building
1 West Street
Mineola, New York 11501

Office of Noise Abatement
U. S. Department of Transportation
Washington, D. C. 20533

Office of Noise Abatement and Control
Environmental Protection Agency
Washington, D. C. 20460

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The following reports and associated documents are available from the National Technical Information Service, Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151 (Phone: AC 703/321-8523). They will not be available from EPA directly:

<u>EPA DOCUMENT NUMBER</u>	<u>TITLE</u>	<u>NTIS DOCUMENT NO.</u>	<u>PRICE</u>
* NCR500.1	Report to the President and Congress on Noise	PB-206716	\$ 6.00
NTID300.1	Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances	PB-206717	6.00
NTID300.2	Noise from Industrial Plants	PB-206718	6.00
NTID300.3	Community Noise	PB-207124	3.00
NTID300.4	Laws and Regulatory Schemes for Noise Abatement	PB-206719	9.00
NTID300.5	Effects of Noise on Wildlife and Other Animals	PB-206720	3.00
NTID300.6	An Assessment of Noise Concern in Other Nations	PB-206721 (Vol. I) PB-206722 (Vol. II)	6.00 3.00

APPENDIX B (cont'd)

<u>EPA DOCUMENT NUMBER</u>	<u>TITLE</u>	<u>NTIS DOCUMENT NO.</u>	<u>PRICE</u>
NTID300. 7	Effects of Noise on People	PB-206723	\$ 3.00
NTID300. 8	State and Municipal Non-Occupational Noise Program	PB-208659	3.00
NTID300. 9	Noise Programs of Professional/Industrial Organizations, Universities and Colleges	PB-207125	3.00
** NTID300. 10	Summary of Noise Programs in the Federal Government	Available at GPO Only	
NTID300. 11	Social Impact of Noise	PB-206724	3.00
NTID300. 12	The Effect of Sonic Boom and Similar Impulsive Noise on Structures	PB-206725	3.00
NTID300. 13	Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines	PB-208660	6.00
NTID300. 14	Economic Impact of Noise	PB-206726	3.00
NTID300. 15	Fundamental of Noise: Measurement, Rating Schemes, and Standards	PB-206727	3.00

* May also be obtained from the GPO for \$2.75 (GPO Stock No. 5500-0040)

** GPO Stock No. 5500-0061

THE NATIONAL HEARINGS ON NOISE ABATEMENT AND CONTROL
HELD IN 1971

<u>VOLUME</u>	<u>TITLE</u>	<u>GPO STOCK NO.</u>	<u>PRICE</u>
I	Construction Noise - Atlanta, Georgia, July 8-9, 1971	5500-0037	\$ 1.25
II	Manufacturing and Transportation Noise (Highway and Air) - Chicago, Illinois July 28-29, 1971	5500-00085	2.10 Postpaid 1.75 GPO Bookstore
III	Urban Planning, Architectural Design, and Noise in the Home - Dallas, Texas August 18-19, 1971	5500-0062	1.25
IV	Standards and Measurement Methods, Legislation and Enforcement Problems, San Francisco - September 27-29, 1971	5500-0036	2.25
V	Agricultural and Recreational Use Noise, Denver, Colorado - September 30 - October 1, 1971	(Limited Copies) Available at EPA Only	
VI	Transportation Noise (rail and other); Urban Noise Problems and Social Behavior, New York, New York - October 21-22, 1971	5500-0038	1.50