UNITED STATES · ENVIRONMENTAL PROTECTION AGENCY

NOISE FACTS DIGEST

U. S. ENVIRONMENTAL PROTECTION AGENCY
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NOISE FACTS DIGEST

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for the

US ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL
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INTRODUCTION

This pilot issue of Noise Facts Digest has been prepared in response to a widely expressed need for more and better information on the prevention, abatement and control of noise.

It contains two general-interest articles as well as about two hundred abstracts of material selected from the most recent and significant of the domestic and foreign literature. These abstracts are designed to provide substantive information. Publications which have been judged difficult to obtain or use have been abstracted at greater length than those judged easy to obtain. All abstracts are supported by detailed bibliographic data in order to enable the reader to obtain the source document directly. We would be pleased to assist you whenever a source document is difficult to obtain. Material was selected for abstracting on the basis of its potential interest to a wide range of readers including not only specialists in noise abatement and control, but also state and local officials, planners, builders, highway engineers and all those who are only peripherally concerned with noise.

Although the Digest concentrates on factual information, we have widened its scope to include opinions recommendations presented at the EPA Hearings on noise he last year. These witness statements provide the reader with a opportunity to obtain an impression of the problem of noise in America as seen from many different viewpoints.

This issue presents the sub-topics of noise comprehensively. Possible future issues might be dedicated to one or two special topics. We are actively seeking the reader's comments and suggestions. Please fill out and return the User Response Form as soon as you have finished perusing this issue. Thank you for your cooperation.

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CHICAGO'S NEW NOISE ORDINANCE - THE FIRST YEAR

Almost a year has passed since the 1971 Chicago Noise Ordinance went into effect, and it is now possible to assess its preliminary impact. There have been two basic reactions noted. The first is the great interest shown by other communities in the Chicago ordinance. Among the hundreds of inquiries received by the Chicago Department of Environmental Control have been many from other towns and cities seeking to develop their own anti-noise legislation or implement noise control programs. Indeed, the noise ordinance recently passed (June 1972) by the city of Baltimore is modeled closely on the Chicago legislation.

The second, and more immediate, reaction to the Chicago law has been a dramatic increase in the number of noise complaints from Chicago's citizens. (See Figure 1.) In 1970 the city government received approximately 120 noise complaints. During the first six months of 1971

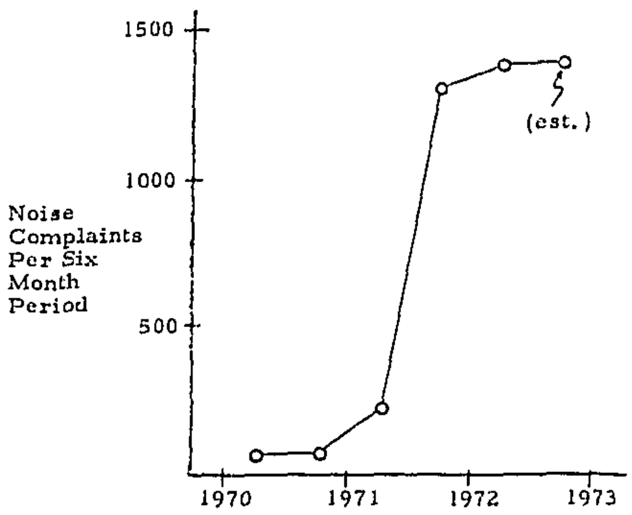

FIGURE 1. INCREASE IN NOISE COMPLAINTS IN THE CITY OF CHICAGO

(before the new law went into effect) the number of complaints rose to approximately 220. The big increase came in the last half of 1971 when noise complaints climbed to over 1,300--or almost 40% of all the complaints received by the Department of Environmental Control. This percentage decreased to around 20% of all complaints during the winter months, reflecting the prevalence of closed windows and the improved noise reduction afforded by them.

The significance of these statistics (especially the almost 1,500% increase in complaints over the 1970 base period) is three-fold. First, they reflect the new stringency of the noise ordinance. Second, they indicate an expanded public awareness of noise as an environmental pollutant. Third, and, perhaps, most significantly, they can be directly related to the well-publicized inauguration of the ordinance and the existence of a single, known, place to which complaints can be addressed.

Other communities planning to establish an office of noise control can look forward to a similar increase in complaints if they, like Chicago, properly publicize their noise-abatement activities.

Table 1 shows a breakdown of noise complaints by noise source. Relatively more complaints came from affluent neighborhoods than from poorer ones.

The remainder of this article will focus on the insights that have emerged from Chicago's first year of experience--insights that may be of great interest to other cities. The reader is also referred to two abstracts* on the Chicago experience in the abstract section of the Digest.

* No. 08-011, and No. 08-012.

TABLE 1
COMPLAINT SUMMARY AND BREAKDOWN
FROM
JULY 1, 1971 to MARCH 1, 1972

CATEGORIES	INVESTIGATIONS MADE
Ice Cream Trucks	13
Buses	3
Trucks	125
Motorcycles	82
Automobiles	80
Air Conditioners	190
Exhaust Fans	97
Chicago Transit Authority	23
Construction	151
Hornblowing	77
Scavengers (privately operated refuse trucks)	142
Musical Instruments	109
Miscellaneous Noises	214
Gas Stations	34
Factory Noises	113
Lawn Mowers	2
Loudspeakers	95
Doorman Whistles	11
Car Washes	9
Church Bells	25
Vibrations	55
Refrigeration Units (Trucks)	8
Dust Collectors	3
Burglar Alarms	7
Airplanes	4
(Subtotal)	1,685
Railroad Noise	60
Total	1,745

Chicago's New Standards

Chicago's present ordinance is the result of new legislation superimposed on an older (1957) noise code. The previous code contained a zoning approach, with limits placed on noise levels at the boundaries separating various use zones--from heavy manufacturing to residential. It also contained nuisance provisions which served as "catch-alls" for the many unusual noise sources which exist in a city. These have been retained and modified. For example, Table 2 shows limits on noise from buildings and installations.

Cosimo Caccavari, Supervisor of the Noise and Vibration Control Office, makes a point of particular interest to owners and operators of factories and buildings with noisy equipment. Sometimes a new source is turned on that produces noise at the lot boundaries 10-15 dB higher than the previous background. If complaints started (and most likely, they would), continued operation would be likely to mobilize opposition to the point where practically no amount of subsequent noise reduction would satisfactorily reduce the stream of complaints.

TABLE 2
LIMITS ON NOISE FROM BUILDINGS AND INSTALLATIONS

Type of District	Where Measured	Limits (For Monitoring Purposes)	
Business & commerical districts	At boundaries of the lot	62 dBA	
Residential	At boundaries of the lot	55	
Manufacturing	At zoning district boundaries		
--Restricted Manufacturing	"	55	On boundary with a residential district
		62	On boundary with a business-commercial district
--General Manufacturing	"	58	On boundary with a residential district
		64	On boundary with a business commerical district
--Heavy Manufacturing	"	61	On boundary with a residential district
		66	On boundary with a business-commercial district

A new provision of the ordinance requires that manufacturers and vendors certify that new equipment on sale in Chicago, including vehicles, meet noise limits. These limits will become stricter on equipment manufactured after certain dates in the future. Limits on present manufactures are shown in Table 3.

TABLE 3
NOISE LIMITS NOW IN EFFECT ON NEWLY-MANUFACTURED EQUIPMENT SOLD IN CHICAGO

	Noise Limit in dBA, Measured at 50 Ft.
Motorcycles	88 dBA
Trucks (over 8000 lbs. gross weight)	88
Cars & other vehicles	86
Construction & industrial equipment, including bulldozers, drills, loaders, power shovels, cranes, derricks, motor graders, paving machines, off-highway trucks, ditchers, trenchers, compactors, scrapers, wagons, pavement breakers, compressors, and pneumatic equipment--pile drivers not included.	94
Equipment of less than 20 hp for occasional use in residential areas, including chain saws pavement breakers, log chippers, powered hand tools, and the like.	88
Equipment for repeated use in residential areas such as lawnmowers, small lawn & garden tools, riding tractors, & snow removal equipment.	74
Snowmobiles	82
Dune buggies, all terrain vehicles, go-carts, mini bikes.	86

The main thrust of the new ordinance is directed at motor vehicles and other types of noisy equipment. Thus, the heart of Chicago's noise control program consists of vigorous enforcement of the older regulations when a complaint is made, plus active enforcement of the new operational limits on motor vehicles.

Operational limits on vehicle noise now in effect are measured at a distance of 50 feet. They are 88 dBA for trucks (or 90 dBA at speeds over 35 mph), 82 dBA for motorcycles (86 dBA at speeds over 35 mph), and 76 dBA for passenger cars (82 dBA at speeds over 35 mph). The limit on trucks is on total emission including noise from auxiliary equipment such as refrigeration units. These limits will be made progressively stricter in the future. (Details on these future limits are given in abstract No. 08-011 also in this issue). So far, the over-35 mph limits have not been enforced, in order to eliminate a variable, tire noise, that might be used by defendents as an excuse in court.

Program Enforcement

Here is how the enforcement program works: Chicago's Department of Environmental Control is responsible for all types of pollution problems, including noise. Its Engineering Division and Enforcement Division cooperate on carrying out the noise control program. The Enforcement Division has 35 Environmental Control squad cars, radio dispatched, on the streets on the streets 24 hours a day, seven days a week. These cars must respond to all environmental complaints concerning air, water, and solid waste, as well as noise. Seven inspectors with special responsibility for noise ride the squad cars. The members of the Envorcement Division write citations for all violations except those involving moving vehicles, where cooperation of the Chicago Police Department is needed to curb a vehicle. Thus, there are two special vehicle enforcement teams which set up at preselected sites around the city to apprehend violators. The sites have been selected by the Engineering Division to meet SAE measurement specification; they must afford a free and clear area within a 100 foot radius of the microphone of the noise meter. This condition is hard to meet in an urban area, and the Engineering Division had to search hard for enough suitable sites. A Chicago police officer, is detailed specifically to work with the measurement team. He stands by in a waiting Environmental Control squad car and is alerted by radio to curb the violator and to issue the citation. To be sure that they have good court evidence, the measurement team rechecks the calibration of the sound level meter immediately after logging the meter reading.

There is a complicating factor, namely, the question of who gets the ticket. When a truck is cited, the issue is, what is more responsible for the noise, the condition of the truck or the way in which it was operated? The procedure that has been developed is that the truck owner usually must post bond to release the truck and its driver.

In an eight month period, 1,026 traffic citations were issued and fines of $7,851 were levied. The work of the Enforcement and Engineering Divisions dovetails. Every complaint must be responded to, Enforcement handles most of this caseload. Some complaint situations are technically difficult, such as when there are two or more noise sources and it is necessary to find the contribution of each; Engineering is then called in to do the job. In enforcing the property line type limits, sound levels are metered around the property line or at the zoning district line, with the offending noise source on, and the maximum reading is taken.

Inevitably there is the problem of violations where the owner is unwilling or unable to comply. Where the owner is merely unwilling, the fine schedule is stiff enough to bring compliance. The fine for first violation, if convicted, is $15-300 plus court costs. Additional violations are fined at $50-500, plus a possible 6-month jail sentence. In an eight month period, fines for building violations have totaled $1,240. Each day of operation can count as a separate violation. It usually takes about six weeks for a citation on the first violation to come to court. If the owner continues to be in violation in the interim, without making any attempt at all to abate the noise, he can find himself with up to 40 or 45 citations by the day he apprears in court, which is a great deterrant to taking the matter too lightly. For example, a railroad was recently fined $5,950 on tickets dating back to last October for noise emanating from the railroad yards.

Help Toward Compliance

Where the owner is cooperative but the abatement problem is difficult, the Engineering Division can and does provide assistance. For example, the ordinance places a 55 dBA limit on air conditioning or exhaust equipment noise at residential lot lines and a 62 dBA limit at business and commercial lot lines. The goal is to be sure that new equipment installations will meet these limits, and to make positive recommendations for a series of steps--from building a simple enclosure to relocating the unit--to help bring older units into compliance. A useful procedure for complex violations, such as noise from manufacturing plants, is the supervisory program with phased noise reduction. After being cited, the violator can request a hearing (there have been79 such hearings in an eight-month period). The Engineering Division and the violator discuss the problem and alternative methods of noise reduction, and the violator has from two to four weeks in which to come up with a proposed noise reduction program. This program can be designed in phases, starting with the simplest and least expensive reduction methods, but must lead to compliance within a fixed period. The phases must be compatible with each other and not go off in different directions. Thus, if "phase one" does not achieve sufficient reduction, the violator knows in advance that he must try the next step, and he knows in advance what the next step will be. If the Engineering Division approves the plan, it may recommend to the court that the violator's fine be waived and that he be put into the supervisory program where his progress will be monitored by the Engineering Division. Several dozen cases are now in the supervisory program, and about ten cases have successfully passed through it and are now in compliance.

Continuing Study of Noise Parameters

Within the Engineering Division, the staff specializing in noise consists of three professionals and three technicians. The annual operating costs of the entire noise program are running about $250,000 (or under 10¢ per capita), and are about equally divided between the Engineering and Enforcement Divisions. Some of the Engineering Divisions support functions have already been mentioned. Studies on special problems are also conducted by the division, i.e., for example, on methods of quieting a pile driver,* the effect of a proposed urban freeway on a school, and the estimated noise climate of proposed mall areas. Another effort is a study of the 24 hour noise levels existing in various city districts, such as residential, commercial, manufacturing, and business areas. These data will establish a base line against which trends and future noise reduction effectiveness can be measured. Also, applications to the city for building permits are reviewed to detect probable future violations that can be prevented in the

* For details, see Abstract No. 01-025.

design stage. Finally, noise specifications are prepared for inclusion in the specifications for new equipment purchases by other city agencies. It can be seen that adequate engineering backup is no mere luxury for a city noise control program, but rather a critical ingredient for its success.

Such preventative measures, which require the scrutiny of engineers experienced in acoustics, are an effective method of achieving noise reduction over the long term at very low cost. The Department of Environmental Control would like to devote more time to this activity.

Public Awareness

One factor of great help to the success of Chicago's program was the effort made to get enforcement of the new ordinance off to a flying start. The two basic ingredients were a thorough publicity campaign before the ordinance went into force, and vigorous enforcement of the ordinance from the very first day it was in effect.

Supervisor Caccavari appeared at length on five or six radio talk shows to answer telephone inquiries. A 60-second public service spot announcing the new law, and giving a telephone number for further information, was run frequently by a local TV station. Day and night telephone numbers for making complaints were publicized. Inexpensive pamphlets that explained the law in detail were printed (cost: about $500 for 50,000). Ten thousand of these pamphlets were mailed out to local businessmen and manufacturers and also to selected manufacturers nationwide. One hundred thousand "SSSHHICAGO," lapel buttons were distributed.

In the weeks before July 1st, 1972, a complimentary inspection site was set up which served several purposes: advising motorists who wanted to learn if their vehicles would be in compliance with the new law, publicizing the new law, and providing the new noise inspectors with on-the-job practice. Several motorcycle groups were among the citizens who turned up to see how loud they were. The cost of various publicity items totaled less than $10,000. The existence of a public relations division within the Department of Environmental Control was a great aid in the timing and coordination of this publicity.

Training the Enforcers

A training program was set up for noise enforcement personnel. It featured a one-week course on noise and noise enforcement, complete with instruction manual, prepared by the Engineering Division of the Department of Environmental Control. This course was presented to 45 attendees, 17 of whom were scheduled for noise field testing work with the Enforcement Division. Because the new ordinance went into effect in the summer, when smoke from buildings was less of a problem, several air pollution personnel in the Department could be transferred to the noise program during the first days, thus increasing enforcement impact.

Evaluation

The Chicago ordinance is, enforceable, for the most part. Investigation of some 1800 complaints over an eight-month period revealed about 900 cases where there was a violation, and citations was issued. Of those citations processed through the courts, convictions were obtained in 85-90% of the cases.

Since abatement was achieved, in some cases without, resort to citations, and since most offenders involved in court cases eventually came into compliance, it may be concluded that legal processes led to abatement in most cases. This contrasts favorably with the situation in New York, where the Bureau of Noise Abatement, which presently has little legal power, has relied chiefly on persuasion to secure some degree of abatement in about 30% of the complaints it has handled.

The most successful part of the Chicago enforcement program to date has been reducing the amount of horn blowing in the "Loop" area of the city. Horn blowing by taxicabs was a large part, but not all, of the noise problem there. Cooperation came from the city courts in the form of some clear-cut decisions accompanied by large fines. The publicity stemming from these court cases has deterred other potential violaters.

Effectiveness of the ordinance in reducing noise levels must be evaluated more cautiously. For one thing, significant reduction of noise sources will be observed only after a period of time, when the progressively more stringent noise limits on equipment go into effect and the supervisory programs, described above, reach successful completion. Presently, trucking firms find they can usually bring their vehicles into compliance by improving exhaust systems. Future limits, especially the 1980 standard of 75 dBA for trucks, may be more difficult to meet.

The limitation on sales seems to entail more enforcement problems. When the ordinance first went into effect in July 1971, only 10 manufacturers or vendors had established communication with the Department. There are now 300 on file, although not all of these have yet filed the required certification. Effectiveness of this program is also threatened by the sale of unregulated products, close to, but not in Chicago.

The outlook for further limits on noise sources is complicated by probable Federal preemption. The main argument for Federal regulation of noise sources is that it would eliminate the possibility of manufacturers being faced with a "patchwork quilt" of local ordinances differing in measurement techniques as well as numbers. Chicago agrees that Federal regulations make sense, but points out that even after the legislation giving EPA authority to set limits is passed it will be several years before those limits can be promulgated and put into force. Until then, the local limits can fill the gap in Chicago. Moreover, experience from the Chicago and California programs will provide valuable data on feasibility and enforceability when Federal standards are drawn up.

A question as to whether the City could not do more about aircraft noise is appropriate since Chicago owns and operates three airports. The problem is a complicated one. Aircraft in the air or landing and taking off are under the jurisdiction of the FAA, and beyond local control. This still leaves the noise from ground run-ups, for which the airport operator is responsible. The Department of Environmental Control handles this nuisance like any other--on a complaint basis. So far, there have been few complaints (Table 2), perhaps indicating that noise from ground run-ups is neglibible compared to that caused by aircraft in flight. In one sense, aircraft noise is a secondary problem in Chicago, compared to its impact in communities like Inglewood, California. It is estimated that about 15% of Chicago's population is adversely affected by aircraft noise, whereas surface transporation noise affects nearly all residents.

The noise control program does not yet regulate total noise at the boundary of construction sites. Provisions concerning this problem and also the problem of noise specifications in building codes were not included in the 1971 ordinance, because it was felt that additional technical information was needed. Meanwhile, other measures are being used for enforcement. The limits on sales equipment manufactured after January 1972 is one example, although it only applies to equipment sold in Chicago. Contractors can be cited for disturbing the peace if they operate equipment with unmuffled exhausts. Construction equipment is prohibited from operating within 600 feet of residential buildings between 9:30 P.M. and 8:00 A.M., except for work on public improvements and the work of public utilities. Upon request, contractors have changed to quieter equipment and re-located noisy equipment. One contractor was required to construct a partial enclosure around a pile driver.

The private scavenger refuse trucks have been a difficult problem so far. They usually meet the noise emissions limits, but since they operate mostly at night, their noise is intrusive enough to be annoying.

Another intractable problem is noise from the Chicago Transit Authority (CTA) system, particularly the elevated portions whose noise annoys the community as well as passengers. The system can not simply be shut down, because thousands of citizens depend on it for transportation. Yet, costs of completely noise-treating it are prohibitive, although the gradual introduction of quieter rolling stock will help. The new CTA extensions now being planned will benefit from noise control features incorporated in the design stage. A private acoustical firm has been hired to do this work, and the Department of Environmental Control is supplying survey data.

In a larger sense, the question of effectiveness must ultimately be defined on the basis of reduction of urban noise to levels consonant with health. As defined by the World Health Organization, this includes not only the absence of disease, but a positive state of well-being. Here, Chicago's noise program can provide only part of the solution unless noise problems in areas outside of the city's jurisdiction are systematically reduced at the same time. These problems include aircraft noise and future urban freeways, for which design criteria are to be issued at the national level. Finally, the ultimate effectiveness of the program will depend on the support and cooperation of the people of Chicago. A large portion of Chicago's program depends on the complaint as the point at which investigation and enforcement are initiated, so the minimum requirement for the success of the program is a citizenry concerned enough to pick up the phone when necessary. As the statistics show, a successful public awareness compaign can do much to foster citizen concern.

In conclusion, Chicago's experience suggests several points to be considered by other cities contemplating noise control programs of their own:

- Enforcement in Chicago's main area of emphasis--vehicle noise--can be effective, but the true impact of the program will not be felt until the more stringent limits scheduled for the future go into effect.
- Start-up costs of a noise program are now somewhat reduced for other cities, because preliminary studies done by Chicago, Boston, and several other cities are available. Chicago's preliminary study cost $54,000; much of its findings are applicable to the problems of other cities.* However, other initial costs must be considered: preliminary noise survey, purchase of measuring instruments (Chicago's cost $30,000, including a mobile measurement van), training costs, and hiring an acoustical consultant.
- The hearing process for proposed legislation is crucial. It is a good idea to hire an acoustical consultant with outstanding credentials to be an expert witness, explain technical points, and assist in writing amendments. Key groups who will be affected by the legislation should be urged to appear at the hearings. An effort should be made to canvass members of the industrial community, because it is often possible to find industrial spokesmen sympathetic to the legislation who can be asked to testify.

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* A copy of this study is available at $15.00 from the Department of Environmental Control, 320 N. Clark Street, Chicago, Illinois 60610.

- The enforcement staff must have at least some engineering back-up if the program is to be a success. It is indispensible for such duties as measurements in complicated situations, training others, testimony in court, helping those cited with violations achieve compliance, reviewing building plans to pinpoint and prevent future noise violations at the design stage, and designing a measurement program to evaluate program effectiveness.

- A noise control program is strengthened when it can draw on the larger resources of a comprehensive city department for environmental affairs.

- The most important single factor to the success of the enforcement of a new noise control law is having trained, practiced enforcement officers ready to begin operations from the first day that the new law is in force.

NEW NOISE INFORMATION RETRIEVAL SYSTEM NOW ON LINE

In late June the Environmental Protection Agency launched a new information system dedicated to noise abatement and control. It is scheduled to be fully operational as early as mid-July. This system, designed for future growth, will contain, initially, approximately one thousand citations and abstracts of various publications. It has been estimated that, ultimately, this data base may exceed 50,000 citations. The abstracts in this pilot issue are representative of the information available from this system. In fact, if future issues of this Digest are to be forthcoming, they will be generated as a by-product of this information system.

The data contained in this new system are directly accessible from a remote terminal. The Office of Noise Abatement and Control anticipates that the data base contained in this system will ultimately be transferred to an EPA-wide system which provides for terminal access from over twenty stations throughout the United States. The capability exists to add further access terminals including overseas locations linked through satellite communications.

For the time being, only recent publications are included in the data base, i.e., publications issued no earlier than 1969. The bulk of the coverage emphasizes current materiel including such items as witness statements given at the EPA Noise Hearings, Environmental Impact Statements, items from the current periodical publications, proceedings of conferences, government contractor reports, as well as special locally oriented reports.

The EPA, in its Report to Congress, showed that the rest of the world has developed a wealth of practical information on noise abatement and control. Therefore, a particular effort has been made to include, in English, the best of this information.

All abstracts are indexed in depth. The index terms contained in this publication reflect only a small fraction of the terms residing in the system. Thus, it is possible to specify a query at a very fine level of detail. Eventually, a comprehensive thesaurus will be developed which should aid the user in formulating his question.

To use the system, full Boolean logic may be applied. Thus, the user can connect his search terms with "and", "or", "not," & "and/or" links. He can also specify geographical areas of interest as well as author, corporate source and other elements of the bibliographic citation. A search formulation might appear as follows:

TRUCKS, or DIESEL ENGINES, and or
MUFFLERS, TRUCK, and (REGULATION,
or LEGISLATION), and or ENFORCEMENT,
not CALIFORNIA

Such a query should provide informative abstracts on enforcement of truck noise regulations in states other than California. Once this query has been keyed and a transmit button has been pressed, the system will respond within a few seconds with an indication of the number of "hits," i.e., the number of abstracts available against such a query formulation. If the number of "hits" is either greater or smaller than desired, the query should be reformulated until the number of "hits" is approximately equal to that desired. A command can then be given which will produce the citations and abstracts in typed form -- or displayed on a cathode ray tube depending on the type of terminal utilized. An alternate lower cost response can be provided if an over-night batch process is requested in lieu of the conversational mode response.

Initially, this system will facilitate ONAC's responses to inquiries. Ultimately, multiple users will interrogate the system simultaneously. Other files, equally accessible, will contain records on on-going research pending and completed litigation and enforcement experience as well as other related information.

ABSTRACTS

EPA HEARINGS

The following pages contain abstracts of selected witness statements at the EPA hearings on the problem of noise pollution. These public hearings were conducted in 1970 by the Office of Noise Abatement and Control in response to a mandate given by Congress in Title IV of PL-91-604, signed into law in December 1970 by President Nixon. Most of the witnesses at the hearing in a particular city spoke on a common theme topic. The cities in which the hearings were held, and the theme topics for each city, were as follows:

Atlanta, GA	Noise in construction.
Chicago, IL	Manufacturing and transportation noise.
Dallas, TX	Urban planning and noise.
	Architectural design and noise.
	Noise in the home.
San Francisco, CA	Standards, measurement methods.
	Legislation and enforcement problems.
Denver, CO	Agricultural and recreational noise.
New York, NY	Transportation, urban noise and social behavior.
Boston, MA	Physiological and psychological effects.
Washington, DC	Technology and economics of noise control.
	National programs and the relations with state and local programs.

In the following pages, the abstracts are arranged by the cities in which the hearings were held.

Full transcripts of all of the witness statements, published by the EPA for each hearing, are available from Supt. of Documents, U. S. Government Printing Office, Washington, D.C., Zip 20402. For a list of all witnesses and their organizations, the reader is referred to Appendix C of the Report to the President and Congress on Noise (also available from USGPO: SN 5500-0040, 1972, $1.75).

EPA HEARINGS

00-001

Haslen, J.
Bergsten, L.

Caterpillar Tractor Company,
Peoria, IL

On: NOISE SUPPRESSION PROGRAM IN THE TRACTOR INDUSTRY

Witness Statement
Public Hearings on Noise Abatement and Control

Atlanta, JUL 8, 1971

The problems encountered in attempting to equip or modify a tractor to meet the operator noise exposure standards of the Walsh-Healey Act are presented. Over 10,000 engineering design hours and 4000 man-hours were required to produce a single set of prototype parts which formed a noise suppression package for one tractor model. This package reduced the level of noise at the operator's station from 96.5 dBA to 89.5 dBA. According to the Walsh-Healey cumulative exposure formula, the total time an operator could be permitted to run the machine in an 8-hour day was 2.9 hours. The only way to meet the Walsh-Healey criteria without requiring the use of protective devices is to enclose the operator in an acoustically treated cab. The heavy structural elements of roll-over protective structures (ROPS), required under the Occupational Health and Safety Act as a necessary part of such cabs, make the noise suppression problem all the more difficult, since these are excellent transmitters of noise. The following recommendations are presented:

1) The EPA should not promulgate additional standards for the protection of operators until it is shown that the regulations of the Walsh-Healey Act of 1969 and the Occupational Safety and Health Act of 1970 can be met.
2) Research should be initiated to acquire and analyze relevant spectator noise data, to the end that realistic and attainable spectator noise level criteria can be established.
3) When the research has been completed, the EPA should establish uniform spectator noise level regulations which will be applicable nationwide.
4) Uniform test procedures should be established for the measurement of both spectator and operator noise levels once standards have been established. These procedures should be representative and reproducible. A single Federal agency should be responsible for both the promulgation and enforcement of all noise regulations.
5) Due to the difficulty of retrofitting noise suppression packages on construction equipment currently in the field, if any retrofit standards are set, they should be less restrictive than new product standards.
6) It is strongly recommended that regulations with respect to spectator noise level criteria for construction machinery not be applied prior to 1974. In a discussion which followed, the additional cost of developing new machines and retrofitting older models was considered. In the final analysis, the increased cost would ultimately be reflected in the product.

00-002

Jackson, E. L.

Delta P. Incorporated

On: CONTROL OF NOISE WITHIN THE CONSTRUCTION INDUSTRY

Witness Statement
Public Hearings on Noise Abatement and Control

Atlanta, JUL 8, 1971

A discussion of state of the art for noise control in construction equipment is presented and recommendations are made for the implementation of existing methods and devices for noise abatement. It is acknowledged that silencing packages have been developed and are available for construction equipment. There is still much work to be done in the field of noise control, but it is also necessary to minimize the economic impact on the construction industry. Technical breakthroughs are not the major requirement. The problem is to get these standard silencing techniques introduced universally into the construction industry.

The basic problem of noise control is economic. Performance is not improved in equipment or machines when silencing is added. Costs varying from 1 to 10% are typically added to the equipment and in some cases operating costs are increased. Various studies have tried to prove that reduction of Workman's Compensation, for example, would more than offset the cost of silencing, but management is not convinced. There is now no economic incentive to the construction industry; in fact, there is a penalty. However, there are benefits for the industry through improved performance, less damage to health through hearing loss, increased productivity and easier and clearer communication.

The following recommendations are presented: Additional legislation with technical meaning in quantitative terms and enforceable language is needed. The economic realities of the situation must be understood. Subsidies and economic incentives should be considered during the transition period. Analysis and research into the problem are also needed to better identify and solve these problems with specific emphasis on how new concepts could lead to quieter and better equipment.

00-003

Codlin, J. B.

Allis Chalmers Corp., Springfield, IL

On: TECHNICAL ASPECTS OF SOUND CONTROL

Witness Statement
Public Hearings on Noise Abatement and Control

Atlanta, JUL 8, 1971

In this discussion of the problems of noise control in the manufacture of construction equipment, emphasis is placed on the cost of these improvements to industry and eventually to the taxpayer. It is estimated that 562,000 pieces of equipment are in operation and that they generate $8 billion worth of construction annually.

The Construction Industry Manufacturers Association (CIMA) has cooperated in the development of measurement and control of noise. Included in the study were noise measurement at operator's station, noise measurement at 50 ft radius, construction job site noise measurement, and cumulative operator noise exposure measurement along with standardized reporting methods.

Experiments on both short-term and long-term methods for sound control are discussed. Short term methods include mufflers, enclosing engine, hood and covers lined with sound deadening materials. Many of these are not durable, and when many sound deadening materials become oil-soaked they are inflamable which creates a definite fire hazard. It is necessary to weigh the tradeoffs in serviceability, effect on reliability, safety and cost.

Engineers are working on a long-range basis on components such as engines, hydraulic pumps, gearing of transmissions and piping to determine what can be done at the source to control noise. To date, success has been marginal. The cost implications are high. Machines have been analyzed component by component, and most will require redesign and retooling. Estimates indicate that noise level reduction will be 3-6 dBA at 50 feet. The cost impact is estimated to be 10 to 25% per vehicle. The estimated long-range cost to the public is $202 million annually. This, in addition to the short-range program costs is a total of $362 million annually, for a reduction of 5 to 12 dBA. A cost of $200 to $2000 for parts plus the cost of installation is estimated for the equipping of existing vehicles.

00-004

Walk, F. H.

Walk, Haydel and Associates, Ltd., New Orleans, LA

On: NOISE IN CONSTRUCTION OF INDUSTRIAL PLANTS

Witness Statement
Public Hearings on Noise Abatement and Control

Atlanta, JUL 8, 1971

A discussion of problems in reducing noise levels in the construction industry is presented.

Although much progress has been made in the isolation and reduction of plant operating noise, far less progress has been made toward noise abatement in the construction industry. The average industrial plant construction manager has been subjected to much less noise abatement pressure than the average industrial plant operator. This is probably due to the temporary nature of construction operation as opposed to a long-term, permanent manufacturing operation.

An improvement in the state of the art of noise abatement in construction can be realized if permissible standards of sound levels are assigned to specific items of construction equipment. Manufacturers should be required to prepare sound pressure levels on a uniform basis for all types of equipment. For each type, operating conditions, distance-measurement criteria, and directionality characteristics must be developed under controlled environment. If noise abatement programs are accelerated, careful attention must be given to the establishment of reasonable standards for the industry and also to the planning of a timetable for stepwise enforcement so that the costs of compliance do not become excessive and further deter capital expansion programs of industry. A discussion followed on the relative cost of developing and using improved equipment and it was concluded that it would be in the order of magnitude of 10 to 10%.

EPA HEARINGS

00-005

Watts, J. A.

Michigan University, Ann Arbor

University of Michigan Law School

On: VEHICULAR NOISE CONTROL LEGISLATION

Witness Statement
Public Hearings on Noise Abatement and Control

Chicago, JUL 29, 1971

A noise control project with participation by the University of Michigan's Environmental Law Society and Department of Mechanical Engineering is designed to develop enforceable noise control legislation for various governmental bodies. It is primarily concerned with vehicular noise.

Local and state police and highway officials were interviewed. It is concluded that the most important aspect of noise pollution legislation is the problem of enforcement.

Enforcement of noise control legislation is expensive. It requires special equipment and training. Enforcement may be extremely difficult. Weather changes affect measurement. Certification and calibration of instruments may be extremely time-consuming. The police want simple, reliable and inexpensive instruments which can be operated under varying conditions. Until this equipment is available, one solution may be to employ noise teams composed of a police officer and a person trained in noise measurement techniques.

Definite legislative standards are necessary to avoid the problems created by the present statutes which prohibit "excessive and unusual noise".

An effective solution to the noise pollution problem is effective enforcement of manufacturing standards. There is little evidence that manufacturers will reduce noise levels without government enforced standards.

The following recommendations are presented:

Federal standards for vehicular noise should be established at the earliest possible date. Provisions should be included which allow for stricter state standards.

Full matching grants should be made available to police and health departments throughout the nation to purchase equipment and train personnel in noise control.

A system of tax incentives for the manufacture of quiet products should be employed to ascertain its feasibility.

The long-term goal in the fight against noise pollution should always be to reduce the noise level and not merely to hold the line at an "acceptable" noise level. And the last recommendation, additional Federal highway funds might be supplied for research on the use of material for quieter road surfaces.

00-006

Lewis, E.

Northwestern Students For A Better Environment

On: NOISE POLLUTION AND EDUCATION

Witness Statement
Public Hearings on Noise Abatement and Control

Chicago, JUL 29, 1971

This statement, made by Northwestern Students For a Better Environment (NSBE), is based on information presented in Volume I and in preliminary drafts to Volume II of a study entitled "Comprehensive Plan for the North Lakeview Section of the Uptown Model Cities Area" (of Chicago).

This study, financed by grants from the Sloan Foundation and the National Science Foundation, was undertaken by students working through the Urban Systems Engineering Center and the Design and Development Center, both at Northwestern University.

Noise Pollution in North Lakeview affects many patterns of human existence. But, its effects on safety and education are the most disturbing.

It was observed that children could not hear approachingg cars and that noise from the elevated trains of the Chicago Transit Authority (CTA) frightened them. A more serious noise pollution problem with many unknown effects is disruption of classrooms.

The following recommendations are made about the level of noise generated in one Chicago community area:

The Walsh-Healey Act should be amended so workers are better protected from hazardous noise levels. NSBE recommends the adoption of 80 dBA, as proposed by the New York State Quiet Communities Program, as a maximum level for prolonged periods.

Second, EPA should adopt Sound Transmission Class levels. The STC level is the level of sound which building materials baffle. EPA should adopt STC levels for building materials that will reduce noise levels below the 80 dBA level.

Third, EPA should perform additional research on the effectiveness of baffles and concrete supports which are used for noise abatement around CTA tracks.

Finally, a new friction reducing compound should be developed. This compound will help reduce noise resulting from rail-wheel interaction on the elevated tracks. A demonstration grant from the Federal government may lead to an inexpensive means of reducing decibel levels.

00-007

Corbett, J. J.

Airport Operations Council International, Washington, DC

1700 K Street, NW, 20006

On: AIRCRAFT NOISE POLLUTION AS A NATIONAL PROBLEM

Witness Statement
Public Hearings on Noise Abatement and Control

Chicago, JUL 28, 1971

Aircraft Noise pollution is viewed by governmental airport operators as the single greatest constraint to orderly aviation development in the 1970's. New airport capacity is stalled across the nation and around the globe primarily because of understandable community and public disaffection with the noise of current day aircraft. The single most beneficial step offering promise of noise alleviation is accelerated Federal applied research toward, and a prompt Federal decision regarding, the retrofit of the existing jet fleet, primarily for those aircraft whose useful service life exceeds 5 years. The international and interstate nature of air transportation requires that action to mitigate aircraft noise be concentrated on reduction of noise at its source, the aircraft engine, and that Federal or international action, and not inconsistent state/local measures, be expedited.

00-008

Spahr, H.

Park Ridge, IL

On: AIR, NOISE, MEASUREMENTS AND PROCEDURES

Witness Statement
Public Hearings on Noise Abatement and Control

Chicago, JUL 29, 1971

The City of Park Ridge has been monitoring aircraft flights originating from O'Hare International Airport flying over the community since 1963. In light of this, Park Ridge adopted an ordinance which essentially provides that flights over portions of the city causing noise in excess of 95 dBC are a nuisance.

To implement the provisions of the ordinance, a bubble top truck equipped with a sound measuring device and a radio capable of monitoring air traffic was obtained and was designed so that visual observation of flying aircraft could be made conveniently.

The sound truck and equipment is generally operated by a member of the Park Ridge Police Department who has received specific training in the use of the equipment.

A consulting acoustical engineer has evaluated the noise measuring program and has determined that the measurement techniques of Park Ridge officials are sufficiently good.

Complaints appear completely justified since levels which evoke complaints are equal to or in excess of the 85 dBA 'critical' or 'danger' level.

A simple, easily demonstrated case can be made to show that present aircraft operations at O'Hare already expose community areas to dangerous noise levels and that the proposed plans for additional runways at O'Hare will increase the exposure levels and the affected geographical area.

The schools of Park Ridge find the inconsistency and high level of noise pollution attributable to the expansion and lack of pattern control at O'Hare International Airport becoming increasingly less tolerant in the educational setting. In general, it was determined that modification in the teachers' approach to instruction are necessary. Particularly where a combination of verbal and auditory faculties are needed, the teacher is forced either to shout or, by preference, to discontinue communication until the noise subsides. Valuable instructional time is lost and crucial learning activities are set adrift as concentration is broken and young minds wander to the source.

00-009

EPA HEARINGS

00-009

Rupert, H. M.

Federal Highway Administration,
Washington, DC

Zip 20591

On: CONTROL OF HIGHWAY RELATED NOISE

Witness Statement
Public Hearings on Noise Abatement and Control

Chicago, JUL 28, 1971

The highway related noise problem and some potential solutions are presented. The control of this nuisance requires the concerted and coordinated efforts of many programs, agencies, firms and individuals.

There is good reason to believe that quieter vehicles can be manufactured. If the manufacturing industry were furnished reasonable noise criteria which would be uniformly applied to all manufacturers, improvement could be obtained without jeopardizing the sales and profits of any individual firm.

The President has recommended Federal legislation which would enable this control. A bill has been introduced in Congress to provide this authority to the Environmental Protection Agency.

If the manufacture of quieter vehicles were required, there is no assurance that they would remain quiet. Most State motor vehicle codes require that a vehicle not be operated without a muffler or in a manner which creates loud or excessive noise. The determination of what is loud or excessive requires a subjective determination on the part of an enforcement official. As a result, enforcement is difficult and ineffective. The Federal Highway Administration recommends State and local enactment and enforcement of numerical noise level limits.

Reduction of the noise which the vehicle creates will not eliminate all highway related noise problems. An amphitheater should not be constructed near an airport or adjacent to a heavily travelled freeway. The same is true of some types of single family residences, some types of schools, hospitals and many other types of land use.

Land use control in areas where noise is a problem should be considered. The lands need not necessarily remain vacant. Most commercial and industrial activities can be made to conform to a noise environment.

Sometimes the local officials who control land use, planning, and zoning are not aware of the potential noise in these situations. Transportation officials must continue to cooperate with local officials, informing them of potential areas of incompatibility, and helping to plan compatible activities. In addition, a national land use policy, with built in incentives to localities is needed to insure compatible land use development.

The Congress has directed the undertaking of some enormous tasks with the enactment of the Federal-aid Highway Act of 1970. One of those tasks is the development of guidelines to assure that adequate consideration is given to the social, economic and environmental effects in the Federal-aid highway program. One of the specific effects the Congress wanted included is noise.

There is great potential in the guidelines and standards efforts for further increasing the highway program's responsiveness to the current concern for the environment. However, great care must be taken to be certain that they are not so severe as to cause a serious impediment to the highway program.

The noise guidelines are expected to be a procedure for analysis of noise impacts. Included in the analysis would be:
(a) determination of existing noise levels, (b) inventory of noise sensitive land uses or activities, (c) prediction of anticipated noise levels from the proposed highway project, and (d) study of noise abatement alternatives. The results of the analysis would be furnished to the decision maker together with the analyses of other social, economic, and environmental effects to provide a more comprehensive basis for making highway decisions.

The noise standards are expected to be numerical noise levels (in decibels using the A-weighted scale) for various land uses and activities. There will be different values for day and night, and there will be both average and peak noise levels.

There are several opportunities available for control of noise during the development of a highway project. During the location studies, the potential noise impact of each alternative alignment can be determined. From a noise standpoint, the alignment having the least noise impact should be selected.

The design of a highway offers additional opportunities to control highway related noise. The advantages of a depressed roadway can be considered. The same noise level reduction can be obtained by construction a noise barrier at much less cost.

Landscape plantings are an aesthetic asset to almost any highway setting. Some noise reduction can be obtained by avoiding steep roadway grades and by holding their length to a minimum.

New acoustic materials are needed for highway work. They must be durable, attractive, economical and easily cleaned. Truck exhaust stacks must be gotten closer to the ground so that low barriers will be more effective. Pavement surfaces must be developed that are both quiet and safe.

A last resort capability is needed which could be used when all other techniques are inadequate or uneconomical. Possible approaches might include authority to purchase noise easements or noise rights, the outright purchase of a property, or installation of noise insulation.

00-010

Ringham, R. F.
Staadt, R. L.

International Harvester Company,
Chicago, IL

Chicago, IL

On: HIGHWAY TRANSPORTATION NOISE

Witness Statement
Public Hearings on Noise Abatement and Control

Chicago, JUL 28, 1971

Typical truck noise and its sources and measures involved in controlling it are reviewed. The overall approach to legislative control of highway vehicle noise is also discussed. Criteria for regulations must reflect test conditions and procedures specified for verification of compliance.

Vehicles which contribute the most to highway noise are the large diesel powered trucks. Several noise sources are inherent in these units: exhause noise, cooling fan, engine air intake, engine mechanical and combustion, and tire and wind noise.

If certain sound sources are eliminated; for example, the 84 dBA exhaust noise by a theoretically perfect muffler, the total noise level would only drop to 86 dBA. Similarly, if other single sources are eliminated, only a slight drop in overall noise is realized. Since exhaust noise cannot be eliminated completely, the only approach which can reduce overall levels is to lower all sources which individually approach the level of the total. Such an approach was taken in the case of the 88 dBA vehicle.

The measures employed were:

1) The cooling fan was run at a slower speed to reduce fan noise and radiator size increased to offset the loss in cooling air flow.

2) A larger, more efficient muffler reduced exhaust noise.

3) The air intake noise was reduced by an improved silencer relocated from the side of the hood to the front to direct sound away from observers.

4) Shields around the engine compartment now block engine radiated mechanical and combustion noise.

The resulting overall noise level is now 86 dBA. It is noted that most of these modifications required considerable redesign thereby making retrofitting extremely expensive if not impossible.

The value of 86 dBA is considered to be the next plateau in heavy truck noise control. Major cooling fan development programs and further engine shielding will be required to meet this level. To get below 86 dBA will involve extensive programs in engine and cooling system redesign and development. This will involve several years and can reflect considerable increase in cost to the user.

Regulations or sound limits for the vehicle user should not be lower than those required of the manufacturer or user at the time the vehicle was built. The operator, or manufacturer, for that matter, has no means of making the vehicle quieter than it was when originally built. As shown earlier, significant sound reductions by retrofit programs generally are not practical.

Regulations cannot be effective without proper enforcement. Enforcement personnel must be trained in noise surveillance and operate at the carefully selected sites which are required for accurate readings.

00-011

Walker, B.

Cleveland, Ohio

On: PREREQUISITES FOR NOISE CONTROL REGULATIONS

Witness Statement
Public Hearings on Noise Abatement and Control

Dallas, AUG 19, 1971

An environmental health commissioner discusses the sources of residential noise and requirements of an effective noise control program.

00-012

EPA HEARINGS

In contrast to older dwellings, the modern dwelling with its light weight construction, open plan design and multitude of noise makers provides very little protection from noise generated within or intruding from the outside. Data from a survey conducted in Cleveland indicated that 80% of the 1000 respondents were disturbed by noise outside the building and 16% by noise from adjoining apartments.

Zoning ordinances are of limited value in controlling urban noise, as they simply aggregate similar land use activities, as residential, commercial and industrial, and tend to ignore peripheral areas and factors such as transportation. These are reasonable grounds on which to question the adequacy of local government, left to its own resources, to control urban noise effectively.

The alleviation of the noise problem frequently requires action that transcends political boundaries. A broad-based, coordinated attack on the problem must involve the Federal and state levels of government. It is practical and highly desirable to establish Federal standards for some items moving in interstate commerce to eliminate noise producing features at the point of origin or at the point of manufacture rather than expect local control once the equipment is operating in a community. The critical areas of continuing research, manpower, training and development criteria, demonstrations and funds for local surveillance and monitoring require the full and effective leadership of the Federal government.

There are shortcomings in our present knowledge and programs for noise control, and if we are to minimize additional environmental stresses on community living, a coordinated attack on the problem must be developed now. It is essential that nationally accepted techniques be developed for the measurement, evaluation and rating of noise and its effect on human health, and to accomplish this will require scientific talent, trained technicians and additional facilities and financial resources at all levels of government.

00-012

Spano, B.

Polysonics Acoustical Engineers,
Washington, DC

On: THE STATE OF THE ART, HOME NOISE

Witness Statement
Public Hearings on Noise Abatement and Control

Dallas, AUG 19, 1971

Examples of ignorance of architects and building mechanics in construction techniques to reduce sound transmission are presented. Some suggestion for activities of EPA in this field are outlined.

A new hi-rise apartment was advertised as having "revolutionary soundproofing." In reality the noise was worse than some old tenement houses. The load bearing walls had a 62 STC rating but the others were on 35 STC and poorly designed.

In another case, a hospital, the penthouse machinery was not properly isolated. After four years professional help was sought and the problem corrected very easily.

Another example is post-tensioned concrete. Using this method of construction, floors can be thin and supports far apart. The buildings vibrated violently. Everyone blamed someone else. It was eventually corrected, but much time and money was wasted.

Two practical methods to both lower cost and noise are presented. The first entails eliminating wood floor and placing carpeting over the slab. The second is changing from a lead oakum joint in the waste pipe system to a neoprene gasket.

EPA could disseminate available information on architectural design on isolation. Simple consumer bulletins could be sent that would help in consumer understanding. The EPA should act as a clearing house for new products that will help build quieter houses, such as the neoprene gasket. Some EPA media is needed through which home-builders could be reached, since they are the environment builders. If the builders could be reached through some simplified type of do-don't corrective mechanisms, they could be put into effect very quickly. Time is a great concern.

00-013

Wegner, R. L.

North Texas Council of Governments

On: REGIONAL AIRPORT PLANNING

Witness Statement
Public Hearings on Noise Abatement and Control

Dallas, AUG 19, 1971

The efforts of a regional organization, the North Central Texas Council of Governments (NCTCOG) to help local governments deal effectively with the challenges and opportunities posed by the new Dallas/Fort

EPA HEARINGS

Worth Regional Airport are discussed. This airport will have the capacity to accommodate 300 aircraft movements per peak hour.

The Regional Airport Environs study stressed the impact of aircraft sound on the development of surrounding land. An aircraft sound exposure map was prepared. A brief simple explanation of the significance of the sound zones depicted on that map was prepared for use by local officials concerned with land development in the areas immediately adjacent to the Regional Airport site.

Several seminars were held for planners, administrators, building inspectors, and representatives of school districts, which gave technical facts and guidance, recommended land uses and information about acoustical treatment of buildings.

Another project, funded by the Department of Housing and Urban Development and entitled the "Cooperative Program of Planning for Airport Impact," was designed to help the cities most directly affected by the new airport to carry on local planning in response to airport impact. The city of Irving developed an Airport Zoning Ordinance and soundproofing modifications to its building code. The soundproofing modifications will add 2 to 10% to the cost of a building.

Another project of NCTCOG is the Cooperative Planning Program, in which a number of model codes and ordinances and guidelines are being prepared to aid local governments in improving their local planning capability.

It is suggested that both preventive and remedial measures to control, reduce and/or eliminate the harmful effects of noise become the concern of all professional planners and official planning agencies. To plan preventive and remedial measures planners and planning agencies require legal authority, political sanction, technical and financial assistance. Federal legislation should make provisions for technical training and financial assistance and incentives for noise control and abatement planning at state, regional and local levels as part of the environmental protective activities at each of these levels. Approximately $6,000,000 per year would provide an average of $25,000 to each of the 240 standard metropolitan areas. Assured funding of this type would establish a sound foundation and a start toward deliberate, continuing environmental protection activity at the regional level.

00-014

Hixon, E.

Texas University,
Austin

On: NOISE ISOLATION IN LOW COST HOUSING

Witness Statement
Public Hearings on Noise Abatement and Control

Dallas, AUG 19, 1971

In 1968, 10 single family, low-cost dwellings were constructed in Austin, Texas, under the sponsorship of the U.S. Department of Housing and Urban Development. The purpose was to develop and test architectural design, building materials and construction methods. The University of Texas was asked to provide architectural, engineering, psychological and sociological evaluations of these houses. Noise isolation studies were conducted as part of the engineering evaluation.

Standard FHA specifications were waived to allow innovations. Ten plans utilizing a wide range of materials and construction methods were chosen. Most of the acoustic tests were made after the houses were occupied by the purchaser. Test results for 6 of the houses indicate generally low values of noise isolation and lack of consideration for noise isolation. In some cases simple changes that would add little to the cost could have resulted in large improvements. It is concluded that noise isolation should be a major consideration in housing for low-income families who have the greatest need to enhance the quality of life.

00-015

Parrott, C. D.

Redevelopment Authority
La Crosse, WI

On: THE RESPONSIBILITY OF THE URBAN PLANNER FOR NOISE CONTROL

Witness Statement
Public Hearings on Noise Abatement and Control

Dallas, AUG 19, 1971

The selected placement of potential major noise producing activities to protect the urban dweller and his neighborhood environment is discussed. Regulatory measures governing intensity of land use, control limits on sound producing devices, and sound reduction engineering and architectural designs for transportation facilities and certain other forms of land use are required to supplement selective placement. With the systematic application of these controlling factors and the public's understanding of the need for such measures, the mounting threat of sound pollution can be reduced. The urban planner is in a unique position to help educate the public and the elected and appointed officials he serves.

The City of Madison, WI, has adopted a code setting maximum noise levels for all stationary and moving noise-producing devices in all zoning districts and public ways with the only apparent exceptions being emergency vehicles and fireworks displays.

Transportation planners should not be preparing plans for communities which call for the construction of high-speed freeways and expressways in association with residential land use. Any freeway network in an urban area may pass through commercial, industrial, residential, agricultural and other types of land use areas. Although normal noise levels from freeway sources may be acceptable in an industrial area, these same levels would be less acceptable in a residential area. From the economic standpoint, it is difficult to justify the costs of purchasing additional widths of right-of-way to protect residents from the adverse effects on high speed freeway facilities at this point in time.

People generally have little or no knowledge of the possible effects that various types of installations can have on their environment until the conditions are experienced, and then it is too late. Therefore, it is important that the planning profession be sufficiently informed on all environmental considerations and take these factors into account in their studies, in their reports, and in their explanations to the public officials.

Land use controls, density controls, public property acquisition, and building code soundproofing requirements for construction in undeveloped areas near freeways and airports can employ limited defensive measures against excessive sound. The problem near transportation facilities already surrounded by urban development is significantly more complicated. Preventive measures, however unpopular, are far less costly and difficult than corrective actions.

The requirements for moving traffic and aircraft will be greater in 1990 and the year 2000 than they are today; but, also, it must be acknowledged that the requirements for preserving our environment will also be much greater than they are now. Somewhere we must turn the corner and make planning for the integrity of our natural environmental resources and the people they serve and protect as commonplace as the planning for residential, industrial and commercial areas and transportation facilities.

00-016

Tanner, C.

Hydrospace Research Corporation,
San Diego, CA

On: MEASURING TECHNIQUES FOR NOISE STANDARDS

Witness Statement
Public Hearings on Noise Abatement and Control

San Francisco, SEPT 29, 1971

This discussion deals with the measurement techniques for use in certain airport noise standards. These techniques are based on the measurement and processing of noise signals to define the 3 basic properties of noise:

1. Absolute level
2. Frequency content
3. Time variations

The resultant measurements are used in a variety of computational procedures to assess not only the basic nature of the sound signal, such as defining a pure tone component, but to evaluate the subjective annoyance of a sound by calculating effective perceived noise level or noise exposure levels.

Each noise standard sets down some rather detailed specifications regarding:

1. The instrumentation that can be used,
2. Calibration measurements,
3. Physical location of microphones,
4. Operating limitations, and
5. Signal processing and computational requirements.

Measurement requirements for the Federal Aviation Regulation Part 36 which specifies the effective perceived noise levels of commercial aircraft, require microphones at 3 sides and the measurement of the noise of at least 6 take-offs and 6 landings. These measurements are processed to define the frequency distribution and energy level every one-half second. These values are corrected and used to compute perceived noise levels which are compared with the allowable limits.

The measurements for the California Noise Standards require that at large airports microphones are located at 12 sides and measure the noise above a specified threshold from every operation. Using an updated summation for specified time periods of the day, the composite noise equipment level is computed. This level is compared with previously established levels around the airport.

Although there are a number of measurement techniques that are used in implementing noise standards, all are subject to outside influences which must be recognized in order to maintain data quality. Background noise can be of sufficient level to invalidate the measurement.

00-017

Olpin, O.

Utah Univ.,
Salt Lake City

On: REDUCTION OF TRANSPORTATION NOISE

Witness Statement
Public Hearings on Noise Abatement and Control

Denver, SEPT 30, 1971

Noise pollution from transportation, cars, trucks, and airplanes is discussed. Engine sounds from vehicles have been controlled for years by mufflers, but the market has not provided the incentives needed to bring about improvement in muffler technology. The aim has been to protect the motorist from noise pollution inside the car with windows shut; but not those on the outside near the highways.

A large part of the sound of the highways is the sound of wheels rolling on the surface of roads. This is not an unsolvable problem, but today neither the pressure nor the market incentive is present. The task is to create both.

An obvious partial solution lies in measures to assure that presently available technology is fully utilized. In the case of mufflers or other vehicle sound controlling equipment, this can easily be made a part of existing licensing and inspecting procedures. Laws should be made firm enough to require that licenses be denied to any vehicle not equipped with adequate, properly functioning sound control devices.

A special problem is posed by noise generated by recreational vehicles. Some seem to believe that more sound means more power, and appetites for both sound and power seem considerable. Motorcycles, dunebuggies, dragsters, and snowmobiles appear to be manufactured and operated with a purpose to maximize sound production. There is available technology to muffle most of the sound generated by recreational vehicles. Up to now, however, laws have not been passed.

Title IV of the Clean Air Act provides for a beginning in the battle against unwanted sound. Authorization is provided for $30,000,000 to begin to identify causes and sources of noise and to learn of the damage and injury which results from noise. No part of that money is allocated to the search for cures. Concrete proposals looking toward cures should be made by the Environmental Protection Agency at the earliest possible moment. It is necessary to adopt laws and rules and regulations which will impel the transportation industries and the consumers of their products to shoulder their share of this burden. Another proposal that should be considered is to use in this effort part of the substantial resources of the Highway Trust Fund.

The Highway Trust Fund represents a practical and appropriate source of support for the solution of the problem of noise from transportation.

00-018

Monaghan, J.

Colorado State Univ.
Fort Collins

On: RECREATIONAL NOISE

Witness Statement
Public Hearings on Noise Abatement and Control

Denver, SEPT 30, 1971

The pervasive noise created by such recreational vehicles as snowmobiles, motor powered boats, all terrain vehicles and the like is discussed. The high decibel output from some of the aforementioned recreational sources is the antithesis of bodily and mental refreshment. The various concepts of recreation seem to be on a collision course. Psychologists tell of the mounting need for periodic escape from the urban environment as a survival mechanism. Some animals and plants are up to 30,000 times more sensitive to noise than humans.

Noise is a national problem, and recreational noise, produced by vehicles that are manufactured and distributed nationally, would be more easily regulated with uniform requirements that manufacturers would have to meet on a national basis. It is also felt that on a local level the health and individual rights of those seeking an outdoor experience could easily be subjugated by local interests focused narrowly on the monetary gains of these loud vehicles.

The Environmental Protection Agency is urged to promulgate regulations for recreational noise within a comprehensive noise control program and include: 1) the establishment of uniform decibel limits on all recreational vehicles, whether manufactured in the United

States or imported; 2) a provision for research of the state of the art in noise abatement for recreational vehicles; and 3) the provision for the periodic testing of such vehicles which are already in use; 4) the concept of differential use and noise zoning.

Decibel limits must be realistic within existing technology. But the freedom of the individual to enjoy a recreational experience, unhampered by an obnoxious environment, is of key importance. The concept of differential use and noise zoning is encouraged. In this manner, certain lakes, for example, would be zoned for such vehicles, setting in each case realistic decibel limits.

00-019

Lincoln, R.

Outboard Marine Corp.
Milwaukee, WI

On: MOTOR NOISE CONTROL

Witness Statement
Public Hearings on Noise Abatement and Control

Denver, OCT 1, 1971

A statement from a manufacturer of snow vehicles, outboard motors, lawn and garden equipment, all terrain vehicles, chain saws and golf carts is presented. The extent to which regulation of noise will help reduce annoyance and contribute to the improved quality of life is of major concern. Noise reduction is not as simple as adding or enlarging exhaust mufflers or building better enclosures. Time, talent and money are required to make a detailed technical analysis of each product. Strict, fair and uniform enforcement codes are a must. Without them, manufacturers whose products do conform to regulations will suffer severe penalties.

Noise levels of typical leisure time products have been examined and it has been noted that technology can probably be developed which will reduce complaints stemming from annoyance. These reductions will penalize the product user in cost, weight, bulk, ease of handling and simplicity of service. Regulations and standards can be established which will be realistic and feasible, but there are many complexities to be considered if fair and equitable enforcement is to be maintained. Since many complaints about noise are from members of small, special interest groups, great care must be taken to assure that large numbers of people are not penalized to satisfy a few.

00-020

Yoerger, R.

Illinois Univ., Urbana

On: AGRICULTURAL EQUIPMENT NOISE CONTROL

Witness Statement
Public Hearings on Noise Abatement and Control

Denver, SEPT 30, 1971

Scientific and engineering developments have contributed to increased productivity and reduced drugery of work on the modern farm. However, the relative economic position of the farmer, compared to his industrial counterpart, has deteriorated over the last 30 years. Before any noise regulations pertaining to agriculture are enacted, the cost benefits ratio must be carefully evaluated.

The farm equipment industry produces $4-$6,000,000 worth of goods annually. The large manufacturers have engineering and research facilities. The small manufacturer must solve problems on a local level and is able to develop and modify machines quickly. Often the small manufacturer develops new machines and establishes the market potentials before a major manufacturer is willing to commit the resources necessary to add the item to his line.

In the past, equipment demanded by the consumer each year had to be larger, operate faster and have a greater capacity than earlier models. Because the industry has met these demands, productivity per worker has increased markedly. In 1960, one farm worker produced enough food for 26 persons; in 1970, enough for 46. The result of building bigger machines has generally been an increase in the sound power level of noise associated with machine operation. Major contributors to the overall noise level of an operating machine are the power source, the gear train and the various functional components of the machine.

Industrial, professional and public service groups have been concerned about the identification and reduction of equipment noise for some time. A research program at the University of Illinois is concerned with the noise and vibration associated with farm and industrial machinery. The research at the University of Illinois has been concerned with reducing 2 of the major components of tractor noise, that resulting from the cooling fan and from the engine exhaust. The goal is to better understand the mechanism of generation and transmission of these noises and to reduce the levels as close to the source as possible.

It is felt that the goal with agricultural machinery should be to reduce noise level so that there is not a serious potential hazard to hearing loss for either the machine operator or for associates working in close proximity to the machine. Agricultural universities, the

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farm equipment industry, 4-H and FAA groups and others are cooperating in an educational program to alert the farmer and farm worker to potential hazards and in merchandising ear protective devices.

Each piece of new mobile equipment should carry a nameplate certification of maximum sound power level generated by that equipment in operation. A consumer should be able to get some idea of the noisiness that will result from the operation of the equipment before he buys it. On the national level, the goal should be to work toward maximum allowable values of sound power emission for new equipment that would not present hazards to the operators or to the bystanders.

With this proposed procedure, the manufacturer would be faced with a single, uniform criteria for all equipment sold throughout the United States, and he would be responding then to the consumers' wishes by competing with his associates to produce more desirable equipment. It seems that this is the best kind of regulation that can be developed. The state, municipal and local bodies can then deal with the manner in which equipment is operated, and the resulting sound pressure levels that occur with their operation.

00-021

Martin, T.

Boulder, CO

On: ENFORCEMENT OF NOISE CONTROL ORDINANCE -- BOULDER, CO

Witness Statement
Public Hearings on Noise Abatement and Control

Denver, SEPT 30, 1971

The purpose of the Boulder Noise Ordinance is to create and maintain an ambient noise level so that mental non-repetitive tasks and daily efforts can be maximized as to productivity; also so that recreational hours can be used to revitalize the body and not add fatigue either mentally or physically.

Noise is a health problem, not a nuisance, and must be controlled like any other disease in our society. HEW figures indicate 80 dBA is the point which creates this health problem. The concept of any noise code must be based on health standards, rather than appeasing any one given industry or punitively attacking any one industry.

Snowmobiles, lawn mowers and motorcycles should be regulated consistently with the overall standard. The snowmobile industry has been notified in many ways that it has to quiet its product. Federal pressure could eliminate this problem.

The noise standard used in residential areas is measured from 25 feet and has been in effect since February, 1970, in Boulder. More than 1300 vehicles have been repaired or modified to meet the Boulder standard. It is predicted that unless quieter motorcycles are produced and other methods are found to quiet the older cycles, much of this nation will become off limits to them. This noise level must be brought lower than 80 dBA. Trucks are allowed 88 dBA at 25 feet and do not use residential streets at night. Industry has been amazingly flexible and responsible to legal requirements. Individuals, once educated, are just as responsive. When the Boulder program began, eight motorcycles out of 100 were being stopped; now, one out of 100 is the average. One automobile out of 166 was initially in violation; presently, it is one out of 301.

Construction noise in most cases has been easily corrected. Most of the excessively noisy equipment was leased, and the basic problem was insufficient muffling. In a few years, with proper Federal legislation, this should cease to be a major noise problem.

The most immediate and pressing problem now is to protect the hearing of youth because of excessive noise from amplified music. This is a real and pressing health problem. It is suggested that Federal legislation be passed that requires every night club or like kind of establishment to maintain a noise level below a 90 dBA level.

In coordination with the University of Colorado, the City of Boulder has submitted a grant request to try to solve some of the social, physical, mental and economic problems associated with noise.

00-022

Weber, H.

Dept. of Public Health,
Denver, CO

On: HEARING LOSS IN SCHOOL AGE CHILDREN

Witness Statement
Public Hearing on Noise Abatement and Control

Denver, SEPT 30, 1071

A report of the results of a 5 year study of hearing problems found in 1000 of Colorado's school age children is presented. The study disclosed that 30% of all hearing loss in these children was probably noise induced. Sixty-three percent of the noise induced-like loss first appeared in the junior-senior high age group. Of these, 8% suffered a hearing loss progression of 10 dB. About 5 times as many males as females suffered from this hearing loss pattern.

The greatest percentage of children with hearing loss came from areas where large farms using heavy equipment were located and where many engaged in hunting. In a less affluent section where farms were small and not mechanized, the children showed much less hearing loss until fire crackers became available on a year round basis. The percentage of children showing noise induced-like hearing loss rose from 22 to 37%.

The State Department of Health has tried to make the public aware of this problem. Warnings are circulated to hunters, and physicians and parents of children. Individuals manifesting hearing loss are also warned of the dangers to hearing of shooting, recreational and agricultural noise and encouraged to wear earplugs or ear muffs.

00-023

Knight, K. G.

Institute for Rapid Transit

Deleuw, Cather and Company
Washington, DC

On: NOISE ABATEMENT PROGRESS IN SUBWAY SYSTEMS

Witness Statement
Public Hearings on Noise Abatement and Control

New York, OCT 21, 1971

The two basic acoustical goals of the rapid transit industry are: to provide system patrons with an acoustically comfortable environment by maintaining noise levels in vehicles and stations within acceptable limits, and to reduce the impact of system construction and operation on the community by minimizing transmission of noise and vibrations to adjacent properties.

Notable improvements in the acoustical field have been made since the building of early transit systems:

1) The use of continuous welded rail has become standard in the industry.

2) Resilient track fasteners have been developed to reduce both noise vibrations in direct fixation track.

3) 'Floating' track slabs are also being developed for use in acoustically sensitive community areas.

4) The importance of smooth rail and wheel surfaces is now well recognized.

5) The transit car of today is much superior acoustically to its predecessors.

6) In underground stations particularly, noise levels are being reduced and reverberation times shortened by the use of acoustical ceilings and under-train-platform absorption systems.

7) Modern and attractive aerial structures which are replacing transit's old "els" are combined with acoustically designed track fasteners and will be as quiet as they are attractive.

8) Sound barrier walls have been developed for use on surface and aerial lines where additional acoustical privacy is required.

9) Acoustical design criteria for ventilating fan selection and fan and vent shaft design are in general use.

10) Ancillary mechanical and electrical equipment and facilities have been improved with more attention being given to reducing noise from this equipment.

Funds to make capital improvements in existing systems are frequently lacking.

Basic research is required to establish more clearly the effects of noise upon people and to establish appropriate criteria for the noises of the types generated by transit system operations. Equal effort should be extended in educating the public and providing them with information. With an educated public as our goal, criteria scales should be standardized throughout the industry. The trend in criteria establishment seems to be towards the use of simple, easy-to-measure, A-weighted sound levels, and this type of standardization is desirable.

The transit industry concurs with EPA's ultimate goal 'to achieve a desirable environment in which noise levels do not interfere with man's health and well-being or adversely affect other values which he regards highly.' However, the industry needs assistance in basic acoustical research, in the development of new and improved control techniques and in the establishment of economically attainable noise criteria which may be easily comprehended by the public. Additional financial assistance is required in order to modernize existing systems and provide the basic noise and vibration controls which are now attainable through technology.

Because of the wide divergence in age and character of existing rapid transit systems, it is obviously impossible to set a standard that all may follow. There must be deviations

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from the guidelines established in order to achieve compatibility. It is believed that transit officials recognize their obligations to the community and that a system of self-imposed discipline in noise control, supported by the technical and financial assistance of government, will prove superior in the long run to enforced legislation relative to noise vibration.

00-024

Driscoll, J.

Hempstead County Government,
Hempstead, NY

On: AIRCRAFT NOISE ABATEMENT

Witness Statement
Public Hearings on Noise Abatement and Control

New York, OCT 22, 1971

Suggestions on regulatory agencies and procedures for control of aircraft noise are presented. It is felt that noise is not only a product, but also a problem of the environment, and its control should be in the hands of the Environmental Protection Agency rather than in the hands of the Federal Aviation Agency.

A demonstration at Minneapolis-St. Paul airport is reported of aircraft operating procedures which did achieve very noticeable lowering of the noise levels of existing aircraft in the present jet fleet. Purely by changing the mode of operation and pilot technique the planes were quieter.

EPA is asked to provide the impetus behind a program which will in effect regulate the air carriers and make them operate the present aircraft in a less noisy fashion. This can be done without any expenditures of vast sums of money.

00-025

McCollom, H.

Hearing Conservation Center,
Lancaster, PA

On: SOME UNRECOGNIZED NOISE PROBLEMS

Witness Statement
Public Hearings on Noise Abatement and Control

New York, OCT 22, 1971

A discussion of 3 examples of noise problems is presented. The first is the ultrasonic vehicle motion detector used with traffic lights to control flow of traffic. Its 18,000 Hz signal is in the upper level of human hearing found in nearly all children and many young women. At the lens opening a 120 dB signal is produced. Many parents are concerned when their children scream and hold their ears at certain highway intersections.

The second example is a hazard of the future. The air bags being considred for automotive safety will inflate with a literally deafening 170 dB. The presently available facts and technology should be used to pre-plan against noise.

Thirdly, the population of Lancaster, PA, has not changed appreciably in 10 years. However, calls to the police concerning noise in the month of August 1969 were 105, while in August, 1971 there were 189. On a very conservative scale this extrapolates into a national figure of $52,000,000 per year just answering noise complaints. These figures suggest that noise is increasing without respect to population growth or people are changing their attitudes and complaining more or both.

00-026

Dougherty, J.

Harvard University,
Cambridge, MA

School of Public Health

On: EXTRA-AUDITORY EFFECTS OF NOISE

Witness Statement
Public Hearings on Noise Abatement and Control

Boston, OCT 28, 1971

A discussion of the short-term physiologic, apparently reversible, effects of noise and the longer term, usually irreversible effects of noise, and the common links between the two is presented.

The short-term physiologic responses to noise are quite similar to those found with emotional stress in animals and man. The similarities have been documented by recording change in blood pressure, pulse pressure, heart rate, perspiration, widening of the pupil, or change in fetal blood flow. When blood or urinary hormone levels are assayed, noise again causes changes similar to those of emotional stress. Blood levels of long-acting hormones such as adrenocorticoids (from the cortex of the adrenal gland) are increased by noise. Levels of shorter-acting (adrenalin-like) hormones from the center of the adrenal and from nerve endings are also increased.

The strength of the response is primarily related to either the dB level or the emotional content of the noise.

Emotional content of noise is a function of several variables. Among them are the individual's previous experience with or prejudice toward a noise, the frequency, band width and rate of change of this change, the amount of startle associated with the noise, the degree of interference with activity, the amount of background stress already experienced by the listener, and the emotional health of the listener. However, even without any awareness of an emotional or physiologic response (in some cases when anesthetized), the listener will manifest most of the physiologic responses noted above. Clearly the willingness of an individual to cheerfully accept noise stresses is no guarantee of his immunity to extra-auditory effects.

Animals which are exposed to chronic noise stress develop much the same disorders as are associated with emotional stress in humans. Diseases such as arterial hypertension, arteriosclerotic vascular disease, myocardial infarction, emotional instability and birth defects have been caused by experimental noise exposures in animals.

Several experiments have been performed which show the similarity between noise and other forms of stress in the genesis of stress-related disease. In general, the same hormonal and central nervous system pathways are involved. No experiment is known which has described a dose-relationship between noise and pathologic effects. However, when stimulation of central nervous system pathways of animals was held to the same level of physiologic response as seen in humans with 70-80 dB white noise, marked arteriosclerotic change occurred in animals fed atherogenic diets. These changes were not seen with the diet alone.

Increased rates of a number of disease processes in workers subjected to industrial noise have been described in the Russian literature. In general these studies have not been well controlled.

The need for well-controlled human studies is further supported by the lack of experiments performed with animals which -- like humans -- have phlegmatic response to noise. Studies of the effects of noise stress on animals such as dogs or primates would provide valuable evidence for or against the role of noise in stress-related human disorders. The absence of a causal link between noise and stress-related disease in noise tolerant animals and the paucity of well-controlled studies of human exposure constitute the greatest weaknesses in any attempt to indict noise as the cause stress-related disease in humans.

Only two studies have clearly linked noise stress to human extra-auditory disorders. In one, performed on hospital patients, those recovering from myocardial infarction experienced 3 to 4 times larger adrenergic hormone outputs following a standard noise stress than other hospital patients. The second paper dealt with admission rates to mental hospitals from equivalent socio-economic groups with the only known difference being the flight paths to and from Heathrow Airport. This airport is near London, England. No significant differences between noisy and quiet areas were found in various subgroups of the population except in older single women who had the highest rate of admission in the quiet areas. Admission rates for this group were significantly elevated (still higher) in the noisy areas. These studies are interesting because they both demonstrate a heightened susceptibility to noise in groups of people who have demonstrated an increased susceptibility to stress-related disease.

A number of areas for future research are listed.

1) Do noise-tolerant animals such as dogs or monkeys develop stress-related disease or birth defects after exposure?

2) What role does the aging process play in effects of noise on animals or human stress-related disease?

3) What are the effects of noise upon individuals with pre-existing disorders such as arteriosclerotic vascular disease, diabetes or emotional illness?

4) What is the relative importance of noise stress among other environmental stresses such as automobile driving, excitement or anger, diet or biochemical stresses such as atmospheric lead or cadmium?

Clearly such research would be multivariant, would require a number of years to perform and would be costly. However, control of environmental pollutants is costly and should be based upon a priority ranking derived from an estimate of the relative costs or benefits of each dollar spent for control.

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00-027

Standley, D.

Boston Air Pollution Control Commission, MA

On: PROPOSALS FOR A NOISE ORDINANCE IN BOSTON

Witness Statement
Public Hearings on Noise Abatement and Control

Boston, OCT 27, 1971

The Boston Air Pollution Control Commission was charged in APR, 1971 with jurisdiction to investigate, control and abate noise in Boston. A report on noise was prepared by Bolt, Beranek, and Newman, Inc. (BBN) under a commission contract, in the light of which the Commission has drafted proposed interim standards for community noise, and initial noise abatement regulations, patterned closely after the Chicago ordinance. A public hearing has been held, comments reviewed, and the regulations drafted. The redraft is now in review, and the standards and some regulations will be adopted in the very near future.

The Commission proposes that noise in residential areas attributable to land uses in or abutting those areas be limited to approximately 60 dBA in the daytime, 50 dBA at night and on Sundays. Limits on the noisiness of new motor vehicles, construction equipment, recreational vehicles, and other powered equipment for outdoor use are proposed. These take the form of certification requirements imposed at the point of sale or lease. Still being reconsidered is a restriction of the noisiness of construction activities. It is felt that noise from this source should not exceed by more than 10-15 dBA the noise standard for the area in which the construction occurs. The framework for a system of registration of certain noise sources and permits for others is being developed. It has been possible, to date, to allocate not more than $25,000 per year to this noise abatement activity.

A certification requirement for motor vehicles of 75 dBA, at 50 feet, to be met by 1980 is recommended.

EPA is urged to take the lead in standardizing measurement, test, and certification procedures, and methods for expressing the impact of noise. Complete Federal preemption of the standard-setting process is, however, unnecessarily restrictive of the right and opportunity for communities to achieve the environmental quality they wish.

00-028

Sutton, A.

Burgundy Farm Country Day School, Alexandria, VA

On: STUDENT RECOMMENDATIONS FOR NOISE CONTROL

Witness Statement
Public Hearing Noise Abatement and Control

Washington, NOV 12, 1971

Suggestions for noise control from a group of sixth, seventh and eighth grade students are presented. These students were completing a science study unit on noise. Some of the suggestions were: the passage of anti-noise codes throughout the country, semi-annual noise inspections for all vehicles, and strict enforcement of a night curfew at Washington National Airport; passage of laws aimed at stopping noise at its source; retrofitting jet airplanes, quieter horns on motor vehicles; production of quieter home appliances. The Washington Subway System should be made as acoustically quiet as possible. The development of quieter drills and jackhammers is needed. Workmen around loud noises should be required to wear ear plugs, until the noise level around them can be reduced. EPA should sponsor a yearly national anti-noise week or day and is urged to develop a vigorous campaign to educate the public.

A discussion of the course content followed and it was suggested that EPA would be interested in fostering further work about environmental ecology at the secondary and primary school level.

00-029

Goldshore, L.

New Jersey State Department of Environmental Protection

On: FEDERAL VS. STATE STANDARDS-PREEMPTION

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 11, 1971

Testimony generally in favor of the bill, S.1016, is presented. Exception is taken to Section 6(d), which appears to preempt the adoption of state regulation of certain noise sources. This section raises some questions regarding the relationship of Federal regulation and enforcement to State activities in the field of environmental protection. It does not appear to be in the public interest to preempt a state from jurisdiction to protect its citizens from environmental insults. The Federal Government does not have the manpower, or data base, or the ability to take over environmental control. It is suggested that S.1016 should be amended to allow for stricter state regulation if the state desires it.

The following relationship between the States and the Federal government is suggested:

The Federal government may adopt legislation which enables a national regulation of activities which can have a harmful impact on the environment. The severity of these regulations should, however, serve as nationwide minimum, not as limitations. Thus those states that wished, could adopt more stringent regulations, and enforce them. This pattern is important if New Jersey is to clean up its severe environmental problems. New Jersey population density is the highest in the nation. The state has more vehicles per square mile than any other state in the union. If the Federal government were the sole regulatory body, New Jersey would be governed by the same regulations as Wyoming and Colorado, where the environmental problems are not so severe.

It is important for the regulations established by the Federal government to be applicable nationwide so that pirating industry from more protective states could be avoided. It is also important for the Federal government to have its own set of nationally applicable regulations so that it can step into the enforcement area if the State falls down on the job.

Other sections of the bill were discussed briefly.

00-030

Lentz, J. L.

Metropolitan Washington Council of Governments, DC

On: REGIONAL PLANNING

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 11, 1971

A discussion of the problems encountered by a regional association of local governments when it tried to obtain funding for a noise pollution study is presented.

The Council of Governments proposed a program to assess the nature and extent of the noise problem, examine successful existing and new control techniques, and develop a noise control ordinance, a noise control section of a land use planning policy, and other programs. This was to take 3 years under an inter-disciplinary Noise Control Advisory Committee and a noise control engineer. The total cost was to be $130,810 of which 25% would come from the local jurisdictions. This was refused, but suggestions were made for modification and resubmission.

Modifications included the identification of and reduction of hazardous and stress producing noise in the environment. This program also was to take 3 years and was subdivided into the following tasks: 1) review literature, 2) inventory current noise control activities, 3) inventory and rank major noise problems, 4) design noise level and opinion surveys, 5) assist local jurisdictions in establishing noise monitoring plans, 6) carry out public education and information activities, 7) conduct and analyze noise level and attitude surveys, 8) rank-order noise problems, 9) demonstrate specific control measures, 10) develop noise control goals and objectives, 11) develop a set of noise control standards, 12) develop a model noise control ordinance, 13) develop a set of local noise control policies, and 14) develop a set of action programs and policies which can be undertaken by non-local governmental agencies, by private industry and organizations and by individual citizens. The total budget for this project was $312,130. This was rejected because existing priorities allowed only new family health care projects to be funded.

In the discussion which followed, it was suggested that projects of this type would be valuable and hopefully funding could eventually be obtained.

00-031

Kreml, F. M.

Automobile Manufacturers Association, Washington

On: MOTOR VEHICLE NOISE ABATEMENT

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 12, 1971

Since the object of motor vehicle noise control is to minimize annoyance to the public, the Automobile Manufacturers Association commissioned a study to define what aspects of motor vehicle are most annoying to people. The study was intended to establish guidelines to needed areas of acoustical improvement of vehicles by manufacturers.

Some of the findings of the study are:

A. To reduce annoyance from motor vehicles most rapidly, the noise from vehicles that cause peaks above background levels should be reduced, because it is the occasional noise excursion that produces most complaints.

B. In the majority of cases where people expressed annoyance at a specific vehicle noise event, they felt that it was a situation the driver could control, such as tire squal, hot rodding, and similar operations.

C. Annoying noise sources are relatively close to the auditor, e.g., 70% of the exposures described as annoying within 100 feet of the noise source.

D. Most people who express annoyance indicate that they are at home when the annoyance occurs and it is generally in the evening.

As regards trucks, reduction of truck noise is difficult because of the varied characteristics of the many sources on each vehicle. Included are exhaust, engine mechanical noise, air intake, fan, transmission gears, tires and other miscellaneous mechanical appurtenances. Truck noise reduction is not a question of putting on an improved muffler. Muffling is available for most trucks that effectively eliminates exhaust noise as a consideration. Tire noise is one of the most serious obstacles to noise reduction at high speeds. The impact on the cost of transporting goods due to vehicle modification to achieve stringent noise levels must be considered. There may be an increase in initial equipment cost. Sales of trucks and buses in the U. S. in 1970 amounted to $4.8 billion; therefore, a 1% increase in cost would be $48 million that must be borne by the general public. Since there are overall weight and length restrictions, vehicle redesign which involves more space or increased weight must do so at the cost of reduced cargo capacity.

There would also be increased maintenance costs because of more complex construction and possible higher engine temperatures.

A strategy for reduction of noise annoyance is presented in the following recommendations:

A. That, after thorough study of need, uniform national standards be issued, with Federal preemption and consideration of possible conflict or trade-offs involving safety and emissions standards.

B. That model legislation be developed for the guidance of states and local communities.

C. That effective enforcement procedures be developed for state and local use.

D. That a long-range policy of motor vehicle noise reduction be undertaken, taking technological and economic feasibility into account.

E. That substantial research efforts be undertaken addressing the problems of: tire noise, technology of noise reduction, and comparative economic impact of noise regulations at various levels.

00-032

Larimore, H. T.

Construction Industry Manufacturers Association, Chicago

On: ECONOMIC FACTORS IN NOISE REDUCTION OF CONSTRUCTION EQUIPMENT

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 12, 1971

Economic considerations of noise control in construction machinery and industry recommendations are presented.

Manufacturers of construction equipment admit that many of their products are noisy. Construction contractors have not been motivated to engage in research for methods to reduce noise and have not asked manufacturers for quieter machines. Thus, the machinery manufacturers have developed machines with increased productivity and lower costs per unit of work output but not quieter.

There does not seem to be any imminent technical breakthrough which can overcome the problem of noise reduction. Noise reduction is a step-by-step process of analyzing each noise producing element of a machine and reducing it to a level which is below the dBA level of other sound-producing components. A 3 to 8 dBA reduction could be achieved at a cost penalty of 10 to 24 percent over a period of 5 years.

In various studies of environmental noise, emphasis is primarily given to urban areas of high population density. Demolition and construction have in many of these locations become almost a continuous process. This is in contrast to highway and civil works construction projects which, when completed, are utilized for many years without new projects being undertaken nearby.

A review of Bureau of Labor statistics information reveals that there is a substantial difference in the expenditures for machinery

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used for buildings (1 to 2% of project cost) compared to the machinery used on highways (12%) and civil works -- land (20%). It can easily be seen that increases in machinery cost will be reflected to a much greater extent in project costs on large rural earthmoving jobs rather than on building projects. In other words, the cost/effectiveness ratio of noise reduction is far better in urban areas. It would therefore seem appropriate that current efforts of noise reduction on construction equipment be initially limited to urban site construction.

Government, i.e., Federal, State and Local, is the largest customer of the construction industry. In a Conference Board article entitled, "Economics of the Construction Industry," the author states, "the share of public construction in total construction has increased from 22 percent in 1945 to 34 percent in 1967. It is generally believed that this trend will continue".

On a trial basis, it would appear that the Federal Government, through EPA, is in the best position to initiate pilot cost studies. On certain selected contracts, the Government could specify maximum noise levels for the construction site. Separate accounting could be established to determine the costs, record the techniques used to limit noise radiation and note compliance difficulties.

The Construction Industry Manufacturers Association (CIMA) points out the following:

1) Member companies are working on machine noise reduction now and are faced with the necessity of pushing the threshold of the art onto new technological ground.

2) In response to CIMA Performance Standards action, various standards writing bodies, including SAE, are establishing uniform, definitive and repeatable noise measurement standards using dBA. CIMA strongly opposes reported current efforts by some noise technicians to develop a different scale, which could seriously delay the noise abatement effort by causing several years of noise measurement to be re-studied.

3) Member companies generally do not oppose realistic individual noise limits for selected machines measured under standardized conditions and test methods to give the repeatable results necessary for any certification or labelling requirement.

4) Member companies do not oppose individual machine noise output labeling, but do not think that labeling requirements should be applicable to export shipments until such time as this may become a requirement for all manufacturers on an international basis.

5) CIMA strongly recommends that standard measurement methods, maximum dBA levels for individual machines, and labeling requirements have national uniformity.

6) Members generally believe that national noise limit Standards could apply to selected individual machines, but control of the total job site noise impact on the adjacent community should be a State and/or Local Government perogative.

00-033

Singer, A. A.

National Association of Home Builders, Philadelphia

On: QUIET HOUSE PROGRAMS

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 9, 1971

The National Association of Home Builders (NAHB) initiated efforts relating to noise and sound conditioning over 10 years ago. "Quiet House" programs were undertaken to familiarize the consumer with well-designed housing and to determine the consumer's interest in such features. A Residential Sound Conditioning Manual was developed to aid builders in providing cost-effective acoustical housing environments.

The NAHB Research Foundation, Inc. has continued research to measure in-place acoustical performance in relation to construction, the background noise levels, and the subjective response of the occupants.

Three studies have been made, involving measurements of airborne noise reduction, impact sound transmission with various impact sources, and the interior and exterior ambient noise levels.

Each improvement to performance level increases the cost of housing, and it is essential that a balance between cost and performance be struck so that a reasonable degree of quiet is provided without adversely affecting the ability of all to live in decent housing.

Several years ago, an attempt was made to develop special construction techniques within the house and special appliances and equipment to reduce the noise level in the house. This was offered as an optional extra at a cost of about $1000. Many were interested, but few willing to pay. The builder then scaled the package down to $100, dealing only with the areas of high noise level and found many who would invest at this level. It was suggested by the panel that perhaps with publicity on noise abatement, more customers would now be willing to pay the $1000. These houses ranged in price from $20,000 to $40,000.

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The most significant acoustical problems are those between apartments, while noise sources within the home or apartment are of less concern and exterior noises are least disturbing. In apartment buildings, structure borne noise transmission is the cause of most disturbance, particularly impact noises are bothersome since they are developed within units and transmitted between units. Airborne noise is not as significant a problem as it was 10 to 20 years ago. Electrical outlets in party walls reduce the effectiveness of otherwise satisfactory construction. Revision of the National Electrical Code, and changes in local enforcement practices are needed so that electrical outlets are not required in party walls. The problems of economically isolating sources of vibration from the building structure need more attention. Basic to solution is the need for development and acceptance of measurement techniques and rating methods. The generally used ISO method of test for impact sound transmission and the Impact Insulation Class rating system have given equal ratings to floor construction which may vary 400% in loudness of transmitted footfall noise. Only when improved methods of evaluation are developed, can the development of practical construction and installation techniques be utilized to reduce the problem. Similar comments are applicable to problems of transmitted plumbing and appliance noise.

In various studies, it was found that some occupants are bothered by noise of kitchen and other appliances when they are in another room. Each of these noise sources is amenable to some control, but most people are unwilling to pay the initial cost of "quieter" appliances or modified installation techniques. Manufacturers should be encouraged to find more cost-effective noise control techniques.

Transportation noises such as those produced by airplanes, trucks, automobiles and trains are the primary source of exterior ambient noise. Other noise sources include building mechanical equipment, powered lawn and garden equipment, power tools, snowmobiles and other off-the-road vehicles. Primary emphasis at this time should be on further research and development and voluntary efforts by producers to reduce excessive noise levels. However, some legislative or regulatory measures might be considered for this equipment provided practically attainable performance levels are established.

One of the recent attempts to provide good acoustical environment is HUD's establishment of interim standards for evaluation of community noise. Because this is only a first step and its effects have not been tested, judgment must be reserved on its practicality and on the criteria themselves. Government planners at all levels might be required to consider the effect of new highways and airports on the noise levels of existing or planned land uses prior to the decision to impose such facilities on the local community.

EPA and other governmental agencies should continue to encourage and support continuing and coordinated research into the effects on people, the development of techniques of measurement and evaluation of noise, and the development of practical and cost-effective noise-control techniques.

Specifically, it is suggested that further research is needed on the following subjects:
(1) Automobile and truck noise, including the design of efficient yet quiet engines and exhaust systems, truck and automobile tires, and techniques of highway design to minimize its effects upon the surrounding land use.
(2) Aircraft noise control, including the development of quieter engines and aircraft use patterns that minimize intrusive noise.
(3) Structure-borne noise transmission, including development of physical evaluation techniques that permit rating products and elements of dwellings and buildings in the manner that people respond to them in use.
(4) More cost effective methods of reducing appliance and fixture noise.
(5) Development of economical, practical, and market acceptable window and door systems specifically designed to minimize excessive exterior noise intrusion.

Additionally, EPA might consider study of enforceable legislation and regulations which local and state governmental bodies could use to keep exterior noise and disturbance at reasonable levels.

Finally, EPA should encourage manufacturers to label noise levels of appliances, equipment, and related items under a rational and consistent rating system to inform consumers so they may evaluate the equipment in relation to noise.

00-034

Orski, C. K.

Organization for Economic Cooperation and Development, Paris /France/

On: TRAFFIC NOISE REDUCTION IN EUROPE

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 9, 1971

The Organization for Economic Cooperation and Development (OECD) has been conducting investigations in the field of noise abatement for a number of years as part of its program of international cooperation in the field of environment. The inclusion of noise within the program has been a reflection of the growing belief on the part of OECD member governments that noise, no less than some of the more visible forms of pollution, represents a real threat to the quality of the environment and to the well-being of people. Activities have ranged over such subjects as airport noise, sonic boom, and most recently, motor vehicles. The reduction of noise levels in urban areas ranks high on the agenda of almost every OECD government.

Within OECD, the concern about traffic noise has led to the creation of a special task force to develop guidelines for a model national traffic noise abatement strategy. The recommendations of the task force stress the necessity of vehicle noise emission standards and effective enforcement machinery as a prerequisite to any substantial reductions in urban noise levels. Such standards should be made progressively more stringent.

Studies within OECD concerning vehicle noise abatement are continuing in the context of a major inquiry, "The Impact of the Motor Vehicle on the Environment." The aim of this project is to carry out a broad technology assessment of the motor vehicle in order to aid member governments in the formulation of comprehensive strategies toward the automobile.

The United Kingdom's proposed 1973 noise emission limits for new vehicles are: passenger cars, 80 dBA; trucks (less than 200 hp), 86 dBA; heavy trucks (more than 200 hp), 89 dBA. The limits recently agreed to by the Common Market countries are: passenger cars, 82 dBA; trucks (over 3.5 tons), 89 dBA; heavy trucks (more than 200 hp), 91 dBA.

It is a preliminary conclusion that reductions of 4 decibels or higher are envisageable, but probably only over the longer run since they would seem to require more fundamental changes in the vehicle system. Nevertheless, a British working group has recommended a reduction in noise limits down to 75 dBA for passenger cars and 80 dBA for trucks, these proposed standards to take effect in 1980.

Following is a compendium of proposed European legislation concerning vehicle noise emission standards:

There is a research program in the United Kingdom with the objective of developing a "quiet" 80 dBA diesel truck. The project is looking at ways of minimizing both body and tire noise as well as engine exhause system noise.

A private company in the U. K. has announced the design of a diesel engine with noise emission characteristics 4 - 9 dBA lower than those of a conventional diesel of the same horsepower. In Germany, the firm of Heinrich Gillet, in cooperation with the Universities of Cologne and Essen, is carrying out, under the auspices of the German Engineering Society and the Ministry of Transport, a technical and economic analysis of alternative vehicle designs with reduced noise emission characteristics.

In Sweden, Volvo has recently announced the design of a new 320 hp diesel engine which is 6 dBA quieter that current engines of equal horsepower. The cost of the new engine is estimated to be 5% higher than the cost of the current engine.

Attention in Europe is principally focused on reducing the noise output of the vehicle system itself, while comparatively little attention is devoted to the problem of tire noise or aerodynamic noise. This is because in the typical European driving conditions the engine exhause noise clearly predominates over the latter.

00-035

Bricken, G.

Northrup Aircraft Company,
Los Angeles

On: A COMPUTER BASED NOISE MONITORING SYSTEM

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 10, 1971

Systems, services and products designed to bring about constructive solutions to environmental noise problems are discussed. Little has been done in the past 10 years to systimatically apply known technology to control the presently controllable aspects of jet aircraft, namely, operations. Control of flight paths, flight schedules, and persistent noisy aircraft can bring about a decrease in airport community noise exposure. Such management of noise is possible through the use of modern data acquisition and data processing techniques. At the Orange County, California, Airport an area-wide noise monitoring system operates 24 hours a day. The system, Ecolog I, serves as a tool for the airport to administer its program of managing aircraft noise. The system consists of 5 sensors, 3 located in the normal departure zone of the airport in triangular array, and 2 located on the normal approach zone. This layout is used for evaluation of conformance to noise abatement procedures, determination of violation levels, and assessment of community noise exposures as proscribed in the new Noise Regulation for California Airports. The system consists of field stations with microphones and electronics to convert sound levels for transmission to a central location. At this location is a processor consisting of an input-output buffer and computer for arranging and manipulating the data for output to 2 display devices. The computer program provides a multiplicity of easily adjusted variables to assist the user in interpreting and extracting needed information. The airport obtains single event readings for every aircraft departing and arriving, single event violations, automatic hourly energy averages, and daily energy averages. Continual surveillance and analysis of computer produced records allow the airport to obtain accurate statistical records of noise levels and changes in those levels. Real time operation allows the airport to respond immediately to community complaints and to immediately signal offending aircraft of their violation condition.

Small systems can be acquired for $30,000 to $50,000. Larger systems can run as high as $200,000. Operating costs will run several hundred dollars a month.

Only 3 such systems are in operation in the United States. Three problems stand in the way of wider use.

First, the lack of simple and convenient standards for measurement make it difficult to develop equipment for wide-scale application.

Secondly, there is no clear-cut jurisdictional authority for noise control at airports.

Finally, there is no real mechanism for bringing citations against violators of local noise ordinances drawn in spite of the specter of federal preemption. Although the technology for such noise abatement is available today and can be applied in some cases at reasonable cost, wider benefit will only come about when there are more definitive assignments of responsibility, standardization of measurement indexes and constructive regulatory criteria.

00-036

Lumsden, K. G.

California Society of Professional Engineers

On: THE ECONOMICS OF NOISE POLLUTION

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 9, 1971

A discussion of the factors involved in the economics of pollution with emphasis on noise pollution is presented. The general rule for economic efficiency is that resources should be allocated until the last dollar spent on any one commodity yields the same satisfaction to society as the last dollar spent on any other commodity. Given the fundamental fact of scarcity of resources, less pollution must mean fewer other goods and services. Thus if society wants less noise, cleaner air and less polluted rivers and seas, it must realize that the cost of less pollution is other goods and services foregone. Society must order its priorities. What costs are we prepared to pay to enjoy less pollution? For almost all types of pollution, costs rise disproportionately in relation to the degree of non-pollution. To reduce the noise level from the local freeway, the local community must decide if the real costs, that is, other goods and services foregone, are worth the reduction in noise. The reduction in noise will be the marginal benefit; the alternatives forego the marginal cost. If the former exceeds the latter, the project is worthwhile. Unfortunately, with many projects, the benefits are difficult to measure.

The policy implications can be stated as follows: 1) educate the public to understand how pollution arises, the costs of pollution, and the benefits of pollution; 2) establish criteria for solving the pollution problem; 3) devote resources to the development of measuring tools of pollution since successful legislation will require an ability to identify pollution and degree of pollution; 4) implementation of criteria to establish who should pay to decrease pollution levels. In some cases, value judgments can be made satisfactorily by designated officials who will act in compliance with established criteria. In other situations, however, a vote of the people concerned is the most satisfactory method to determine whether a noise polluted community is in economic equilibrium with other conflicting demands of the populus.

00-037

Howe, J. T.

Engine Manufacturers Association, Chicago

On: LEGAL ASPECTS OF NOISE CONTROL

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 11, 1971

Three areas which provide the foundation for any effective program to legally control noise emissions are discussed.

00-038

EPA HEARINGS

First, the need for objective standards which are achieved by a balancing process which takes into account the relative position of all parties is an approach which has the capability of protecting the interests of all. A review of arguments for and against uniform standards, and the test procedures and enforcement methods used to enforce them is mandatory.

Representative cases show that common law remedies based upon subjective standards are not the answer. In each situation, the case must be decided on its own merits through a lengthy trial.

Considering statuatory and regulatory approaches to the problem, it is noted that each state, with the exception of Alaska, has adopted some legislative or regulatory scheme for the legal control of noise emissions from motor vehicles. In 1969, the Department of Commerce's panel on noise abatement examined state and local ordinances concerned with noise control. This study noted that vehicular noise control in 32 states was limited to muffler requirements. In seventeen states and the District of Columbia, the basis of noise control was a subjective "disturbing the peace" appraoch with some objectivity occasionally interspersed by the regulation or statute setting specific noise standards. Other methods limiting or prohibiting noise sources have been adopted in several states.

In 1969, only 3 states had specific noise standards, with regulations, imposing criminal penalties for noise measured at prescribed distances from noise sources. Since 1969, however, many states, in response to the need for some legislation, have been enacting laws and regulations. Standards applicable to engines should be balanced between the concerns for the environment with the benefits of technology. The establishment of fair and equitable standards, with technological and economic feasibility being a major factor to be considered on an increasing basis as health or medical considerations decrease will be to the benefit of all. Such standards should take into consideration their effect on other environmental areas.

The question of preemption was dominant in these hearings. Noise standards range in some states from a low of 74 to a high of 90 dBA. There is a lack of consistency in enforcement methods. Some local governments have passed standards but failed to adopt any enforcement procedure. The Engine Manufacturers Association (EMA) recognizes the need for effective legal control of noise emissions and supports uniform federal standards and enforcement procedures with federal preemption. Also, because of the variances in test methods, a uniform procedure should be established under the aegis of one Federal government agency, preferably the Environmental Protection Agency. This agency, in turn, should be given the authority to delegate responsibility for enforcement of noise standards applicable to engines to state and local governments which adopt identical plans in accordance with the uniform procedures established by the Federal government.

Opponents to uniform standards, or preemption, have expressed the concept that only the state or local government can do the job effectively. A thorough understanding of any law is always essential for its effective enforcement. By permitting confusing and conflicting noise standards, it would be impossible for the public to understand and difficult for the industry to respond and comply with such standards. It is also important that only one agency within the Federal government itself be charged with the responsibility for the promulgation of standards.

00-038

Bennin, R.

Bureau of Noise Abatement,
New York

On: MUNICIPAL NOISE CONTROL

Witness Statement
Public Hearings on Noise Abatement and Control

Washington, NOV 11, 1971

The groundwork for a comprehensive urban noise abatement program for New York City is discussed.

With the help of HUD the first leg of a pilot study has been completed. When the study is completed, a methodology for accurate and comprehensive measurement of urban noise will have been developed.

A Noise Control Code has been developed which may become a model for the nation. It is stronger and more comprehensive than any other code in the country. The Code attempts to deal with urban noise pollution in 4 ways: through 1) statutes on unnecessary noise modeled after those already on the books; 2) specific decibel limits on a number of noise sources, such as air compressors, paving breakers, etc.; 3) ambient noise quality zones for the different communities of the city; and 4) and enforcement section patterned after the recently passed Air Code which will bring noise violations before our Environmental Control Board instead of criminal courts.

The Bureau of Noise Abatement currently handles more than 400 complaints a month using moral persuasion and community pressure since its legal power is limited.

EPA HEARINGS

Currently the Bureau has a staff of seven and an operating budget of $100,000. When the code is passed, the need for a force of 15 inspectors, plus 3 equipment certification officers, an acoustical engineer and 2 electronic technicians is predicted at a cost of $250,000 and $500,000 for the study and development program, make a total budget of about $800,000 for Fiscal Year '72-'73.

The first priorities are the expansion of the community noise survey and a traffic noise survey. Three additional projects are underway; a construction noise survey, a study to explore and assess alternatives to automobile horn noise, and a siren noise study.

The city is pressed to meet its most urgent financial needs, and the Noise Bureau cannot realize its program fully within current budgetary limits. A federal program of development, establishment and maintenance grants for local noise abatement programs is urgently needed. A system of matching funds is not satisfactory since the city cannot guarantee to match it.

Another area where federal assistance is essential is that of mass transit. The subway system in New York is old and noisy. The City does not have and is not going to have the estimated millions of dollars needed for a comprehensive program of subway noise abatement. A program of federal noise abatement grants for mass transit, either out of an expanded Office of Noise Abatement or out of the Department of Transportation is needed.

In addition to establishing a system of grants for local noise abatement programs, there are a number of ways in which the federal government can play a powerful role in noise abatement. First, the government should promote the use of quieter equipment by incorporating noise specifications into all of its vast purchasing programs. Second, all federally contracted construction projects should be required to meet specific noise standards. Third, the federal government should make funds available for demonstration projects to promote advancement of noise abatement technology. Last, more research is needed in the area of health effects of noise.

The Federal government must also play a role in jurisdiction. Some of the major sources of noise pollution in urban areas are not susceptible of solution on the municipal level. The most obvious is aircraft noise. The noise problem created in urban areas by motor vehicles illustrates an important aspect of the Federal noise abatement role. New York City is attempting to regulate this source in its Noise Control Code. The most effective way to stop noise is at the source and Federal limits on all classes of motor vehicles would be welcome. It is essential that the Federal government set specific noise limits wherever possible, but states and municipalities must be left free to set more stringent standards if necessary. Noise pollution is ultimately a local problem.

Noise in our cities can no longer be ignored. It is a problem ranging in seriousness with pollution of air and water. It must be attacked vigorously by all levels of government, by industry, and by the individual citizen.

ABSTRACTS

NOISE SUBJECT FIELD AND SCOPE NOTES

As an aid to the reader with specialized interests, abstracts of journal articles, reports and other sources have been grouped by subject area. The twelve categories used are listed and briefly described below. However, there is often considerable overlap, and related categories, as well as the subject index, should also be consulted.

1. EMISSION AND SUPPRESSION RESEARCH AND DEVELOPMENT

   Phenomenology of noise generation, transmission and suppression, including experimental data and theoretical studies.

2. PHYSIOLOGICAL EFFECTS

   Aural and non-aural effects: e.g., hearing loss, circulatory and cardio-vascular effects, sensory perception, neural effects, etc.

3. PSYCHOLOGICAL AND SOCIOLOGICAL EFFECTS

   Effect of noise on sleep and work patterns and other human activities; personal attitudes toward noise; effect of noise on learning, convalescence, etc.

4. ECONOMIC ASPECTS

   Costs of noise abatement and control; costs of non-abated noise, impact on trade both domestic and foreign.

5. BUILDING ACOUSTICS AND NOISE CONTROL

   Use of construction materials and their installation, such as techniques for isolating and decoupling electrical outlets, plumbing and air flow ducts from partitions; reduction of impact and airborne noise transmission.

6. NOISE MEASUREMENT

   Units, instrumentation, techniques, scales, weighting networks, recording and monitoring systems, data processing systems.

7. PLANNING, DESIGN AND ARCHITECTURAL SITING

City planning, industrial plant layout and design, land use, airport and highway siting, land development, zoning.

8. LEGISLATION, STANDARDS, LEGAL PRECEDENTS

Laws, codes, zoning ordinances, statutes, standing of parties, jurisdiction of courts, court's decisions, etc.

9. ENFORCEMENT

Enforcement techniques and experience, including training, equipment costs, staffing.

10. PROGRAM, PLANNING, AND BUDGET

Federal, state, and local policy decisions; budget information; program status, program descriptions.

11. NOISE MEASUREMENT DATA

Noise emissions generated by equipment or activities; attenuation levels for particular materials, time histories, octave band analysis.

12. EDUCATIONAL AND GENERAL

Textbooks, university curricula, general education articles, mass media coverage, popular brochures, and other popular awareness materials.

EMISSION & SUPPRESSION

01-001

Flanagan, W.

Automotive Engineering

RECENT STUDIES GIVE UNIFIED PICTURE OF TIRE NOISE

Automotive Engineering

Vol 80 No 4:15-19, 1971

Data establishing truck tires as a noise source are presented. Tires fall into three clearly defined categories as noise producers: pocket re-tread, cross-bar, and circumferential rib. Loudest are older recapped tires, particularly the pocket retread. Lateral elements of cross lug tires may wear into pockets and produce noise the same way, but most noise is generated by the gripping and releasing action of the tread elements during traction. The quietest tires are rib designs.

Rankings within tire noise categories may shift as the road surface changes from concrete to asphalt. Sound levels rise with increasing speed on all tires, but at slightly different rates. The National Bureau of Standards (NBS) reports an average 3 dBA increase per 10 mph. At lower speeds, down to 20 mph, total truck noise changes faster, 5-10 dBA per 10 mph.

NBS reports that loudness (peak dBA reading) produced by most tires rises 3-5 dBA when the tire is half used. Some tire types make more noise fully-worn than when half-worn. NBS data indicate that the difference in peak sound level between new and half-worn states is greater on concrete than on asphalt, depending on the frictional properties of the road. Theories on the effect of wear seem to agree that pressure distribution in the contract patch may be an important variable. Most tires wear first in the middle, transferring weight to the outer edges of the patch.

Higher forces on tread elements make for more noise, regardless of where the force comes from. Sound level differences due to load in the NBS data are only 1-3 dBA for rib tires, but increase significantly for cross bar (6-8 dB) and pocket retread tires (4-8 dB). Inflation pressure has no definite effect.

The tire industry has not subscribed to dBA exclusively because of its deficiency in measuring tonality. Subjective comparisons point to tonality and persistence as major factors of annoyance.

High hysteresis rubbers could reduce noise by damping the snap actions of tread elements, but the energy would go into heat instead of sound. Because of the thickness and low thermal conductivity of truck tires, heat generation creates high temperatures and has a deleterious influence on durability and safety.

01-002

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Biborosch, L.
Popped, N.

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Technische Hochschule in Jassy, Str. Karl Marx No. 38, Iasi, R. S. Romania

INVESTIGATION OF SOME TRAFFIC NOISE RELATIONSHIPS

Untersuchung Einiger Strassenlaermabhaengigkeiten

Laermbekaempfung

No 2/3:46-48, 1970

Investigations of traffic noise in Jassy, Rumania, were conducted. The results showed that the noise levels exceeded regulations even for the low density traffic. Measurements were taken at 7 to 10 m from vehicles travelling at 30-50 Km/h. The results were as follows:

Type of Vehicle	Level in dBA
Buses with diesel engine	91-93
Trucks with internal combustion engine	81-84
Automobiles	80-82
Street-cars	82-85

The measurements were conducted on 3 different types of main arteries, those with greenery, close, and distant house-fronts. The first group had tall trees on the side-walk area between the street and houses, group II had some lawn and sparse shrubery and group III had closely congested houses and narrower streets.

Group I and II showed a small variance of 6 dB from group III. Frequencies play an important part especially in the ratio of the echo time.

In order to attain considerable noise reduction in the lowest frequency range screening by means of walls or types of building can be used.

EMISSION & SUPPRESSION

01-003

Rainey, J. T.

Carrier Corp., Syracuse, NY

Research Division, Zip 13201

EVALUATION OF NOISE CONTROL TECHNIQUES FOR QUIETING PLATE FIN PRESSES

Syracuse, Carrier, 21 p.

Methods for quieting a plate fin press when machine enclosures prove to be infeasible are examined.

The die areas were found to be the greatest contributors to the noise generated by plate fin presses. It was also established that most of this noise was generated by metal to metal contact of the traveling pads and stationary pad keepers.

A reduction of 3-4 dBA was achieved by imposing a resilient material between the normally metal to metal contact areas of the traveling stripper pads and the stationary pad keepers. The application of the resilient material using urethane rubber requires less than a work-day for each machine, has been shown to last for at least a year, and does not affect the production rate of the machine.

When all of the presses are running the noise levels produced at the operator's locations can be expected to be about 3 dBA above the noise level produced by a single press. The noise reduction achieved by using impact strips may not, however, be enough to meet the 8 hour 90 dBA limit set by the Federal Occupational Safety and Health Act. Preliminary tests of an additional noise reduction modification, namely that of splitting the traveling pads, show promise for reducing the noise even further; however, the specific benefits of this modification must await further testing.

01-004

Wiedefeld, J.

CONSTRUCTION TECHNOLOGY FOR ABATEMENT OF AVIATION NOISE IN THE RESIDENTIAL AREAS AROUND THE DUESSELDORF AIRPORT. PART 2

Bautechnische Massnahmen zur Bekaempfung des Fluglaerms in den Besiedelten Wohngebieten des Flughafens Duesseldorf. Teil 2

Kampf Dem Laerm

Vol 18 No 1:13-17, 1971

Part 2 of this article describes the technical measures for the abatement of aviation noise in a Catholic elementary school Duesseldorf-Lohhausen, in the vicinity of the Duesseldorf Airport.

Acoustical measurement taken by the Max-Planck Institute gave values of 105 dB and 110 dB for jet aircraft.

The noise level in the classrooms facing the west and with closed windows was 89-98 dB. Double box-windows were installed and quality materials were used in the construction. After the windows were installed the sound level was lowered at least 15 dB.

A 2 meter wide and 1.40 meter deep outer chamber (ante-room) consisting of bricks and mineral fiber tiles was constructed on both sides of the entrance with a soffit over the door. A double layered door consisting of 50 mm thick metal frame and a 12 mm thick wired plate glass, the inner door is similarly constructed, was installed.

Because of the frequency of starting and landing jet planes the east and north side of the corridors were reinforced with an outer sound-absorbing wall.

With these new sound-absorbing means the instruction in the classrooms could be carried out without any disturbance or interruption.

01-005

Rosenberg, C. J.
Salter, C. M.

Bolt, Beranek, and Newman, Inc.,
Cambridge, MA

NOISE OF PILE DRIVING EQUIPMENT

AT: Acoustical Society of America Meeting, Washington, APR 20-22, 1971

Cambridge, Bolt Beranek, and Newman, 1971, 9p.

The problems of measurement analysis and evaluation of pile driving equipment is discussed.

Impact hammers and vibratory drivers comprise the two main categories of pile drivers. Impact hammers have either steam pressure or diesel engines, and noise is generated by both the power source and by the impact of the hammer and pile.

EMISSION & SUPPRESSION

The vibratory hammers are either low frequency (30 Hz) with electric engines, or high frequency (50-150 Hz), powered by two unmuffled gas engines.

Comparisons of noise spectra generated by 3 types of pile drivers are presented in Figure 1. Total sound energy varies with blows per minute.

Comparison of Noise Levels of Different Pile Drivers

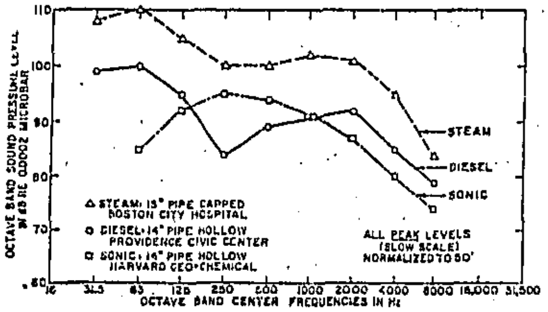

FIGURE 1

Diesels are best suited for hard soils, whereas steam hammers are best used on soft soils. Diesels, diesel crews, and fuel are more economical than steam. A sonic driver costs about 2-2½ times as much as steam equipment.

Much more research is necessary in the field of construction equipment such as pile drivers; presently the state of economy dictates the choice of equipment.

01-006

Priede T.

Southampton Univ. /England/

ROAD TRAFFIC NOISE-ITS ORIGINS AND CONTROL

In: Janson, P. G., Conferences in Connection with the International Air Pollution Control and Noise Abatement Exhibition, Joenkoeping, Sweden, SEPT 1-6, 1971

Joenkoeping, Sweden, 1971, 525p. (p. 7:12-7:30)

A comprehensive study of the relation between subjective rating of noise emitted by motor vehicles and the objective measurements with a sound level meter has been made. Subjects were asked to rate the noises which were presented to them according to a six-point rating scale by verbal description. It can be concluded that a level close to 80 dBA fairly represents the demarcation line between "acceptable" and "noisy" for most vehicles.

The range of measured dBA levels for various types of vehicles were: heavy commercial vehicles, 88-92; light commercial vehicles, 79-91; cars 77-91. The legislated standards in the United Kingdom for these vehicles are 89, 85 and 84 respectively. Tests indicate that truck noise is predominantly controlled by the power unit. This increase of noise is 11 dBA per doubling the speed. In gasoline cars a doubling of speed results in an increase of 15 dBA.

It can be concluded that noise is generally independent of the volume of work done per unit time or horsepower. The main criteria which determines the noise is the operational speed or how short the time interval is within the operation of one cycle of events is being performed by the machine.

Transmission noise ranges from 75-85 dBA and seems dependent upon engine vibration. Road conditions have greatest effect on tire noise, an 8-10 dBA increase in noise is noticed if the road surface is wet and a 3-5 dBA increase if it is coarse rather than smooth.

A quieter vehicle can only be achieved by close co-operation between the vehicle and engine designer and the following essential aims should be observed. First, design a vehicle giving adequate attenuation of the engine noise. Also appropriate choice of engine design parameters is necessary including:
1) limitation of the maximum engine rated speed;
2) limitation of engine cylinder capacity,
3) increase of engine load even to four times the values at present used,
and, finally, a quieter engine structure. Methods of rating noise and noise as a function of engine speed are also discussed.

01-007

Warren, C. H.

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Structures Dept.

SONIC BOOM EXPOSURE EFFECTS I.2: THE SONIC BOOM GENERATION AND PROPAGATION

Journal of Sound and Vibration

Vol 20 No 4:484-497, 1972

EMISSION & SUPPRESSION

A description is given of the technical aspects of the generation and propagation of sonic booms in order to provide the background for an understanding of their effects on animate and inanimate objects.

Any aircraft in flight creates a pressure field in the surrounding air. At supersonic flight speeds the pressure disturbances are concentrated in waves. The pressure disturbances in those waves decrease at roughly the inverse first power of the distance from the aircraft. Because of this lower intensity decrease with distance as compared to subsonic aircraft, the pressure disturbances made by supersonic aircraft are experienced at larger distances from the aircraft. Moreover, the sharp variations in pressure make the disturbances audible as the sonic boom.

01-008

Myles, D. V.
Hirvonen, R.
Embleton, T. F.

National Research Council of Canada,
Ottawa /Ontario/

AN ACOUSTICAL STUDY OF MACHINERY ON LOGGING OPERATIONS IN EASTERN CANADA

Ontario, National Research Council of Canada, APR, 1971, 41 p.

A survey concerning noise from logging machinery and the effect of the forest in reducing that noise was carried out following a meeting held in Ottawa in April, 1970, that was attended by representatives from the Canadian Forestry Service, National Research Council, Ontario Department of Lands and Forests, Pulp and Paper Research Institute of Canada, Ontario Forest Industries Association, and the Canadian Pulp and Paper Association.

The survey had the twofold purpose ofobtaining a statistical picture of: 1) the noise produced from typical logging operations and from the different types of machines on them; and 2) the influence of normal forest conditions on the propagation & attenuation of sound from logging operations.

This approach was expected to produce results from which preliminary conditions could be drawn concerning: 1) the noise characteristics of common logging machinery; 2) the risk of hearing damage to machine operators; and 3) the propagation of sound in the forest with respect to other forest users.

Field work was carried out from August to early October, 1970, in eastern Ontario & western Quebec.

01-009

SOUND-DEADENING IN SOIL PIPE SYSTEMS

Compressed Air Magazine

Vol 76 No 11:18, 1971

A 2-year study conducted by Polysonics Acoustical Engineers demonstrated neoprene synthetic rubber's role in alleviating noise in soil pipe systems. Random vibration sources were set up and neoprene was applied in various axes to the pipe being measured. Measurements of cumulative vibration drops over a large number of joints, as well as the per-joint reduction, were made. Polysonics determined that in a cast iron soil pipe system, use of neoprene gaskets provides a positive reduction in vibration, and hence noise, at each joint. (Soil pipe systems made of cast iron are quietest because of their heavy mass.)

A neoprene compression gasket was found to provide vibration drops as high as 20 dB per joint at the higher frequencies. A CI No-Hub neoprene gasket with stainless steel coupling provides vibration drops of as much as 11 dB per joint at higher frequences. Both types prevent direct metal-to-metal contact at joints.

Field tests conducted in Washington, DC high-rises showed even greater vibration drops per joint than in the lab tests.

EMISSION & SUPPRESSION

01-010

Goncharenko, V. P.

Steklotarno-Izolyatornyy Zavod, Ordzhonikidze /USSR/

ON THE REDUCTION OF AUTOMOBILE AND TRACTOR NOISE

K Voprosu o Snizhenii Shuma Automobiley i Traktorov

Gigiyena Truda i Professional'nyye Zabolevaniya

Vol 14 No 1:46-47, 1971

Soviet sound pressure meters with frequency analyzers were employed to measure noise levels at a 7 meter distance emitted from vehicles travelling at speeds of 19 to 25 mph. The range of readings was 74 to 109 dB. The total sound pressure level (SPL) for trucks with frequency range predominantely 351-800 Hz, was 89-107 dB, while for light weight cars it was 74-103 dB with an average of 88 dB. The "Belorus" tractor ranged from 78-101 dB, while heavier tractors and bulldozers produced readings of 95-105 dB at frequencies above 800 Hz. In all cases the existing standards were exceeded. Vehicle interior readings were 70-80 dB (800 Hz) at rest and 76-89 dB in motion.

To reduce automobile and tractor noise, dynamic balancing is required for the engine, the gear box, the Cardan shafts, the fan, the divided axle, the wheels and the tires. Elastomettalic coatings made of perforated materials must be more widely introduced, along with antivibration coatings and soundproofing shields. Damping devices must be improved and put into wide use. Impacting metal shafts, gears, etc. need to be replaced by plastics; hydraulic and pneumatic suspensions should phase out springs; straight-toothed gears should be replaced with spiral helical or worm gears. Manufacturing tolerances must be cut to a minimum to reduce joint clearances and prevent frictional noise. The bearing surfaces of joints must be fully protected by lubricants and rocker bearings must be replaced by slide bearings and noise and vibration insulating coverings. Power transmission can be damped by flexible couplings and housing openings for passage of shafts, etc. should be equipped with mufflers in the form of pipes whose interior is faced with sound-absorbent materials.

01-011

Bobin, Ye. V.

Leningradskiy Institut Inzhenerov Zheleznodorozhnogo Transporta im. V. N. Obraztsova, Leningrad /USSR/

NOISE REDUCTION FOR RAILWAY TRAFFIC AND RHEOSTAT TESTS OF DIESEL LOCOMOTIVES

O Snizhenii Shuma pri Dvizhenii Poyezdov i Reostatnykh Ispytaniyakh Teplovozov

Vol 34 No 1:94-97, 1969

Soviet regulations prescribe the distances that residential areas must be located from railway tracks, depots and rheostat-test areas. Recent measurements have shown that the standards for residential noise in the vicinity of such railway facilities are universally violated, although distances in many cases are in keeping with regulations.

Realistically, means must be found to attenuate the noise, both by insulation at the source and by screening along the sound path. The protective effect of brick shields built in Lvov is cited.

The brick shield was built 15 meters high 18 meters from the railroad tracks and 72 meters from the housing it was to shield. It reduced the noise levels in the housing area by 20 dB, or a factor of four in terms of subjective loudness, enabling the regulations to be met.

01-012

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LETTER TO THE EDITOR: EFFECTS OF LOUVRES ON THE NOISE OF AN AXIAL FLOW FAN

Journal of Sound and Vibration

Vol 15 No 3:421-424, 1971

The effect on the sound field of axial flow fans of louvers positioned across their intakes was studies in light of design of lift fans for vertical take-off aircraft and ventilation systems.

EMISSION & SUPPRESSION

A rig configuration was chosen which was typical of many practical situations but which avoided detailed complexities of such systems. For the acoustic wavelengths of interest, this meant that the louvers, individually, were not major scatterers of sound. The louvers, contributed to noise generation only through the interception of their wakes by the rotor blades.

Only the following areas were investigated: the effect of the louvers on the rotor as a source, and the effect on the rotor-generated sound field of blockage due to the louvers.

A preliminary survey of mechanical and aerodynamic noise from the fan assembly was performed for the louvers at 0 degrees for the shaft and rotor running at 600 and 12,000 rev/min. Three microphone angles were considered: 0, 45, and 90 degrees. The assembly was operated first with and then without the rotor, to determine the mechanical noise. Third-octave band spectra indicated that only above about 1000 Hz was there a significant difference (of 15 dB or more) in the sound pressure levels with and without the rotor.

Measurements were made of overall sound pressure level for rotor speeds of 6000 and 12000 rev/min at ten degree intervals of microphone position between -90 degrees and +90 degrees. This was performed for ten louver angles from 0 degrees to 90 degrees.

A comparison of the airflow measurements and and the results indicated that the increase in sound pressure level when the louvers were tilted about 40 degrees occurred when the louvers began to have a spoiling effect on the flow to the rotor. This effect became more marked as the louver angle increased until a point was reached at about 65 degrees where the opposing effects of reduced mean flow and acoustic blockage became effectively equal, and beyond 65 degrees the amount of noise radiated from the intake decreased.

The overall noise field was found to be roughly non-directional for all louver angles, but the distribution in angle of the radiated noise at the third-octave band containing the blade passage frequency was found to deviate in a rather irregular manner.

01-013

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EVALUATION OF CITY TRANSIT BUS "EIP" KITS TO REDUCE ENGINE SMOKE, ODOR, NOXIOUS EMISSIONS AND NOISE

Springfield, VA, NTIS, PB 204 813, 1971, 33p. HC $3.00 MF 95 cents

The General Motors' Environmental Improvement Program (EIP) retrofit was designed to be installed on GM city transit buses with two cycle diesel engines for the reduction of air emissions and noise. Field testing has shown that EIP kits, properly installed and maintained, reduce visible smoke, odor, noxious emissions of hydrocarbons and carbon monoxide and (slightly) noise levels inside the bus. However, exterior noise was not reduced and even increased under certain circumstances. Better noise reduction performance might be attained, with no worsening of other performance parameters, if certain kit components were redesigned.

The kit consisted of: (1) use of LSN fuel injectors, (2) vertical, aspirated exhaust stack, (3) muffled air induction system, (4) energy absorbing engine mounts, (5) muffler incorporating a catalytic reactor, as well as changes in operation: revised fuel injector timing, higher transmission shift speed setting, and use of Number 1 grade diesel fuel.

Bus noise is transmitted to the interior through engine mountings and various ducts. Exterior noise is radiated from exhaust and intake openings, the air conditioner and the cooling fan. The EIP kit's improved motor mounts and air intake muffling reduced interior noise levels slightly. The mounts used additional rubber insulation between the engine cradle and the coach chassis. Field observations showed that some of the mounts had soon deteriorated with service use, suggesting that redesign may be needed.

One reason exterior noise was not reduced was that the exhaust stack and catalytic muffler treatments were chiefly aimed at abating air pollution. Since the catalytic muffler was not particularly effective toward that purpose, it might well be replaced with a muffler that was more effective acoustically. The other reason that exterior noise tended to increase was the higher shift speeds needed to reduce the smoke produced at shift points.

EMISSION & SUPPRESSION

GM first assembled the kits in late 1969. Of 53,000 transit buses in the national fleet, the majority are of GMV manufacture. The EIP kit or at least its most effective component, the LSN injector, could be fitted in its entirety to the 24,000 "new look" buses produced since 1959. Buses fitted with EIP kits were tested in San Francisco, San Antonio, and Washington, DC, during 1970-71.

A bus presently in service could be fitted with an EIP kit for about $2650, parts and labor. Including the kit at the factory in a new bus would cost about $500-550.

01-014

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Hirvonen, R.
Embleton, T. F.

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ON: NOISE MEASUREMENTS OF LOGGING MACHINERY IN THE FOREST

In: Mylos, D., An Acoustical Study of Machinery on Logging Operations in Eastern Canada

Ontario, National Research Council of Canada
APR, 1971 41p. (p. 17-41)

Noise measurements of logging machinery in the forest and a few suggestions to reduce noise that is recreationally intrusive are presented.

Sound level readings were taken of about 130 different logging operation machines. Skidders and chain saws are the most common noise sources. Readings were taken at the operator's ear for both loaded and empty machines at 15 and 50 feet for eight frequency bands (63 to 8,000 Hz).

The maximum distances at which the noise from logging operation was audible were also determined for several sites at upwind, cross wind and downwind. Temperature, humidity, wind speed and direction were noted at all times, notes on topography and forest cover were kept, and ambient noise levels were measured as often as practicable, using Bruel and Kjaer portable sound level meters.

The number of machines producing various sound levels is illustrated for all skidders and chainsaws, by histograms of the measurements taken in dBA (Fig. 1) and dBC (Fig 2). For sound energy following the inverse square law the levels should be 10dB lower at 50 ft than 15 ft, but skidder noise decreases by only 6 dB because of the machine's size. On rough terrain, skidders produced more noise when empty than when full. For the noisiest 10% of the chain-saw operations the sound levels ranged 115-119 dBA. There was great variation between chain saws of the same make and model.

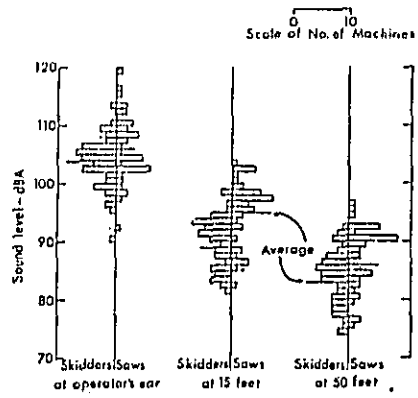

FIGURE 1.

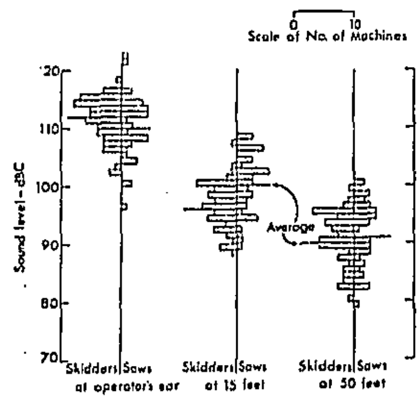

FIGURE 2.

Noise spectra measured at 50 feet were averaged and plotted for chain saws, skidders, loaders and logalls (Fig. 3) According to the inverse-square law, the noise levels should decrease 22.5 dB between 50 feet and 10 chains (660 feet). However, the decrease was actually about 32 dB in the low frequency octave bands and 42 dB in the high frequency octave bands. This additional reduction is probably due to forest absorption and the average of many different atmospheric conditions.

EMISSION & SUPPRESSION

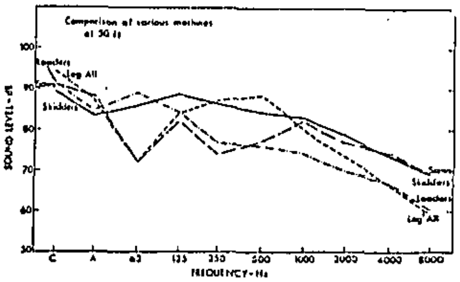

FIGURE 3.

The human ear can certainly distinguish machinery noise from background noise in the forest, even when the machinery noise is less than the ambient background noise. For this reason a human measured (rather than machine measured) approach was applied to the problem of intrusiveness of noise on a recreational use of the forest. In the average situation, the chain saw noise could be heard to a distance of 115 chains (1.43 miles). Skidder noise could be heard to a distance of 116 chains (1.45 miles).

Particular situations can differ markedly from the average. On still mornings logging operations could be clearly heard for distances of over 2 miles. Noise from a skidder working across a bay registered 58 dBA at a distance of 0.9 miles. On some occasions in hilly country, noise was not heard much beyond 0.5 mile, but from a hill top a slasher was heard 2.25 miles away. On a windless, misty day, chain saws could be heard at 2.25 miles in fairly flat country, but in a 5 mph breeze the same operation was inaudible beyond 0.7 mile upwind.

When considering the propagation of sound over long distances, any reduction at the noise source would help reduce the distance that such noise would travel. A 6 dB reduction can be obtained by muffling and will reduce by 40% the distance at which it can be heard. Further improvements would require an attack on engine noises other than exhaust.

To prevent intrusiveness of noise to campers, it is concluded that logging operations should not be permitted closer than one mile from the location being used.

01-015

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PROPAGATION OF SOUND WAVES IN FORESTS

In: Myles, D., An Acoustical Study of Machinery on Logging Operations in Eastern Canada

Ontario, National Research Council of Canada
APR, 1971, 41p. (p. 2-17)

The propagation of sound waves in forests is investigated as acoustical background to a Canadian survey on noise from logging equipment and the effect of the forest in reducing that noise.

When a source radiates noise outdoors, the sound levels naturally decrease with distance. At distances greater than four times its average linear dimension (the 'far field") sound energy radiates according to the inverse-square law and decreases by 6 dB for each doubling of the distance from the noise source. The deviation from this law grows greater with higher frequencies and is very dependent on humidity and temperature, as shown.

Table 1: Decrease of sound-pressure levels due to energy absorption in air by molecular processes, stated in dB per mile.

Relative humidity %	Temperature oF	1000 Hz and below	2000 Hz	4000 Hz	6300 Hz
30	59	2	25	85	185
	68	2	21	66	147
	77	2	20	54	120
	86	2	19	49	99
50	50	2	17	50	110
	68	2	17	42	88
	77	2	17	41	77
	86	2	16	41	75
70	50	2	15	39	79
	68	2	15	37	70
	77	2	15	37	68
	86	2	14	36	67

Sound propagation through extensive forests has a reasonable attenuation of 2 dB per 100 feet. The thickness of the forest affects sound propagation, but reaches a plateau, regardless of density, at about 10 dB for all frequencies. This value fluctuates due to wind and other factors, so it is not constantly accurate.

Wind primarily redistributes the sound energy in different directions. When the gradient of the wind velocity is positive (downwind from the source), sound energy is refracted downwards. Likewise, as temperature increases with increasing height (positive gradient), it refracts sound energy downwards in all directions increasing the sound level pressure. Wind also causes leaf rustling on trees. There are two species of poplar and birch which generate noise at levels as high as 40 dB at wind speeds of 5 mph.

The measurements discussed here apply to the intrusion of noise from woodland operations upon those using the woods for recreational purposes. Most criteria for intrusiveness are based on typical urban environments, and very little has been done on forest noise. In places such as concert halls, however, criteria for noise are set, and at very low levels. It is assumed that these criteria will be the same for forest noise.

Such criteria are expressed in terms of Noise Criteria (NC) curves, which specify noise levels allowed at each octave band. The annoyance of a measured noise is found by plotting levels superimposed on the NC curves. In those terms, the background noise in concert halls should not exceed NC 15 to NC 20. However, this applies to continuous noise, and time-varying noise such as those produced by a chainsaw would lower the criteria to NC 10-15.

The threshold of hearing (12 dB lower than 10) could also be used as a criterion for forest noise, although this assumes that there are no masking noises in the vicinity of the listener.

01-016

POLYURETHANE FOAM CONTROLS MACHINE NOISE

Sound and Vibration

Vol 5 No 7:12, JUL, 1971

The noise from high-speed computer printers has been lowered from 80 to 55 dB using a sound absorption material made of compressed polyurethance foam. The major source of noise printers is a large number of rapid-fire hammers--132 or more--that print out up to 1250 lines per minute.

The compressed foam is made by applying heat and pressure to the original material until its dimensions are reduced by the desired ratio. This process changes the internal structure of the foam, improving its sound absorbing properties. In the computer printer application, the brand used was Scottfelt and the printer was the RCA 70/242-30. The original thickness of the foam layers was attached to interior metal surfaces of the printers using adhesive, as well as installed on a sound baffle near a point where cooling air entered the printer. Other materials considered, but not used included glass fiber and closed cell foam.

Other applications of the material have included tractor engine compartments and gas turbine power plants, both stationary and aircraft types.

01-017

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HUMAN ASPECTS OF VIBRATION AND NOISE IN HELICOPTERS

Journal of Sound and Vibration

Vol 20 No 4:343-351, 1972

Types and sources of helicopter vibration, methods of vibration testing and monitoring, methods of vibration reduction, and internal and external noise are discussed and information is given on results of internal cabin noise reduction.

The fundamental mechanics of the helicopter, involving a number of rotating components, make the machine subject to vibration and noise. The prime sources of excitation are the main rotor, the transmission system, the tail rotor and the engine. This frequency range of 20 to 15,000 Hz encompasses main and tail rotor harmonics, gearbox noise, noise generated by engine components and aerodynamically-produced broad-band noise.

Externally, the predominant noise is generated aerodynamically by the main and tail rotors.

Harmonics of the main rotor blade passing frequency occur at the low frequency end of the audio range. Tail rotor rotational harmonics, broad-band noise from the main rotor and gear meshing noise dominate the mid-frequency region and engine compressor orders exist above about 10 kHz.

The subjectively dominant internal noise sources are transmission (gear meshing) orders.

EMISSION & SUPPRESSION

If the helicopter is to fulfill future civil requirements it will be necessary to reduce cabin noise further. Although the internal noise in military helicopters is considerable the crew wear helmets which attenuate the level at the ear.

Noise can be transmitted to the cockpit and cabin as airborne noise and/or as structure borne vibration. Present soundproofing schemes consist of lining the cabin with an absorbent material such as fiberglass. The whole surface area of the cabin is treated.

Considerable reductions in cabin noise levels have been obtained. The mid and upper audio frequency region of the noise is subjectively most important and in this area the greatest reductions are apparent.

Future investigations are planned to optimize soundproofing, in an attempt to reduce the noise levels even further.

It appears that the subjective effects of noise and vibration are additive, and thus the helicopter is a vehicle on which combined field and laboratory environmental studies should be directed.

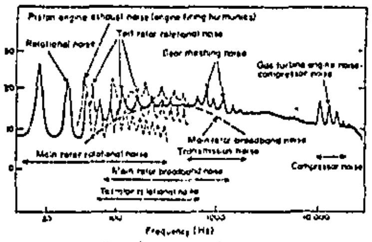

Figure 1 Helicopter noise sources.

HUMAN ASPECTS OF HELICOPTER VIBRATION

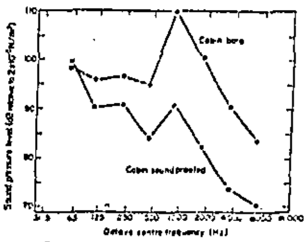

Figure 2 Effect of cabin soundproofing

01-018

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EFFECTS OF AIRCRAFT OPERATION ON COMMUNITY NOISE

Seattle, Boeing, JUN, 1971, 10 p.

Industry and government studies in response to airlines, airframe and engine manufacturers, and local airport authorities to reduce aircraft generated noise in airport communities are reported.

Three general areas of community noise improvement are summarized as:
1) Reduction of the noise at its source by quieting the engine installations on the aircraft
2) Changes in land utilization in airport communities
3) Changes in regulatory and operational procedures in the vicinity of airports.

Considerable work now being done in industry and government programs is related to examining means of retrofitting the existing fleet of commercial fanjet transport aircraft to significantly reduce their community noise levels. The magnitude of noise reduction attained is closely related to technical feasibility and to the economics of airplane modification and operation.

Both Federal and local agencies are continuing to study the possibilities of community noise relief through better land utilization. Such studies encompass the subjects of improved planning for new airports, tightened building codes and zoning restrictions, and revised land utilization around existing airports. Economics is an important and unavoidable consideration in land utilization studies.

Noise reduction through operational procedures offers much relief to the community at relatively little cost, without affecting safety. These procedures include Federal and local regulations and operating procedures available to the airlines.

Holding and maneuver attitudes can be raised by Federal and local regulation. Traffic patterns and routes can be optimized over less populated areas. If glide slopes are steepened by ½ degree, significant noise reduction will occur. Finally, the glide slope intercept altitude can be raised. If all of these points were accomplished, Federal and local regulation would be responsible for a good deal of noise reduction.

EMISSION & SUPPRESSION

Operational procedures available to the airlines themselves could also effect changes in aircraft noise levels. Noise can be reduced considerably by delaying landing gear and flap extension. Two-segment approaches, or intercepting the final glide slope from a steep descent, will keep aircraft at a high level over the community, and the noise level will remain low. Flap position during approach and landing could be set at a lesser angle, producing less noise. This would require additional runway yardage. Take-off procedures could be modified by implementing a power cutback at an acceptable altitude.

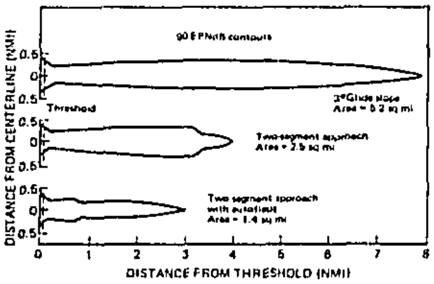

FIGURE 1. Noise Footprint Comparisons of Two-Segment Approaches

01-019

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AUTOMOTIVE NOISE ENVIRONMENTAL IMPACT AND CONTROL

At: Highway Research Board Annual Meeting, Ingenjoersvetenskapsakademlon, Sweden, 1972

Canoga Park, CA, Bolt, Beranek, and Newman, 1972, 30p.

The units used to describe automotive noise, which is the most widespread and important contributor of urban noise, the current criteria used in assessing the impact of traffic noise on people, various automotive sources that combine to create traffic noise, and control of motor vehicle noise are discussed.

The effects of automotive noise on people can be divided into the subjective effects of annoyance, nuisance, and dissatisfaction and interference with tasks such as sleep, speech and learning. Interference with speech and T.V. listening is the predominant complaint against automotive noise and interference with sleep is also often cited. In describing subjective response, measurements of time average noise levels and the magnitude and frequency of the occurrence of peak noise levels are important. In conjunction with these points, criteria specifying maximum noise levels to which people will agree have been derived. One method, known as the statistical time distribution, identifies each noise level with the percentage of time which that level is exceeded. For example, L10 is that level which is exceeded 10% of the time.

Automobiles, by sheer number alone, produce the largest source of motor vehicle noise. Tire/roadway noise is the main contributor from autos at high speeds. Diesel trucks are the noisiest vehicles on the road. Figure 1 shows the spectra of typical noise sources from trucks:

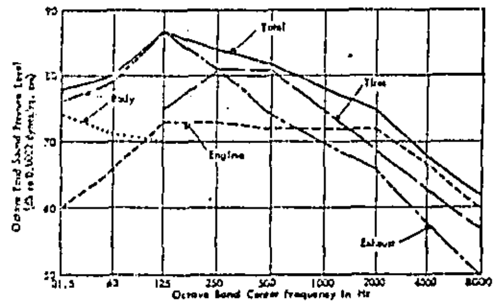

FIGURE 1. TYPICAL BREAKDOWN OF TRUCK NOISE

Motorcycles produce most noise from their exhaust systems.

Predictions of traffic noise under different roadway conditions can be made by statistical time distribution, given vehicle volume and average speed.

Noise can be controlled at three points: the source, the receiver, and along the transmission path. Limiting noise at the source can be achieved by legislation on noise levels of motor vehicles. Control at the receiver can be obtained by zoning and planning of land use, and by acoustic insulation of buildings. Reducing noise along the transmission path can be achieved by design of roadway configurations and alignments. Increased distance, relocation, and depression/elevation of the roadway will reduce noise levels. Construction of earth berms will also control noise considerably. Depression of the roadway, on one case, resulted in a 13.5 dBA noise reduction.

Proper planning seems to be the best and most effective criterion for control of automotive noise.

01-020

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NOISE FROM CHEMICAL PLANT EQUIPMENT

Annals of Occupational Hygiene

Vol 14 No 2:91-99, 1971

The large scale industrial noise problem resulting from increases in chemical plant and equipment size together with the use of higher fluid velocities is discussed.

One problem is compressor noise, due to blade passage, turbulence in rotating elements of centrifigual compressors, turbulence in by-pass systems and normal turbulent flow in pipes. Noise reduction has been accomplished by removing diffuser vanes, reducing the surface area, fitting silencers, and cladding pipes.

A second problem, fan noise, comes mostly from air coolers, and has caused complaints from the community. A reduction of 6 dBA was achieved at one plant by using both inertia and absorption silencers.

Efforts to silence the third problem, flarestacks have been disappointing so far. Noise is a function of the steam rate per nozzle, not the overall steam rate. Evenness of combustion is a negligible factor in noisiness. Use of peripheral steam jets of different orientation resulted in a 7-9 dBA improvement; however, this is inadequate. New methods of flaring gas need to be developed.

Two components of noise from vents are noise from pressure let down and atmosphere mixing. The sizing of pipes and vent silencers must be applied according to location, and hence there are no simple design rules.

For the most effective noise control, it is suggested that possible noise sources be treated at the design stage.

01-021

GREAT POSSIBILITIES IN NOISE ABATEMENT

Nagy lehetosegek a zaj csokkentesere

Ujitok Lapja (Budapest)

Vol 23 No 20:13-14, 1971

The SILKA sound damper, based on a patent granted to physicist Domokos Horvath and mechanical engineer Gyorgy Sardi, went into series production at the Somogy County Enterprise in Kaposvar, Hungary. The patent, granted in 1970 and entitled "Sound damping enclosure for damping noise caused by flowing gases, for example, motor exhaust gases," is an enclosure bounded by walls consisting of multilayered film with dead space between the layers which are filled with loose granular, porous or other vibration damping media. The invention has been in use in the Ganz-MAVAG Engine Testing Station since 1966. Noise has been abated in the plant environment, and an attenuation of low frequency noise of 30 dB at 12 Hz has been attained. Previously, the noise level in the plant environment had reached NC 105, extending into distant communities. The level is presently below NC 70 (about 75 dBA).

Prototypes of the noise damper will be tested in apartment house ventilation systems in Obuda and Zuglo. Tests on prototypes of the MONO apartment house ventilation systems produced by the Ventilator Plant and equipped with the noise attenuation device show attenuation of 15 dB. A 30-40 dB attenuation from 110 dB to approximately NC 65 was also achieved in exhaust noise from the compressor room of the Pecs Leather Plant.

The noise damping device is to be applied to damping noise from diesel and Otto engines in engine testing stations, ventilator noise from exhaust and air conditioning systems in apartment houses, air filtering systems, and noise from gas turbine exhaust systems.

01-022

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REDUCTION OF NOISE FROM COMPRESSOR INSTALLATIONS

Snizheniye Shuma Kompressornykh Stantsiy

Tekhnologiya i Organizatsiya Proizvodstva (Kiev)

No 1:87-88, 1971

Effective noise reduction by means of a simple pipe muffler was achieved for a piston-type air compressor installation located in a separate shed on factory property, enabling the compressor installation to meet the Soviet norms for noise emitted to adjacent residential areas. Piston compressor noise is composed of airborne noise from the air intake and exhaust, and noise radiated from the body of the compressor itself. The noise spectra of four Soviet compressor installations would not meet the legal limits within certain distances.

Since noise radiated from the compressor body is mostly contained inside the shed, it is the intake and exhaust noise of the engine that accounts for most of the noise heard at a distance from the installation. Measured at the pipes, it reached 102-104 dBA.

A simple cylindrical muffler attached to the air intake pipe proved effective for reducing noise for compressors of capacity of up to 50 cubic meters per minute (Figure 1). This muffler is simple to make, durable, and is effective over a wide range of frequencies. By using this muffler, a Soviet IVV-10/8 compressor (capacity 10 cubic meters per minute at eight atmospheres) was quieted by 13-15 dB over a wide frequency range.

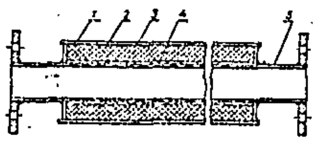

Figure 1. Cylindrical muffler for exhaust pipe.
1. Outside surface of muffler.
2. Sound absorbing material (density 15 kG/m3, layer thickness 100mm).
3. Layer of fiberglass 0.1mm thick.
4. Perforations 5mm in diameter in inner wall of muffler, spaced 10mm apart. Length of muffler: 1 meter.
5. Air intake pipe with flange.

Further reduction in noise emissions to nearby housing can be achieved by locating the compressor installation away from housing areas, by orienting the intake and exhaust pipes away from these areas, and by using factory buildings for screening.

01-023

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NOISE AND THE SNOWMOBILE

In: Crocker, M., Proceedings of the Purdue Noise Control Conference, JUL 14-16, 1971

Lafayette, Purdue Univ., 1972, 594 p. (p. 77-79)

The noise problem of the snowmobile is discussed with special emphasis on methods of measurement and control. Snowmobiles have found wide use both for recreation and utility. Conservationists are concerned about this noise impact on wildlife. In response legislatures are acting on noise limits. Snowmobile noise can cause permanent hearing loss and has been responsible for many accidents because of its masking effect, making warning signals inaudible.

To measure the sound pressure levels, the snowmobile was tested in a large semi-anechoic room with the machine blocked up so as to allow the drive track to run free. Recordings were taken at five positions around the machine. The levels of a new machine were 98-101 dBA.

The following modifications were most effective:

1. All unnecessary openings in the body were sealed. Openings which were required for engine cooling were retained.
2. One inch of polyurethane acoustical foam was stuck to the interior surface of the engine cowling.
3. Three-quarter inch embossed polyurethane acoustical foam was stuck to the interior surface of the instrument console.
4. A silencer was attached to the carburetor intake.
5. The foot-well openings in the engine cowling were reduced to a minimum practical size.

These modifications did not lower the noise level around the machine, but the value at the operator's ear was lowered by 5 dBA. In order to lower sound pressure levels around the machine an effective engine exhaust muffler must be added.

01-024

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NOISE CHARACTER OF A RIDING LAWN MOWER

Columbus, OH, Ohio State Univ., 12p, 1971

Minor modifications to an 8 HP riding lawn mower enabled it to meet the ANSI Standard B71.1 recommendations for maximum noise levels at the operator's ear; the limit in this standard, which became effective JUN 1, 1971, was 95 dBA. Various noise levels measured at the ear level microphone position were as follows:

Configuration of Mower	Sound Level (dBA)
No Muffler	98
Stock muffler	93
Stock muffler with engine cover	87
Experimental muffler with engine cover	85

Another useful method was reduction of maximum engine speed. However, meeting community noise ordinance limits such as those in the Chicago Code will become quite difficult as the limits become more stringent with time. Engine noise may be reduced, revealing an even tougher problem--blade noise. The Chicago Code gives a maximum limit of 74 dBA at 50 ft effective JAN 1, 1972, and this limit drops to 65 dBA by JAN, 1978.

The two riding mowers tested had 4 cycle, aircooled, non-dynamically balanced engines producing 3600 maximum RPM. Vibrating loose parts such as the seat and fenders were significant noise sources. A 3 dBA reduction was obtained merely by placing a hand on a vibrating fender. It is recommended fenders be removed during these tests, and that manufacturers eliminate them. A dynamically balanced 8 HP engine was 4 dB quieter at ear level than the standard mower engine. This engine would cost $12, or $3/dB more than the standard one.

Replacement of the stock "tin can" muffler with an experimental multichambered muffler reduced noise only 2 dBA, but perceived reduction of loudness was greater because the new muffler eliminated harsh-sounding components at the firing frequency. Improved mufflers alone are not the answer because direct radiation from the engine casting was the controlling source, not the exhaust noise. Tests with a long tailpipe completely eliminating exhaust noise confirmed this. Likewise, vibration isolation of the engine from the frame had no effect because the engine casing itself was the controlling source. A partial sheet metal cover with absorption material on the engine side gave a 6 dBA reduction, however. The absorption material was glassfiber blanket approximately 2 in thick.

The combined reductions achieved by the above means are enough to meet the limit of 74 dBA at 50 ft, but meeting the future limits of 70 dBA (1975) and 65 dBA (1978) will be a real challenge.

The only other possible means of reduction, other than drastic engine and blade redesign, is reduction of engine speed. For these two mowers, with stock equipment, a relationship of about 1 dBA/200 RPM was observed:

Engine speed	Sound level at ear of operator (dBA)
3380 RPM	92
3175	91.5
2875	89.5
2550	88
2400	87

Reducing engine speed will perhaps be the most common way to meet legal limits, since it requires only the change of the governor setting.

01-025

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NOISE STUDY OF AN AIR PILE DRIVER

Chicago, Dept. of Environmental Control, 1971, 9p.

The problem of noise from the use of pile drivers on steel sheet piles at a downtown construction site was studied and a three-sided enclosure developed that produced some quieting.

EMISSION & SUPPRESSION

The study, performed by the City of Chicago's Department of Environmental Control, was done on pile driving operations at the First National Bank construction site. The equipment was a double action air pile driver. Preliminary measurements established the duration of the peak noise, the frequency characteristics of the noise, the repetition rate, and the true peak level (about 122 dB at 25 feet, equivalent to 102 RMS dBA and 106 RMS dBC).

The City recommended that a three-sided enclosure be installed on the existing support frames of the pile driver. The enclosure was left open in the front to provide visual freedom for the crane operator, but it still partially shielded observers to the rear of the pile driving operation. The enclosure was constructed of an outer steel shell (¼ inch sheet steel), coated with a damping compound to minimize the vibration of the shell (⅛ inch "Vibradamp") and lined with 1¼ inches of open celled polyurethane, an acoustical absorption material.

A test was made where measurements were taken as the enclosure was elevated above the pile driver and gradually lowered over it. The results showed a 15 dB reduction of the peak level (and a reduction of 7 dBA in the "A-weighted" level) to the rear of the pile driver, and a slight reduction to the side of the pile driver. (See Table.)

Sound level	Without enclosure	With enclosure
At rear of enclosure (about 25 ft.):		
Peak levels (dB)	123	108
RMS Peak (dBA)	106	99
RMS Peak (dBC)	108	104
At side of enclosure (about 25 ft.):		
Peak level (dB)	113	110
RMS Peak (dBA)	107	103
RMS Peak (dBC)	108	105

Noise levels at the First National Bank site.

Further reductions could be achieved by improving the design of the enclosure, which in this case did not extend far enough down and forward because of the presence of an angle iron support frame. The enclosure could be slotted to allow it to descend upon the sheet pilings, thus better cutting off noise emissions. By making the enclosure more triangular in shape and eliminating the opening on the fourth or open side through the use of a plexiglass or glass shield, the size of openings in the enclosure could be further reduced. Finally, thicker acoustical treatment would provide increased attenuation at the lower frequencies.

In this case, the study was initiated from a series of complaints received by the Department of Environmental Control. A series of meetings with representatives of the bank and the construction company led to the decision to try the enclosure. Additional actions agreed upon were that air mufflers or baffles were to be installed on all pile driver units, and a vibro driver was to be used for extracting the sheet metal piles after the completion of the project.

The vibro driver is a different type of pile driver that operates at speeds of 18 to 30 cycles per second. The vibro driver's noise level, as measured at a second construction site, was between 82 and 84 dBA at 20 feet, markedly quieter than the air pile driver. This device functions well as a driver only in certain types of soils. However, it is effective for the extraction of sheet metal piling in all types of soils.

01-026

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SONIC BOOM EFFECTS II.1: STRUCTURES AND TERRAIN

Journal of Sound and Vibration

Vol 20 No 4:505-509, 1972

Effects on structures due to pressure waves from explosions and guns have been known and studied for a long time. Three general sets of parameters determine the effect of sonic booms on the structures and terrain; (i) the generation; (ii) the propagation of shock waves; (iii) the characteristics of the structures.

When an acoustic shock wave strikes the ground, a ground wave is set in motion and travels at a speed which is a function of the terrain and its composition. A component of this ground motion travels along the surface (Rayleigh wave), exposing buildings and other structures on the ground. Its effect on structures would no be sufficient to cause damage. It has been shown that ground motions associated with sonic booms are usually of the same order as those associated with the passage of vehicles. The structural vibration induced by ground motion is far less than excitation by the acoustic shock wave.

The effect of the ground motion on surface topographical features is the same as that already discussed for structures. The effect on underground features such as mines has not been studied, but should be noted that the amplitude of the ground motion caused by the sonic boom usually diminishes with depth.

EMISSION & SUPPRESSION

The main effect of the boom on topographical features, or on structures, will come from the direct excitation by the acoustic shock wave. On many features, for example cliffs, existing natural disturbances such as wind have been found to be compatible with or greater than sonic boom disturbance. A sonic boom could trigger a fall, but this would only be slightly premature to the naturally occurring event. Damage to primary structure of dwellings even under extreme assumptions is not to be expected. Structural elements with large surfaces and small masses and not preloaded by other structural elements, are more susceptible to booms than any other structural part. Therefore damage to plaster, panes, suspended ceilings and roofs can be expected to be more numerous than other structural damages. Damage expectancy will decrease with overpressure, but theoretically there is no overpressure level at which damage is impossible. Relevant boom characteristics on a certain structural part are normally not known mainly because the free field waveform is altered by the structure itself and by reflections from neighboring buildings.

In an Oklahoma City study with 1235 sonic booms having an average maximum intensity of about 70 N/sq.m. there was no evidence of cumulative damage in the four test structures intensively studies throughout the program. By a suitable choice of buildings and by an examination of their maintenance histories, it is feasible that appropriate fatigue data could be accumulated on the problem of repeated sonic booms.

Effects of booms on structures vary from slight vibrations, detectable only by special equipment, to severe vibrations which might cause damage. Type and number of damages in structures follow a certain order. This is determined by the peak overpressure, the time history of the boom shock waves and the susceptibility of the structural element. Glass panes and plaster are more susceptible than roofs which in turn are more susceptible than walls. In connection with an exposure to a sonic boom of very high intensity in MAY 1970 over the German town of Westerburg and some villages situated 1 km to the south, 378 damage claims were filed. Most involved damage to glass panes and slated roofs where slates were shaken up. Some chimneys were damaged, some closed doors went off the hinges and door panels were broken. No serious damage on the main house structures was recorded. Extended criteria for statistical assessment need to be developed. These can be based on both figures of damage claims and results from experimental investigations. In the case of one single boom with the intensity of 125 N/sq.m. which exposes an urban community with a population of 500,000 people and 20 window panes/person, one window (out of ten million) can be expected to be broken.

In several cases, preventive measures chiefly performed to protect plaster and glass have been successful. The best way to prevent damage from sonic booms is to keep buildings in a good state of preservation.

Suitable sonic boom generators can be used to obtain fatigue data on building elements or sections. Since there is some evidence that higher order modes can play an important part in the damage mechanism, it seem prudent that experimental generators produce N-waves that contain all frequencies found in a real sonic boom. Three items appear pertinent for general research. The first is glass, which features extensively in sonic boom claims in walls where the point of interest is fatigue work. Third, crack propagation in plaster and other structural elements is important.

Data on structures should be standardized to facilitate comparison among different experiments.

01-027

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HIGHWAY ENGINEERING AND THE INFLUENCE OF GEOMETRIC DESIGN CHARACTERISTICS ON NOISE

Journal of Sound & Vibration

Vol 15 No 1:17-22, 1971

In contrast to the quantitative approaches to traffic and design problems which are available, in highway engineering, noise is an area in which the boundaries between quantitative and qualitative assessments are frequently diffuse.

The motorway requires the segregation of vehicles from pedestrians; this allows its design as a ground level facility, an elevated structure, depressed in a cutting or in a tunnel. It is feasible to submerge most urban motorways in tunnels, but the cost is so much greater than elevated or ground level construction that tunnels are kept to a minimum. Thus, what would be desirable in terms of reduction of noise is usually unacceptable on grounds of cost, and disruption of services. The general effect of an elevated motorway or one which is in a cutting is a reduced level of noise in its vicinity, although the introduction of ramps and slip roads on gradients result in concentrations of relatively higher levels of noise in their particular localities.

PHYSIOLOGICAL

The results of a comprehensive factual survey of 600 properties and 200 sites in various parts of the United States on the effects of landscape treatment, highway alignment and traffic noise on property indicated the following: (1) The depressed or subsurface highway is potentially the greatest single reducer of noise level. (2) Tree plantings affect noise levels only slightly. (3) In tall apartment buildings which are adjacent to roads of the motorway type, the occupants found the disturbance from traffic noise highly objectionable. (4) Trucks were considered the most objectionable source of noise, insofar as it disturbed normal domestic activities. (5) The presence of limited-access highways of the motorway type did not result in the general devaluation of houses and properties which were adjacent to them. (6) A general equation was computed by multiple regression in indicate the probable combined effects of distance, alignment and vegetation of the level of noise from road traffic.

For different types of road surfaces, the following equations were established for passenger cars:

Open textured asphalt:	noise level (dBA)= 28+30 log (speed).
Motorway concrete:	noise level (dBA)= 23+30 log (speed).
New asphalt:	noise level (dBA)= 18+30 log (speed).

It is noted that the most effective resistance to skidding is generally obtained from new concrete and new asphalt. A high quality surface is therefore beneficial both in terms of safety and noise. The methods of shielding from traffic noise the occupants of properties adjacent to major highways require attention to landscape treatment and the insulation of buildings.

The importance of research in the field of barrier design has increased because of the problems which arise in regard to the planning and implementation of urban projects.

02-001

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MAN AND NOISE STRESS AND RISK OF INJURY

In: Jansson, P. G. , Conferences in Connection with the International Air Pollution Control and Noise Abatement Exhibition, SEPT 1-6, 1971

Joenkoeping, Sweden, 1971, 525 p. (p. 4:1-4:6)

An estimate shows that more than half the machines in heavy industry can cause noise with levels above 90 dBA, and that roughly 50% of industrial workplaces have noise levels of over 85 dBA. Since noise is known to produce harmful effects in man, a study was made on the physiological and psychological effects of noise on 20 female card punch operators.

Group 1 was exposed to sound levels of 76, 82, 88, & 94 dBC on 4 consecutive working days respectively while engaged in their normal work. The other group was exposed to the same sound levels in reverse sequence while working. The normal sound level of the card puching machines was 76 dBC. The other levels were produced by playing tape recordings of punching noise and superimposing this on the 76 dBC level. Preliminary findings show that only slight increases in physiological and mental stress were observed. No proportionality was established between the sound level in dBC and the mental and physical reactions recorded. These sound levels, physically speaking quite high, produced only mild stress reactions. The reason for this is believed to be a favorable attitude toward the test and hence toward the noise. However, a positive relation was confined between subjective disturbance, and secretion of adrenalin and noradrenalin. Considerable individual differences were exhibited in reactions to the same noise stimulus.

02-002

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NOISE AND ACOUSTIC TRAUMA
NOISE LEVELS IN DISCOTHEQUES IN NEW DELHI

Indian Journal of Medical Research

Vol 58 No 12:1758-1763, 1970

PHYSIOLOGICAL

Live music in discotheques may be more dangerous to hearing than recorded music of seemingly equal loudness. Discotheques in New Delhi, India, were surveyed for potentially dangerous noise levels, both when recorded music (8 discotheques) and when live music interspersed with recorded music (2 discotheques) was being played. Bruel and Kjaer equipment was used.

In a typical discotheque the general noise level (GNL), based on an average of 10 trials, was 90 dB for recorded music and 109 dB for live music from a "rock" band.

Frequency analysis showed that highest sound pressure levels were found in the lower octave bands (125, 250, and 500 Hz) for both recorded and live music, but that levels in the higher bands were also considerable. Sound pressure levels in the 4000 Hz band ranged from 61-84 dB for recorded music in the various discotheques. Levels for live music in the same octave band were 84 and 86 dB. Background noise was typically 20-30 dB down from recorded music levels at all frequencies.

The authors account for the significantly higher sound levels for live music, as opposed to recorded music, by assuming that volume of the recorded music was set to seem as loud as the live music for which it was substituting. One of the factors which contributes to the sensation of loudness is the distortion content of the signal, and it is likely that distortion levels were markedly higher with recorded music. They conclude that the levels measured for live music definitely exceeded levels usually accepted as ear damage risk criteria (Lebo and Oliphant, California Medicine, Vol 107 (1967), p. 378), and that risk of acoustic trauma existed not only for the musicians, but also to habituees if they were particularly susceptible to such a noise trauma.

02-003

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PHYSIOLOGICAL CHANGES IN WEAVERS OPERATING LOOMS WITH DIFFERENT NOISE INTENSITY

Fiziologicheskiye Sdvigi u Tkachey Obsluzhivayushchikh Tkatskiye Stanki s Raznymi Urovnyami Shuma

Gigiyena i Sanitariya

Vol 37 No 1:29-32, 1972

Measurements were conducted in a weaving plant to determine the affects of noise on workers. Two groups were investigated: Group I worked on a shuttle looms type TSFS, reaching noise levels from 108 to 113 dB, and group II operated microshuttle looms type STB, reaching noise levels from 100 to 102 dB. Measurements on the workers were taken 4 times per day: before work, before and after lunch, and at the end of the work shift.

The weavers in Group I showed more pronounced changes in the nervous system and the systolic arterial pressure. These changes result in fatigue, headaches and ringing in the ears. All of these symptoms cannot be relieved by a noise free period during lunch or during time away from work. Definite measures should be taken to relieve the nervous tension caused by noise exposure, which can easily turn into trauma.

02-004

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NOISE LEVEL MEASUREMENTS DURING A FISHING EXPEDITION

Schallpegelmessungen Waehrend einer Fangreise

Seewirtschaft

Vol 3 No 12:926-928, 1971

Noise measurements were conducted in East Germany on the fishing vessel "Willi Bredel" during its 100 day expedition. Noise meter 101 of the Technical Vibration and Acoustics Plant in Dresden was employed and the noise levels were measured on the A, B, C weighting scale.

All possible noise sources were taken into account and measured . The noise levels ranged from 62 dBA in rooms located on the first deck to 104 dBA at the main oil-diesel machine.

Recommended norms for work places were considerably exceeded on "Willi Bredel". Most complaints came from patients of the hospital, which is located on the deck where 3 elevators for fish supplies are situated. The highest noise levels come from the conveyor-refrigeration unit and "fish flour mill".

PHYSIOLOGICAL

The guards at the main-machine use individual Hermetos ear plugs produced by Prothetik Plant Berlin or superfine hearing-protection cotton from Lauscha/Thueringen. The ear plugs reduce the noise level of 104 dBA by 22 dBA, and at level of 89 dBA by 9 dBA, at level of 93 dBA only by 8 dBA. "Cotton" reduces the level of 89 dBA by 14 dBA and that of 93 dBA by 15 dBA. At values below 75 dBA the ear plugs, not only do not reduce the level, but raise it by means of resonance.

Of importance are the extra-aural noise damages; a frequently observed noise symptom is the delay of the stomach peristalsis. Seamen often complain of digestive problems. Also the vegetative nervous system is affected, as well as pulse frequency and systolic blood pressure. Medical research shows that the vegetative system does not aclimate itself to noise even though it can be tolerated as a psychological phenomenon.

02-005

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HYGIENIC EVALUATION OF INTERMITTENT NOISE IN TESTING OF AIRCRAFT HYDRAULIC UNITS

Gigiyenicheskaya Otsenka Preryvistogo Shuma pri Ispytanii Aviatsionnykh Gidroagregatov

Gigiyena Truda i Professional'nye Zabolevaniya

Vol 15 No 10:9-12, 1971

Noise conditions were studied in areas for testing hydraulic aviation units in four aircraft maintenance plants. Noise meter type 2203 (Bruel & Kjaer) and octave spectrum analyzer type 1613 were used in the tests.

The job requires working in a standing position and manual visual coordination. It also involves static nerve stress. The dominant adverse working factor is noise. Sources of noise include the hydraulic unit itself, the engine and reducer of the test stand, and the system for loading the test stand. The intensity of the noise in the work area depends on the type of unit being tested and the test conditions. The noise consists of alternating noise levels of various intensities and spectral composition, thus considered intermittent. Measurement was conducted for 5 or 6 days in each plant. The noise level in the work area is 88 to 107 dB for 3.9 + or - 1.01 minutes and alternates with pauses in the operation of the test stand at 1.94 minutes, during which the noise level is 68-90 dB. The noise is generally of high frequency, but in some work areas medium frequency dominates the noise spectrum. Workers are affected by this noise 7 hours a day. The noise level exceeds the limits prescribed by Health Norm 785-69 of April 30, 1969 by 14-18 dB (see Figure 1).

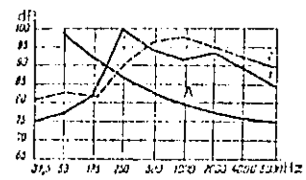

FIG. 1. Noise Spectrum of Test Stands in an Aircraft Maintenance Enterprise
A = ISO Curve 80
(1 - Test Stand No. 1; 2 - Test Stand No. 2)

Subjects of the study were 6 male workers, 28-35 years old, and all worked on the same test stand. All were practically healthy, with normal hearing, and had been on the job one to three years. Figure 2 shows the spectrum of noise to which the workers were subjected. The test stand consisted of a test cubicle and a control console with a door outside the cubicle. At the control console, workers were subjected to a sound level of 92 dB for 3.02 minutes, then in the testing cubicle for 0.42 minutes at a noise level of 104 dB, and then to 98 dB for 1.2 minutes at the console with the door open. During the pause in test stand operation, a noise level of 88 dB from adjacent test stands for 2.66 minutes affected them.

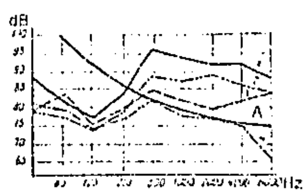

FIG. 2. Noise Spectrum Affecting Workers Tested
A = ISO Curve 80
(1 - In Test Cubicle; 2 - At the Control Console With Door Open; 3 - At the Control Console With Door Closed; 4 - Noise Level During Pause

PHYSIOLOGICAL

The following physiological and psychological measurements were recorded: selected air audiometry at 125, 500, 4000, and 8000 Hz and bone audiometry at 4000 Hz; critical frequency of auditory flickering; performance in the black-red table psychophysiological tasks; memorizing numbers; muscle fatigue; functional state of cardio-vascular system by measuring arterial pressure and pulse rate. Studies were conducted at the beginning of work, after 3 hours work and after 30 minutes rest.

Results showed that auditory sensitivity thresholds increase no more than 10 dB, within the limits of auditory adaptation; critical frequency of auditory flickering changes from 134 to 120.3 flickers per second; indicators of muscle fatigue (V. V. Rozenblat method) decreased from 117.4 to 92.5 per second; pulse rate decreased from 73.6 to 68.7. Indicators did not return to original values in 30 minutes of rest after 3 hours work. No essential differences from base data were observed for arterial pressure, short-term memory, or performance in the black-red table psychophysiological tasks. Results of the study prove that the intermittent noise prevailing in the testing areas is physiologically adverse.

02-006

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CONTINUOUS VERSUS INTERMITTENT EXPOSURE TO ROCK AND ROLL MUSIC

Archives of Environmental Health

Vol 22 No 4:413-420, 1971

In the past few years concern has risen over the possible bad effects of loud rock and roll music. A number of recent studies were made on the effects of rock and roll. Five types of experimental approaches were used.

One method involves measuring the hearing of people who have been exposed to rock and roll music over long periods of time. A study made using this method found that 95% of 42 rock and roll musicians did not incur hearing losses, even though they had been exposed to 105 dB sound pressure level (SPL) of music for an average of 11.4 hours a week for 2.9 years.

Another approach was a histological study of laboratory animals that have been exposed to music with a peak intensity of 122 dB SPL over a 2 month period of time. Marked sensory cell damage was found in the cochlea.

Measuring high frequency thresholds is a third approach to assessing the effects of rock and roll music. Thresholds were found for 24 high school musicians and for a 24 subject control group. Of the musicians 75% were found to have poorer high frequency pure-tone thresholds at one or more frequencies than those in the control group.

A fourth approach is to attempt to predict hearing loss on the basis of damage risk criteria (DRC). DRC are the maximum intensity levels and durations of noise exposure to which individuals can safely be exposed. Noise levels of 95 dB are considered hazardous, while rock and roll music is usually played from 98 to 108 db. Thus, a potentially hazardous situation does exist.

A fifth approach is to attempt to predict hearing loss on the basis of temporary threshold shift (TTS), or the reduction in the auditory threshold resulting from noise exposure provided that thresholds return to pre-exposure levels in time. Determinations have been made with the recommendation that the TTS does not exceed 10 dB at 1,000 Hz and below, 15 dB at 2,000 Hz, and 20 dB at 3,000 Hz and above. On a prediction basis, noises greater than 92 dB between 500 and 8,000 Hz for a period of one hour will produce as much as a 40 dB TTS in the area of 4,000 Hz in 10% of the exposed ears, no measurable shifts in another 10%, and a 30 dB TTS in the remaining 80%.

A study done on the TTS approach found SPL's as high as 120 dB produced by a rock and roll band, with four spectators sustaining up to a 35 dB TTS following a four hour exposure. The conclusion was drawn than rock and roll music poses a serious threat to hearing.

One characteristic of the sound produced by rock and roll is that it is intermittent. The on-time is generally 3 to 5 minutes in duration, and the off-time is usually less than one minute. This allows at least partial recovery from auditory fatigue. Continuous vs. intermittent exposure to rock and roll music, then, should result in different TTS's for the respective exposures.

PHYSIOLOGICAL

02-007

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NON-AUDITORY EFFECTS OF ENVIRONMENTAL NOISE

American Journal of Public Health and the Nation's Health

MAR:38-398, 1972

Excessive noise, as everybody knows, can impair and even damage the hearing apparatus. But noise has other effects, too, and a knowledge of these is necessary for a proper evaluation of noise. The effects of noise on mental and motor activity and on general health and mental well-being are discussed.

Sudden bursts of noise cause responses in man and organisms that may be designated as "arousal" and "stress" responses. These are instinctive, and exist for self protection in potentially dangerous situations. However, with continued exposure to a certain noise, the organism will adapt and cease to show an arousal response. Sudden noises will also cause an eye-blink response, but this does not cease with continued exposure. Years of exposure to steady noise above 110 dB can cause temporary and permanent changes in the size of the visual field, and noise above 130 dB can cause mystagmus and vertigo. Continued elicitation of the arousal response by noise can become stressful and can cause damage to the cardiovascular, gastrointestinal and neurological-glandular systems.

The awakening effects of the noise on sleep are related to the effective perceived noise level, the meaning of the noise to the person, the age of the person, and the stage of sleep the person is in. The hearing threshold as a person goes from light to a deep stage can increase as much as 70-80 dB. However, the awakening reaction to noise that does occur does not decrease with continued exposure. Individual reactions to and attitudes toward noise vary greatly. Some people can adapt to noise and appear to be unaffected by it, while those who cannot, suffer physiological stress.

More laboratory studies regarding individual sensitivity to noise are recommended. Open field studies should also be conducted, but with caution, because of the multiple variables involved.

02-008

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SENSORY OVERLOAD

Hearing & Speech News

MAY-JUN:10-11, 1969

A study was made of the effects of amplified rock and roll music on hearing. Specialists point out that sound levels in the music (105-122 dB) over prolonged periods exceed safety limits set forth by the Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology. They argue that loss of hearing is too great a price for the dubious pleasures of overloading the senses.

It has not been easy to show that ears are damaged by continued exposure to the blare of rock and roll, although it has been shown beyond doubt that the high noise levels of gunfire produce permanent damage to hearing. Apparently, standard audiometric measurements do not show hearing changes in young people exposed to electronic music. Standard hearing tests are done in the frequency range from 250-8,000 Hz. Damage to the ears from noise exposure such as rifle fire usually shows up in the area near 4,000 Hz. No one, however, has shown what effects noise exposure may have on hearing in frequency ranges above 8,000 Hz.

Twenty-four musicians and eleven riflemen were tested and compared with thirty-six boys who neither played in bands nor participated in rifle team activities. These young men were given two types of audiometric tests: (1) a high frequency threshold test covering the range from 4,000-18,000 Hz and (2) a pure tone screening test at 25 dB (ISO) in the range from 500-8,000 Hz. In the rock and roll group, hearing levels at frequencies above 10,000 Hz are consistently worse than in the non-exposed group by 10 dB or more. In the rifle team group, differences of 10 dB or more occurred only at frequencies above 16,000 Hz.

This preliminary study poses many questions to be answered by more exhaustive investigation. For example, the audiometer used (Rudmose ARJ-4HF) was biologically calibrated on younger high school students than the seniors who were tested. The Means of high frequency thresholds, even in the non-exposed, presumably "normal" seniors, were much poorer above the 10,000-12,000 Hz range than would be expected. This could mean that at the present time there is

PHYSIOLOGICAL

great attrition to high frequency hearing during the high school years, as a result of ears being assalted by loud levels of noise.

02-009

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"SOCIOCUSIS" -- HEARING LOSS FROM NON-OCCUPATIONAL NOISE EXPOSURE

Sound and Vibration

Vol 4 No 11:12-20, 1970

An evaluation is made of hearing loss risks from exposures to non-occupational noise conditions. Hearing loss risks exist in non-occupational situations such as in using home power equipment, in recreation, and from public services like transportation facilities. "Sociocusis" denotes noise-induced hearing loss with emphasis on everyday noise and noise at work. Even limited exposures to off-job noises can cause temporary threshold shifts (TTS) in hearing. However, even when such noises are of high intensity, their usual intermittency and the relatively small daily total exposure time involved greatly reduce their threat to hearing when compared to that of noise at work, which is usually much more continuous.

Noise conditions in off-job situations were compared with quite protective noise limits (deliberately chosen 15 dBA stricter than the Walsh-Healey standards for industry). The results suggest that people receiving frequent or protracted exposures in everyday situations are liable to some risk of hearing loss. Even though daily exposures to everyday noises may not be a distinct hazard to hearing, they may increase industrial hearing loss by making it impossible for the worker to find enough off-job quiet to allow his ears to recover each evening.

The off-job exposure criteria selected are shown in the following table:

Limiting Daily Exposure Times	Sound Level in dBA
less than:	
2 min	115
4 min	110
8 min	105
15 min	100
1/2 hr	95
1 hr	90
2 hr	85
4 hr	80
8 hr	75
16-24 hr	70

Continuous exposure of eight hours to octave bands of noise in the 75-78 dBA range causes no significant TTS in hearing at 4000 Hz, the frequency most prone to noise-induced loss.

Typical sound levels and exposure times, described below, may be compared with the limits in the table above.

Recreational activities provide the highest levels found in off-job settings.

Impulse noise, peak sound level in dB, can not be compared with levels in dBA. A relevant but not particularly protective criterion for impulse noise exposure has been proposed by the Committee on Hearing and Bioacoustics and Biomechanics (CHABA) of the National Research Council; peak sound level should not exceed 128-164 dB, depending on the pulse duration and rise time. These limits apply to 100 impulses distributed over periods of 4 minutes to several hours on any single day.

Music fans who regularly attend rock and roll sessions may risk exposures harmful to hearing. Hazards to band members are even more significant; one study showed the average playing time of such musicians, both practice and performance, was 11 1/2 hours per week. Both musicians and listeners showed significant differences in pre- and post-exposure hearing levels (TTS) after a 3 hour session at 112 dBA. (Figure 1). On the other hand, one study found that only 2 of 42 rock musicians showed distinct permanent hearing losses. It was conjectured that the intermittent nature of rock music, with on-time of 3 to 5 minutes and off-times of about one minute, allows partial recovery from the build-up of auditory fatigue.

Average dBA levels found in the cockpits of small airplanes could be tolerated, according to the off-job exposure criteria, for 3/4 hours per day or 3 3/4 hours per week. Figure 2 shows the TTS resulting from a comparatively short flight in a light plane.

Racing motorcycles are potentially hazardous to hearing even with brief exposure times.

Hearing tests for sports hunters and a control group of non-hunters show marked difference in median hearing level (Figure 3). The hunter group consisted of sportsmen who had used

PHYSIOLOGICAL

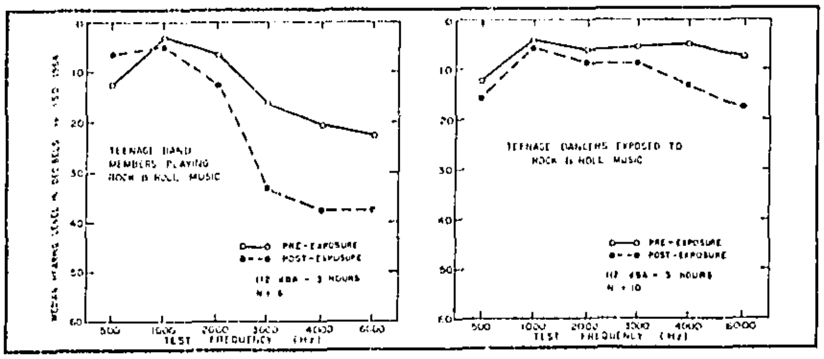


Figure 1

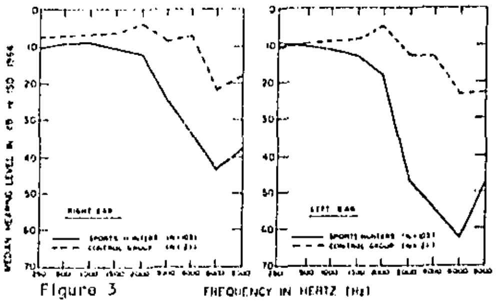
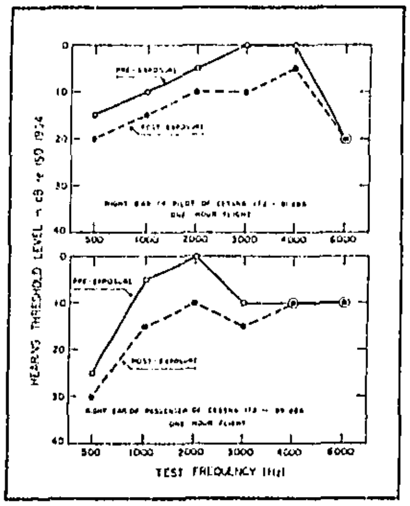


Figure 3

assorted rifles, shot-guns, and pistols, most of whom had never worn ear protectors. The hunters and non-hunter groups were of similar age distribution, and the hunters had poorer hearing, averaged across all ages.



—Hearing levels for a sport pilot and passenger measured just before and between eight to sixteen minutes after a one-hour flight in a single-engine Cessna with cockpit noise levels varying between 89-91 dBA. Data from PHS sample observations.

Figure 2

In the home power equipment and appliances category, chain saws produce the most intense sound levels: 97-107 dBA. According to the off-job criteria, daily safe time limits are 4-15 minutes, but in fact chain saws are usually not used often enough to pose a serious sociocusis problem.

Gasoline power lawnmowers (94-94 dBA) are used perhaps twice a week for 4 months of the year in most parts of the U.S. Off-job criteria suggest limits of one hour per day or 5 hours per week.

Home appliances (77-83 dBA) could be tolerated from 1 1/2 to 6 hours per day, depending on the sound level, and evidently do not pose hearing risks unless there is protracted use on a daily basis.

Public transportation noise exposures of passengers of typical aircraft (77-90 dBA), subway cars (90-97 dBA), and buses (78-85) vary in the amount of hearing loss risk because some means of transportation are used much more frequently than others. The worst problem may therefore be subways, with a segment of the subway riding public probably exceeding the off-job criteria limit of one hour per day.

General environmental noises include those radiating from airports and expressways, construction sites, and industrial plants. The intermittent nature of aircraft flyovers (87-103 dBA) usually makes them a minimal hearing loss threat. Construction noise levels (82-98 dBA) are more continuous, can occur for periods exceeding the off-job criteria, and often, although supposedly temporary, exist for several years. Roadway noise (62-98 dBA) could be hazardous to hearing in areas where heavy traffic conditions last for more than 2 to 4 hours per day.

PHYSIOLOGICAL

02-010

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EFFECTS OF NOISE ON THE PHYSICAL AND PSYCHICAL EFFICIENCY OF WORKERS

Wplyw Halasu Na Spranosc Fizyczna I Psychiczna Pracownikow

Nafta

Vol 27 No 8:11-12, 1971

The Warsaw Polytechnical Institute prepared an exhibition on the topic of noise. Various kinds of equipment, abatement devices and instruments were displayed.

The workshop on the Psychology of Work at the Petroleum Institute in Cracow carried out noise measurements at the oilwells of Pil. In the "Babilon" Mine in Pil noise levels ranged up to 114 dB when drilling machines were operated, one type even reached 129 dB. The noise levels in the "New Tavern" Mine (Nowa Kurczma) ranged up to 124 dB when the same type of drilling machine was used.

Such high noise levels are not only hazardous to the workers' ears, but also are harmful to the nervous system of the workers. Noise can cause headaches, fatigue, distraction, loss of concentration and neurosis.

On AUG 21, 1959, the Council of Ministers passed a norm establishing 90 dB as the permissible noise level in work places. Polish norms specify the following base noise levels:

1. residences	25 dB
2. staircases	40
3. offices	30
4. hospital rooms	25
5. construction offices	50
6. precision offices	50
7. factory workshops	90

Noise is a subjective type of annoyance and affects people differently, both physically and psychologically. The effects may become more obvious in one person than in another. However, gradually noise affects everyone, and this is especially evident in the production output of workers. It is, therefore, recommended that people working in noise exceeding 85 dB should be sent for prophylactic purposes for a rest in the country, in order to restore their psychological state of mind, rebuild physical strength and regenerate the whole nervous system.

02-011

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SONIC BOOM EXPOSURE EFFECTS II.3: STARTLE RESPONSES

Journal of Sound and Vibration

Vol 20 No 4:515-526, 1972

Somatic reactions to impulsive acoustic stimuli will cause startle responses which consist of the startle reflex, the orienting response, or a combination of the two. Because of their similarity, they are often confused.

The startle reflex is primarily a muscular response where the complete reaction consists of involuntary contractions beginning with an eyeblink and rapidly progressing to the legs. The time history of the total response ranges from 0.3 seconds for a mild response to 1.5 seconds for an intense reaction. There is also a great increase in autonomic and central nervous system activity. The eyeblink response is the only reflex in the startle response that does not habituate.

Stimuli of medium intensity are likely to evoke the orientation response. The most characteristic reaction is a turning of the body or head toward the source. Suppression of activity, increased receptor sensitivity, and increased EEG activity also occur.

Startle response tends to impair performance, while the orienting response merely serves to alert. Tasks requiring precise arm-hand coordination are generally impaired for only a few seconds which suggests that the major cause of the disruption is the muscular reflex response associated with startle.

Tasks involving complex perceptual and or cognitive processes may be impaired for long periods. Significant impairment may persist for up to thirty seconds. Impulsive noise produces impairment by distracting attention from the central task.

Acoustic stimuli tend to impair performance at levels above approximately 95 dB, but have little effect or increase performance below this level. Whether this value also corresponds to the threshold for startle reflexes is unknown.

Research suggests that stimuli ranging from low enough intensity to evoke only orienting responses (approximately 40 dB) to stimuli high enough to be startling (such as 120 dB) produce increases in such measures as the galvanic skin response, muscle action potentials, respiration amplitude and period, and peripheral vasoconstriction which are approximately proportional to the increase in sound pressure level. Startle or defensive reflexes are accompanied by vasoconstriction in the head region as well as in peripheral regions. Orienting responses are accompanied by peripheral vasoconstriction, but vasodilation at the head. The predominant initial heart-rate change associated with the orienting response is deceleration, while startle appears to evoke an initial accelerative response.

Intensity is not the only parameter in impulsive acoustic stimuli. Rise time, as well as overpressure, is a major determinant of loudness. Both the behavioral and physiological aspects of the orienting response will habituate completely with repeated stimulation--possibly after 10-30 repetitions. Even a small change in the characteristics of the stimulus may result in a partial or complete reappearance of the response.

Tracking performance has been investigated following bursts of 105-117 dB white noise presented against background noise of 45-84 dBA. Performance impairment was least with the highest level of background noise and most when the noise was at room level. These results conflict with other findings and underline the need for further research. Subjects with the greatest skill levels prior to presentation of impulsive noise display the least impairment.

Systematic research is needed on the patterns of muscular, autonomic, and subjective response to impulsive stimuli. Subjective measures (i.e., rating scales) should not serve as substitutes for objective indices of startle at the present time, but it would be useful to obtain the intercorrelations between subjective and objective indices in order to determine the extent to which such measures could substitute for objective ones in future research.

02-012

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EFFECT OF NOISE PRODUCED BY AIRCRAFT ON THE POPULATIONS RESIDING IN THE VICINITY OF AN AIRPORT

Vliyaniye Aviatsionnogo Shuma na Naseleniye, Prozhivayushcheye v Rayone Raspolozheniya Aeroportshch

Gigiyena i Sanitariya

A study of aviation noise was conducted at 9 busy airports. Ranges for the dispersion of noise at a fixed level for various types of airplanes were measured, a public evaluation was performed, physiological testing on the effect of noise was done, and safe noise levels based on the research were established.

During plane landing, noise levels of 85 dBA and higher were found to range from 9 to 19 km away from the noise source. Noise ranges for aircraft takeoff are much smaller: 0-12 km at 85 dBA and 9-25 km at 75 dBA. The distance depended upon the type of aircraft used. The 'noise radius' therefore extends quite far for relatively intense sound.

Public reaction to aircraft noise was researched by sending questionnaires to 2,000 people in 22 urban and rural regions, all located within a 40 km radius of an airport. Adverse public reaction was found to be a function of the following factors: noise intensity, population age group, and years of habitation near the airports. Complaints go up as noise level and age increase, but diminish as habitation near the airports grows longer. Physiological investigations of the population revealed that those living 1 to 6 km from airports suffered 2 to 4 times as much otorhinolaryngological disorders as did those living 40 km away.

Investigations made on the effect of aircraft noise upon the human central nervous and cardiovascular systems revealed significant results for noise of 90 dBA. To study reaction time, noises ranging from 60 to 90 dBA at a rate comparable to 10-20 flights passing over per hour were exposed to people in isolation booths. Reaction time to visual and audio signals varied only slightly (1-10 msec) for noises of 60 to 80 dBA at 10 and 20 "flights" per hour, as compared with the silence-exposed control group. Noise levels of 90 dBA (10 overhead flights per hour), however, caused a difference in reaction time of 19-29 msec. An even greater difference of 30-36 msec occurred when the number of noises at 90 dBA was increased to 20 per hour. These results indicate that while noise levels of 60 to 80 dBA have a negligible effect on the central nervous system, 90 dBA affects it adversely.

Effects of noise on the cardiovascular system were also studied. Plethysmograms did not indicate much change due to noise levels, but pulse rates decreased by 23% at 90 dBA.

The results of this study indicate that the restrictions put on noise levels in other countries are not low enough. Their standards set aviation noise at a maximum of 100 dBA during the day and 90 dBA at night. The authors recommend a tightening of restrictions to 85 dBA in the daytime and 75 dBA at night.

PHYSIOLOGICAL

02-013

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On: EFFECTS OF FACTORY NOISE ON THE EQUILIBRIUM

Wplyw halasu fabrycznego na narzad rownowagi

In: Malecki, J., Bardadin, T.,
Pamietnik XXVII Zlazdu Otolaryngologow
Polskich W Katowicach 1968 g.

Warsaw, Panstwowy Zaklad Wydawnictw Lekarskich,
1970, 352p. (p. 80-83)

The Department of Laryngology of the Pirogow Hospital in Lodz carried out investigations to determine the effects of noise on equilibrium. Tests were administered to 68 persons who at one time or another had suffered from equilibrium imbalance. Of these, 42 reacted rather intensely to noise. For control group purposes 12 healthy individuals were tested. Brief noises emitted from a wea ng mill were used to determine their effects on workers suffering from ear ailments. The results show that noise exposure caused vertigo, equilibrium imbalance and other vegetative disorders in some of the workers. The most common reaction observed was equilibrium difficulty. The noise levels during the experiments reached 95 dB.

The experiments consisted of audiometric measurements, the Barre and Romberg statistical tests for equilibrium, the Unterberg and Babinski-Weile kinetic tests, the Hallpike caloric tests and the rotation test. The duration of all the tests was between 10 to 20 minutes, depending on the patient's reaction.

Out of the 12 healthy individuals one showed a strong reaction to the rotation test. However, none suffered from equilibrium imbalance after noise exposure.

The 68 patients suffered from some of the following ailments: skull injury, Meniere's disease, ear infection and deafness. The most sensitive were those patients who had taken streptomycin and had head injuries or Meniere's disease. All authors concur that noise definitely affects the inner ear and causes irritability.

02-014

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On: EFFECTS OF NOISE ON THE HEARING OF BLIND WORKERS

Wplyw pracy w halasie na narzad sluchu w niewidomych

In: Malecki, J., Bardadin, T., Pamietnik
XXVII Zlazdu Otolaryngologow Polskich w
Katowicach 1968 r.

Warsaw, Panstwowy Zaklad Wydawnictw
Lekarskich, 1970, 351p. (p. 18-21)

The Department of Laryngology of the Academy of Medicine in Warsaw conducted a study to determine whether noise affects blind workers more than normal workers. The test group consisted of 243 individuals ranging from 16 to 69 years of age; 99 of the group were women. The biggest age group, from 20-30 years old, contained 91 persons; the smallest group contained 12 persons.

Reason for blindness fell into three categories: 1) congenital, 2) through illness and 3) through accident.

About one third of the group had some degree of hearing loss.

The first test showed that the noise level in the work area in which the blind were employed ranged from about 80 to 103 dBA.

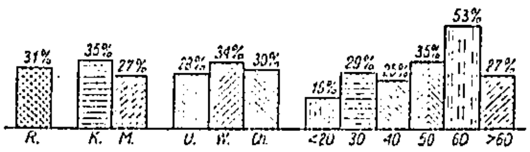
The next step was to determine to what extent the blind can tolerate noise in their work, when it becomes subjectively annoying and when actually tiring.

Fatigue was felt by 20.9% of the workers. Age played no major role in the complaints. However, women seemed to be more affected by noise than men.

Laryngological examinations showed that 10% of the workers manifested otoscopic changes such as scars or perforated ear drums, especially workers who had been born blind.

Below is a chart showing the percentage of the whole group that had hearing loss, as well as the similar percentages of various sub-groups.

PHYSIOLOGICAL



R = Total group
K = Woman
M = Man

Cause of Blindness:
U = Accident
W = Congenital
Ch = Through sickness
20-60 = Age range

02-015

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On: PHYSIOLOGICAL EFFECTS FROM INTERMITTENT NOISE BY SEX AND AGES

Kankotsusei-soon ni Tai Suru Shinshin Hanno de no Sei to Nenrei no Eikyo

Nippon Kooshu Eisei Zasshi

Vol 18 No 10:508

For the first time in Japan, an experimental test on physiological effects of intermittent noise was carried out by sex and age with 10 men and 10 women as subjects. Five men and five women were in their 20's and five men and five women were in their 40's. Men and women carried out their normal light mental tasks during the 90 minutes exposure to intermittent noise in a sound absorbent room.

Tape-recordedd noise of the following types was used in separate trials:

1) 60 seconds of jet noise once every five minutes;

2) 20 seconds of noise from freight and passenger trains crossing an iron bridge; once every five minutes;

3) Pile-driver noise pulses every second for 7 minutes, followed by a 3 minute rest interval;

4) In contrast to above intermittent noises, the pink-noise was played continuously in the fourth trial.

The noise levels at the subject's ear were adjusted to 70-85 dBA for trials 1-3 and to 50-60 dBA for the pink noise.

During the 90 minute periods, continuous recordings of electrodermogram reaction (GSR) and finger plethysmogram were taken. The total number of leucocytes, acidocytes, and basocytes in venous blood were measured 30 minutes before and immediately after the experiment. Quantities of adrenalin, noradrenalin and uropepsin in the urine were measured 30 minutes before and 120 minutes after the experiment.

The results were as follows:

1) Regardless of sex and age, degree of discomfort was higher when the noise level was 85 dBA than 70 dBA.

2) Regardless of sex and age, ranking of discomfort from intermittent noises, classified by the noise types, was arranged in decreasing order: jet noise, pile-driver noise, train noise, and pink noise.

3) Except for electrodermogram reaction (GSR) and change in pulse frequency, the greater physiological effects were in females and in younger subjects. Effects included: higher frequency of pulse contraction in fingers, increase in total leucocytes, decrease in acidocytes and basocytes, and increase in adrenalin, noradrenalin, and uropepsin in the urine.

4) The GSR frequency was higher in men and older subjects than in women and younger subjects.

5) The pulse frequency change was higher in younger subjects.

02-016

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SONIC BOOM EXPOSURE EFFECTS II.5: EFFECTS ON ANIMALS

Journal of Sound and Vibration

Vol 20 No 4:531-534, 1972

The pressure waves produced by supersonic aircraft cause variation of pressure on and in the ground which are audible as the sonic boom. The noise can influence the behaviour of farm and wild animals while the variation of pressure in itself could eventually cause physiopathological disorders.

The evaluation of effects of sonic booms on the hatchability of chicken eggs was studied at White Sands Proving Grounds. The particular

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set of eggs exposed for the full period received over 600 booms. It had a hatch of 84.3% (control 84.2%). An extensive hatching failure of Dry Tortugas Sooty Terns has been found. Two reasons as to the effects of the booms were suggested; death of the embryos after abandonment of the colony by the terns in panic flight after exposure, or physical damage to eggs not covered by a sitting bird at the time of the boom.

Investigations on effects of sonic boom (average 72 N/m2, maximum 265 N/m2) on farm animal behaviour and performance were made in 1966 at Edwards Air Force Base in California.

The behavioural reactions to the sonic booms were considered minimal. Occasional jumping, galloping, bellowing, and random movement were among the effects noted. The poultry showed more response than the large animals, especially in the early stages of the tests. Occasional flying, running, crowding and cowering were noted.

French Army dogs subjected to sonic booms with high overpressure during focalization have been studied. A minor effect on the cardiac frequency and on the dogs' behaviour was found. Certain dogs became frightened, fled and sometimes became aggressive.

Mink reactions to sonic booms have received more attention than reactions of other animal species possibly because these animals are known to be rather sensitive to unusual sounds. The responses to the booms have been reported as similar to responses to truck traffic, snow plows, barking dogs and mine blasting noise in the area.

Differences in boom intensities (average 72 N/m2, maximum 96 N/m2) had no effect, repeated booming produced no signs of increased excitability and reproduction in boomed and non-boomed mink was normal.

Wild deer studied at Eglin Air Force Base showed no apparent response to high level sonic booms. Animals in the London Zoo were observed in 1968 during a short program of sonic booms over London. Except for a small group of young chimpanzees, which showed a tendency toward fright, the reactions of the zoo animals were negligible. Sonic booms of around 60 N/m2 caused a slight startle effect among herds of reindeer, but only exceptionally were on-going activities interrupted. As boom levels increased up to 200 N/m2 the reactions became more noticeable but none of the lying or resting animals arose.

Only one sonic boom has been examined in detail. In this case, a boom of an approximate overpressure of 100 N/m2 gave an overpressure of 1 N/m2 at a depth of 15 m in the sea. A single fish did show a brief slowing of heart-rate (bradycardia), immediately after the arrival of the boom. However, fish frequently respond similarly to other sound stimuli, and in particular to sounds generated by ships.

Studies have been conducted where the effects of sonic booms on chick embroyos during hatching are studied in terms of embryo death or congenital malformation. Experiments were carried out with increasing boom intensity (100 N/m2, 300 ms duration; 500, 300; 1500, 300, etc.). Chick embryos in hatching which were exposed to three sonic booms every morning and three every evening every day (100 N/m2, 300 ms; 500, 300; 1500, 300; 3000, 300) were not affected. Chicks from these eggs were normal.

Concerning wild animals the following statements may be made with a degree of confidence: (1) sonic booms of overpressures around 100 N/m2 have no direct, acute effects upon wild mammals or birds; (2) sonic booms of extreme overpressures (above 20,000 N/m2) may have the potential to crack bird eggs, but the question awaits an adequate experimental test; (3) chronic direct effects on wild animals have not been investigated, but no significant effects of this kind are presently foreseen; (4) the disturbance effects of sonic booms of overpressures around 100 N/m2 on wild mammals are probably insignificant, but the responses of a much greater diversity of species should be studied.

02-017

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STARTLE IN THE PRESENCE OF BACKGROUND NOISE

Journal of Sound & Vibration

Vol 17 No 1:77-81, 1971

Sudden, or impact, noise causes a startle response in humans and may also cause startle induced accidents. Noisy sonic booms are examples of impact noise which can disrupt the domestic and working environment, as well as quiet environments. A question arises as to whether background noise inhibits or facilitates the startle response in humans when startle noise occurs.

The arguments for inhibition of the startle response by background noise are based on a hypothesis of auditory and other masking. The impact of the startle noise is theoretically lessened in effect in the presence of steady background noise.

The arguments for facilitation are based on findings by Hoffman and Searle that background noise increases startle in rats. This is

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possibly true because startle is a response to a potentially dangerous stimulus, and could be greater in a stimulus of given intensity the more inaudible (and difficult to interpret) a background noise can cause the stimulus to be.

Since an objective of the study was to begin to assess a worker's susceptibility to sonic boom accidents derived from involuntary limb movements when he is startled, the indicant of startle used was a measure of control precision performance in the seconds immediately following an impulse. A pursuit tracking task was devised for the experiment.

The background noise used was essentially white noise of 72 or 84 dBA; without it, there was a general background level in the room of 45 dBA, which in itself was cr ere a background level. The four startle uli were noise bursts of 105, 112, 114, or 117 dB, with a duration time of 40 ms. The single startle stimulus was applied at the 4 minute mark at a point in the task cycle that was identical for all subjects, the instant at which the task cycle was mastered.

Startle was defined operationally as hand acceleration measured from positive peak to negative peak in the task cycle immediately following the impulse minus that in the task cycle immediately before the impulse. The task cycle was 1.8 sec. A period of essentially this length has been found to be of interest in evaluating the effects of startle on control precision tasks.

For startle, the effect of the background levels was as follows:

TABLE 1

Background level (dBA)	45	72	84
"Startle"	2.78	1.62	0.65

A significant value was obtained from the results, indicating that background noise does inhibit the startle response in humans. Conversely, the quieter the background, the greater the startle amplitude will be.

03-001

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AUDIOLOGICAL INVESTIGATIONS OF THE MASKING EFFECT OF AVIATION NOISE

Audiologische Untersuchungen Ueber den Maskierungseffect Durch Fluglaerm

Monatschrift fuer Ohrenheilkunde und Laryngo-Rhinologie

Vol 103 No 110:438-44, 1969

A partial review of the literature on speech interference level is given. The work falls mainly into 3 categories: 1) differences in the required amplitude of speech under varying noise conditions (20 dB over various aircraft noises, 40 dB under the noise of a compressor) 2) Characteristics of the masking effect itself (for example, linear up to 90 dB, irregular thereafter; degree of masking by low and high frequency tones, both complex and pure). 3) the degree of masking permissible under various communication condition (for example, normal conversation and traffic).

Two sets of experiments were performed. In the first the noise of 2 sports planes and a helicopter was compared with white noise by determining syllable intelligibiligy at a noise level of 95 dB and speech level of 90 dB.

Intelligibility with the 3 aircraft noises was about 90% and with white noise about 66%.

In the second experiment 3 hearing protection devices replaced the white noise. The aviation noise was 110 dB and the speech level was 95 dB in one test and 100 dB in the second test. Intelligibility proved to be about the same with and without the protection devices.

03-002

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HUMAN RESPONSE TO SONIC BOOM IN THE LABORATORY AND THE COMMUNITY

Journal of the Acoustical Society of America

Vol 51 No 2:766-782, 1972

PSYCHOLOGICAL & SOCIOLOGICAL

Present day estimates regarding the acceptability of sonic booms by man are derived from various observations, overflight programs, and experimental field and laboratory studies conducted both within and outside the United States. The loudness and annoyance of individual booms and their dependence on the boom overpressure and pressure-time function as well as the complex reaction of individuals, groups, and communities exposed to sonic booms of varied magnitude and frequency are discussed.

The few experiments available proving that even sonic booms of the maximum intensity presently feasible do not produce direct medical injury are described. Based on the integrated body of results of recent physiological, psychoacoustic, behavioral, and sociological studies in various countries, estimates of the effects and acceptability of regular, frequent supersonic commercial overland flight schedules are presented and discussed in terms of aircraft noise pollution in general, and of potential certification of aircraft with respect to noise and sonic boom.

Findings support the current policy that commercial supersonic transport aircraft will not be permitted to fly over the United States unless and until the noise factors are brought within acceptable limits.

03-003

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SONIC BOOM EXPOSURE EFFECTS III: WORKSHOP PERSPECTIVE

Journal of Sound and Vibration

Vol 20 No 4:541-544

The exposure to sonic booms is a new facet in the environment. The most reactions in man after exposure to the sonic boom were identified by the workshop as startle, sleep disturbance and annoyance. It was pointed out that there are other stress reactions such as increases in the excretion of stress hormones, cardiovascular, gastrointestinal and central nervous system responses.

The commonly used expression "startle" was found to be poorly defined and often confused with orienting responses. It was considered essential to develop criteria to distinguish between startle reflexes and orienting responses, since their effects on performance could be quite different. Minor effects on performance were reported to occur at indoor boom peak overpressures as low as 6 N/m2 but these appeared more likely to have resulted from the orienting response rather than the startle reflex. Momentary impairment of performance on complex perceptual motor tasks may occur after exposure to booms of moderate peak overpressure, but is less likely to have significant effects on comparatively uncomplicated tasks such as driving.

The effect of the sonic boom on sleep was considered to be of great importance. Several studies show that sleep is disturbed at boom overpressures around 30 N/m2 under laboratory conditions.

Data so far accumulated indicate the presence of groups of high sensitivity or risk in the population, notable elderly people or persons with a neurotic predisposition. Concerning day flights estimates of the number of day sleepers in different communities were considered essential.

In the nominal peak boom overpressure range of 60-100N/m2 the individuals might hear fewer booms than they are exposed to. Booms may be masked by background noise or decrease below perceptible levels when penetrating through structures.

The animal reactions encountered after exposure to sonic booms seem to be limited to short periods of alerting and orienting responses. The workshop agreed that results from studies on domestic or semi-domesticated animals were relatively conclusive but additional studies would be required.

A general conclusion reached by the group working on structures was that damage to primary structures in buildings in good condition is not to be expected. The type of damage that occurs is mostly superficial and often connected to already existing strains in the structure itself. Although the damage in itself is technically unimportant, its psychological consequences in terms of a criterion for annoyance reactions should not be underestimated.

Based upon the available information on boom effects in the different areas of concern in the workshop the following suggestion for general sonic boom exposure criteria for outdoor reactions has been compiled. Special caution should be exercised concerning the exact classification of startle because this reaction has shortcomings in terms of definition.

The conclusion was that whereas the nominal peak overpressure would be adequate for certain types of responses, the pressure rise time, the dBA fast level or other technical parameters might be more suitable for other types of effects. In order to facilitate the comparison between results from different research projects the need for a common reference noise signature was expressed. This could be in the form of either a burst of white noise or some other sound and should be included in all human experiments.

The nature of the vibrations of loose objects, particularly the secondary response, and the method by which such response creates sound from shelves, tables, etc., should be examined. There is some evidence that aural stimuli supported by visual stimuli, for example, amplified apparent movements by window reflections can create fear and annoyance.

Concerning field studies, the opportunity should be taken to perform studies in areas where sonic booms occur regularly and are experienced as part of normal daily life.

A problem deliberately avoided during the discussions was how scientific information concerning sonic boom effects should be conveyed to the decision-makers in society. The formation of representative groups with sufficient technical expertise may provide an alternative to the situation in which scientists feed information into a bureaucracy which processes data and forms decisions by its own unknown standards.

A concurrent sociological study masked a study of general attitudes toward living conditions; one of the problems here was the variety of Italian words to express degrees of irritation. It is noted that the results may be due either to inadequacies in the questionnaire or to exposure itself.

The following observations were:

1) With the exception of public places, all sources of noise were noticed more by the citizens of Stockholm than Ferrara; in the case of motor vehicle noise, the rates were 92 and 63%, respectively.

2) Of those who noticed traffic noise, the respective percentage of those who were disturbed by it were 61 and 49.

3) Of those who felt themselves disturbed, the percentage of those feeling greatly disturbed were 23 and 21%.

4) Of all respondents in Stockholm, 70% thought their neighbors were probably disturbed by traffic noise, in Ferrara, 59%.

It is concluded that "data obtained from annoyance studies in one country are valid in other countries without corrections."

03-004

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Paccagnella, B.

ANNOYANCE REACTIONS TO TRAFFIC NOISE IN ITALY AND SWEDEN: A COMPARATIVE STUDY

Archives of Environmental Health

Vol 19 No 11:692-699, 1969

A comparative study was made of subjective reactions to traffic noise in Swedish and Italian block-style multifamily dwellings situated on either side of highly traveled urban streets. Variables such as road width, wall thickness, year of construction and traffic composition are described.

The dBA scale was preferred to other more sophisticated predictive methods. Measurements inside residences were made with windows open and closed, and a standard deviation was calculated.

For all, but one, vehicle type and for windows open and closed, the mean values in Italy exceeded those in Sweden; for passenger cars the differences were 8.0 and 5.4 dBA for closed and open windows, respectively.

03-005

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EDUCATIONAL ENVIRONMENT

Kyooiku Kankyoo

Koogai: Yosoku to Taisaku

Tokyo, Asahi Shimbunsha, 1971, 291 p.
(p. 145-164)

The Japanese Ministry of Education made a nationwide survey of educational environments in public elementary and middle schools. The survey covered 8,236 schools (23.3% of total schools in Japan). Many had noise, air pollution and traffic safety problems. The sources of noise are, principally, automobiles, but also jets, trains in the cities, and factories. This survey was based on the teacher's view of the educational environment in the 2,210 schools affected by noise.

The survey of students' opinions of the educational environment included 108,000

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7th grade students in 623 schools in 13 major cities. About 30% answered that the environment in their school vicinities was 'bad' or 'very bad.' Noise was particularly mentioned, with street noise as the worst source of pollution.

The Osaka Educational Research Institute measured actual noise levels in "noisy" classrooms (Group A) and 102 "quiet" classrooms (Group B) in 67 schools in Osaka. Mean values of noise levels for Group A was in the 58.8-60 dBA range with windows open and in the 54.6-56.8 dBA range with windows closed. This means that 80% of the "noisy" classrooms exceeded the environmental standard (55 dBA) designated by the Ministry of Education.

School children in the 5th and 6th grades in 40 classrooms were questioned on noise, with 1,148 from "noisy" and 1,552 from "quiet" rooms. Noise bothered 50% of them. Only 6.3% said noise did not bother them.

The questionnaire responses showed the following problems in the students:

Emotional irritation:
(1) can not listen to teachers calmly;
(2) become irritated or angry;

Motivation:
(1) wish that the class period were over soon;
(2) do not want to study any more;
(3) feel like shouting;

Disturbance of mental work:
(1) often make mistakes in mathematics problems;
(2) spend more time on solving problems;
(3) can not remember once memorized Japanese characters (or difficult to remember);
(4) while answering teacher's question, forget the last half of answer and therefore can not give a complete answer;
(5) can not complete thoughts in composition class;
(6) find it difficult to grasp contents in reading;

Speech interference:
(1) misunderstand what teachers are saying;
(2) can not hear classmate's answer to a question from the teacher;
(3) have to shout to the teacher for him to hear;
(4) during class period, classroom naturally becomes noisy;

Physical influences:
(1) when concentrating on listening, become absent minded or get headache;
(2) become fatigued early;
(3) become sleepy and distressed;
(4) experience ringing in the ears.

The Osaka results indicate a clear correlation between noise level and speech interference. In teaching, normal noise level of a teacher in a normal classroom measured at a distance of 6 meters from the teacher is 65-66 dBA. Therefore, the noise level in the classroom should be below 60 dBA, but since 46% of the total city classrooms have noise levels of more than 60 dBA, the teachers must raise their voices up to the 70 dBA level. The teachers must therefore do a great deal of shouting, which can be both fatiguing and emotionally upsetting.

A study by Kyoto City of 572 students in the 5th and 6th grades found a serious effect of noise on mental performance (calculation, memorization, creative work and understanding). The Uchida-Kropelin census method was used in this test. The study reveals that noise increases mistakes and lowers the beneficial effects of recess. Noise as a causative factor in mistakes was 1.3 times more important than other factors, and the higher the noise level, the greater the number of mistakes. The study also revealed that when there was excessive noise in the outdoor recess environment, the recess was only 92% as beneficial as a recess in a quieter setting. There was also a trend of increasing number of mistakes after recess. Working efficiency at first slightly rose (this was considered to be the result of concentration on mental work) but decreased drastically after 25 minutes.

Prof. Tama of the Osaka Educational University studies noise effects on students' mental work in the classroom by reproducing taperecorded automobile noise. The speaker was suspended from the classroom ceiling, and produced a level of 70 dBA in the room. Children in another classroom with a noise level of 45 dBA performed the same tasks. The results reveal that for such complicated mental work for children as judgment, reasoning, composition and reproduction of numbers in mathematics, students in the 70 dBA classroom scored much lower than those in the 45 dBA classroom. Only for the reproduction of Japanese characters were the scores for the two rooms comparable.

The Tokyo Anti-Pollution Study Committee for Elementary and Middle Schools made a similar study of 18,000 students in 651 schools throughout the country and reached similar conclusions.

03-006

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HEARING AND PERSONALITY: A REVIEW

Journal of Sound and Vibration

Vol 20 No 3:287-298, 1972

03-007

PSYCHOLOGICAL & SOCIOLOGICAL

Two groups of personality inventories have been repeatedly found to influence a variety of auditory measures. These groups may be referred to as the introversion extroversion group of measures and the anxiety group of measures, respectively. The introversion group may be regarded as containing the various introversion-extroversion scales, and scales of impulsiveness, receptivity, and the strength of the nervous system, all of which have been interrelated. The anxiety group of measures may be regarded as comprising the various scales of anxiety, neuroticism, ego-strength, and failure-avoidance motivation, all of which are again interrelated, but show very little relationship to the introversion group of scales.

There is some evidence to suggest that the 2 groups influence different aspects of auditory perception, perhaps respectively related to different parts of the auditory pathway, although some interaction of scales within the 2 groups and certain complex auditory measures has been shown to occur. The introversion group of scales has been found to influence largely the overall level of arousal, the variability and perhaps the sensitivity of the detection mechanism, and fundamental responses to noise. The anxiety group of measures, on the other hand appears to be related rather to the subjective response to noise and also the the various autonomic responses evoked by these stimuli.

The relevance of these personality measures to psychoacoustical testing may be regarded as threefold. First, in the context of endeavoring to assess aspects of community response to various noise nuisances, it is important to ensure that the sample of subjects selected is representative of the entire population to be exposed to the noise and does not comprise just the most sensitive or the least sensitive group of the population. Second, in a diagnostic context in which it is essential to have reliable measures, it is useful to have some indication as to the degree of reliability which can be attributed to the results given by certain individuals and to distinguish the individuals who might require more sophisticated test procedures in order to produce reliable results. The third and final area of relevance is in more valid determination of the effects of various stimuli which, may produce a decrement in performance among the introverts and an increment among the extroverts, so resulting in no apparent change when the mean results for the whole population are considered.

03-007

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SONIC BOOM EXPOSURE AND EFFECTS II.2: SLEEP EFFECTS

Journal of Sound and Vibration Research

Vol 20 No 4:511-517, 1972

Laboratory studies and social surveys have provided pertinent information concerning the general problem of sonic boom induced sleep interference. Social survey data indicate clearly that sleep interference is an important human response element in community reaction following exposure to sonic booms.

Two variables associated with patterns of human sleep which may determine whether or not awakening to a stimulus will occur are accumulated sleep time and sleep stages. Awakening in response to a stimulus appears more likely to occur with accumulated sleep time. Awakening thresholds appear to be lower in Stages REM and 2, than in Stages 3 and 4, both for ordinary noise and sonic booms.

A major factor contributing towards differences in awakening thresholds from ordinary noise or boom exposure is age, older people being more easily awakened. The quality of sleep appears to depend upon temperament, health and responsiveness to sound during sleep. Evidence suggests that women are more easily awakened than men.

Stimuli with little or no information content for the sleeper are less likely to induce a response than a stimulus having some significance: e.g., his name. With repeated exposures habituation to sounds occur, particularly when sounds are regular, frequent and not temporarily associated with any subsequent noxious event. Experimental data suggest that adaptation to the laboratory environment is still present after several consecutive nights of exposure to sonic booms.

In the range 25-300 N/m2 (as measured outdoors) children are relatively insensitive to simulated sonic booms while middle-aged people awaken to about 30% of the stimuli. Young men are awakened by 10-30% of stimuli depending upon the experimental conditions and techniques.

There is insufficient evidence available to judge the effect which existing environmental noises have on sleep patterns and health in the population. A limited study was performed in Sweden where a community was exposed to 7 sonic booms on irregular days during a three month period. The reaction was evaluated by using a postal questionnaire on 220 persons. More than 20% of this random sample of the population had heard all the booms and about 40% indicated difficulties in returning to normal sleep.

Standardization of experimental techniques among laboratories is necessary. Simulators for sonic boom sleep research should ideally take account of both the acoustic and the vibratory responses of typical bedrooms. The acoustic response characteristics of the indoor boom produced by the simulator should be specified and measured. It is recommended that certain EEG measures of sleep stage be obtained. Response frequencies to stimuli occuring in these stages should be described, and if possible, the time for returning to sleep following an awakening by noise. It is proposed that at least one standard noise be used during each experiment. Presentation of this standard stimuli could be made to correspond to estimated flight schedules. Personal information must be obtained for each subject. Sleep questionnaires and subjective tests to assess fatigue, stress, etc., are felt to be very good indicators of sleep disturbance.

Existing information indicates that the behavioral and attitudinal reaction of a community to noise may be predicted with reasonable accuracy only by combining the annoyance due to the noise in question with the total human reactions to other noises in the environment.

03-008

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ON THE INFLUENCE OF CITY NOISE AT MIDNIGHT ON SLEEP

Shinya Toshi Soon No Suimin Ni Oyobosu Eikyco

Nippon Kooshu Eisei Zasshi

Vol 17, No 8:423-426; No 9:445-448

Traffic noise from midnight to 3:00 am in Nagasaki City was measured with equipment conforming to JIS Z8731 equipment. The number of outdoor measuring points was 247 in residential areas, 48 in commercial areas, 8 in semi-industrial areas, 8 in industrial areas, and 40 in heavy traffic regions; or a total of 351 measurement locations. Duration of measurements was two months.

The community's annoyance reactions (relating to sleep disturbance) were investigated at the same time by self-checking questionnaires for 3,493 residents in the vicinity of the 351 places. Mean values of noise levels were calculated for each point after the 10% lowest readings were thrown out. The lowest values of these means were 59 dBA for the industrial area, 65 dBA for semi-industrial and commercial areas, and 50 dBA for residential areas.

Of the residents (1,110) investigated in the city, 32% complained of annoyance, relating to sleep disturbance from street noise. Their complaints included lengthened time for falling asleep, waking up in the middle of the night, reduced waking time in the morning, and drowsiness during daytime because of lack of sleep the night before. Of these 1,110 residents, 686 residents in the residential area (28% of residents in that area), 296 (40%) in the commercial area, and 62 (50%) in the semi-industrial area were disturbed in their sleep by the street noise at midnight.

The degree of the annoyance reactions was a function of volume of traffic on nearby roads. The size of roads in Japan in decreasing order is: national, prefectural, municipal, and private.

Fifty percent (101 residents) of the residents in the vicinity of the national road in the city were annoyed by noise. So were 42% (90) in the vicinity of a prefectural road, 32% (787) in the vicinity of city streets, and 21% (132) in the vicinity of a private road.

Thirty percent of the residents in the city suffered sleep disturbance when the median level of the traffic noise was 40-49 dBA. At a median level of 55-59 dBA, about 50% of the residents complained of sleep disturbance.

03-009

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AWAKENING EFFECTS OF SIMULATED SONIC BOOMS AND AIRCRAFT NOISE ON MEN AND WOMEN

Journal of Sound and Vibration

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The effect of sonic booms in the light of potential SST development on a sleeping populace is discussed.

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In the course of several studies, 22 male and female subjects, ranging in age from 5-75 years, were subjected while asleep to simulated sonic booms equivalent to 84 dBA, and to recordings of subsonic jet flyover noise equivalent 86 dBA near the subject's ear.

Results of these studies show general patterns according to age and sex. Children exhibit the least awakening, while older people tend to be awakened most easily. Individuals vary greatly within common age groups, with middle aged men with high sensitivity awakening about 20% more frequently than old men with low sensitivity. Subjects were most prone to awakening during sleep stages 2 and REM. Women were found to be more sensitive to noise than men, in addition to being awakened much more early by aircraft flyover noise than by simulated sonic booms.

03-010

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PECULIARITIES OF HUMAN SLEEP UNDER CONDITIONS OF CONTINUOUS PROLONGED INFLUENCE OF BROAD-BAND NOISE OF AVERAGE INTENSITY

Springfield, VA, NTIS, AD 696500, 1969, 17p. HC: $3.00, MF: 95 cents

Studies were conducted at the Garbov Laboratory (USSR) on the effects of broad-band noise (2000-12,000 Hz) of 75-78 dB intensity on sleep and the transitional state between sleep and wakefulness. Ten healthy subjects aged 23-36 years old were exposed to the noise continuously up to the onset of sleep (10-12 Hrs.) and then throughout the sleep. The reason for the study was that Soviet cosmonauts, including Nikolayev and Tereshkova, complained that the noise of the spaceship cabin ventilating system (76 dB, frequency spectrum 800-2000 Hz) interfered with their rest, although other cosmonauts were not disturbed. Likewise, noise in Gemini-5 periodically interfered with the sleep of American astronauts Cooper and Conrad.

Reaction of the subjects to the noise varied during the pre-sleep period. The broad-band noise led to the development of drowsiness in certain subjects and fatigue (expressed as tension, irritableness, and absence of desire to work) in others. Latent period of motor reaction increased, as did thresholds of auditory sensitivity.

Six of the ten subjects fell asleep quickly (7-25 min). Three subjects took longer than 72 min, but in only one case was this clearly attributable to the noise exposure. Quality of subsequent sleep was related to how quickly a subject fell asleep. Most of those who fell asleep rapidly had strong and deep sleep. Those who did not, had superficial sleep with frequent wakenings.

A direct relationship was observed between restoration of auditory thresholds and the quality of the sleep period. For subjects with good sleep, a lowering of the auditory threshold averaging 15-35 dB was observed in comparison to threshold before sleep, testifying to the restoration of the auditory analyzer during sleep. Subjects who had, in their opinion, poor sleep were observed to have increases in auditory threshold of 15-30 dB.

Conclusions are: (1) the stay of man in a noisy setting can disturb the quality of sleep;
(2) unequal auditory adaptation to different frequencies can make broad-band noise seem more unpleasant to cosmonauts in flight;
(3) the degree of restoration of disturbed functions of the auditory analyzer is directly dependent on quality of sleep;
(4) capacity to withstand continuous noise well should be a criterion for selection of cosmonauts; they should be able to sleep well, and also the auditory analyzer should have good adaptation as well as sensitivity to tones and speech signals.

03-011

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On: BEHAVIORAL RESPONSES TO AUDITORY STIMULATION DURING SLEEP

Journal of Sound and Vibration

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Although much research has been concerned with numerous aspects of sleep in man, little experimentation has been carried out to evaluate the long-term physiological and behavioral effects of sleep disruption that might occur in response to auditory stimuli.

PSYCHOLOGICAL & SOCIOLOGICAL

It is generally agreed that sleep consists of five relatively well-defined stages during which people respond differently to varying levels of auditory stimulation. During a normal night of sleep the cycle of five stages repeats approximately every 90 to 120 min, with decreasing amounts of stages 3 and 4 and increasing amounts of rapid eye movement (REM) time as the night progresses.

The auditory awakening threshold (AAT) is defined as a measure of how much sound stimulation is required to awaken the sleeping human subject. Several variables are associated with the AAT. Among these are stimulus intensity, sleep stage, subject differences, accumulated sleep time (and/or time of night), amount of prior sleep deprivation, and the amount of past experience with the test stimuli.

It appears that the awakening thresholds in stage REM and stage 2 are similar if the auditory stimuli are "meaningful". A person in some stages of sleep can discriminate among auditory stimuli in terms of their personal significance and can "listen" for certain sounds while asleep and at the same time ignore others. There may be some habituation to successive stimuli. Studies have shown adaptation of a behavioral awakening response when simulated sonic booms and jet aircraft noise were presented over several test nights.

Both the physiological and the psychological consequences of sleep-disturbing auditory stimuli are greater for old and middle aged persons than for those of college age. The cyclic patterns, which are clearly defined in younger subjects, become interrupted in the older subjects, with less of stages 3 and 4 and increasing amounts of stages 1 and 2. A longer period for adaptation to laboratory conditions is required for the aged than for young adults. With increasing age, REM time is reduced.

In this experiment it was found that the sleep of children is essentially unaffected by either simulated sonic booms or subsonic jet flyover noises over intensities from 0.63 to 5.0lb/sq ft (30.18-129.50 N/sq m) for booms and 101 to 119 PNdB for flyover noises. Partial sleep deprivation experiments have shown that short- and long-term sleepers have equal percentages of REM sleep. It appears that REM sleep duration adjusts to length of sleep.

Older age groups show greater performance decrement with increased sleep disruption than do younger age groups.

03-012

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VEHICULAR NOISE

At: American Association for the Advancement of Science, 138th Meeting, Philadelphia, DEC 29, 1971

Highland Park, IL, Chrysler, 1971, 5p.

The Automobile Manufacturer's Association sponsored a research project concerning the annoyance due to motor vehicles. The heart of the research project was a social survey in Boston, Detroit and Los Angeles and physical measurements of community noise. The interviewees who cited annoyance with vehicle noise were usually at home; they were annoyed predominantly in the evening or during the night; and 22% of the respondents were annoyed because of sleep interference. People were mostly annoyed by automobiles, then motorcycles, diesel trucks and buses.

Another part of the research project related to the subjective responses with measured noise levels in the areas where the respondents lived. Only a third of the variance in annoyance could be accounted for by the loudness level. Factors other than the amplitude of the noise were important. It was also shown that the peak noise levels correlated well with the respondents judgements of noisiness. Squealing tires, drag racing, bad mufflers or other operator controlled action were considered the most annoying noise sources.

It would be most efficient to reduce the peak noise levels of diesel trucks since their annoyance index is much larger than that of any other vehicle. Roadway design, land use, and traffic control may be necessary to reduce passenger car noise. By applying today's technology to a future truck, 1980 or later, it would be possible to reduce the component noise levels by about 6 dB. Tire noise will not likely decrease significantly in the near future. Overall noise levels at 35 and 55 MPH can be expected to be reduced to about 84 and 89 dBA respectively. At road load, tire and aerodynamic noises are typically equal to or greater than powerplant generated noises. Passenger car tires already have all the presently known tire noise reduction techniques applied to them.

PSYCHOLOGICAL & SOCIOLOGICAL

03-013

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On: A STUDY OF SENSITIVITY TO NOISE

Springfield, VA, NTIS, AD 728332, 1971, 63 p.
HC:$3.00 MF:95 cents

The effects of certain kinds of impulse noises and typical nonimpulse noises upon the physiological and psychological behavior of adults were investigated. Specific goals were: 1) to compare the effects of the two kinds of noises, 2) to compare psychological with physiological responses, and 3) to attempt to find other characteristics of those individuals who were found to have the greatest reaction to noise.

Sixteen everyday noises were reproduced in the laboratory and presented to 140 subjects over a 6 month period. Typical noises included airplanes, sonic booms, vacuum cleaners, barking dogs, motorcycles, truck traffic, and freeway traffic. Heart rates and electromyographic measurements were made. Subjects rated the various noises subjectively and filled out general questionnaires on attitudes toward noise.

The relative ranking of the perceived annoyance of the various noises remained constant over the six month duration of the experiment. The 2.5 psf boom was distinctly the most annoying sound. The 1.25 psf boom was rated more annoying than all other noises except for the 90 dBA jet flyover and the 81 dBA vacuum cleaner. The 0.63 psf boom was rated less annoying than all other noises except for the 67 dBA truck traffic and the 62 dBA motorcycle recording. The sonic boom overpressures are expressed at the levels that would be found outside a typical frame house with windows and doors closed; the subject actually heard the booms and noises at the level that would be present inside the house.

The index of psychological sensitivity to noise revealed potential differences between the most sensitive third of the subject population and the least sensitive third of the population. The noise-sensitive individuals rated all kinds of noises as being more intrusive in their daily activities than the noise-insensitive individuals. They were also more likely to perceive themselves as being more sensitive to noise then the average person, and they were more likely to believe that noise was affecting their personal health. The noise-sensitive individuals were also more negative in their ratings of non-noise factors in their environment and were more likely to have high anxiety scores than were the noise-insensitive individuals. The best prediction of noise sensitivity came from questions about individual's beliefs concerning the effects of noise upon their health and behavior intended to ameliorate the effects of noise.

Analysis of the physiological reaction to the noise indicated a definite heart acceleration in response to the simulated sonic booms. This was true even of the 0.63 psf boom, which was not rated as very annoying. It was not possible to find an index of individual physiological sensitivity, nor was there evidence of correlations between psychological and physiological reactions to noise. The results cannot be taken as proof that such responses and correlations did not exist; rather the discovery of good indexes of physiological responses to non-impulsive noises may depend upon the monitoring of more physiological parameters and the use of more elaborate electrophysiological recording and signal detection techniques.

03-014

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TRAFFIC NOISE INTENSITY IN IRKUTSK AND ITS HYGIENIC ASSESSMENT

Intensivnost Transportnogo Shuma v Irkutske i yego Gigiyenskaya Otsenka

Gigiyena i Sanitariya

No 8:29-33, 1971

In many large cities and growing communities, noise has become a major problem. Such a problem developed in Irkutsk, a rapidly developing industrial city in the Soviet Union. This study was undertaken to measure the noise levels of various kinds of traffic, to evaluate public opinion of noise, and to recommend measures for noise reduction.

Special research was carried out to determine the characteristics of noise produced by various kinds of vehicles. Road, air, and railroad traffic were all taken into account. The highest urban noise levels were created by airplanes (81-105 dBA), helicopters (73-94 dBA), and trucks (72-103 dBA). Automobiles were found to produce the least noise (66-75 dBA).

During the study, peripheral factors affecting noise levels were found. The quality of automobile engines, conditions and velocity of traffic, street width, building height, building location and time of day, were considered as factors. The highest noise levels (85-95 dBA) were measured on unpaved and cobblestone roads.

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In comparison with asphalt roads, these were 4 and 9-11 dBA louder, respectively. Faulty engine parts emitted 3-5 dBA more than well-tuned engines. The intensity of noise on narrow streets rated 2-5 dB higher than on wide roads. The least traffic noise was 30-32 dBA, measured in urban apartments with windows closed between 1 and 4 am, and the most 63-70 dBA, between 8 am and 8 pm.

In Irkutsk, noise caused by air traffic affects 84.3% of its area; 20.5% of the area is subject to noise levels of 90-100 dBA and higher.

For a subjective evaluation, questionnaires were sent out to 700 persons living within a 10 km radius of the airport. A large majority (65%) complained chiefly about the noise from air traffic, which disturbed them day and night. Noise from other traffic sources was reported to be less disturbing. Those who complained of airport-related noise rated it twice as high as those complaining chiefly of traffic noise.

An interesting outcome of this study was that attitudes towards traffic noise were in direct proportion to the age of the population. The most indifferent age group was under 20 years of age, with 15-28% registering complaints. The age group of 21-40 years of age had a stronger feeling towards noise (56-67%), and those older than 61 had the strongest reaction (65-77%).

It was also found that noise tolerance to air traffic was related to the length of time the population lived near the airport. Of those living near the airport for less than 3 years, 76-85% found the noise disturbing; inhabitants from 3-6 years, 65-72%; from 6-12 years, 54-63%; and longer than 12 years, 41-50%. These results indicate that tolerance of noise does develop in relation to the exposure to it.

In this study, some recommendations on traffic noise control were made consisting mostly of architectural planning and administrational organization measures. Direct solution included the paving of roads, stricter controls on the loudness of automotive engines, and the isolation of heavy urban traffic from domestic areas.

03-015

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On: EFFECTS OF NOISE ON THE COMMUNITY

At: American Association for the Advancement of Science, 138th Meeting, Philadelphia, PA, DEC 29, 1971

New York, Columbia Univ., 1971, 14 p.

Noise intensity near airports and major highways may be approaching the health hazard exposure levels and may be contributing to hearing loss. Intense noise as an environmental stressor has been found to increase a number of physiological responses, such as cardio-vascular, gastro-intestinal, and endocrine and central nervous system responses. Whether these physiological reactions place some strain on the organism and if continued over sufficiently long periods are precursors or causes of disease has not been established. It is believed that the major acute effects of intense environmental noise are primarily psychological annoyance responses. Interference with sleep and communications as well as unwanted structural vibrations are the most frequently reported disturbances. Variations in noise exposures generally account for 20-25% of the variance in human annoyance. Attitudes, experiences and other human variables account for as much as two-thirds of the response differences. Combined British and American recent surveys of residents living near airports indicate that about half of all persons with moderate psychological predispositions or attitudes of fear and aircraft operator misfeasance report serious annoyance at Composite Noise Rating (CNR) levels of 100 or greater. At the same noise exposures, over 70% of those persons with feelings of high fear and high misfeasance report high annoyance, compared to only 12% of similarly exposed people with no fear and feelings of no misfeasance.

PSYCHOLOGICAL & SOCIOLOGICAL

03-016

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HOSPITAL ENVIRONMENT

Byooim Kankyoo

In: Koogai: Yosoku to Taisaku

Tokyo, Asahi Shimbunsha, 1971,
291p. (p. 164-174)

Three doctors at the Kyoto City Hospital made a survey of 956 families and 293 clinics (providing both out-patient and short hospital stay services) and physicians' offices to find out the effect of noise on their environment. The questionnaire covered the following areas:

(1) influence of noise from daily activities on conversation, telephone calls, reading and concentration while at work; influence on children's study;

(2) emotional irritation; influence on recuperation at home;

(3) sleep disturbance in the middle of the night and early morning;

(4) disturbance of naps;

(5) physical effects: appetite, fatigue, headache, palpitation and ringing in the ears;

(6) influence on ability to listen to a stethoscope.

Degree of Nuisance (DN) was calculated in terms of percentage by dividing the number of people answering "yes" to the question "Is noise a nuisance?" by the total number of respondents. The results of the survey from residents reveals that DN/emotional irritation was more than 50% when the noise level was more than 50 dBA. This DN was 15-25% higher than DNs for other types of effect. When noise level was more than 60 dBA, DN/emotional irritation was 69%. Adverse effects on naps, daily activities, and sleep were ranked second, third, and fourth respectively, in DN in this survey.

The survey of clinics and doctors' offices shows that DN is much higher for the same noise level than it is in a residential setting. When the noise level is 36-40 dBA, DN/emotional irritation is 36-40%. When the level is 50 dBA, the various DNs are much higher: 67% in doctor's conversation with patients, doctor's rounds, and audiometry; 80% in listening to the stethoscope; and 90% in listening to a fetus by stethoscope. When a doctor listens to the stethoscope during chest diagnosis and treatment, DN is 65% for a noise level of 30-40 dBA.

The frequency of lung and bronchial sounds is below 1000 Hz and in the 2000-3000 Hz range for coughing. A stethoscope on the market today has a transmission loss of 30-40 dB in the 2000-4000 Hz range.

Vibration of the rubber tube itself and permeability of noise through the rubber tube from outside noise make the stethoscope more difficult to use, particularly for city doctors. When the background noise level increased from 30 dBA to 35 dBA, patients required 20% more time to fall asleep and woke up earlier in the morning 10% of the time. The survey found that a mean noise level of 50 dBA within the hospital caused emotional tension, sleeplessness and shouting when conversing. The main sources of noise within the hospital were loud speakers, radios, cooking in the kitchen, trucks, ambulances, footsteps, elevators, motors, noise from experimental animals, and cleaning by janitors.

The survey also found that when noise level exceeded 60 dBA, 60-69% of patients either (1) complained by telling doctors that they wanted to recuperate at some other place, (2) got angry or, (3) became nervous. Also, 50% of patients complained that they could not sleep, and had to shout to carry on a conversation. Doctors and staff also complained about difficulty in using stethoscopes.

When the noise level was 55 dBA during morning and evening hours more than 50% of both staff and patients were annoyed. The level prescribed by the environmental standard is 40 dBA.

The survey found that noise did not result in doctors making many more mistakes in diagnosis. However, the frequency of mistakes by the staff increased in simple tasks such as matching blood for transfusions, measuring correct quantities of the right medicines, and recognition of patients.

03-017

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Anderson and Angevine, Inc., E. Aurora, NY

PSYCHOLOGICAL FACTORS IN ACCEPTANCE OF NOISE

New York, Anderson and Angevine, 10p.

PSYCHOLOGICAL & SOCIOLOGICAL

Emotional or subjective reactions to noise vary from one individual to another. Several psychological factors are involved which will determine a person's attitude toward noise:

1) Noises produced by other people are more disturbing than noises produced by oneself.
2) A certain noise must be perceptible against background noise to become irritating. Music and speech are more difficult to disregard than random sounds.

3) People who suffer from anxiety are much more likely to be disturbed by noise than those who do not.

4) Individual conditioning and perception of reality determines how a person will react to noises. Individuals who were exposed to air raids during WWII will react much differently to sirens than will those of today's generation.

5) Adaptation to a noise develops if it maintains a steady value; only if there are changes in the noise itself will it then be noticed. Also, noise is more apt to be adapted to if it occurs in the presence of background noise.

6) Individual interpretation and recognition of sounds determine whether they are annoying or not. For example, a man experiencing the noise of an earthquake for the first time thought his furnace had exploded.

7) A study has shown that people will accept more noise from aircraft than from cars simply because they accept aircraft to make more noise.

8) Reaction to noise also depends upon its appropriateness. Consider the difference between hearing a brass band while in church, and hearing it while watching a parade.

9) Some noises are not annoying until they are combined with mental pictures. The sound of fingernail running down a blackboard does not bother some people until it is identified. Then, it is intolerable.

10) Cultural differences influence the loudness of conversation. Americans are generally considered very loud talkers by Europeans.

11) Once a person complains about noise, he is thereafter much more sensitive to it.

12) Fatigue from noise comes from trying to talk above it or not being able to talk above it. This fatigue can lead to stress.

13) Biological rhythms, common to both men and women, determine response to noise. At the time when a person is most awake, noise will have the greatest effect.

03-018

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EFFECTS OF NOISE ON HUMAN EFFICIENCY AND SOME INDIVIDUAL DIFFERENCES

Journal of Sound and Vibration

Vol 20 No 3:299-304, 1972

Laboratory research into the effects of loud noise on the efficiency with which human beings carry out mental work has a long history in experimental psychology. Much recent research has tended to concentrate on continuous noise, as found in most industrial and military situations, and particulary unchanging broad-band noise. Performance changes brought about by exposure to continuous noise actually increase with time spent at the task. One such task is that of vigilance or monitoring.

Normally, efficiency at monitoring drops off with time spent on the task. Noise, in these studies, accentuated this effect, increasing the number of signals missed, but only at the end of the work period. Although noise does not affect the overall speed at which successive decisions are made, it does increase the number of wrong decisions (or result in occasional very long decision times).

It is important to point out, however, that noise can sometimes enhance efficiency of work. A number of studies have demonstrated better performance at the end of a vigilance task when the level of background noise was continuously varying, though this is the kind of environment which is usually associated with distraction. Certain kinds of variable noise (that of a car radio, for example) clearly prevent boredom and may thus have a real effect on efficiency.

Noise can be assumed to have a general effect of increasing the amount of stimulation reaching the central nervous system (CNS). On the basis of results from clinical observations and research on anxiety and the psychological stress it has been suggested that a high level of arousal may result in efficient behavior. A principle of this kind has been found to apply to the effects of noise in monitoring tasks. Primary task performance (tracking) is facilitated, especially towards the end of 40 minute work period, while monitoring is, on the whole, impaired. Signals occuring near the periphery of vision (60 degrees each side) are more likely to be adversely affected by noise than those in the center, which may show an improvement. In other works, noise is producing a structured change in the way in which attention is distributed over the components of the task, causing it to become more selective. This has the effect of enhancing performance on high priority aspects of the task at the cost of neglecting low priority elements.

Little is known of the relation between personality and susceptibility to loud noise, at least as far as changes in efficiency are concerned. The Heron unsociability scale, a measure of introversion-extroversion, has proved to be of considerable value in accounting for individual differences in mental work efficiency in general.

Both tracking and selectivity give consistently positive correlations with introversion. The degree to which the distribution of attention changes with noise, however, is consistently negatively correlated with introversion.

It has been demonstrated that liking for noise exhibited by extroverts extends to preferred levels of continuous white noise in the same kind of task. It is not at all clear at the present time how these differences between individuals in the effects of noise can be interpreted. The underlying basis for such differences will probably be found in further neurophysiological work on the structure of the various mid-brain arousal systems and their control.

03-019

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On: INTENSITY & DISTURBING EFFECTS OF NOISE CREATED BY PLUMBING IN BUILDINGS

Intensivnost, I Bespokoyashcheye Deystviye Shuma, Sozdavayemogo Vodoprovodno-Kanalizatsionnym Oborudovaniyem v Zdaniyakh

Vodosnabzheniye i Sanitarnaya Tekhnika

No 1:13-15, 1972

Establishment of controls on construction organizations for reducing noise is reported in the light of an investigation of plumbing noise in buildings conducted by the Department of Hygiene of the Irkutsk Medical Institute.

The test assessed the noise intensity from water pipes and systems in domestic quarters in various regions of Irkutsk. Multi-storied, well-constructed buildings, new and old, were evaluated. Subjective public reaction to the noise was obtained from questionnaires delivered to the inhabitants of 657 apartments. A total of 2,015 noises was measured during the course of the study.

The highest noise intensities occurred on the lower floors of the buildings, and in buildings with panel construction. Noise intensities themselves were found to depend on the water pressure inside hydrant fixtures: the higher the water pressure, the higher the noise levels.

The noise levels had more effect on confined and sick people than others. Complaints of noise ranged from 56-73% of those polled; 64-89% of the inhabitants of panel construction buildings complained of noise, while 52-77% of those living in brick buildings with iron reinforcements complained of noise.

A direct relationship was found to exist between the noise level and the number of complaints. As the noise level increases by 5 dBA, the number of complaints increases by 10%.

It is concluded from this study that the noise from water fixtures in apartments is a serious problem, and that more attention should be paid to quieting it by acoustic insulation.

03-020

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HEARING DAMAGE AND RESULTS OF CLINICAL AND PSYCHOLOGICAL RESEARCH ON PERSONS WORKING IN NOISE

Uszkodzenie Sluchu Oraz Wyniki Badan Klinicznych i Psychologicznych Osob Pracujacych w Halasie

Pamietnik XXVII Zjazdu Otolaryngologow Polskich W Katowicach 1968 r.

Warsaw, Panstwowy Zaklad Wydawnictw Lekarskich, 1970, p. 15-17

A study was undertaken in Poland to determine the aural and extra-aural effects that result from occupational noise. The group examined consisted of 500 persons, 20 of which were women. The examination was subdivided into otolaryngological and internal. Hearing was tested by means of whispering. Blood pressure was taken before and after work and an eye test was given. Reaction tests were also given to determine concentration span and the quickness of perception.

PSYCHOLOGICAL & SOCIOLOGICAL

Analysis of group I of the KFWM Plant working between 2 and 4 years in noise levels of 100 dB showed 18.3% of hearing loss, and decreased hearing sensitivity by an amount of 25-35 dB. In workers of 5 to 10 years the percentages rose to 19.2 and loss of 24-35 dB, and for those employed for 11 or more years the percentage increased to 25.4% and loss of 29-44 dB.

In a noise environment of 100 to 122 dB, the statistics showed a 2-3% increase in each category. Also the blood pressure increase was from 3-5 mm Hg.

For the psychological test, 2 groups were used: the first group consisted of 75 persons who worked in noise surroundings up to 100 dB and the second group involved 25 persons employed in noise levels above 100 dB. Tests were conducted before and after work. The reaction time of the hearing stimulus before work in group I was 280 msec and 303 msec after work. In respect to visual stimulus, the reaction time was 274 msec before work and 289 after work.

It was found that after 3 hours' work in noise levels 90 dB and above, the concentration span and quickness of perception showed considerable drop.

The study showed that a degree of hearing loss occurs in noise levels of 85-100 dB, and that a temporary threshold shift of up to 13-18 dB occurs after work, but is rectified to a certain degree after a few hours rest. In the light of hemodynamic changes and psychological reaction, noise is definitely a negative factor.

03-021

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THE UNDERSTANDING OF COMPLAINTS IN A NOISY WORKSHOP

Ergonomics

Vol 14 No 1:95-102, 1971

This article reports testing to determine personal attitudes toward noise. Although the Noise Rating Number developed by the International Standards Organization (ISO) converts a physical value into a psychological value, individual attitudes toward noise vary greatly, and there may be no complaints even though noise levels are dangerously high. The Noise Rating Number is not adequate to determine personal attitudes toward noise.

In five workshops the following factors were studied: type of work, source of noise, intensity of noise, spectrographic character of noise, mode of exposure to noise, and the situation and response of the worker to noise.

A questionnaire surveyed 920 workers and 8 general kinds of complaints were determined: 1) fatigue, 2) headache, 3) palpitation, 4) stiff shoulder, 5) decrease in body weight, 6) disturbance of sleep, 7) irritation, and 8) gastrointestinal disturbance.

Also surveyed were 92 workers exposed to noise in an adjacent workshop over a 3 month period. They were investigated before and after the administration of a placebo.

Workshop D had the highest complaint rate, as compared with workshop E, which had the lowest. There was no direct relationship between all types of complaints and actual noise level, except in the case of workshop E. Noise levels in workshop A were the highest, although workshop D registered the most complaints.

These results cannot be interpreted on a physical noise level basis alone. Another factor other than noise intensity and hearing damage must exist. Workshop D was the only one which did not produce its own noise; hence, it may be more irritating to listen to noise from a source other than one's own.

Fig. 1 shows the results of the group administered a placebo. In each group there was not much change in complaints. The results of this study indicate that complaints related to noise exposure do not necessarily relate to the intensity of noise. A psychological factor must be involved. Conversely, the results of the study on the placebo group indicate that the basis for complaint is not completely psychological either. A reasonable balance must be somewhere in between.

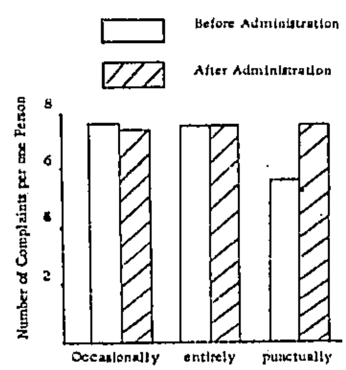

FIGURE 1. Changes in the Number of Complaints Before and After Administration of Placebo

PSYCHOLOGICAL & SOCIOLOGICAL

03-022

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AIRCRAFT NOISE AND THE COMMUNITY: SOME RECENT SURVEY FINDINGS

Aerospace Medicine

Vol 43 No 1:27-33, 1972

To study community reaction to aircraft noise, two surveys were conducted in 1968 and 1969 in the communities surrounding Los Angeles International Airport. The survey questionnaires sought information in the following areas:

1. Identification and definition of aircraft noise as a problem-comparison with other major problems
2. Awareness of aircraft noise and its effects on daily activities
3. Emotional reactions to aircraft noise
4. Noise abatement activity
5. Prior awareness of aircraft noise
6. Perceived economic effects of aircraft noise

Figure 1 shows the results of a rating of the seriousness of 4 current problems, including aircraft noise.

The frequency of awareness is shown in Figure 2 for the total sample and by distance to the airport.

Of the sample 31% were aware of aircraft noise twice a day or more, while 21% were never aware. Those respondents living less than 3 miles from the airport were much more likely to be continually aware of aircraft noise. Awareness of aircraft noise changed with the time of day, being low from 1:00 am to 1:00 pm. A gradual increase occured between 1 and 5 pm with a rapid increase after 5, with a peak awareness at 7:00 pm.

Respondents were asked about their emotional reactions to aircraft noise. Figure 3 shows the most common responses. The majority of the sample reported no reaction at all. The next most frequent responses were "annoyance" and "acceptance." It was found that people most exposed to aircraft noise tended to polarize in their reactions, becoming either angered or adapted to it.

FIGURE 2.

Frequency of awareness of aircraft noise.

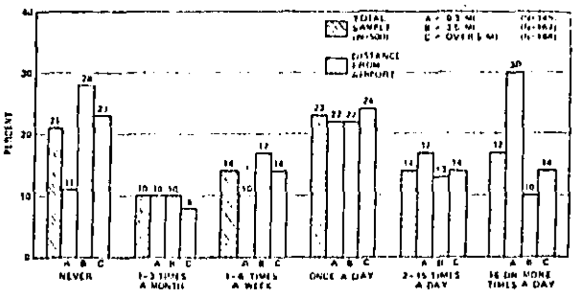
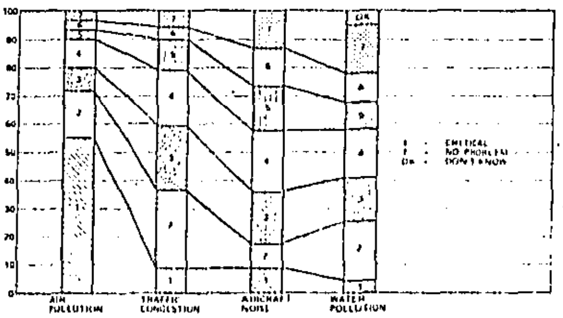


FIGURE 1.

Seriousness ratings for four current problems.



Only 4% of the sample had ever made a complaint (6% in 1968). Complaints were generally that there was too much noise or that aircraft were flying too low. Most respondents felt there was no result from their complaints.

The survey on prior awareness of aircraft noise showed that 43% of the entire sample knew of it before moving in, and 60% of those living within 3 miles of the airport were aware.

The economic effects of aircraft noise were important to most people. Respondents were far more likely to perceive an increase in their property value over the preceding 5 years than a decrease.

When asked how much they would be willing to spend to eliminate aircraft noise, 58% of the sample answered that they would be unwilling to pay anything.

Of the sample 49% were aware of current noise abatement activities, while 66% of those living within 2 miles of the airport knew about them. The most frequently mentioned activity was "developing quieter engines."

The results show that community reaction to aircraft noise in Los Angeles is not as great as might be expected. Annoyance is about even with apathy, and complaints are almost negligible.

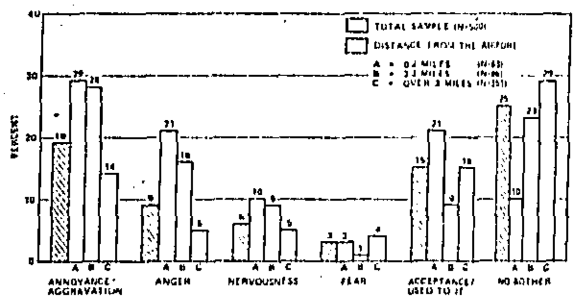


Figure 3. "Usual" reactions to aircraft noise.

03-023

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THE ASSESSMENT OF RAILWAY TRAFFIC NOISE BY THE POPULATION (QUESTIONNAIRE DATA AND VERBAL ASSOCIATION EXPERIMENT)

Otsenka Naseleniyem Shuma Zheleznodorozhnogo Transporta (Po Dannym Oprosa I Slovesno Assotsiativnogo Eksperimenta)

Gigiyena I Sanitariya

No 2:29-32, 1971

Mass complaints of high noise levels from the population living near railroad tracks near Moscow prompted a study on public reaction to noise and resulted in a verbal association test. Noise had become such a nuisance and distraction to inhabitants that 87% of the population filed complaints.

The neighborhood studied was broken down into 3 areas, and noise levels in dBA recorded for each: 1) 40-100 meters from railway lines, with a maximum measure of 84 dBA; 2) 150-160 meters, measured at 67 dBA; and 3) 250-280 meters, measured at 63 dBA.

It was found that the most intense railway traffic occurred between 1 and 5 am, which resulted in sleep disturbance for the neighboring population.

To measure subjective reaction to railway traffic noise, questionnaires were distributed among the inhabitants. Of the 144 persons living in the area 40 to 100 meters from the railroad tracks, 126 (87%) complained of intense discomfort and disturbance; 47-64% reported interruption of sleep because of intense traffic in the early morning hours; and 21-45% complained that noise from the trains and signals caused fright in their children.

Inhabitants living 150-200 meters away from the noise source reported less discomfort due to railway taffic; about 50% had serious complaints. For those at a distance of 250-300 m the noise was even less disturbing, though still noticeable.

For an objective analysis of the effect of railway noise on the population, a verbal association test was given to 136 persons living near the noise source. Subjects were presented with a list of general words, interspersed with key words such as "silence," "train," "station," "transport," and "sleeplessness." Reaction time to key words averaged out to 1 second longer than reaction time to general words, in all groups tested. This is in comparison to the control group, which showed a 0.6 second difference in reaction time. The group closest to the railroad tracks showed the most delayed response time. It was inferred from this study that high noise levels have detrimental effect on the central nervous system, and cause a delay in response to verbal cues proportionate to the noise level.

Typical responses to the key words themselves showed the influence of railway traffic noise upon the public. For instance, in response to the key word "silence," almost 75% answered: "(It) will never be," "seldom," and "loudly." To the key word "sleeplessness, responses were: "often," "didn't sleep," "because of the trains," "because of the noise."

This study shows that high noise levels can affect a community. Even latent response time in verbal speech is affected, indicating the effects of noise on the central nervous system.

TABLE I

Distance from railroad tracks (in meters)	Maximum noise level with windows open (in dBA)	Latent verbal response time to words (in sec)	
		General	Key
40-100	84	3.3	4.3
150-180	67	2.7	3.7
250-280	63	2.4	3.4
Control Group		2.6	3.2

04-001

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CONSTRUCTION EQUIPMENT-WHO WANTS IT QUIET?

At: American Association for the Advancement of Science, 138th Meeting, Philadelphia, DEC 29, 1971

Princeton, Ingersoll-Rand, 1971, 14p.

One of the targets of noise control legislation is construction equipment noise. Noise control codes of various cities, however, are either too strict or too lenient. An example of the former is a code which prohibits paving breakers from producing over 85 dBA at a distance of 1 meter, an impossible standard to meet at present. On the other hand, a too lenient code limits maximum permissible noise to 85 dBA at 100 feet.

In quieting machinery, some negative factors involved are increased cost, size, or ineffective work and difficult maintenance.

The cost of mufflers for most hand-held tools is from zero to five percent of the cost of the unmuffled tool. However, cost for the development of a paving breaker with a built-in exhaust muffler and built in force cancellation totalled over $300,000.

Drills without noise control produce about 120 dBA at one meter, which can be reduced to 100 dBA at a cost increase of 10-15%, and to 90 dBA at an estimated cost increase of 30-40%. The cost increase of reducing compressor noise from 110 dBA to 85 dBA (at one meter) is about 30%. For smaller, gasoline engine driven units the cost increase is about 10-15%.

04-002

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CAN INDUSTRIAL PLANTS BE ADEQUATELY QUIETED?

At: American Association For The Advancement of Science, 138th Meeting, DEC 29, 1971

West Caldwell, NJ, Ostergaard Assoc., 1971, 14p.

Industrial noise as discussed in this report, can be divided into two general areas of concern. One is the high noise levels within factories. The other is the noise which a factory radiates to the community and which annoys people residing near the plant.

When a factory becomes a community noise nuisance, legal action can be brought against it by annoyed neighbors. It is expected that noise levels will be set by environmental organizations such as the EPA.

Reducing the noise that radiates outside a factory is discussed. Enclosing the plant prevents the escape of noise to the outside; in doing this a closed loop air system circulation is used with the added advantage of purifying the air.

The installation of mufflers on fans and vents outside eliminates noise at little cost. Distance from neighborhoods, of course, is always an important factor. The best solution to the noise problem is the development of quiet equipment.

The question concerning noise control is what kind of costs are involved. It is fairly cheap to provide an employee with ear plugs or earmuffs. The cost might run anywhere from $5.00 to $10.00 for plugs or muffs and this should provide around 30 to 35 dB of noise reduction in the critical frequencies, if the employee wears them properly. This form of noise control, however, may not be particularly cheap when the noise source is one or two machines and many, many employees are subjected to the noise levels. These costs work out to be 25 to 30 cents per dB per employee protected.

Noise control for the path is harder to estimate. Barriers, for example, when installed can be quite sizable in extent. The cost of installation may be about 50 cents per square foot and the noise reduction in the order of 15 to 20 dB. This means the costs will be something like 3 cents per dB per square foot of the barrier. To be effective, the barrier may have to encompass 50 to 60 square feet and the costs then run roughly $1.50 to $2.00 per dB.

A complete enclosure around a piece of machinery will probably provide twice as much on a decibel scale than a barrier, but the costs run around ten times as much. The benefit per employee, however, can be quite high since all employees will benefit from the noise reduction of the machine which has been enclosed.

The amount of noise reduction which can be achieved using sound absorbing materials is usually limited to something like 10 to 15 dB. The costs will run something like 10 cents per dB square foot of material. Since it is essential that practically all of the interior surface of the plant be treated with sound absorbing materials, the cost can be quite high. However, when it is distributed over all employees, the cost might be quite low.

In figuring all of the costs above, no account has been taken of the engineering work which may go into studying the noise source, etc.

It's obvious that in the long term it is going to be the purchase of quiet machines in a plant which will provide the most noise control.

The whole approach in the longer range future can be summed up by the two words: "buy quiet".

04-003

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IMPACT OF TRANSPORTATION NOISE ON URBAN RESIDENTIAL PROPERTY VALUES WITH SPECIAL REFERENCE TO AIRCRAFT NOISE

Springfield, VA, NTIS, PB 1940101, AUG, 1970, 23 p. HC:$3.00 MF:95 cents

The purpose of this study is to establish some statistical evidence on the effect of transportation noise on residential property value, especially on the value of residential property in strictly residential areas in comparison to that in commercial areas.

The study was made up of 2 parts: The first is an attempt to measure the impact of variations in the level of aircraft noise on residential property values in the vicinity of John F. Kennedy Airport. The second consists of a comparative evaluation of the noise effects between the relatively commercialized neighborhood in the same vicinity.

The technique used was the linear regression method. Data consisted of 162 observations from the 1960 U.S. Census of Housing and Population.

In all models of the regression equation, the noise level turned out to be a statistically significant factor. The level of significance was slightly higher for the residential area compared to the commercial industrial area. The sizes of houses turned out to be the most important price determining factor.

At this point, nothing can be said on the validity of using the result for policy purposes until the study is completed and the predictive capability of the model is tested.

04-004

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Environmental Development Group

TRAFFIC NOISE-THE PERFORMANCE AND ECONOMICS OF NOISE REDUCING MATERIALS

Applied Acoustics

Vol 2 No 3:207-213, 1969

ECONOMIC ASPECTS

The cost is as much a property of a material as are its physical properties.

The cost means the total cost of the particular course of action. An example of the importance of finding the total cost is a London office block which is being modified at the moment. It is built on a major traffic route and in order to reduce the effect of traffic noise the owners decided to install double glazing.

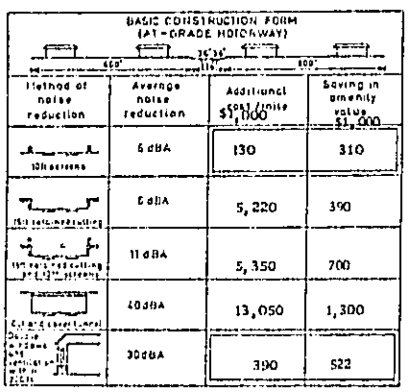
The double glazing costs $73,000 (supplied and fixed) and could have been installed with little inconvenience to the office staff. However, as double glazing really works only when it is closed, air conditioning was also necessary, bringing the total expenditure to $624,000 and causing considerable disturbance to the office staff. Thus the total cost is probably ten times the direct cost of the double glazing.

After calculating the cost the next step is to compare it with performance in a meaningful way.

There is a scale already in use for evaluating things which are essentially different in character and it is well established and widely used; money.

It has proved possible to calculate the values which people put on subjective things. It has been done for the particular case of houses subjected to noise, etc. and in principle could be used for any loss of amenity.

The example in Fig. 1 shows how this kind of evaluation might be used in deciding what action too take over the noise from a motorway. Of the five possible measures considered three cost vastly more than they would save in amenity value and may be eliminated from further consideration. The remaining two possibilities appear to be worth while.



BASIC CONSTRUCTION FORM (AT-GRADE MOTORWAY)

Method of noise reduction	Average noise reduction	Additional cost/units $1,000	Saving in amenity value $1,000
[illegible]	6 dBA	130	310
[illegible]	6 dBA	5,220	390
[illegible]	11 dBA	5,350	700
[illegible]	40 dBA	13,050	1,300
[illegible]	30 dBA	390	522

Fig. 1 Use of cost and performance data.

A fact which is often missed is that noise is not necessarily a bad thing; sometimes it can be very desirable.

The office modification mentioned earlier provided an example of this. During the preliminary tests it was found that the noise level with the windows open for ventilation reached about 74 dBA in the front offices. Simply closing the original windows reduced this to 61 dBA, which was easy enough to measure. However, when a secondary window was installed the level dropped to 54 dBA and internal noise (doors slamming, conversations in the corridor, etc.) became noticeable.

The next step in the test was to seal the outside window as well. This brought the traffic noise level down to 49 dBA and measurement became almost impossible because of the internal noises, which followed one another in an almost continuous sequence.

The internal noises were caused by hundreds of acts of minor thoughtlessness and by minor defects in the construction of the partitioning and in the maintenance of the building. Noise from such sources would tend to give rise to dissension among the occupants, whereas traffic noise coming from outside the building had a unifying effect and provided a bond between people in adjacent offices. Consequently it was decided to leave the windows unsealed. In addition a sum of money was earmarked for dealing with internal noise problems as they became apparent.

04-005

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AIRCRAFT NOISE EFFECTS ON PROPERTY VALUES

Inglewood, CA,
City of Inglewood, FEB, 1972, 2 p.

A study of property values in Inglewood, CA, showed that residential land values are approximately 50% higher, and rental dwelling vacancy rates approximately 50% lower in areas where aircraft noise is less than 80 PNdB compared to areas where aircraft noise exceeds 110 PNdB.

The results were computed by a linear regression analysis of data from the Inglewood General Plan, Preliminary Housing Element. The data from 21 census tracts, comprising the entire city of Inglewood, were used for land values and vacancy rates. The corresponding noise levels used were those at the approximate mid-point of each census tract. Three possible correlations with noise levels were studied: residential land values, vacancy rate of

rental dwelling units, and vacancy rate of all dwelling units. The first two correlations were significant at the 5% level.

Variable Y=Land value in $/sq ft or vacancy rate in %	Regression equation (computed)	R:computed correlation coef.	R05 Coef. required for significance at 5% confidence level
Residential land value ($)	Y=5.02-.024x	0.5489	0.456
All dwelling vacancy rate (%)	Y=0.22+0.43x	0.2766	0.433
Rental dwelling vacancy rate (%)	Y=-1.29+.067x	0.4427	0.433

05-001

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ACOUSTICAL DESIGN GUIDELINES FOR OFFICE LANDSCAPING

Sound and Vibration

Vol 5 No 6:17-18, 1971

Open plan office arrangements are becoming increasingly popular, but there can be problems in providing necessary speech privacy between work stations and in eliminating disturbing noise from office equipment.

The three main principals that can prevent significant loss of acoustic privacy are:

1) use of carpeted floors and sound absorbing materials on ceiling and room surfaces that could reflect sound from one work station to another;

2) placing acoustic screens between work stations and around noisy office equipment;

3) adding background masking sound through a loudspeaker system to cancel transmission of word information between work stations.

Carpets on floors should have a pile height of at least 0.156 inch and either be carried on a separate sponge rubber or hairfelt pad or have an integral sponge rubber backing at least 3/16 inch thick, to eliminate noise such as foot shuffling. Ceilings of "normal" construction (thin mineral acoustical tile) are not sufficient because their Noise Reduction Coefficient (NRC), a measure of average sound absorption, is only about 0.65 or less, but modifying the ceiling by adding vertical baffles of glass fiber panels can bring overall ceiling absorption up to NRC 0.95. Other successful ceiling treatments have included:

1) a flat ceiling of glass fiber panel with an NRC of 0.95; (2) an open light grid panel with a plenum above it made of vertical baffles or flat glass fiber ceiling panels; 3) coffer or modified baffle ceiling systems made of glass fiber panels. Because lighting fixtures are assumed to cover 25 percent of the ceiling area, their light diffusers should be of the open rather than solid type.

Walls, partitions and columns should be covered with sound-absorptive materials such as fabric- or vinyl-covered perforated glass fiber panels. Carpeting can also be used if pile depth is at least 3/8 inch on jute backing.

Window draperies are essential; with 150 percent fullness and semi-open weave, they may still be translucent enough for exterior objects and colors to be defined. Screens should be placed to eliminate line of sight paths between seated personnel at different work stations and around noisy equipment. They should work most efficiently in the 250-2000 Hz range, which is the crucial range of speech and business machine spectra. They should be at least 2½ inches thick, have an impervious membrane in the middle to reduce noise propagation through the screen, and have equal thickness of sound-absorptive material on either side.

Background masking sound is produced electronicly through loudspeakers hidden in or above the ceiling. Its frequency spectrum is designed to match that of speech and although it is audible, its level and composition are such that it does not sound "noisy" to personnel. Its purpose is to increase speech privacy by reducing intelligibility of speech propagated between work stations. The background noise system must be tuned after it is installed by adjusting the level and spectrum of the speaker system for the optimum combination of masking and quietness.

BUILDING ACOUSTICS

05-002

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EFFECTIVENESS OF SOUND ABSORPTIVE MATERIAL IN DRYWALLS

Sound and Vibration

Vol 4 No 5:16-18, 1970

Results of field measurements of four wall specimens in a small apartment building showed that urea formaldehyde foam and mineral wool were effective sound absorptive materials in wood-frame party walls. Light-weight walls can thus be provided with a Sound Transmission Class (STC) number of 50 or more.

The foam used was the patented Isoschaum Process type. Its three components are urea formaldehyde resin, a foaming agent and air. It was applied in the spaces between studs before the walls were faced with gypsum board. It firms in about one minute but continues to dry for one or two days. The cellular charcteristics are 60% open cells. The foam is nontoxic, self-extinguishing, non-corrosive, mold-resistant, and has a density of about 0.6 lbs per cubic foot.

The wall construction was double 2x4 studs and plates with a space of 1/2 inch between both studs and plates. This was faced with 5/8 in. fire-rated gypsum board.

The four different filler treatments and their results were as follows:

	Field-tested STC
1) Wall filled with foam on both sides (foam 7 in. thick)	52
2) Wall filled with foam on one side (foam 2½-5 in. thick) plus resilient channels under one gypsum facing.	50
3) A 2 in. blanket of mineral wool in stud spaces on both sides of the wall (total thickness: 4 in.), plus ½ in. sound deadening board under one gypsum face.	47
4) Wall filled with foam on one side (foam 2½-5 in. thick) plus ½ in. sound deadening board under one gypsum face.	47

The ratings of the latter two walls were limited to STC 47 by their poor performance at 160 Hz.

There are other ways to get equivalent acoustic isolation in double-stud walls. One way uses thermal insulation as the filler material and uses either resilient channels or sound deadening board under the gypsum board on both sides of the wall.

The in-place cost of urea formaldehyde foam is higher than that of thermal insulation (in the Seattle area). Full-thick foam (6-7 in) costs 30 cents per square foot and half-thick foam (2½-5 in.) costs 16 cents per square foot installed.

Similar investigation, made on the floor ceiling construction, showed that 6 in. of foam or 3 in. of mineral wool, together with the other components of the construction, produced about the same isolation. All measurements were made according to ASTM standard E336-67T, "Tentative Recommended Practice for Measurement of Airborne Sound Insulation in Buildings."

05-003

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WINDOWS--THE WEAK LINK?

Sound and Vibration

Vol 5 No 6:19-21, 1971

For windows in exterior walls of buildings near airports, a systematic design approach includes forecasting the noise exposure, determining the required insulation, and only then choosing adequate materials and construction details. Adequate design knowledge for external windows has existed for years. Construction providing adequate noise protection near airports is 15-20% more expensive than "standard" construction. Builders' and clients' insistence on exterior windows cause the most serious problems for the designer, because the window, especially if operable, is the "weak link' in the wall construction. For this reason, many critical buildings near airports have no exterior windows. If exterior windows must be used the design method below is sufficiently reliable for small projects. For large scale projects professional acoustical help is a good safeguard.

To determine the probable external noise exposure from aircraft, the straight-line distance to the nearest airport apron position (not to the edge of the airport or to the nearest runway) must be determined.

BUILDING ACOUSTICS

The designer determines background noise levels acceptable for the various rooms from the table below. "Background" level does not include the sounds of human activity, but includes ventilating noise, lighting hum, sound of air conditioning units, plus noise coming in from outside. The table below is based on thousands of measurements of what people will accept, within reasonable limits of confidence (approximately 90%).

Maximum permissible interior background levels in dBA

Type of Building	Room	Max. Permissible Interior Background Levels-dBA
Hotel or Motel	Bedrooms	45
	Meeting Rooms	50
	Offices	50
	Lobby	55
	Shops	55
	Restaurants	60
Airport Terminal Facilities	Ticketing Areas	60
	Restaurants	60
	Main Waiting Room	70
	Loading Gate Areas	70
Office Buildings	Executive and Private Offices	45
	General Office Areas	55
	Lobbies	55
Shopping Centers	Lobbies	55
	Stores	55
	Restaurants	60
Schools	Classrooms	50
	Gymnasiums	60
	Auditoriums	40
Apartments	Bedrooms	40
	Kitchens	60
	Living Rooms	50
Hospitals & Nursing Homes	Patient Rooms	45
	Activity & Social Rooms	55

Next the acceptable interior level is subtracted from the anticipated exterior noise level to determine the exterior wall isolation required. For example if exterior noise will be at least 87 dBA (from Figure 1), and the interior background level for a motel bedroom should be no higher than 45 dBA (from the table), 87 minus 45 indicates a 42 dB barrier, and the window must provide at least that isolation. Sound Transmission Class (STC) numbers for various types of window systems provide a good approximate method of choosing the correct window treatment even though they were originally developed to provide a single number rating for interior partitions. For example, if 42 dB external isolation was required, it could be provided by a window system with an STC 42 rating.

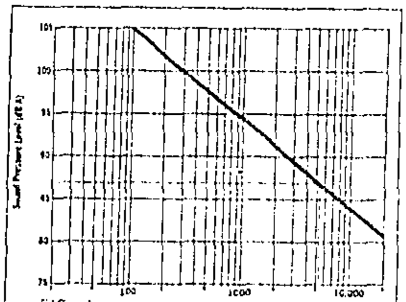

FIG. 1. Distance to Loading Apron Position at Airport (Feet)

The table shows that a single pane of glass with ordinary glazing is a poor sound barrier. Spaced, double or triple glazed assemblies do much better, but only if the space between panes is more than one inch. However, normal glazing procedures often do not provide air-tight edges, leading to severe acoustical leaks unless installation is closely supervised. Another draw back to spaced window systems is their expense, bulk, and maintenance problems (interior soiling). The laminated acoustical glazing consists of multiple layers of thin glass laminated with thick, soft layers of polyvinyl-butyrate plastic. The resulting total pane thickness ranges from ¼" to over one inch.

Sound transmission class ratings for various types of glass.

Glass Type	STC
Single Strength	18
Double Strength	21
¼" Plate	26
½" Plate	31
1" Plate	34 – 37
1" Insulating, ½" air space	32
¼" Safety	31
9/32" Laminated Acoustical	35 – 38
½" Laminated Acoustical	38 – 40
Spaced units, with air spaces from 2" to 4"	38 – 48

In general, however, there should be no operable windows used, whether of the hopper, double-hung, or casement type, if performance better than STC 32 are needed. If building codes require operable hoppers, the hoppers should have double or triple edge gaskets, at least two can-type handles or catches, and close tightly under considerable pressure. Even better, they could be made only technically operable--that is, openable only by a custodian with a wrench.

BUILDING ACOUSTICS

05-004

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In: Jansson, P.G., Conferences in Connection with the International Air Pollution Control and Noise Abatement Exhibition, Joenkoeping, Sweden, SEPT 1-6, 1971

Joenkoeping, Sweden, 1971, 525p. (p. 7:100-7:106)

In this report an engineer from Saab-Scania Sweden gives the motor manufacturer's views of the part played by production environmental pollution.

During the past ten years, the need for active measures in the field of environment protection has become increasingly pronounced and this in turn has led to a rapidly growing proportion of development work being concentrated on making motor vehicles more suitable for the environment.

When talking about noise made by vehicles, it is important to use figures obtained by the same methods of measurement. ISO has issued instructions as to how the measurement of vehicle noise shall be carried out. When regulations are drawn up it is extremely important that they conform to international standards. There may be good reason for some extremely large centers of population to introduce special regulations.

Local sources of pollution can also be brought under control by means of traffic engineering and road planning.

The most difficult vehicle noise to combat is the noise made by diesel-engine vehicles. Although common belief is that exhaust noise is most dominant, modern silencers have brought exhaust noise below a level that would add to the total noises.

Noise from the combustion process passes via the engine crankcase to the surrounding air. This noise is difficult to subdue. Another source of noise is the cooling fan, the noise level of which increases with engine rpm. Induction noise used to be difficult to control, but this is now silenced to such an extent that it no longer has any effect on the total noise level. The difficulty of suppressing noise is emphasized by the fact that very little is gained by silencing one source of noise. The noise occurring at speeds as low as 40-50 km/hr begins to have an influence on the total noise level.

Less than 3% of the total number of vehicles in Sweden consists of heavy vehicles. Due to traffic restrictions and other traffic engineering measures, noise from heavy vehicles has been further restricted. Buses, on the other hand, are among the vehicles that are frequently driven in residential areas. Saab Scania has designed a city bus with a noise level no higher than 74-76 dBA, according to the ISO method of measurement.

Another example of the work done in reducing noise is that represented by the refuse collection vehicles developed. By using low-speed hydraulic pumps for driving the machinery and by the use of special insulation around the engine, gearbox and refuse handling unit, Saab-Scania can make refuse collection vehicles with a working noise level of around 75 dBA.

Heavy trucks can be driven quiter if they have larger engines. One of the reasons for this is that a more powerful engine enables the truck to be driven in a higher gear. This in turn means that engine rpm will be lower at an equivalent road speed.

Present-day society is completely dependent on road transport. For all parties concerned it is therefore of utmost importance that regulations governing these important environmental questions are of a uniform shape and that technical and economic considerations are not ignored.

05-005

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TECHNICAL CONSTRUCTION METHODS AGAINST NOISE

In: Jansson, P.G., Conference in Connection with the International Air Pollution Control and Noise Abatement Exhibition, Joenkoeping, Sweden, SEPT 1-6, 1971

Joenkoeping, Sweden, 1971, 525p. (4:29-4:34)

Propagation of industrial noise by means of design changes and extra devices on machines is discussed. It is necessary to use technical construction methods against noise.

If a source of noise is out of doors, the reduction of noise with distance is most effective over the first few meters. Large reductions in noise require large protective distances and in general noise from a source out-of-doors reaches very far.

The intensity of reflected sound can be affected by absorbents in the room. By providing a room with good sound absorbents, the level of the reflected sound can be decreased by 5 to 10 dB, and a decrease of

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this size is not insignificant since it implies a reduction of 25-50% of the intensity actually heard.

Noise problems in industry cannot be solved by means of sound absorbing material, especially since the sound level near the source where the direct radiation dominates, is unaffected by absorbants.

Much larger reductions can be achieved by means of sound-insulating construction that is airtight. The most simple door in an apartment has a sound insulation of about 15 dB. The sound insulation of a 15 in thick concrete wall is about 50-55 dB. With frame wall constructions, within a range of 7-15 cm in thickness, sound insulations in the range 30-55 dB can be achieved.

Sound screening arrangements use screen as high as possible, placed as near as possible to the source. In typical situations this can give reductions of about 5-10 dB at medium and high frequencies.

Vibration insulating of machines is often necessary because of noise. It involves standing the vibrating source on springs. In this way the transmission of vibrations to the foundation is reduced above a certain frequency. It is necessary that the foundations be heavy and rigid.

When technically planning industries and industrial premises with respect to noise problems, these guidelines can be followed. Noisy machines and processes should be separated not only from those activities which require silence, but above all so that one avoids exposing more individuals to noise for longer periods than one must. For industries which have appreciable parts of their activities out of doors, much can be gained by screening and by enclosure. Industrial premises should be provided with effective sound absorbents. The absorbents must naturally be suitable for the particular environment and be suitable from a practical point of view. The size of sound insulating constructions is not generally a problem, but physical presence can be restrictive. This can mean that industrial premises should be made somewhat larger so that space is available for dividing walls between various parts of the operations. Finally, with respect to vibration insulation, even this starts at the constructional planning stage. Building planning in general and constructive design in detail are important here.

05-006

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ACOUSTICAL FOAMS FOR SOUND ABSORPTION APPLICATIONS

Sound and Vibration

Vol 4 No 7:12-16, 1970

The physical and acoustical properties of polyurethane foams were investigated for sound absorptive wedge applications for semi-anechoic rooms. (Wedges, several ft long, are used on walls and ceilings of acoustical measurement chambers to make the inside surfaces of the chamber as completely sound absorbtive as possible; sound is bounced back and forth in the spaces between the wedges, and practically none is transmitted back into the main chamber space.)

Polyurethane wedges can give better acoustical performance than glass fiber. Although most of the investigation concerned the wedge application, with emphasis on low frequency performance, some aspects of the results are of general interest.

There are many types of foams on the market, of varying rigidity. Polyurethane flexible foams can be divided into polyester and polyether types. The following table compares their physical properties:

Criterion	Polyether	Polyester
Hydrolysis	More stable in humid environment	More durable in dry environment
Ultraviolet		More stable; used almost exclusively by garment industry
Air flow	Max 90% open cells	Max 60% open cells
Flammability	Neither type self-extinguishing, except with additives at time of foaming. The flame retardant additives lower the air flow resistance. Without additives polyester is less flammable.	
Cost		Less expensive
Fatigue	More durable. Used for seat cushions.	

Air flow resistance is the most important parameter in determining the sound absorptive characteristics. It depends on the number of cell membranes present and the size of the cells. Polyurethane foam is an open cell foam, with relatively few membranes present. For the wedge application, a cell count of 45-50 per linear in is best.

Foams are easily obtained in densities of 1.0-2.5 lbs per cu ft, and as specials up to 6.0 lbs per cu ft. Most of the special properties found in the denser foams do not seem to improve acoustical absorption, however.

Foams can be obtained in almost any color, but u-v light, sulphur dioxide, and nitrous changes cause discoloration toward a light yellowish brown. If the foam is initially colored light yellowish brown, therefore, it will be less likely to show changes over time.

Although foam making is still as much as an art as a science, it is possible to obtain foam with specific mechanical properties.

Flat sheets of foam can exhibit a 95% normal incidence sound absorption above the frequency where a 1/4 wavelength is shorter than the foam thickness. To increase absorption to 99%, wedge shapes must be used to make the bulk impedance increase between air and foam more gradual.

06-001

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TECHNICAL NOISE PROTECTIVE CONCEPTS AND MEASUREMENTS

Laermschutztechnische Begriffe und Messungen

OAL-Richtlinie

No 20, DEC. 1969, 7p.

A detailed definition of sound and loudness and terms used in their measurement are presented. It is noted that at present, instrumentation alone is not sufficient for technically accurate measurement of noise. It also requires a working knowledge of acoustical principles. It is suggested that only equipment recommended by the International Electrotechnical Commission be used for measurements. A list of such sound level meters is given below. It is further recommended that equipment be inspected by the Federal Bureau of Standards and Measures every 2 years. Measurements, as prescribed by the guidelines for particular noises, should be taken at least 1.2 meters above ground when performed outside. Inside rooms, they should be taken at 1.25 meters above the floor, in the center of the room. The area in which the measurements are taken should be free of people and obstructions, and the microphone should be located distant from the observer. Weather conditions should be taken into account for outside measurements. For example, wind can influence the noise level by 10 dB.

Manufacturer & Type	IEC-Publ.	Filter	Measur. area for A curve	Weight in kg
Bruel & Kjaer (Denmark) Type				
2205	123	A,B,C	32-140	0.8
2206	179	A,B,C	37-140	0.8
2207	123	A	54-140	0.8
2203	179	A,B,C	19-134	2.7
Imulse-SPM2204	179	A,B,C,D	15-150	2.7
Peekel N. V. (Netherlands) Type GRA & built-in octave band filter	123	A,B,C	20(25)-150	4.7
General Radio Co. (U.S.A.) Type				
1565 A	123	A,B,C	44-140	0.8
1561	179	A,B,C	31-1501	2.5
Rhode & Schwarz (Germany) Type ELT BN4514	179	A,B,C	55-120	0.6
Philips N. V. (Netherlands) Type PM 6400	123	A,B,C	38-130	2.1
L.E.A. (France) Type SST 2	123	A,B,C	24-140	1.5

MEASUREMENT

06-002

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CONTROL OF NOISE FROM MACHINERY

In: Crocker, M., Proceedings of the Purdue Noise Control Conference, JUL 14-16, 1971

Lafayette, Purdue Univ., 1972, 594p. (p. 81-83)

Proposed methods and problems encountered in efforts to measure noise from machinery are discussed. The need to standardize methods for this measurement is stressed, as are differences in the requirements for different kinds of machinery and applications.

There are alternative ways to present sound data for a specific machine in five separate areas.
1) Sound power versus sound pressure: pressure describes conditions at the listner location, power is necessary in accounting for different transmission conditions.
2) Single number versus spectrum: data for noise control must provide frequency information. Octave band spectra generally are sufficient by 1/3 octave band spectra may be necessary.
3) Frequency weighting: the A-scale is the simplest and most common. However, other weighting methods, which correlate better with subjective judgements of unsteady noises and sounds, may be better suited for labelling of consumer products.
4) Increments and accuracy: the increments in which noise ratings are given must be consistent with the accuracy of the measurements on which they are based and with human reaction scales.
5) Certification: It is desirable for sound ratings to be certified and policed, which can only be done effectively by trade associations.

06-003

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PROPOSED AMERICAN STANDARD FOR COMMUNITY NOISE

At: American Association for the Advancement of Science, 138th Meeting, Philadelphia, DEC 29, 1971

Bethlehem, PA, Bethlehem Steel Co., 1971, 4p.

A working group of a subcommittee of the American National Standards Institute (ANSI) has developed community noise standards for community sampling procedures and for equipment noise measurement, and is planning to draft a model noise ordinance.

This group, the Working Group on Measurement and Evaluation of Outdoor Community Noise, was established by the Sectional Committee on Bioacoustics of ANSI. The ultimate goal is to achieve maximum human privacy from intrusion by noise. The first step toward this goal is the capacity to define the acoustical quality of the environment in terms of prevailing noise levels in a reliable and repeatable way. A simple, inexpensive technique is needed that may be used by the non-specialist. Therefore, an A-weighted sound level meter was chosen, to be used on the slow meter response. One problem in measuring community noise is that it varies considerably with time because of aircraft, vehicular traffic and other variable noise sources. To get a repeatable estimate, the following procedure is suggested:

The A-scale reading is observed for five seconds and an estimate of the central tendency is recorded, as well as the range of the meter deflections. Readings are repeated until the number of readings equals or exceeds the spread in decibels of all the readings. The average of all the readings will be considered the community noise level for that location. Observations should be carried out under similar conditions on each of three different days. At least five different locations must be measured before readings may be considered typical of a neighborhood.

The equipment noise measurement standard proposes a test-site method for determining the maximum noise emitted by public conveyances, motor vehicles, including recreational equipment, and construction and industrial machinery. The test site consists of a flat outdoor area with no reflecting surfaces or obstructions within 150 feet. Seven categories of equipment each have specific operating instructions to insure maximum noise output during testing. These categories are broad enough so that almost any device will fit into one of them. The A-weighted sound level meter is used on the "fast response".

Vehicles that travel over 10 mph are tested while moving. They are driven by the microphone at a distance of 50 feet with wide open throttle at near-maximum engine rpm. The gear is chosen so that the speed stays under 35 mph. The vehicle passes by in both directions, and only data from the noisiest side is used.

Other equipment is tested at a standstill while being operated at maximum noise conditions. The sound level is measured around a circle 50 feet from the equipment, and the highest sound level is recorded. To insure repeatibility, the same method is used as for community noise readings. When a given model of equipment is being type tested, different units of that model are tested until the number tested equals or exceeds the range in decibels of the individual test results, and the average is then taken as the maximum sound level of that model. This method is intended for certification testing by the manufacturer and conformance testing by communities, but is not intended for enforcement purposes except at a qualified test site.

The standards described above are still in the draft stage, and the Working Group is now revising them to meet some objections that have been raised.

06-004

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TRAFFIC NOISE

Halasy Komunikacyjne

In: Zagadnienia Akustyczne w. Zakladach Przemyslowych

Warsaw, Wydawnictwo Zwiazkowe Crzz, 1971 311p. (p. 136-141)

Warsaw, like any other city, considers traffic noise next to industrial noise, its biggest noise source.

The first step in noise education should be undertaken in city planning and siting. Also greenbelt and parks, according to the author, can prove to be the most effective abatement device. They should be constructed along the main arteries, along street-car and railroad tracks and in all heavy traffic areas of the city. Any type of a green oasis should also be considered an essential for school and hospital areas.

Another source of noise abatement should be time restriction put on certain railways.

The highest noise levels are emitted by trucks, streetcars and motorcycles, for instance:

Type of vehicle	Noise level in dB
Streetcar	63-78
Tractor (No. Ursus 45)	84
Truck	77
Trolley car	75
Motorcycle	76
Bus	75
Passenger car	60

Measurements were conducted at a 6 meter distance.

Measurements were conducted throughout the various streets of Warsaw to determine the noise levels. Narrow streets, like "Zabkowska", with width of about 20 meters containing buildings with 4-5 stories high registered noise levels up to 78 dB. Wide streets like 'Plac Unii Lubelskiej' which is 120 meters wide and contains buildings up to 7 stories manifested levels of 64 dB.

Studies were also conducted on greenbelts containing various trees and shrubs. The results showed that greenbelts with taller trees and thicker shrubs reduce the noise levels considerably. For instance, 2 rows of poplars, 7 meters high and planted 3 meters apart, with a row of fruit trees and a living fence in front of them, totaling 15 meter depth of the greenbelt, can reduce the noise level up to 30 dB (with trees containing leaves), and 18 dB-(without leaves).

A method for noise reduction of streetcar noise is the "wetting" process of tracks. Results showed that noise levels from tracks on concrete ranged from 82-85 dB after wetting, 73 dB on asphalt background and 60 dB on a concrete plate with elastic insulation. These measurements were taken at a 7-10 meter distance with the streetcar going about 25-30 km per hour.

The author suggests installments of street microphones which will register excess noise levels by special monitoring. This method will aid the abatement program.

06-005

On: PNEUMATIC EQUIPMENT NOISE TEST CODE

Sound and Vibration

Vol 5 No 2:4, 1971

A recently prepared test code specifying standard techniques for measuring sound from pneumatic equipment covers both portable equipment such as hand-held pavement breakers and trailer-mounted air compressors found on construction sites, and stationary equipment like large rotary vane compressors found in industrial plants. The document, "CAGI-PNEUROP Test Code for the Measurement of Sound from Pneumatic Equipment," was developed by the Compressed Air and Gas Institute (CAGI) in cooperation with the European Committee of Manufacturers of Compressed Air Equipment (PNEUROP).

MEASUREMENT

In the code, pneumatic equipment is divided into three classes: 1) small machines, both percussive and non-percussive; 2) large portable equipment; and 3) large stationary equipment.

Two types of measurements are taken, A-weighted sound levels and octave band sound pressure levels, at each of five or more specified locations one meter from the outline of the machine. For large portable equipment, readings at 7 meters are also required.

During measurements, the equipment must be stationed above a hard plane (e.g., a concrete floor) and operated under specified loads. Noise radiated from any loading device used in conjunction with the equipment must be at least 10 dB lower than that from the equipment, to insure that only the latter is being measured.

One measurement problem in enclosed areas is reflected sound. The code solves this problem by specifying that the levels at the measurement point be at least 6 dB greater in each octave band than levels measured at points more distant from the equipment.

Another measurement problem dealt with by the Code is the likelihood of large errors when strong pure tones are present; these errors occur because of interference between direct sound waves and those reflected from the floor. This problem is solved by moving the microphone vertically over a range of 30 cm above and below the measuring point, at a rate of at least once over the path per second, while the measurement is being made.

Calculation rules and standard test data forms are provided in the Code, which has been submitted to International Standards Organization (ISO) and American National Standards Institute (ANSI) for approval as a standard.

06-006

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HOUSEHOLD NOISE PROBLEMS

Journal of the Acoustical Society of America

Vol 50 No 5:1232-1235, 1971

This article discusses recent standards for performance ratings and application information of the Air-Conditioning and Refrigeration Institute as an example of what an industry can do to communicate acoustical data between manufacturers, installers and users.

Noise in the home is not just an acoustical problem; it is economic and social as well. Legislation on noise control is not needed as much as is the cooperation of industry in manufacturing quieter machinery.

In order to achieve this cooperation for effective noise control, information is needed in three categories:

1) equipment sound ratings
2) proper application and installation of equipment
3) appropriate noise levels for specific situations

Standardized methods of sound rating have been started by the Air-Conditioning and Refrigeration Institute (ARI), which is now publishing a directory containing acoustical ratings of outdoor condensing units.

It has also published an Application Standard to aid the buyer to use these ratings for selection and application of air-conditioners. These ratings should aid both the buyer and the manufacturer and should spread in their applicability to other machinery and equipment as well.

ASHRAE (the American Society of Heating, Refrigeration, and Air Conditioning Engineers) is updating its Standard 36 and is working on the development of international standards.

Social and economic factors enter the field of noise control. Individual tolerance of noise and willingness to pay for its control also have to be considered.

The publication of universal noise standards is a step in the right direction, but the price and performance of quiet equipment will have to be improved, too.

06-007

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PERMANENT MICROPHONE MONITORING SYSTEM

In: Hurlburt, R. L., Inglewood's Noise Monitoring Program. Report on Phase I

Inglewood, CA, City of Inglewood, SEPT 30, 1971, 33p. (p. 5-8, 38)

MEASUREMENT

A description of and results obtained from a four-point automatic noise monitoring system in Inglewood, California is presented. The system measures noise from aircraft taking off and landing at nearby Los Angeles International Airport. The four remote microphones are bolted to telephone pole crossarms about 25 feet above the ground and are connected via broadcast-quality telephone lease lines to City Hall, where the data is processed.

These four points monitor noise continuously to show long term noise exposure trends. The microphones are rain and wind protected, with an integral calibrating system. Upon command a 1000 Hz signal magnetically drives the microphone equivalent to a sound pressure level of 90 dB.

At City Hall information is displayed on a Noise Exposure Monitor that presents the total time that noise in the area around each microphone exceeds thresholds of 80, 90, and 100 dBA.

Other modes of data presentation are available.
1) An unweighted signal played to tape recorder enables a record of the noise itself to be kept, and also a frequency analysis to be made if desired.
2) The unweighted noise can be monitored with loudspeaker to check if it may be caused by some source other than airplanes, such as trucks or motorcycles. In practice, noise above 90 dBA usually comes from aircraft.
3) The A-weighted noise is played to a graphic recorder which plots it against time, this permitting calculation of CNEL (Community Noise Exposure Level) figures.

The system was checked out during a monitoring period in September, 1970. Also in December, 1970, an acoustical consulting firm did a more sophisticated analysis of nine recorded flyover signals using computer calculation techniques yielding results in dBA, SENEL, and EPNL units. All of the results in dBA correlated within 2 dBA of Inglewood's data, showing that Inglewood's system correlates very well with more complicated measurement techniques.

06-008

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THINK QUIET: PART II - INSTRUMENTATION AND MEASUREMENT AND SOUND

Compressed Air Magazine

Vol 76 No 3:12-14, 1971

Instruments used for sound measurement and the function of each are discussed. The basic instrument is the sound level meter. It consists of a nondirectional microphone, a calibrated attenuator, an amplifier, an indicating meter, and weighting networks. The meter reading is in terms of root-mean-square (rms) sound pressure level. The instrument cannot measure the peak level of high-speed sounds, as those produced by hammer blows, punch presses or gunshots. Special instrumentation is required for such applications.

Usually, three weighting networks are included in these instruments--A, B, and C. Originally the A network was to be used for sounds below 55 dB, the B network for sounds between 55 and 85 dB, and C for levels above 85 dB. The A network gives a very good indication of the loudness of sounds regardless of the level and is most important. The C network is essentially flat, and sounds read with it are called sound pressure levels. All frequency analyses must be measured on the C scale. The A network reported as dBA falls off sharply at low frequencies, to correspond to the response of the ear. The microphone is the most important part of the sound-measuring instrumentation. Frequency response, sensitivity, directionality, and range are primarily determined by the microphone.

The octave-band analyzer is the most common analyzer for industrial noise measurement. It separates the complex noise into frequency bands one octave in width, and measures the level in each of the bands. Narrow-band analysis must be performed when the source of a noise component must be identified for purposes of sound reduction, or some other reason. For these analysis, half-octave, third-octave and tenth-octave analyzers are used.

An acoustic calibrator fits over the microphone and calibrates the entire system of microphone, attenuator, amplifier, and meter. The microphone should be shielded by a wind screen when wind velocity is high. Noise recorded for analysis in the laboratory can be analyzed with various band-width analyzers, displayed on a graphic chart, and retained for other purposes if desired. However, recording supplements, rather than replaces, directly measured data.

Microphone placement depends upon objective, noise at a workers ear, of a compressor inlet, etc. At each of the microphone locations, the following data should be taken with the machine operating: 1) overall sound level using the A-weighting network; and, 2) octave-band sound pressure levels using the flat response or C network.

A similar set of data, background noise, should be taken at one of the locations with the machine shut down. A sketch should be made showing the machine, locations of other

MEASUREMENT

machinery building walls, and microphone locations, as well as a description of the machine and operating conditions.

Certain calculations are required to interpret data taken in sound tests. It is often necessary to combine sounds made by different machines, or even octave-band data measured on the same machine. Background noise often must be subtracted from the total noise to obtain the sound pressure level of a machine alone.

06-009

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THINK QUIET: PART IV--NOISE CRITERIA

Compressed Air Magainse

Vol 76 No 5:12-13, 1971

Preventing communi . complaints about noise from industrial sc.rces is discussed. Criteria to prevent annoyances are more restrictive than criteria to prevent hearing damage or speech interference. Annoyance depends upon the level of the offending noise compared to the pre-existing background level, its absolute value, its frequency, how it varies with time, and whether it occurs during the day or night.

While it is impossible to predict exactly the response from any particular neighborhood to any specific noise, a fairly reliable method has been developed by Stevens, Rosenblith, and Bolt. One can plot the measured octave band sound pressure levels on Figure 1 to determine the initial level rank. The highest zone into which any of the octave band levels penetrates is the level rank of the noise.

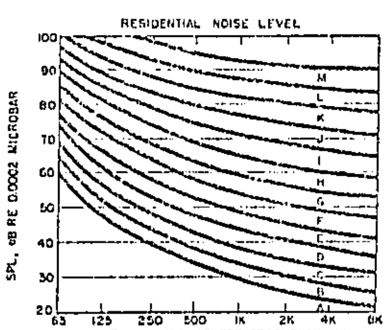

Figure 1

Corrections are next applied as follows:

CONDITION	CORRECTION
Pure-tone components	+1
Wide-band noise	0
Impulsive	+1
Not impulsive	0
Continuous exposures, to 1 per minute	0
10-60 exposures per hour	-1
1-10 exposures per hour	-2
4-20 exposures per day	-3
1-4 exposures per day	-4
1 exposure per day	-5
Very quiet suburban	+1
Suburban	0
Residential urban	-1
Urban near some industry	-2
Area of heavy industry	-3
Nighttime	0
Daytime only	-1
No previous conditioning	0
Considerable previous conditioning	-1
Extreme conditioning	-2

The sum of the various corrections then is applied to the original level rank to obtain the corrected level rank. The expected community response can then be predicted by Figure 2.

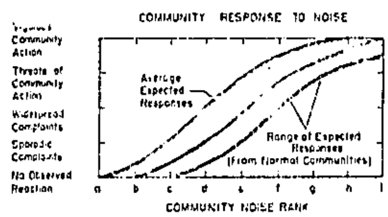

Figure 2

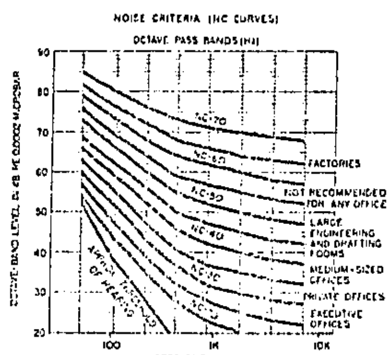

Figure 3

MEASUREMENT

A widely used set of noise criteria for various offices, conference rooms, residences, and the like was developed by Dr. Leo Beranek (Figure 3.) The International Standardization Organization also has recommended a similar set of criteria, called NR (Noise Rating) curves. The National Electrical Manufacturers Association (NEMA) has produced a set of noise criteria for gas turbine installations.

Precautions should be taken when using dBA levels. The popularity of A-weighted sound levels is increasing rapidly as a means of expressing all types of sound criteria, whether it be hearing damage, speech interference levels, community annoyance levels, or machinery acoustic performance. However, it should be remembered that dBA levels must be used with caution; whatever noise control must be engineered, octave band data are needed. Sound should be combined on an octave band basis only, and not by adding or subtracting overall levels.

06-010

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Consultative Group on Transportation Research, 2, rue Andre-Pascal

URBAN TRAFFIC NOISE: STRATEGY FOR AN IMPROVED ENVIRONMENT

Paris, OECD, 1971, 166p.

An Organization for Economic Co-Operation and Development report recommends international abatement measures for traffic noise. The sponsoring committee set two goals for public policy: to prevent further increases in traffic noise, and to roll back present levels at an economically, technically, and politically feasible rate. Limits on maximum noise at the source should receive priority over limits on method of operation because they automatically bring more widespread benefits. Source limits should be at levels consistent with the technology available at the time, but should be made more stringent as improvements in technology permit. Governments should promote production of quieter vehicles by specifying them in their procurements, and with progressively more stringent limits that will encourage research and investigation of alternate urban transportation modes which offer a long term solution to the problem. Measurement techniques should conform to International Standards Organization (ISO) recommendations. Governments should encourage control of traffic noise by urban planning and highway engineering techniques such as rerouting noisy traffic, better traffic flow to minimize noise from acceleration, zoning and land-use planning, location of new major roads to take advantage of existing natural acoustic barriers, more use of tunnels and open cuts, better location and sound insulation of housing, and development of alternative, quieter modes of urban transportation.

Since motor vehicles move in large numbers in international trade, government regulation of vehicular noise limits should be internationally compatible. The work done so far by the Economic Commission for Europe (ECE) and the Common Market (EEC) is clearly only the first step. Any internationally agreed-upon limits should encourage reduction from current levels and not merely underwrite the status quo.

Three chapters of technical background information summarize the nature of the urban traffic noise environment, effects of traffic noise on man, and methods of control.

The chapter on the urban environment discusses the predominance of urban traffic noise, its peak/background structure, specific noise sources, and noise level factors (weather conditions, night driving, natural barriers, speed, flow, and density of traffic).

The chapter on effects of traffic noise discusses subjective effects, speech communication, interference with sleep, effects on learning and task performance, and immediate and cumulative physiological effects.

The chapter on noise control discusses source modification by vehicle type and subsystem; operational modification such as rerouting, limitation of night operation, improvement of traffic flow; transmission path modification such as road design, noise barriers, proper siting of buildings, and zoning; and architectural modifications such as window treatments and interior building layout.

There are two Annexes. Annex One contains current administrative and legislative practices of OECD member countries Canada, France, Italy, Japan, Netherlands, Denmark, Norway, Sweden, Switzerland, and the United Kingdom.

Annex Two presents the directives of the UN (ECE, Geneva) and the Common Market concerning maximum noise levels from vehicles.

MEASUREMENT

06-011

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SPEECH INTELLIGIBILITY IN THE PRESENCE OF TIME VARYING AIRCRAFT NOISE

Journal of the Acoustical Society of America

Vol 50 No. 2:426-434, 1971

A discussion of the large number of complaints made about aircraft noise and its disruptive effect on speech communication suggests that a measure of speech interference may be useful for evaluation of the annoyance of aircraft noise.

Usually the level at only one point in time (the peak level) or the average sound pressure level, is used to predict the amount of speech interference that would occur during an aircraft flyover. Since the sound-pressure level and spectral contents of an aircraft flyover change with time, such predictions are often inaccurate. A meaningful definition of speech interference should take into account both the degree to which speech is masked by aircraft noise and the duration of such masking.

For various kinds of steady-state noises, the amount of speech interference produced is uniquely related to the Articulation Index (AI). There is some question, however, as to whether relations established for predicting speech intelligibility in steady-state noise can be applied without modification to a situation involving time-varying noise. The objective of this study was to determine whether the relation between speech intelligibility and AI for time-varying aircraft noise is different from that for steady-state noise.

The results show that, for a given AI, the time-varying noise masked speech less than the steady-state noise.

The magnitude of the difference cautions against the use of relations established for steady-state noise to predict speech intelligibility in the presence of time-varying noise.

It is concluded that the relation between word intelligibility and AI for time-varying aircraft noise is different from that for steady-state noise. There will be an appreciable disruption of contextual speech when the peak level of an aircraft flyover exceeds 88 PNdB, an SIL (speech-interference level) of 68 dB, or an A-weighted sound-pressure level of 76 dB.

06-012

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TEMPORARY THRESHOLD SHIFT IN HEARING FROM EXPOSURE TO DIFFERENT NOISE SPECTRA AT EQUAL DBA LEVEL

Journal of the Acoustical Society of America

Vol 51 No 2:503-507, 1972

This study seeks some clarification of the adequacy of dBA measures for rating hearing-loss risks for assorted noises which may display broad differences in spectral, temporal, or other acoustic features. Its specific intent was to test whether sound-level readings in dBA could suitably depict the harmfulness to hearing from exposures to noises differing greatly in spectral shape.

Three test noises having spectral slopes of 6 dB/oct, 0 dB/oct, and +6dB/oct provided the test conditions of interest. These three noises were presented at a constant 100 dBA level in three separate 30 min exposure sessions to each of 11 male subjects, and then presented again to the same listeners in three additional retest sessions. Figure 1 shows the spectral shapes of the three noises at the prescribed 100 dBA sound level. Also noted in Fig. 1 is the frequency response curve for the A-weighting network. It is relatively insensitive to low-frequency sound energy. This weighting curve is most biased against the energy contained in the noise with the 6 dB/oct slope.

Temporary threshold shifts in hearing served to evaluate the degrading effects of the different noise spectra on the ear. Such hearing thresholds were measured for pure-tone frequencies 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz. Each tone was presented for 30 sec in which time the subject controlled the attenuator so as to fluctuate about his threshold level for that sound. The attenuation rate was 4 dB/sec. During the postexposure test, the listener was allowed to stabilize his 500-Hz threshold, beginning at 1-1/2 min after noise cessation, the actual postexposure test commencing at 2 min.

Temporary-threshold-shift data for the various pure-tone frequencies were corrected to postexposure measurements at 2 min, abbreviated as TTS2.

MEASUREMENT

If dBA is a satisfactory indicator of noise hazard to hearing it would be expected that equal dBA exposures to the test noises, despite their spectral variations, should cause equivalent amounts of TTS2. Spectral differences among the noises caused no statistically significant differences in threshold shift when pooled for all pure-tone frequencies. Over-all TTS2 means for the various noise spectra were nearly identical with mean differences less than 0.5 dB.

However, significant interactions between noise spectra and pure-tone test frequencies were also found. At pure-tone frequencies below 3000 Hz, frequencies above 3000 Hz, the reverse was true; the +6 dB/oct noise caused more threshold shift than the 0 dB/oct noise which, in turn, caused more TTS2 than the -6 dB/oct noise. The -6 dB/oct noise is more harmful to hearing than the other two test noises for equal dBA exposures. Perhaps the weighting curve for dBA is too severely biased against low-frequency energy, and thus does not adequately take account of its degrading effects on hearing relative to that caused by high-frequency sound. The +6 dB/oc slope noise should be most harmful to hearing followed by the -6 dB/oct slope noise and the flat spectrum noise.

In short, dBA ratings of noise hazards to hearing may be discounting too much low-frequency energy. Except for one procedure which simply averaged the sound levels of octave bands with midfrequencies 500, 1000, and 2000 Hz, other noise rating schemes using spectral determinations did not improve on the amount of TTS2 produced by the test noises of variable spectra.

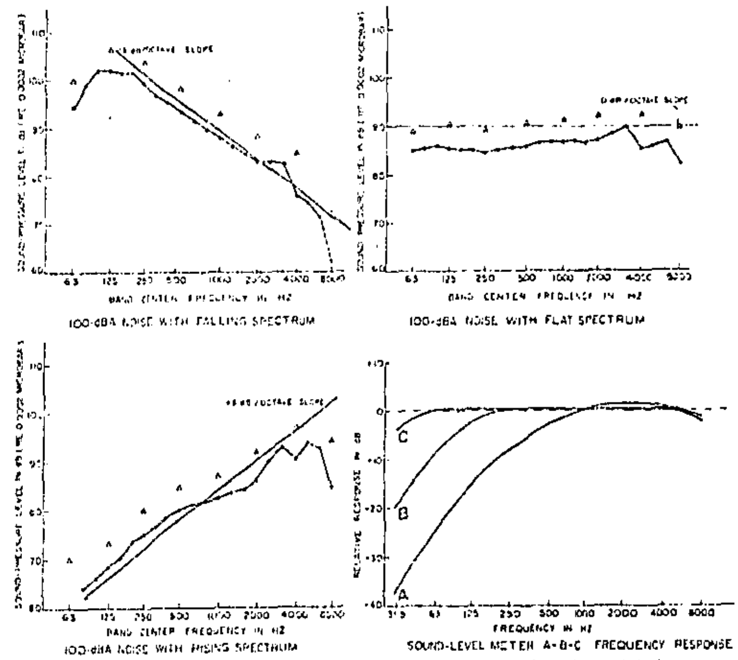

Fig. 1. Spectral descriptions of the three test noises having −6 dB/oct, 0 dB/oct, and +6 dB/oct slopes and the frequency response of a general purpose sound-level meter when set at A-, B-, and C-weighting according to the "American National Standard for Sound Level Meters" (S1.4-1971, American National Standards Institute, [illegible] East 45th Street, New York, N.Y. 10017). ●—●: 1/3 oct-band levels; △—△: octave-band levels.

MEASUREMENT

06-013

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TRAFFIC NOISE CONTROL CRITERIA

Build International

Vol 2 No 6:26-30, 1969

The peculiarities of traffic noise are characterized and the essential pre-conditions for a useful noise nuisance criterion outlined. The nature and origin of the Traffic Noise Index (TNI) developed by building research studies are discussed, and comparison is made with the equivalent noise level (ENL) as an alternative method of devising such criteria.

Numerous efforts to relate traffic noise level to human response have failed to produce measures with real predictive value.

In order to measure and control traffic noise nuisance, there are at least three points to consider. First, noise produced by traffic is extremely varied in both intensity and character. Second, its propagation is complex and imperfectly understood. Third, there are great differences between individuals in the degree to which they can tolerate noise.

A practical noise control criterion must be based upon correlations between measured noise and social nuisance, resulting in a functional relationship which permits the interplay of all the relevant variables correctly weighted.

Two methods are discussed: the technique of the ENL and the method of the (TNI) developed by Building Research Station. In short, the ENL is the mean of a logarithmically weighted summation of all noise levels at 5 dB intervals.

In developing the TNI, variations of traffic over 24 hours were taken into account by noise sampling, over an adequate period, 1) the relative attenuation bases by recording noise at building facades over a wide range of distances, and 2) individual differences by using a sample large enough to obtain a normal distribution. A multiple weighted correlation was obtained to enable prediction of social nuisance with fair accuracy over the range of noise climates.

In comparing the two measures, the TNI gives greater weight to peak noise as against background levels, whereas the ENL tends to give weight to situations in which high noise levels will prevail. Also, the TNI gives better predictions of nuisance and disturbance of sleep during the evening and night than between hours 1-5 in the morning. This is important because most sleep disturbance due to noise occurs during the first hour of sleep.

Both indices have their advantages and shortcomings. The most important requirement for noise control, given the measure of social nuisance, is to reduce the peaks and surges in traffic noise.

Purely physical scales will not be useful in noise control, since they measure only the intensity. Only indices such as the ENL and the TNI assess the degree of disturbance.

07-001

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AIRPORT ENVIRONS: LAND USE CONTROLS

Washington, HUD, MAY, 1970, 35 p.

This environmental planning paper points out some of the problems, methods and prospects for solving a variety of aircraft noise problems facing urban communities.

The comprehensive planning process for compatible land use and airport development is directed toward achieving an optimum relationship between an airport and its environs. As such, planning for compatible land use in the airport environs and planning for the airport itself should be integral parts of an areawide comprehensive planning program.

The compatible land use approach must be related to noise alleviation made possible through engine modification, aircraft certification, and revised operational procedures. All relevant avenues must be considered and applied to the problem in a coordinated fashion. Research and development efforts on methods of reducing noise at the source and modifying flight paths and operating procedures to bring about further reductions should proceed simultaneously with similar investigations of airport community land use strategies.

The conflicting pressures for both the further expansion of the air transportation system and for urban and metropolitan growth in the United States are so strong that further impaction of airport environs is almost inevitable.

Therefore, the use of innovative approaches to land use planning and controls for development, as well as the proper application of existing controls, is urgently needed. Land use controls must apply also to the airport itself, in terms of maximum acreage and intensity of use, so that the airport is compatible with the area in which it is located and so that changes in the character of the airport and its operations do not continually expose new areas to noise. The costs and benefits of airport development must be weighed against those associated with incompatible neighboring uses. Further, the costs and benefits of "on-the-ground" and "in-the-air" solutions must be assessed to develop a total program to reduce aircraft noise impact.

07-002

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LEGAL MEASURES FOR PROTECTION FROM AVIATION NOISE

Stand der Gesetzlichen Massnahmen zum Schutz vor Fluglaerm

In: Fluglaermtagung, Wiesbaden, MAR 17-18, 1969

Wiesbaden, Deutscher Arbeitsring Fuer Laermbekaempfung, 1969, 2 p.

The Inter-parliamentary Committee, which is represented by all Government factions, has presented its first draft as publication V/355 in 1966, dealing with all air-traffic noise problems. It intended to divide the vicinity around airports in three noise zones. The average noise level for Zone I should be about 72 dBA, Zone II, 67-72 dBA, and Zone III, 62-67 dBA.

There should be no construction of hospitals, orphanages, retirement homes, sanitariums and schools in any zone.

In Zones I and II, there should be no new residences constructed; and Zone III only residences with good sound-protection.

Finally, it was proposed that owners of Zone III residences should be granted allowances for the insulation of their homes, and restitution for landowners whose land could not be used for construction.

Financially, this plan was found to be unrealistic because the cost for the civil airports would amount to about $630 million and that of the military-airports $3.15 billion. In September, 1968, a new draft was drawn up. Now there are only two zones, Zone I - noise level can exceed 75 dBA and Zone II 67 dBA. In Zone I, residences can only be constructed in populated areas with special insulation regulations. In Zone II, all new construction requires all insulation regulations. The cost is carried by the airport owners, and in case of military airports, by the Federation.

The cost estimated for the civil airports is from $10 to maximum $12.6 million, and those of the military airports between $37-47 million.

In addition, airports are required to erect noise monitoring stations. Also, local commissions should be established as advisory organs for the communities. They should comprise representatives from the communities surrounding airports, airplane owners, Federal agency for air safety, and Federal organization against aviation noise and the Health Organization.

It is also necessary to enforce certain noise-reducing measures, especially in respect to arrival and departure. It is believed that take-offs and landings can be curbed during the night time.

07-003

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MOTORWAY NOISE AND DWELLINGS

Building Research Station Digest

No 135:1-7, 1971

Introduction of the "10% Level" (L10), a single figure measure of traffic noise exposure, is proposed for measuring design purposes. This unit is related to subjective reactions, in this case dissatisfaction with traffic noise. The unit gives a fair correlation with dissatisfaction and makes the best use of the current state of knowledge.

L10 is the arithmetic average of the hourly values, over a weekday period from 6 am to midnight, of the levels in dBA just exceeded for 10% of the time at one meter from the facade of a dwelling. The practical application of L10 to traffic noise control at housing sites involves obtaining the noise exposure by direct measurement, by estimation from design data, or by a combination of the two. The maximum level for L10 recommended by the Noise Advisory Council is 70 dBA. To apply this standard to all new housing and to existing houses affected by new urban motorways is useful in reducing the nuisance of traffic noise.

Where a road already exists, noise exposure is measured at the housing site, provided that no major changes, such as pulling down old buildings which intervene, are proposed. The measured noise levels should be adjusted to take account of any foreseeable increase in traffic flow on the road. If the motorway does not exist at the building design stage, noise levels are estimated. Adverse wind conditions should be the basis for design purposes, even though more favorable conditions sometimes prevail.

Ground surface that is grassed or planted (not paved in any form) will absorb energy at some frequencies from sound waves that are propagated close to the ground. For propagation distances greater than about 20 m, this absorption can reduce the noise exposure level in a complex manner.

Traffic composition, particularly the proportion of heavy trucks, sometimes affects noise level. However, in fairly fast, free-flowing traffic, heavy vehicles and normal gradients have only a minor effect on noise levels.

Well-designed noise screens can sometimes achieve as much as 20 dBA reduction, although 10 dBA would be more typical. It is an advantage to put it close to the noise source, to make it as high as may be practicable and of adequate length. Buildings may themselves be used as noise screens for screening other buildings. However, the noise levels behind the screen building itself, close to the facade facing away from the road should take into account that other buildings can reflect noise back to the otherwise shielded facade.

To be effective, tree belts must be wide and dense. A width of at least 50 m is necessary to give a reduction of about 10 dBA, and a high proportion of the trees and shrubs must be evergreen if the protection is to be maintained at all times of the year.

Every building gives to its occupants some measure of protection from external noise. The noise level inside an uninsulated dwelling, away from the windows, should be at least 10 dBA less than the outside level. If the external level of 70 dBA cannot be met, it may still be possible to restore a satisfactory acoustic environment indoors by improving the sound insulation of the structure.

A method has been proposed for estimating L10 due to free-flowing traffic for a range of circumstances. This exposure level provides a basis for planning against the noise from urban motorways. Until more knowledge is obtained, it is suggested that the same procedures may be useful for other free-flowing traffic.

07-004

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AIRPORT NOISE AND ITS CONTROL

Flughafenlaerm und seine Bekaempfung

In: Fluglaermtagung, Wiesbaden, MAR 17-18, 1969

Wiesbaden, Deutscher Arbeitsring Fuer Laermbekaempfung, 1969, 2p.

This paper discusses abatement measures taken to reduce the noise from an air-freight terminal in West Germany.

Initially an embankment was planned to be planted with trees and was found to be unsatisfactory due to the time it would take for them to grow. A sound protection wall was constructed at the airport boundary and all freight handling sections were confined to a large hangar. By these means the noise level was reduced about 13 dBA at the adjacent residential area.

07-005

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FREEWAY AND HIGHWAY NOISES: AN INFORMATION BASE FOR URBAN DEVELOPMENT DECISIONS

Springfield, VA, NTIS, PB204434, 1971, 90p.
HC: $3.00 MF: 95 cents.

In the 30 by 50 mile core area of Los Angeles there are 350 miles of freeways causing almost continuous noise levels of 70-90 dBA in the five block wide strips on either side. Because of this, most new proposed freeway routes meet active opposition from the communities that would be affected. Criteria should be developed for compatibility of transportation routes with human activity;

these criteria would relate the costs and benefits of noise reduction to impacted communities.

Data for Los Angeles are presented for residential population densities, freeways and traffic volume patterns, leading to calculation of the number of residents near freeways.

Cars and trucks on freeways are then considered as noise sources, and together with other considerations such as surface street traffic noise and noise reduction in buildings, this information is used to specify zones of intrusion. Data from other U. S. cities and from the United Kingdom are incorporated.

Much past work done on subjective response to motor vehicle noise has not succeeded in giving an accurate picture of the degree of annoyance individuals actually experience in the contextual situations of their various daily activites. One reason for this failure has been the artificiality of the test setting and the limited number of subjects used; another reason is that the descriptors of degrees of annoyance were chosen by the experimentor. The research done by the Building Research Station in the United Kingdom avoided some of these pitfalls by using survey methods in actually impacted residential areas.

Criteria for acceptable residential noise limits from various sources, including the City of Inglewood Ordinance, and various standards widely used in Switzerland, England, and the Scandinavian countries are compared with each other, and with noise levels implicit in the California Vehicle Code.

It is concluded that about one million people currently live within four blocks of a freeway in Los Angeles. Traffic noise is likely to exceed 75 dBA within one or two blocks of a freeway, and 60 dBA within four blocks. The latter figure is about 10 dBA above urban residential background levels where there is no high level noise source.

The freeway system will probably double to 750 miles by 1980. Exact delineation of impacted zones will require detailed surveys, because of complex sound propagation patterns caused by variations in shielding and reflection. There is a need in Los Angeles for a noise data system commensurate with the current level of effort in other environmental activities. Community resistance to expansion of the freeway system has already been effective, forcing government and the transportation industries to account for the costs of noise production. A comprehensive decision/allocation system is needed to deal with the problem.

07-006

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NOISE ABATEMENT: THE NEED FOR A MULTI-DISCIPLINARY APPROACH

Municipal Administration and Engineering

Vol 36 No 430:1971

The first committee on noise abatement in South Africa was established in 1969 by the Johannesburg City Council. The committee has not only concentrated on Johannesburg's municipal problems, but has resolved to form a national coordinating committee to deal with noise in all municipal areas as well.

In addition, there is a call for a multi-disciplinary approach to all forms of pollution, in which cooperation and coordination of various pollution organizations are the keynotes.

Ekistics, or the science of human settlements, must be an integral part of architecture. As far as this relates to noise abatement, consideration must be made for factors affecting outdoor urban noise, such as spacing between buildings, as well as silence within the buildings themselves.

Other ekistical schemes include creating areas of the city which are relatively free from motor traffic at certain times of the day, designing quieter motor vehicles and construction equipment, and asking for government grants to encourage program development.

The cooperation of business interests is essential. In addition, an emphasis must be put on the individual citizen's role in noise abatement by being quiet, cooperative, and considerate.

The noise pollution problem has been recognized by the parent organizations of the neighborhood schools and they in turn have sent expressions of their feelings to the local school board, city, state, and Federal governmental bodies in this regard.

The following suggestions are made in reference to any proposed standards:

1) Well established criteria include some means of limiting noise at any time, even for short duration, to 85 dBA minimum. Energy averaging or similar integration procedures probably do tend to predict hearing damage, but they do not define annoyance, nuisance, or other subject effects.

2) It is simple to measure noise levels in dBA with simple, low cost equipment, which can be operated by competent law enforcement personnel; or to automate such measurement quite simply.

3) It is simple to forecast noise exposures on the ground whenever airport configuration and aircraft type and operational procedures are known. Thus, it is possible, without any measurement procedure at all, to establish the operating parameters of aircraft, the airport layout (especially runway direction and orientation), and to determine zoning areas near the airport in advance.

This would tend to preclude the need for much of the proposed complex measuring procedure; and it would go a long way toward avoiding the nuisance of noise.

07-007

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ASPECTS OF TRAFFIC DESIGN AND TRAFFIC MANAGEMENT

Journal of Sound and vibration

Vol 15 No 1:23-24, 1971

This discussion is centered on three types of road: 1) through motorways: 2) urban main roads: 3) residential roads. In general, noise increases with the traffic flow, with the steady speed, and with the degree of hill climbing and acceleration. All three are clearly correlated with the type of road concerned.

For through motorways, a reduction of 10 dBA in the average sound level would require a reduction in flow from 10,000 to 1,000 vehicles/hr. For a flow of 10,000 vehicles/hr, a six-lane road would have to be replaced by ten 3-lane roads operating near their maximum economic flow. The cost per vehicle/km would be increased and the resulting nuisance from the numerous smaller roads might well be worse than that from the roadway itself.

In rural areas, noise is likely to be a problem only where the motorway passes near towns or particular buildings. In general, therefore, distance can be used as an alleviator, possibly aided by the use of trees in suitable areas. In sensitive rural localities, and more generally in urban areas, the policy clearly seems to be to use motorways to their capacity and to provide noise protection by use of sound barriers or by environmental planning.

A reduction in speed from 70 mph to 50 mph would reduce the sound level by about 4 dBA. The economics of doing this for long-distance rural motorways could be investigated but would undoubtedly be unpopular, even if shown to be economic.

Urban main roads include commuter, bus and commercial routes. In general, both flows and speeds are moderate, but the noise is increased by the starting and stopping at traffic signals, rotaries, pedestrian crossings and other interruptions. Distance is not available as an alleviator and in many circumstances barriers would be unacceptable. Alleviation from noise must therefore be sought by reducing the flow as far as possible and by smoothi·g it out to achieve moderate but steady speeds, by the use of clearways, over and underpasses, etc. In these respects the means of noise reduction seem quite compatible with other aspects of traffic engineering.

An experiment in area traffic control was made in which 80 signalized intersections in central Glasgow are brought under computer control. Various control strategies are being tested, and results to date indicate an improvement of 10-13% in journey times over the pre-existing system, with a probable reduction in noise. No "before and after" noise measurements were made.

The provision of noise barriers by means of walls, embankments, or cuttings, raises a number of problems. If a roadway has a wall placed near the edge of the shoulder, the wall will be struck occasionally by vehicles, and to avoid casualties it will have to have the qualities of a good crash barrier or bridge parapet. It must present a smooth surface to the vehicle and must be strong and stiff enough to deflect the vehicle back along the roadway so that the driver has some chance of regaining control. The ends should be tapered to avoid "gust" effects on cars caused by side winds.

Roads in Britain are wet for about one-quarter of the time, and skidding plays an important part in accidents. At low speeds the friction between the tire and the road surface is affected by the material and the fine texture of the surface, but as speeds increase a rough surface is required for adquate braking. This tendency is unfortunately adverse as far as noise is concerned. "Grooving" the concrete surface to improve skid resistance produced high frequency noises in one test.
The Traffic Noise Index (TNI) is an advance in that it draws attention to the importance of the range of noise levels in addition to the upper and lower limits. But as the range to be expected from a proposed new road will not be known in advance with any certainty, and indeed may well change with time, it may be difficult to use the TNI as a design criterion.

Assuming that in many cases some reduction in noise level is desirable, the following broad conclusions are reached.

PLANNING & SITING

1) On major through motorways reduction of traffic noise by control of traffic flow, speed or composition is unlikely to be viable. It may be necessary to accept the generated noise and alleviate its effects by barriers or environment design.

2) On urban main roads, carrying mixed traffic where there is a conflict between transport and environmental considerations, some reduction in flow should be sought, and traffic management techniques used to encourage modest but steady traffic speeds.

3) In residential and other areas where a quiet environment is the dominant consideration, it may be necessary to discourage through traffic and take measures against individual noisy vehicles.

4) The incorporation of noise barriers into the highway does not present serious engineering problems, but snow removal problems are possible.

5) Developments in road surfacings need investigation from the point of view of noise.

07-008

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JET NOISE AND ITS IMPACT

Airport Services Management

Vol 12 No 10:16-18, 1971

The evolution of the jet noise situation in the Minneapolis-St Paul area (Wold-Chamberlain Field) and the efforts of the Minneapolis-St. Paul Airports Commission (MAC) to deal with it are described. Persistent and organized opposition to jet noise came in 1967-68, as exemplified by news stories reflecting public concern. In 1962, MAC established a Noise Abatement Committee, whose members included representatives of the FAA, airlines, the Air Transport Association, and the Airline Pilots Association. Positive results included the introduction of a visual approach slope indicator (VASI) with the minimum approach slope angle first set at 2.7 degrees (1966) and later at 3 degrees, advisory signs on the runways reminding pilots of take-off procedures to minimize noise, and new traffic patterns directing aircraft away from populated areas.

In response to increased public concern the MAC staff prepared a comprehensive report in 1967-68, which concluded that a solution to the local noise problem was not possible until Federal regulations limited the noise of the aircraft. The MAC actively supported such legislation in the following period, writing to each member of the Minnesota Congressional delegation and briefing two members of the Senate Aviation Subcommittee on the noise problem faced by the airport operator.

In 1968 MAC created the Metropolitan Aircraft Sound Abatement Council (MASAC) to provide continuous study of the problem and to advise MAC.

A positive feature of Wold-Chamberlain is that cleared land at the end of instrument runways is far in excess of federal requirements (one mile or more; the FAA requires 2,500 ft). However, volume of traffic at the airport has increased from 1.4 million passengers in 1956 to 4.3 million in 1967. Use of terminal air space will increase 10 times in the next 30 years.

Retrofitting of the present generation of jet aircraft is advised, because NASA studies indicate that the cost of not retrofitting is greater than the costs of retrofitting, if one considers costs of alternative methods to reduce noise around airports. Alternate methods include expensive land acquisition contiguous to present airports and reduction of airport capacity. The latter results in increased operational costs to airlines caused by delay in departing and arriving. It is suggested that the aviation industry and the general public share the cost of retrofitting. Moving airports to isolated locations is not feasible because this method defeats the goal of providing fast and convenient transportation and also because such airports only remain isolated for a very short time. New economic activities generated by the airport attract people who soon begin the crowd the airport boundaries.

There is presently worldwide opposition to expansion of airline facilities. The noise of the jet engine is used as a catalyst for arousing anti-airport attitudes. Without quieting of the jet engine source, maximum efforts by airport owners and operators will not be enough to prevent strong community reaction.

PLANNING & SITING

07-009

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NOISE FROM PLANT AND EQUIPMENT--AN OIL INDUSTRY APPROACH

Annals of Occupational Hygiene

Vol 14:101-107, 1971

The Oil Companies Materials Association (OCMA), a British association of oil companies, has developed specifications that will enable the prediction of plant noise levels, both within the plant and also for noise emissions to the community. These specifications enable the oil company to require builders and suppliers of equipment for new plants to provide noise data in their bids in a standard, comparable way. They have been used by British Petroleum Co. for some time in draft form, and Esso Petroleum has used similar specifications for about 5 years. The specifications are:

NWG-1 Procedural specification for limitation of noise in plant;
NWG-2 Noise limitation for individual items of equipment;
NWG-3 Guide to the setting of limits and use of NWG-1 and NWG-2.

NWG-2 consists of the excerpts of NWG-1 of most interest to suppliers bidding on petroleum plant projects. While manufacturers' representative bodies often seek limits set in dBA for simplicity, OCMA felt that at least octave band data were needed for the effective design of new plants.

Part 4 of NWG-1 contains a system for dividing the entire plant area and environs into four types of areas for the purpose of setting limits:

G--general work area limits
R--restricted exposure work area limits
S--speech and work interference limits
C-- community area limits.

Part 5 gives standard forms for equipment noise limits that can be used by the plant operator equally well in the case of user designed plant or contractor-designed plant. Part 2 of NWG-1 details standard noise measurement procedures; Part 3 gives standard calculation methods to be used. These standard calculation methods--one for large and one for small equipment--are not scientifically precise but experience has shown that they are sufficiently accurate to meet the demands of plant situations. For plant design work and for calculating the total effect of an array of installations at a point distant from the plant, the approach of Part 3 is to measure sound pressure levels around sources, convert to sound power figures for each source, and combine the individual power levels to get a total power level that can be converted to sound levels at distant points. The calculation method for predicting noise to the community considers not only ground absorption, but also two degrees of screening.

The plant operator must go through three important steps for controlling noise. First, he must decide on limits for the four types of areas mentioned. In some countries limits already imposed by authorities decide this for him; otherwise he must decide for himself on the basis of "good neighbor" and "good employee relations" considerations.

Second, he must have a way to break down the limits he has chosen into limits for individual items of equipment that can be passed on to suppliers and manufactures.

Third, he must have a standard for measuring the actual noise performance of the completed plant as compared with the specified limits, so that it may be objectively determined whether guarantees by contractors or suppliers have been met. The OCMA Specifications give the plant operator the tools to accomplish steps two and three.

Insofar as guarantees are concerned, the principle is that the user/operator takes responsibility for remote area noise, while the plant designer/contractor takes responsibility for meeting limits within the plant area. This principle has also been seen in operation in other industries, but not in a formalized way.

07-010

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URBAN HIGHWAY PLANNING FOR MINIMUM NOISE

At: American Association For the Advancement of Science, Philadelphia, DEC 29, 1971

Cambridge, Bolt, Beranek, and Newman, 1971, 7p.

Noise control through highway design is discussed.

In Baltimore City a screening procedure has been developed that combines the distance to the projected highway with estimates of future traffic flow and speed to predict a new highway noise level - both its average level and its degree of fluctuation. These predictions are then compared to noise design goals derived from land use and estimates of the existing noise. Using this procedure, ten neighborhoods in Baltimore have been spotlighted as potential problems.

Four case studies on Baltimore neighborhoods are discussed. Highways were designed for noise control by use of earth berms, transparent acrylic shields, and corrugated steel barrier walls.

Noise control designs for projected highways in the North-Central and Northeast Corridors in the District of Columbia should reduce noise impact from 970 dwelling units to 45; from 325 dormitory rooms to zero; from 11 school buildings to zero; and from 54 acres of parkland to zero.

Baltimore City's interstate noise control should cost $3,500,000 - a large figure, but only one-half of one percent of the total construction cost. For the District of Columbia, the additional construction cost is estimated between 0.2 and 0.5 percent of the total project cost, for a sum of $3,600,000 if all sections of the highway network are constructed. Funding is available from the federal government for well-designed noise barriers. The problems of esthetics are being overcome by the more imaginative designers who have accepted the challenge. What is primarily needed now is a broader acceptance of these goals, and a wider application of the handbook methods.

07-011

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CASE STUDY OF REDUCTION OF FACTORY NOISE EMISSIONS

Koojoo Sooon Koogai Taisaku Jitsurei

Sangyoo Koogai

Vol 7 No 5:241-245

As an example of achieving 12 - 15 dB noise reduction at little extra cost, a warehouse was built between a residential area and the factory. The factory which manufactured pipe, was 140 meters long; the residential area was 70 meters away. The residents were mostly employed by the factory. Both employees and residents who were not employees complained, but the latter complained more. Noise sources were clankings between pipe and the roller-conveyors when pipes are transferred, pipe assembly lines, and boring machines. They produced more than 60-70 dBA at the eight different measuring points alongside the residential area.

The factory studied three possibilities for noise reduction: 1) suppression of the noise sources (machines and conveyors); 2) building a wall between the factory boundary line and the highway (33.5 meters wide between the factory and the residential area); and 3) building a noise barrier alongside the residential area facing the highway and the factory. Because of economic factors and probable hindrance of production, the factory abandoned all of the possible plans. Instead, the factory finally came up with the idea of building a warehouse, which was needed for storage, and at the same time getting a noise barrier.

The wall of the warehouse alongside the highway was 5.6 meters high, and 6 meters from the factory boundary line. The wall facing the factory building was 8 meters wide and 11 meters high so that the warehouse could act as a barrier between the factory and the residential area.

After the construction, the noise level conformed with the environmental standard set by Noise Abatement Law of 55 dBA during the night time. Measurements before and after the construction show the amount of reduction achieved.

Measuring Place	Before Construction of Warehouse	After Construction of Warehouse
Boundary Lines (1 and 2)		
1	63 - 73 dBA	57 - 59 dBA
2	62 - 71	52 - 55
Residential Areas (3 to 8)		
3	66 - 71	53 - 58
4	64 - 69	53 - 56
5	64	53 - 57
6	65 - 72	53 - 57
7	71	53 - 57
8	65 - 72	53 - 57
Mean Values	65 - 72 dBA	54 - 57 dBA

PLANNING & SITING

07-012

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NOISE ASSESSMENT GUIDELINES

Washington, Supt. of Documents, USGPO,
SN 2300-1194, 1971, 20p. 70 cents

Paper-and-pencil calculation methods are presented by the Dept. of Housing and Urban Development (HUD) for evaluating the noise exposure of a housing site to intruding noise from aircraft, nearby roads and railroads. Designed as a preliminary screening tool, the guidelines do not constitute HUD policy, but HUD is encouraging their use so that they may be evaluated. The site is placed in one of four categories: Clearly Acceptable (pleasant both indoors and outdoors), Normally Acceptable (some noise exposure, but acceptable indoors with common building techniques and reasonably pleasant outdoors), Normally unacceptable (unusual and costly constructions needed for some indoor quiet, and barriers separating noise source and site needed outdoors), Clearly Unacceptable (the constructions needed for some indoor quiet are too expensive, and outdoors environment is intolerable at any rate).

The category determined for noise from the worst source is deemed the category of the site, even though the categories dictated by noise from other source may be more favorable.

The calculation for aircraft noise presupposes the availability of Composite Noise Rating (CNR) or Noise Exposure Forecast (NEF) contours for the nearby (15 miles or less) airport, but a simple method is provided to construct approximate contours in case a map with CNR or NEF contours can not be obtained. This method involves multiplying the number of night operations (10 pm - 7 am) by 17 and adding this to the number of daytime operations. The resulting number is used to lay out the 30 and 40 NEF contours around the airport's runways.

If the site is inside the NEF-40 (or CNR-115) contour, it is Clearly Unacceptable. If it is between the NEF 30 and 40 contours, it is Normally Unacceptable. When the site lies outside both the NEF 30 and 40 contours, the decision about whether it is Normally Acceptable or Clearly Acceptable depends on how close it is to the NEF 30 contour.

For roadway noise, all major roads within 1000 feet of the site are considered separately, and the worst case controls the determination of the category. Likewise, separate evaluations are made of noise from automobiles and from trucks for each roadway, and the worst case is controlling. For automobile noise, the data required are 1) the effective distance of the road from the site (a function of the distances from the site to the centerlines of the nearest lane and the farthest lane; the effective distance read off of a nomogram); 2) the peak hourly flow of traffic (vehicles per hour, both directions combined). In the simplest case, which assumes a mean vehicle speed of 60 mph, these numbers are plotted on a graph and the category of the site is read off directly. However, for other speeds, and for other factors like the existance of shielding barriers or stop-and-go traffic, appropriate adjustments are made to the vehicles-per-hour number before it is plotted on the graph. (No correction for night-time noise is offered.)

For truck noise, the procedure is roughly the same, but adjustments are made for road gradient. Trucks make more noise going uphill; if the gradient is more than 3% this fact must be taken into account. If the gradient is more than 6%, the effect of the calculation method is to double the effective trucks-per-hour number actually used to plot the noise effect.

The calculation of positive effects from any shielding barriers (either cuttings or fences and berms) is required only when the noise effect is a borderline case between two categories. To make an adjustment for shielding barriers, the input data required are:

- distance between the center of the road and the barrier,
- distance between the site and the barrier
- elevation of the roadway
- elevation of the site
- elevation of the top of the barrier
- height of the building to be erected on the site.

A simplified graphical method, with interrelated sets of families of curves all laid out on one work sheet, is provided to aid in the actual computation.

For railroad noise, on the other hand, nighttime traffic is heavily weighted; a simple table gives the noise exposure category if the railway has more than 10 nighttime operations (10 pm--7 am). For less active railways, the distances from the railroad to the site are adjusted before the table is used.

A final optional evaluation, 'The Walk-Away Test, is a simple on-site method of screening the total noise level from all sources without the use of sound pressure level meters or other equipment, and relating it to probable acceptability as a housing site. Two men make the measurement. One man holds reading material with which both are familiar in such a way as not to block the path between himself and the other man. The other man backs slowly away as the first man reads aloud, not raising his voice in an attempt to maintain communication. At the point where the listener can only understand a scattered word or two over a period of 10 seconds or more, he stops. The distance between the two men is measured. Several trials are taken, with the men changing roles, and the results are averaged. If the test is performed on the site during peak noise periods (e.g., during traffic rush hours) and also at times when the noise is likely to be least annoying (e.g., between 10 pm and midnight), then the averaged distances for the worst trial period may be used to evaluate acceptability:

Distance Where Understanding Becomes Very Difficult	Acceptability Category
More than 70 ft	Clearly Acceptable
26 - 70 ft	Normally Acceptable
7 - 25 ft	Normally Unacceptable
Less than 7 ft	Clearly Unacceptable

07-013

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AUTOMOBILE AND TRUCK TRAFFIC NOISE INTRUSION

In: Lane, S., Freeway and Highway Noises: An Information Base for Urban Development Decisions

Springfield, VA, NTIS, PB 202434, 1971, 90p., (p. 8-42) HC:$3.00 MF:95 cents

A study designed to estimate residential interior noise levels in Los Angeles houses near freeways is presented. In order to determine truck noise and automobile noise as a function of distance from the freeway, generalizations were made from data from four studies in the Los Angeles area and one from Detroit. Because the reporting formats varied, adjustments and approximations had to be made. The reference point for distance was chosen to be the center line of near traffic flow. Measurements made from other reference points were adjusted.

The assumption, substantiated by a separate Michigan study, was made that peak noise levels correlated with truck traffic and the average of the continuous noise level correlated with automobile traffic. A composite of various noise levels as a function of distance from the freeway follows.

Type of Source	Sound Path	Distance (from center line of near traffic flow) 100ft	200ft	500ft
Steady flow traffic (2000-4000 per hour in the near-side lanes), avg. sound level	Unobstructed	75dBA	70dBA	68dBA
	Obstructed	62	57	53
Freeway truck traffic, typical peak sound levels (one peak per truck)	Unobstructed	82	75	68

These composites were then used in the estimation of noise intrusion into the residential areas.

The outdoor background noise (without nearby traffic) was taken to be an average of 50 dBA. Measured background levels for other U.S. communities were taken into account, as well as the following data from Inglewood, in the Los Angeles area:

Location	Time	Range,dBA	Ave.,dBA
Middle of residential area	Day	42-56	48
Periphery of area	Day	52-58	55
Residential area adjacent to main roads	5 am		37
Residential area	4 pm		58

Although adequate theories for noise reduction of assembled buildings are still in the formative stages, a review of observations made in several U.S. cities indicated that, in general, the average noise reduction for traffic noise of residential buildings is 10 dB with windows open and 23 dB with windows closed.

In Los Angeles, residential unit lots start at least 100 feet from the center of the near lanes. There are about three blocks within 1000 feet (or 1/5 mile) of a freeway. Since the average outdoor background noise level in a quiet neighborhood is about 50 dBA, the interior noise level (windows closed) will be about 30 dBA. Combining all the variables, it was estimated that one block from a freeway, auto and truck noise will cause intrusion levels of 15-25 dBA. Three blocks from the freeway, intrusion levels are still greater than 10 dBA. These estimates apply when the sound path is unobstructed, e.g., houses located on a street perpendicular to the freeway.

When the sound path is obstructed (e.g., houses in the middle of a block on a street parallel to the freeway), estimated intrusion levels are about 6 dB less than those given above.

With windows open, the interior background noise is about 40 dBA (50 dBA outdoor background noise level minus 10 dBA noise reduction of the residential building). Again, intruding freeway noise can cause noise levels 10 dBA above background interior levels within three or four blocks of the freeway, and greater than 20 dBA within one block.

The estimates are probably conservative. Although there were few actual measurements to compare with the estimates, observed noise level contours obtained in one residential area were plotted against the computed contours because of differences in attenuation in various sound paths. In this case, actual observed noise levels were significantly higher than was expected, perhaps because of above-average volume of truck traffic and underestimation of noise on nearby surface streets.

07-014

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NOISE CONTROL IN OUTDOOR PROCESS PLANTS, GENERAL DESIGN CONSIDERATIONS AND SPECIAL PROBLEMS

In: Crocker, M., Proceedings of the Purdue Noise Control Conference, JUL 14-16, 1971

Lafayette, Purdue Univ., 1972, 594p. (p. 163-168)

Corrective measures taken in a noisy plant after startup are more costly and less effective than proper design of original plant equipment as long as you know what to do at the design stage.

The remote effect of an outdoor plant depends on the nature of outdoor sound transmission. The designer has little control over this problem. However, the designer can deal, to some extent, with the sound power generated within the plant.

Intense noise accompanies the high rates of heat release inside process plant furnaces. There is a general agreement that combustion roar is the most serious problem. Combustion roar, inherent in today's burners, has to be confined to the firebox. Other design alternatives for noise suppression lack practicality, effectiveness, or both.

Fan noise is produced by turbulence created by blade passage through air. Except for motor fans, external acoustic treatment is rarely practical. Designs that minimize turbulence are used for noise control. Fans are usually the major source of noise in air-cooled motors. In large motors electro-mechanical noise may become important. Some relief from fan noise can be obtained from designs that utilize higher temperature insulation and smaller, unidirectional fans. When fan noise is the problem, external treatment is effective. Acoustically-lined fan covers and enclosures are used for noise control.

Control valves are responsible for nearly all the noise generally blamed on piping systems. Valve noise often persists for long distances. For noise control, there are valves with special low-noise internal design, or inline silencers. Valve designs which limit the internal velocity to substantially less than sonic are most effective. Acoustic lagging is the least effective noise control because of the downstream propagation of valve noise.

Like valves, compressors produce noise of high intensity in a frequency range which spreads easily in the connected pipework. Inlet and outlet silencers may provide sufficient noise reduction without total enclosure. Further technological development is needed here.

In many piping systems, noise can build up in the fluid or more can escape through the pipe, or both, and probably explains why a normally unimportant noise source is occasionally found to be a real troublemaker.

Recent studies suggest that for high speed compressors and valves in gas service, most of the energy will remain in the gas, and inline silencers are most effective. For pumps and valves in liquid service, it appears that most of the energy is transferred to the pipe, suggesting that vibration isolation should be most effective. Flares used to burn excess process gases can be sources of community annoyance. In the simple steam jet, the major source of noise is the highly sheared mixing zone just downstream of the nozzle. Combustion noise and light are the major problems in elevated flares. Flare noise can be reduced to some extent by using multiport steam nozzles. The quicker the steam becomes thoroughly mixed with the inspirated air, the less the noise produced.

To be successful today, specifications should set forth specific minimum design features for noise control.

A process plant should be viewed as a noise producing system. Many sources contribute to the composite noise levels. For each source, some noise reduction can usually be had by several different means, each having its own effectiveness and cost. This suggests that a system approach needs to be taken to assure least-cost designs.

Where design solutions are available, corrective measures taken in a noisy plant after startup are more costly and less effective than proper design of original plant equipment.

PLANNING & SITING

07-015

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OPERATIONAL PROCEDURES

Airport Services Management

Vol 12 No 10:19-20, 1971

Operational procedures already carried out at Wold-Chamberlain Field (Minneapolis-St. Paul) that have reduced aircraft noise include reduction of training flights, installation of more electronic navigational aids, take-off signs, and partial nighttime curfew. Further measures under consideration are extension of the curfew to charter aircraft and the introduction of special ground run-up areas.

Northwest Orient Airlines and North Central Airlines, both of which use Wold-Chamberlain as home base, have cooperated in removing all training flights except the minimum required by FAA for pilot certification. Other training flights use less noise-sensitive airports.

Large yellow and black noise abatement signs installed at the take-off end of five runways request pilot's cooperation; signs also serve as a visible reminder to passengers of the airport's effort to reduce noise.

Aircraft approaching the airport on the back course ILS fly over noise-sensitive areas. The installation of glide slope and marker beacons on the back course ILS, the first of its kind in the US, has furnished the pilot the electronic guidance needed to follow a 3-degree descent slope, insuring higher approach altitudes than before.

After a public hearing in 1970 showed that night operations were the primary reason for complaints, scheduled carriers voluntarily agreed to limit night flights in the 11 pm-6 am period.

Further noise abatement measures are under consideration. The night curfew does not now apply to charter aircraft, which may legally refuse to accept a noise-preferential runway and instead take off at night over heavily populated areas. A proposed field rule would apply night curfew rules to charter aircraft.

A second proposed measure is the designation of a specific ground run-up area chosen to minimize jet engine noise emissions to the community. An interim area may be chosen while a permanent area is prepared, possibly with blast fences to act as noise barriers. The FAA, the airlines and the Metropolitan Airports Sound Abatement Commission must collaborate on the choice of a location.

07-016

Vulkan, G. H.

NOISE FROM URBAN MOTORWAYS

At: Seventh International Congress on Acoustics, Budapest, 1971

Budapest, 1971, 4p.

Guide-lines for the planning and construction of new motorways in London designed to protect the environment were set out in the London Transportation Study. The main points, as they affect noise, are as follows:

(a) In residential areas the motorway should be concealed and normally depressed;
(b) the edge of the pavement should be at least 20 meters from the nearest dwelling, if possible;
(c) where the motorway is depressed, the 20 meter clearance standards can be relaxed but the nearest dwelling should still be at least 12 meters from the edge of the excavation or retaining wall;
(d) In areas of public buildings or urban open space the motorway should be concealed and normally depressed.

The broad policy of the Greater London Council on traffic noise, as set out in the Statement of the Greater London Development Plan, is that: "In its own developments the Council's policy is to protect building interiors from traffic noise to the utmost that modern practice allows, both by careful siting and layout, and appropriate design and construction."

At an early stage in planning, all major road schemes are now studied so as to minimize any damaging effect on the environment. In London, 80% of the lengths of new motorways will follow existing linear features, and about 90 kilometers are routed along railway lines. In urban areas, distance is usually too expensive a method to use for noise reduction, so screening by non-noise sensitive buildings, single aspect design of flats or landscaping can be used.

The methods used for the prediction of future noise levels are based on experimental work carried out over the past 10 years by the Scientific Branch and also on data published by other research organizations. Principally, the factors considered are the predicted traffic volume and composition, the design speed for the traffic, the distance from the motorway, and relative heights of the motorway, intervening buildings or obstructions, and the building being examined. The estimates cannot be precise and are generally made in 5 dBA steps.

The Greater London Council has adopted the recommendations set out in the Wilson Committee Report on Noise, as the standards to be aimed at in all new housing developments. These suggest that in busy urban areas 50 dBA by day and 35 dBA by night should not be exceeded for more than 10% of the time inside dwellings. Methods of achieving those standards for existing buildings near motorways may range from providing openable double windows for bedrooms only, to sealed double windows for both bedrooms and living rooms.

The Greater London Council is urging the Government to recognize for grant purposes unavoidable expenditure in dealing with the noise factor and with daylighting and amenity problems when new motorways are introduced into 'quiet' urban areas.

Before motorway M.1 was opened into the northern suburbs in 1967, a survey in the residential Mill Hill and Hendon areas was carried out to establish existing noise levels. Measurements were repeated on the same day of the week and at the same time. The main conclusions found were that the biggest increase in noise levels due to the motorway occurred at night, up to 14 dBA. In the case of houses whose back gardens were 3-4 meters above the motorway, the noise levels dropped rapidly from the back fence to the back wall of the house, which shows the effectiveness of route selection combined with taking advantage of ground contours.

At Heston, M. 4, at a height of 2-4 meters, passes only 16 meters from typical three-bedroom semidetached houses. As a noise abatement procedure, the simple wooden fences now standing will be replaced by a purpose-built noise barrier 2.5 meters high and consisting of a double skin of plastic with an overall surface density of 12 kg per sq. m.

On the two shorter lengths of motorways within London, the A.102(M) and A.40(M), measurements were also made before and after the opening of the roads. The most striking results were found in Tunnel Avenue and Westcombe Hill, two roads parallel to the A.102(M). When the motorway was opened, noise levels at the front of the houses, which faced away from the motorway, dropped by about 5 dBA (daytime) and rose by about 5.6 dBA at the rear.

In the case of the A.40(M), measurements are not complete. However, in several previously quiet roads consisting of older 3-4 storey houses, noise levels of up to 80 dBA were recorded by day outside windows.

07-017

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NOISE PROTECTION IN A LARGE REFRIGERATION PLANT LOCATED IN A RESIDENTIAL AREA

Laerm-Immissionschutz bei Einer Groesseren Kaeltoanlage im Wohngebiet

Laermbekaempfung

No 2/3:33-35, 1970

The City Hospital in Essen, Germany had to expand its refrigeration plant to provide air conditioning.

The neighboring residences were located only 30 meters away in a totally residential area, where the noise level could not exceed 35 dBA during the night. Therefore special sound protection measures had to be used in order to comply with the prescribed standards.

After two prospective cooler sites (A&B) were established, considerable measurements were taken at 6 measuring points in order to determine the noise levels and thereby the appropriate location. The noise levels at cooling tower A at a thirteen (13) meter distance reached 65 dBA when in full operation. The background noise there reached 57 dBA. The Cooling Tower location B showed noise levels of 63 dBA at a 13 meter distance.

Therefore the noise level had to be reduced by about 30 dBA by means of damping devices.

Absorbant materials staggered in baffle boxes on the ducts were chosen. After these devices were installed, measurements were taken between midnight and 1 o'clock at night at the nearest home, with the following results:

Number of Coolers in use	Noise Levels Full Power (dBA)	Half Power (dBA)
4	48	42
2	46	42
1	44	41

PLANNING & SITING

07-018

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TRAFFIC NOISE IN WARSAW, GDANSK AND POZNAN

Untersuchungen Ueber den Verkehrslaerm in Warschaw, Danzig and Posen

Laermbekaempfung

No 3:65-69, 1969

In 1966 the Institute for Building Technique (ITB) in Warsaw conducted its first survey on traffic noise in Warsaw. Later the cities of Gdansk and Poznan were included.

As a result, uniform measurement and noise maps and a catalogue with the acoustical characteristics of various city planning elements were prepared. These were later used as a basis for aviation, city, traffic, and railway noise measurement investigations. Measurements were taken in:
1) Warsaw at 1500 measuring points and included aviation, railway, truck and street car noise,
2) Gdansk at 500 measuring points (railways, truck and street car noise),
3) Poznan at 100 measuring points (truck and street car noise).

The heaviest traffic intensity was between 1-5 pm, with hardly any variations between the time span, whether 20 or 240 minutes. During that time the traffic noise level reached above 90 dBA in the heart of Warsaw.

The surveys and noise maps have produced valuable material for future projects and further city planning.

08-001

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A CRITICAL LOOK AT AN AIRPORT CONTROL ORDINANCE

American Industrial Hygiene Association Journal

Vol 32 No 7:480-487, 1971

Growing airport development and advancing aircraft technology have not only resulted in higher noise levels, but in public awareness as well. As a result, ordinances regulating aircraft noise have been passed. Noise regulations are now in effect at London's Heathrow Airport, and in New York. A critical look at these ordinances is presented.

The State of California has proposed the most complex regulations against aircraft noise to date. The two-fold purpose of their regulations is: 1) to bring about cooperation between airport personnel and the community, and 2) to impose penalties on aircraft operators exceeding set noise limits. The proposed regulations are based on perceived acceptable noise limits of the communities surrounding the airports and the economic and technical feasibility of complying with the standards. The regulations contain eight separate airport classifications based on traffic density and aircraft type. Maximum single event noise exposure levels are established for each type and measured as the noise exposure level for a single event with a duration of 10 seconds. Any aircraft exceeding specified limits would be committing a misdemeanor and the operator could be subjected to a $1,000 fine. To maintain these standards, elaborate noise monitoring equipment will have to be used 24 hours a day. The airport operator is responsible for the monitoring and maintaining records, county inspectors to review the records.

Economic questions arise. Typical installation at Los Angeles International Airport will initially cost $200,000 to $250,000 to monitor 4 runways on a 24-hour basis at 30 points surrounding the airport. Installation, operation and maintenance will cost about $1,000,000 for the first year.

Older jet aircraft will have to be retrofitted with noise attenuation kits to meet regulations. It will not be feasible to enforce regulations until then.

Although unduly complex and very costly, it is felt that the proposed regulations will accomplish a much needed reduction of noise levels in and around U. S. airports.

08-002

THE FIRST TRUCK RESTRICTION ON FEDERAL HIGHWAYS DURING NIGHTTIME

Erstes Lastkraftwagen Fahrverbot auf Bundesstrassen fuer die Nachtzeit

Kampf dem Laerm

Vol 18 No 6:166, 1971

The first truck restriction on Federal highways was passed in Hessen, Germany. The law passed in Hessen pertains to Highway 354 between Alsfeld and Homberg in North Hessen for night-time between 10 P.M. and 6 A.M., and restricts the passage of trucks over 4 tons.

Minister Karry explained that all attempts must be made to restore peace at night to citizens living near Federal highways. It is unfortunate that the restriction does not apply to other main routes in Hessen as well. Consideration was given to the citizens instead of to the freight industry in this case because a parallel route was available that could be used by trucks instead of Highway 354.

08-003

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A PROTOTYPE STANDARD AND INDEX FOR ENVIRONMENTAL NOISE QUALITY

At: The Eighty-Second Meeting of the Acoustical Society of America, Denver, OCT 21, 1971

Mclean, VA, Mitre Corp. 1971, 11p.

Author

A prototype technical standard for environmental noise is proposed in terms enabling an index of noise quality to be defined and calculated. The standard takes into account the damaging aspects of chronic exposure to loud noise as well as psychologically disturbing aspects of typical community noises which are not loud enough to be physically dangerous. Inasmuch as the standard is intended to portray environmental quality rather than to reflect damage risk criteria, it is generally conservative with respect to work-related noise standards, such as those specified by the Walsh-Healey Act. The basic standard specifies a distribution of noise intensities to which an individual might be exposed in a 24 hour period. The distribution may be approximated by the composite of three Gaussian distributions with means and standards deviations of (30 and 3), (50 and 8.5), and (70 and 14) dBA. These component distributions correspond to 8 hour periods for sleep, miscellaneous daily activities, and work, respectively. Alternative strategies for obtaining data for calculating the related noise quality indices are discussed.

08-004

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NEW HEALTH NORMS ON NOISE

Novyye Sanitarniye Normy po Shumu

Gigiyena Truda i Professional'nyye Zabolevaniya

Vol 14 No 5:47, 1970

"Health norms and regulations on noise abatement in areas and rooms of industrial enterprises," No. 785-69, promulgated by the Ministry of Health of the Soviet Union on April 30, 1969, was elaborated by the Laboratory for Noise and Vibration of the Institute of Labor Hygiene and Occupational Diseases. The norms and regulations were based on in-house documents and international recommendations. The document establishes permissible noise levels, conditions and specifications for measuring it, basic measures for noise abatement and for prevention of harmful effects.

The norms regulate the maximum permissible spectra of noise using the family of criteria curves recommended by the TK-43 Committee on Acoustics of the ISO. Rooms used for intellectual work (offices, design bureaus, etc.) have a maximum permissible noise limit equivalent to about 50 dBA; rooms for office work (typing pools, rooms with office calculators, etc.), 60 dBA; control consoles and observation rooms, 65 dBA; laboratories with noise sources, 75 dBA; and work areas in rooms and areas of industrial enterprises, 85 dBA. The norms allow for corrections for duration of the noise during the work shift and for the character of the noise (a correction of 5 dB is allowed for tonal or impulse noise measureable by a standard noise level meter).

The norms also indicate measures for technical and medical prevention of adverse effects of noise. They require periodic medical observations of persons working under noise conditions beyond the permissible levels and give contraindications to employing persons in noisy shops. These are based on domestic research on the effects of noise not only on the auditory organs, but on the organism as a whole. The norms allow for elaboration of departmental norms on noise, with subsequent promulgation by the Ministry of Health of the Soviet Union and by the State Construction Agency of the Soviet Union (Gosstroy SSSR). These are to be based on ergonomic requirements and not solely on established maximum permissible levels of noise.

LEGISLATION & STANDARDS

08-005

Lesser, J.

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THE AIRCRAFT NOISE PROBLEM: FEDERAL POWER BUT LOCAL LIABILITY--PART I

The Municipal Attorney

Vol 13 No 1:13-21, 1972

It is largely because of aircraft noise that new desperately needed airports cannot be developed and existing air terminals cannot be expanded.

Since 1815, courts have been deciding questions of who owns the air above property. The first Supreme Court decision on aircraft noise came in 1946, in the case of United States v. Causby. The court found in favor of Causby, ruling that the low aircraft altitudes caused trespass and nuisance. The owner and operator of the aircraft was held liable; the case did not involve possible liability of the airport operator.

In 1952 local government attempted its first regulatory role in the field of air traffic control. The Village of Cedarhurst, NY, near Kennedy International Airport, enacted an ordinance forbidding aircraft flyovers at less than 1,000 feet altitude. The Airline Association and Port of New York Authority brought suit in Federal Court to enjoin enforcement and were upheld. A similar ruling was made in New Jersey in 1954. Three 1958 Court of Claims decisions, all on cases modeled after Causby, awarded compensation for de facto taking of easements. Since each suit dealt with military aircraft, the government was held liable as owner and operator.

08-006

Lesser, J.

Port of New York Authority, NY

THE AIRCRAFT NOISE PROBLEM: FEDERAL POWER BUT LOCAL LIABILITY--PART II

The Municipal Attorney

Vol 13 No 2:30-39, 1972

The impact of the Supreme Court decision rendered in the Griggs litigation against the operators and users of the Greater Pittsburgh Airport is discussed. This 1953 litigation was a test case. The Board of Viewers awarded $12,690 to Griggs for the condemnation of his property as of the day in 1952 when the Pittsburgh Greater Airport opened.

Federal courts have held that before a property can be condemned aircraft must physically invade the landowner's airspace. On the contrary, some state courts have ruled that lateral flights can constitute compensable takings within the meaning of constitutional standards. The burden of proof that property has been constitutionally appropriated is in dispute, as well as the statute of limitations.

The effect of the Griggs ruling was to direct property owners to sue the airport operator in an inverse condemnation action, thus placing the financial burden on the segment of the aviation community least able to do anything about it. In a recent inverse condemnation action involving over 1,500 plaintiffs owning 750 separate residential properties in the vicinity of Los Angeles International Airport, total damages of $750,000 were awarded. Similar awards have been made in other states.

Local ordinances have generally been defeated, but have prompted regulatory action by airport authorities. Zoning laws by themselves have not been much help in fighting aircraft noise, because when they limit the use of property of existing owners, they constitute a taking of private property without compensation.

The 1968 Federal legislation on aircraft noise requires the FAA not only to prescribe standards for measuring noise, but also issue rules for its control and abatement. In 1969 the FAA's standards for noise took effect. Unfortunately, the noise standards were not as strict as airport neighbors and airport operators had hoped, since the FAA had previously stated that noise levels of 106 EPNdB measured at three statute miles from the start of take-off roll, one statute mile from the landing threshold, and 1,500 feet from the centerline of the runway were 'well within the state of the art.' Yet, the FAA's rule would permit noise levels on very heavy future aircraft to reach 108 EPNdB at measuring points farther from the runway than originally proposed and contains a "trade-off" provision which would mean that noise levels as high as 110 EPNdB would be permissible. Since the EPNdB scale is constructed on logarithmic base, the difference between 105 and 110 EPNdB alone would reflect about a 50 percent increase in annoyance. The "trade-off" provision would allow noisier take-offs and landings, for instance, if they were compensated for by a reduction in sideline noise. In addition, the rule was further diluted by exempting the initial group of approximately 160 Boeing 747's, the jumbo jets, from its coverage. However, the FAA makes no claim that the rules are acceptable or unacceptable for particular airports.

LEGISLATION & STANDARDS

08-007

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NOISE REDUCTION DESIGN SPECIFICATIONS FOR A SOUNDPROOFING ORDINANCE FOR SINGLE AND MULTIPLE FAMILY DWELLINGS

In: Inglewood's Community Review Program: Final Report

Inglewood, CA, City of Inglewood, 1972 (p. 64-68)

The City of Inglewood proposed a special residential sound proofing ordinance because of Inglewood's particularly high exposure to aircraft noise from Los Angeles International Airport and aircraft operations associated with it. However, the ordinance is not applicable to communities generally or even to those impacted by aircraft noise, without further study of the particular local conditions. These conditions include housing practices in the area and the particular aircraft noise environment.

The zones and design criteria envisage a two stage reduction of noise levels inside single and multiple family dwellings. They were developed primarily from the results of soundproofing programs in a localized area around the airport. For the Inglewood area, residential areas outside the 65 CNEL contour need only normal housing construction to provide an acceptable noise environment indoors.

Areas in the 65-75 CNEL range require that the building construction provide a reduction of 28 dBA, and those inside the 75 CNEL contour need a 35 dBA reduction, which appears the practical limit without detailed soundproofing studies and designs in each new construction at extreme increases in cost. Zones in the soundproofing ordinance bounded by the 65 and 75 CNEL contours seem the best choice for specifying two stages of soundproofing, with the goal of providing uniform indoor noise environments for all the dwellings in Inglewood. These zones are to be selected not on present CNEL contours, but rather on those estimated for the year 1980.

New housing (and additions costing more than $10,000) in the 65-75 CNEL contour interval must provide at least 28 dBA noise reduction with all external doors and windows closed, according to the proposed ordinance, which specifically requires certain construction features. These features include an air conditioning system, interior fiberglass linings in air ducts, solid core external doors, special workmanship on external doors and windows, and well-fitting dampers on chimneys. Prohibited outright are direct openings to the outside such as mail slots. Also prohibited are jalousie windows and skylight constructions (unless the skylights provide overall reduction of at least 28 dBA).

Requirements within the 75 CNEL contour are for a noise reduction of at least 35 dBA. In addition to the specific construction requirements needed for 28 dBA reduction the following are mandatory: external doors of sealed acoustical design with an STC rating of at least 36 dB; sealed acoustical double-glazed windows with an STC rating of at least 39 dB; vents to the outside having fiberglass lined baffle boxes in addition to the normal grills. The use of exposed beam ceilings is prohibited unless special plywood and fiberglass acoustical treatment is provided between the ceiling and roofline. Details of this treatment, or its equivalent, are specified.

The Building Director would have the power to require changes in design plans that he deems necessary to meet the 28 dBA and 35 dBA noise reduction requirements, according to the proposed ordinance. Details of field tests are to be specified.

08-008

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A FRESH BREEZE IN STANDARDS WRITING

Sound and Vibration

Vol 5 No 11:24-27, 1971

Noise ratings for mass consumer oriented products are complicated by the number of requirements such ratings must satisfy:
1) rank-order the noisiness of various models and brands of a products; 2) relate the noisiness to sounds familiar to the consumer so that he may easily interpret the rating number; 3) provide repeatable measurements, so that the manufacturer can be sure of conformance, avoiding the possibility that he will have to redesign; and
4) be simple enough to be approximated in the home rather than the laboratory, for purposes of preliminary screening by regulatory officials in the field.

LEGISLATION & STANDARDS

The office of Noise Abatement and Control welcomes the cooperation of the various professional societies in developing measurement standards, because a combination of voluntary action and regulation will mean better progress in noise control than regulation alone.

08-009

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NOISE AND THE COMMUNITY

Annals of Occupational Hygiene

Vol 14 No 2:109-117, 1971

Increasing attention is being paid to neighborhood noise from industrial plants and increasing costs are being incurred in noise control. The first step in neighborhood noise control is a realistic assessment of noise as a nuisance or source of discontent. The legal position in Great Britain is reviewed and the problem of insufficient information on public response to the relatively low level of noise generated by industrial plants is discussed.

The ideal is obviously that no one should be disturbed, and the only way to do this is to keep industrial noise totally from the community. However, this is unreasonable, and so perhaps the most common criterion is that noise be kept as unobtrusive as possible without causing widespread or persistent complaints.

The British Standard BS4142 (British Standards Institution, 1967) sets the following procedure for predicting noise complaints:

1) A "corrected criterion" is calculated based on factors such as the type of neighborhood, the location of the plant in relation to the neighborhood, and the time of day the noise occurs.

2) A measurement is made of the background noise alone (without the noise from the factory) if possible.

3) The noise level from the factory is corrected by factors such as noise character to determine the "corrected noise level."

4) The corrected criterion, together with the background noise, is compared with the corrected noise level to determine the likelihood of complaints.

Generally, if the corrected noise level equals the corrected criterion, complaints are not likely to occur. If it is 10 dBA higher than the corrected criterion, complaints are likely.

The Standard only enables assessment of the problem and the prediction of complaints; it does not set criteria for acceptability or limits. It seems to be a fairly reliable guide, although one shortcoming is that the measured nightime background noise level is often significantly lower than the corrected criterion. Actual background noise level can vary from urban to rural areas and is greatly affected by transient noises such as intermittent traffic, dogs barking, and wind noise. Besides these factors, wide variations exist depending on local activity and noise from distant sources.

08-010

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ACTIVITIES REPORT FOR 1971

Taetigkeitsbericht 1971

Duesseldorf, Verein Deutscher Ingenieure, 1971, 33p.

The Annual Report for 1971 of the Commission on Noise Abatement of the German Engineer Association details its activities in the field of noise abatement and control.

As of December 1971, membership in the Commission amounted to 300 voluntary workers. It is subdivided into sub-commissions and groups concerned with the following noise areas: 1) industrial noise, 2) traffic noise, 3) residential noise, 4) effects of noise, 5) application of measurement methods, 6) special problems, and 7) less noisy construction.

The first colloquium of the Commission was convened in 1971 and covered the theme of 'Noise Reduction in Rail Traffic".

LEGISLATION & STANDARDS

The Commission on Industrial Noise met twice with the Commission on the "Application of Measurement Methods" and drafted a number of guidelines, one of which became a DIN-norm. Many of these guidelines resulted from efforts of sub-groups working on the various subjects of industrial noise and some tasks were even undertaken by private firms.

The Commission on Traffic Noise with the cooperation of the sub-commission on "Rail Noise" held a colloquium entitled "Noise Reduction in Rail Traffic" on FEB 9, 1971, in Duesseldorf, with not only domestic but also international participation.

In FEB, 1971 the sub-group on "Rail Noise" drafted a guideline on Noise Measurements in Rail Traffic, which will be printed as a DIN-norm, after its revision.

The various other sub-commissions and groups concerned with the aspects of traffic noise were preoccupied with other research tasks and the drafting of guidelines.

The Commission on "Residential noise" met in OCT 28, 1971 in Duesseldorf. The main purpose of this conference was the discussion on the draft of the VDI 2719 guideline on "sound-damping of windows," produced by the sub-commission by the same name. It was decided to reedit the draft and a spring 1972 publication date was set.

Other sub-groups dealing with elevators, heating systems, armatures and home appliances, in general, have also dealt with noise control and the establishment of guidelines in these areas.

The Commission on Measurement Methods has been busy with other sub-commissions on guideline draft VDI 2058 "The Assessment of Occupational Noise within the Neighborhood". This commission also convened study conferences, such as the "Noise Reduction in the Bottling Industry" conference held in Munich in OCT, 1971. All manufacturers and operators of bottling plants agreed to conduct measurements and compile all pertinent data in order to coordinate plant measurement technology with DIN 45635 "Noise Measurements in Machines."

The VDI-Commission on Noise Abatement made plans to draft guidelines on the "Constructive Measures Toward Noise Reduction - General Principles" and "Constructive Measures Toward Noise Reduction - General References".

The importance of this work was stressed in a meeting in DEC and a "Sofort" (Priority) plan was initiated for the drafting of those guidelines. Part of the work is to be finished by mid-MAY 1972.

In sum total the Commission has drafted over 18 guidelines, some of which have already been published.

08-011

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A NEW COMPREHENSIVE CITY NOISE ORDINANCE

In: Crocker, M., Proceedings of the Purdue Noise Control Conference, JUL 14-16, 1971

Lafayette, IN, Purdue Univ, 1972, 594p., (p. 263-268)

Chicago's quantitative noise ordinance, passed in 1957, set a nationwide example, but increased urban noise required design of a new ordinance which, after a preliminary study and extensive hearings, was passed in MAR 1971 and went into effect in JUL 1971. The main source of thrust of the new ordinance is directed at motor vehicles. Sales and operational limits are both used. By 1980 all vehicles manufactured to be sold in Chicago must meet a 75 dBA criterion at 50 feet from centerline of travel. By 1978 vehicles travelling at 35 mph or less in the City must emit no more than 78 dBA (motorcycles) and 70 dBA (cars), respectively, at the 50 ft distance. Trucks (= any motor vehicle with gross weight of 8000 lb or more) travelling 35 mph or less must emit no more than 86 dBA at 50 ft by the beginning of 1973, including noise from their auxilliary equipment.

In the month before the new ordinance went into effect, vehicle measurement teams measured about 200 motorists per week, both to develop proper enforcement techniques and to provide motorists with a courtesy warning. In the first week of actual enforcement, 48 vehicles were given citations, almost all of which were trucks.

Restrictions on the sale or leasing of noisy powered equipment or hand tools is given in the following table:

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Type of Equipment	Noise Limit at 50 ft
(1) Construction and industrial machinery--not including pile drivers, manufactured after:	
1 JAN 1972	94 dBA
1 JAN 1973	88 dBA
1 JAN 1975	86 dBA
1 JAN 1980	80 dBA
(2) Agricultural tractors and equipment manufactured after:	
1 JAN 1972	88 dBA
1 JAN 1975	86 dBA
1 JAN 1980	80 dBA
(3) Powered commercial equipment of 20 HP or less intended for infrequent use in a residential area, such as chain saws, powered hand tools, etc., manufactured after:	
1 JAN 1972	88 dBA
1 JAN 1973	84 dBA
1 JAN 1980	80 dBA
(4) Powered equipment intended for repetitive use in residential areas, such as lawn mowers, small lawn and garden tools, snow removal equipment, manufactured after:	
1 JAN 1972	74 dBA
1 JAN 1975	70 dBA
1 JAN 1978	65 dBA

Restrictions on the sale or leasing of recreational vehicles are as follows:

Date of Manufacture after:	Noise Limit at 50 ft
Snowmobile	
1 JAN 1971	86 dBA
1 JUN 1972	82 dBA
1 JUN 1974	73 dBA
Any other vehicle, including dunebuggie, all-terrain vehicle, go-cart, mini-bike	
1 JAN 1971	86 dBA
1 JAN 1973	82 dBA
1 JAN 1975	73 dBA

A further restriction on the operation of recreational vehicles is that they may not be operated on property zoned for business or residential use so as to create noise levels exceeding 86 dBA at 50 ft. This limit will be tightened to 82 dBA at the beginning of 1973.

A restriction on the operation of motor boats operating in the harbor of Chicago, or anywhere on Lake Michigan within two miles of the city limits, is that they may create noise levels of no more than 85 dBA at 50 ft. This limit will be tightened to 76 dBA at the beginning of 1975.

Measurement of all the limits listed above are to be made in accordance with ANSI, SAE, and IEEE standards specified in the law.

Noise at the boundaries of construction sites is not covered in the new ordinance because it was felt that more technical data was needed. Data needed to design noise limits on construction sites is now being gathered. Meanwhile, disturbing the peace statutes, persuasion, and the limit on operating hours are all being used to achieve some control over construction site noise.

Noises emitted from buildings or equipment on property is covered by the old ordinance, which has been modified in the new ordinance in three ways:

1. Introduction of the new preferred octave band center frequencies.
2. Use of the "A" scale (use of dBA units) for monitoring purposes.
3. Noise limits are now applied to the lot lines of business, commercial, and residential property, instead of to the zoning district boundary lines as before.

08-012

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URBAN NOISE LEGISLATION

In: International Conference on Transportation and the Environment, Part II
MAY 31-JUN 2, 1972

New York, Society of Automotive Engineers, 1972

The sources of noise in urban areas, existing regulations in Chicago to control such noise, and needs for additional legislation are discussed.

Transportation noise is the major source of noise in Chicago. Trucks operate in close proximity to residential dwellings. Trucks on inner city expressways, operating at night at higher speeds that make tire noise a more severe problem, create a very intrusive noise

LEGISLATION & STANDARDS

problem because of lower background noise levels at night. Specialized truck noise problems occur when large numbers of refrigerated vans stand at terminals with motors left running, and when scavenger refuse pickup trucks (engine noise plus noise from the packer unit) and oil delivery trucks (pump noise) operate at night.

In addition to trucks, automobiles and motorcycles can be noise problems when the exhaust muffler systems are defective or modified. Automobile horns are another problem, especially when used for prodding traffic or alerting passengers waiting to be picked up.

The older elevated system in Chicago is a nuisance to the community 24 hours a day. The subway system affects only its passengers, but is a more severe problem in the summer when train windows are open.

Railroad noise comes not only from pass-bys on the right of way, but also from switchyards, where diesels are run night and day. A new noise problem is the loading of "piggy-back" trucks onto railroad cars in the railroad yard near residential areas--both the noise of the diesel-driven loading equipment and the trucks themselves, which are often refrigerated and left standing with equipment running. Train whistle intensity, which has been increased to penetrate the newer sound proof cars, is another problem.

Chicago has three regulatory instruments for dealing with transportation noise: limits on new equipment sold for use in Chicago (Table 1), limits on use (Table 2), and limits on noise levels at boundaries of Zoning Districts.

Table 1 - Sale of new vehicles

Vehicle Type	Date of Manufacture	Noise Limit at 50 ft. from center line of travel, dBA
1) Motorcycles	before 1 JAN 1970	92
Same	after 1 JAN 1970	88
Same	after 1 JAN 1973	86
Same	after 1 JAN 1975	84
Same	after 1 JAN 1980	75
2) Trucks (gross weight of 8,000 lbs. or more)	after 1 JAN 1973	86
Same	after 1 JAN 1975	84
Same	after 1 JAN 1980	75
3) Passenger cars, (and any other motor vehicle)	before 1 JAN 1973	86
Same	after 1 JAN 1973	84
Same	after 1 JAN 1975	80
Same	after 1 JAN 1980	75

The manufacturer, distributor, importer, or designated agent shall certify in writing to the Commissioner that his vehicles sold within City comply with the provisions of this section.

Table 2 - Maximum noise levels during operation of motor vehicles under any condition of grade, load, acceleration or deceleration.

Type of Vehicle	Noise Limit at 50 ft. distance in Relation to Posted Speed Limit: 35 MPH or Less (dBA)	Over 35 MPH (dBA)
1) Trucks (gross weight of 8,000 lbs. or more)		
before 1 JAN 1973	88	90
after 1 JAN 1973	86	90
2) Motorcycles		
before 1 JAN 1978	82	86
after 1 JAN 1978	78	82
3) Passenger cars (and any other motor vehicle)		
after 1 JAN 1970	76	82
after 1 JAN 1978	70	79

This section applies to the total noise from a vehicle or combination of vehicles.

As Tables 1 and 2 show, lower limits will be required in the future. One automobile manufacturer removed six car models from the Chicago market because they did not meet Chicago's law. Three of these models were reinstated after exhaust systems were redesigned.

The problem of several trucks with refrigeration units running simultaneously on a factory property can not be handled with the motor vehicles codes, because the individual units can all meet the noise limits. However, in these cases the property line noise limits can be used to regulate the nuisance.

In Chicago's enforcement program, most of the citations were given to trucks (nearly 50%) followed by cars and motorcycles. In addition, 1800 complaints were responded to, not all of which proved to be violations. Most frequently complained about were air conditioners, construction noise, scavenger trucks, other trucks, factory noises and musical instruments. Even when there was no violation, the Department of Environmental Control made suggestions for quieter operation, such as moving the air conditioner to another location. In a case involving residential complaints about "piggy-back" unloading in a railroad yard, a violation of the district zoning noise

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restriction was found. Action was taken inducing the railroad to undertake a major noise reduction program, including removal of refrigeration units to a different yard and design of sound absorbant enclosures for the diesel engine and mechanized arms of the unloader. The program will gradually reduce noise from the railroad yards to the legal limit of 55 dBA at the residential/manufacturing zone boundary line.

Excessive hornblowing has been controlled using the provision of the ordinance prohibiting use of any audible device on a moving vehicle unless it is an emergency, and no use whatsoever while the vehicle is standing. This provision is also used to restrict excessive noise from ice cream trucks.

A drawback to the present limits on sales of new vehicles is that the manufacturer may be faced with a multiplicity of local and state requirements. Uniform federal regulation of noise from new equipment would ideally solve this problem, and still give local governments the option of setting more stringent use requirements.

Local restrictions would be needed even if Federal restrictions on noise sources were set. One example is trucks accelerating from a stop sign in a residential area. Another example is the grouping of trucks with refrigeration units, although the individual trucks could meet Federal limits. Finally, construction equipment could meet Federal standards individually but when operating all at once on a construction site, create a community noise problem that should be regulated locally.

Another problem is that it is financially impossible for cities like Chicago, New York, and Boston to replace existing mass transit systems with something quieter. Controlling this noise source will be a slower process, with the gradual purchase of quieter equipment and installation of smoother rails. Cities building new systems should not repeat the mistakes made by those with existing systems.

A problem in enforcing against railroad noise is that noisy rolling stock is owned by dozens of different lines, and the local yard has little control over what comes in. This is a suitable area for Federal action.

Proposed Department of Transportation standards for noise from new expressways--recently revised to 70 dBA at the property line--will be only marginally useful in protecting adjacent residential communities because the 70 dBA number is too high. Noise problems around existing airports occur because buildup of residential communities close to traffic patterns has been allowed. With present knowledge of airport noise, it should be possible to avoid similar problems in the future through land use planning. Information of the design guide type, supplied by several Federal agencies, can be useful only if it is incorporated into the development and growth of our urban areas. The EPA should provide both technical and financial assistance to state and local agencies.

09-001

Schenker-Spruengli, O.

Schweizerische Liga Gegen den Laerm
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PROGRESS OF NOISE ABATEMENT IN SWITZERLAND

Fortschritte der Laermbekaempfung in der Schweiz

Laermbekaempfung

No 3:27-28, 1969

Since 1957 Switzerland has established a Federal Expert Commission for Noise Abatement. It consists of 52 experts and is divided into 5 sub-commissions dealing with the following problems:

1) Medical, acoustical and technical principles,
2) Motor vehicles, Railroads, Ships and Cable cars,
3) Aviation noise,
4) Construction and industry noise, Sound protection in buildings, etc.,
5) Legal problems.

It has accomplished considerable progress with the cooperation of the Swiss League Against Noise. The biggest enlightment action resulted in 1962 through the conference of city police directors in which 150 communities participated. In 1963 a special instructional course in Noise Abatement and Control for law enforcement groups was conducted in Zurich. The League also conducted 4 big scientific conferences, 6 technical exhibits and numerous demonstrations concerning the practical and technical aspects of noise abatement.

One big progress is the establishment of the recommended noise levels. The noise levels are measured on a dBA scale according the CEI publication #123 taken in an open window.

Background Noise		Frequent Peaks		Occasional Peaks		Zone
Night	Day	Night	Day	Night	Day	
35	45	45	50	55	55	A
45	55	55	65	65	70	B
45	60	55	70	65	75	C
50	60	60	70	65	75	D
55	65	60	75	70	80	E
60	70	70	80	80	90	F

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A - Recreational areas
B - Quiet residential areas
C - Mixed areas
D - Commercial areas
E - Industrial areas
F - Main traffic artery

Desirable Values: about 10 dB less, however not below 30 dBA
Background noise: mean value (average level, without peaks)
Frequent Peaks: 7-60 sound peaks per hour
Low Peaks: 1-6 sound peaks per hour

Also many other reasons and ordinances were instituted, for instance: the health insurance was revised to incorporate hearing loss as an insured occupational illness; the establishment of Noise Abatement Commission in various cantons and cities; and Noise Abatement offices supervised by the police in many cities, as Basel, Bern, Lausanne, Luzern, Lugano and Zurich. Zurich's office is an examplary and most active one.

The biggest battle is civil supersonic overflight. Much has been done, although much still remains to be accomplished.

09-002

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NOISE CONTROL LEGISLATION IN FLORIDA

At: Noise Control Workshop, Harriman, NY, JAN 18, 1972

Tampa, University of South Florida, 1972, 4p.

Activities of the Florida Legislature in the area of noise control are discussed. The State Environmental Protection Agency has been given authority to set standards. The State's particular interest is vehicular noise and it will set up noise test equipment at its Motor Vehicle Inspection stations.

State and local governments are interested in controlling noise, but are not yet willing to fund it. There are no noise control experts on the State EPA staff.

Most local ordinances are "do not disturb the peace" variety except for a few which set noise limits. For instance, a cement plant was forced to close when it could or would not bring its noise down to acceptable levels.

A survey was made by acoustics students of the University of South Florida to test the effect the new proposed standards, such as the Chicago Ordinance, would have on the noise level. The results showed a small percentage of violators. Among those found, the worst offenders were trucks and motorcycles.

Florida hopes that the new national noise standard for vehicles will be set considerably lower than those of the present Chicago Ordinance and that the enforcement will become part of the annual motor vehicle inspection program.

09-003

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THE PROBLEM OF NOISE: HAS ANYONE HEARD AN ANSWER?

Popular Government

Vol 38 No 2:16-19, 1971

A discussion of noise pollution and laws, ordinances and legal actions which involve noise is presented.

Noise is generally defined as unwanted sound. Too much exposure to it obviously induces hearing loss, along with heart disease, migraines, intestinal disorders and some allergies. It also interferes with conversation, hinders concentration and disturbs sleep.

A study of the Maban tribe in Africa revealed that its noise-free society left 70 year old men with hearing as acute as the average 20 year old New Yorker. An estimated 5,000,000 American males from ages 10 to 59 have some degree of hearing loss, and 1,000,000 need hearing aids.

A number of legal tools against noise are available and have been put into effect in some areas of the U.S. The private nuisance action, for instance, has been used to a small degree in North Carolina. This is a civil tort, and to be used, the interference must be both a substantial and a legal cause of the harm involved. Public nuisance affects the public as a whole. Anything acted upon under this action must interfere with public health, safety and peace. The nuisance ordinances now in effect are very vague. There is no clear guideline as to what really creates a nuisance. Furthermore, citizens themselves, may be unwilling to go through the trouble and expense of court action.

ENFORCEMENT

In North Carolina, a farmer complained that aircraft take-offs and landings in the space directly above his chicken farm were an unconstitutional taking of his property (U.S. v. Causby). He was awarded damages under the inverse condemnation principle, which has been applied only against aircraft.

Antinoise laws must be aimed at preventing or controlling noise. Most of the traditional laws are zoning, antinoise ordinances, and muffler controls; some of the new measures are called decibel ordinances.

If used properly, zoning can be a great aid in noise abatement and control. It can separate industry and busy highways from residential areas, for example. In order to be effective, however, it must be used in conjunction with other planning efforts.

California, Connecticut and New York have all enacted decibel ordinances with maximum noise levels which traffic noise must not exceed. Although difficult to enforce, traffic noise has been reduced.

The answer to noise control lies in the cooperation of industry, government, city planners and individual citizens.

09-004

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ANNUAL REPORT 1971 OF THE NOISE ABATEMENT OFFICE

Jahresbericht 1971 der Laermbekaempfungsstelle

Zurich, City Police, JAN 4, 1972, 3p.

Activities and actions of the Noise Abatement Office of Zurich during 1971 are outlined in the Office's Annual Report.

The Noise Protection Law of 1971 was promulgated by decree of the Zurich Municipal Council. The law was reviewed by the Cantonal Health Office and put into effect on SEPT 1, 1971. This law has been quite effective and successful in the enforcement of the prescribed noise measures during the 4 months since its promulgation.

The 'Zurich Environmental Protection Week' took place between MAY 3-8, 1971. The program was arranged by the Acoustics Department of the Health Inspection Office and the Noise Abatement Office of the City Police. A film produced by the City Police, entitled 'Noise', was shown in various neighborhood movie-houses and in schools throughout the week.

The whole teaching community was requested to dedicate at least 2 hours of their teaching program on the environmental topic. For this purpose, a document was distributed to the teachers. One section of the document entitled, "Will we, should we, destroy ourselves by Noise" was prepared by the Noise Abatement Office.

The tasks and methods of the Noise Abatement Office were investigated by BBC of London and Norwegian TV. Officials from London, Washington and other parts of Switzerland also visited the office.

The following statistics show actions of the Noise Abatement Office recorded by noise sources:

Noise Source	1970	1971
1. Traffic Noise (Various types of Motor Vehicles)	642	1,016
2. Construction	863	898
3. Commercial Noise (incl. restaurants & private clubs)	433	502
4. Other Noise Sources (household, neighbors, animals, churches, schools, etc.)	527	583
	2,465	2,999

Out of 618 vehicles cited for noise violations in 1971, 27 were condemned; 125 inquiries concerning noise abatement measures were answered by mail; 1402 interviews were granted; 16 frequency analyses were plotted; and 3037 inquiries were processed by phone. Only 8 of 2465 recorded actions could not be completely resolved.

10-001

Kvitka, V.

NOISE FROM THE SKY

Science and Engineering Newsletter of Novosti Press Agency

No 11(525):1-4

Current approaches toward solving the problem of aircraft noise in the USSR include introduction of a new generation of aircraft with high bypass ratio engines, restrictions on building near airports, and flight operating techniques for noise reduction.

The noise during take-off from IL-62 and TU-154 airliners, which have bypass turbojet engines, is 9-12 dB lower than that of the older generation of Soviet commercial jets. In order to reduce noise of the exhaust jet on new planes a special noise-reducing nozzle operates only during take-off and, consequently, does not affect the flight performance of the plane.

At present both construction of new airports and expansion of old airports is regulated for the purposes of noise abatement. Town building near airports is restricted. However, new regulations are being prepared by the USSR Ministry of Health and USSR Ministry of Civil Aviation. These are presently in the form of recommendations on the zoning to provide rational planning near airports. But they are being submitted for approval as normative standards i.e. standards given the force of law.

Changes in piloting methods have yielded a reduction of 5-8 dB, measured under take-off paths, and of 7-16 dB during flight over communities by means of thrust reduction. Although there is a substantial increase of noise at the airport during the take-off run of SST's, due to the high thrust of the engines, this same high thrust enables the SST to climb steeply. Thus, there will be rather low noise levels at the second ICAO take-off gauging point, which is located about 600 meters from the start of roll. Furthermore, the Soviet SST engines are to be fitted with devices for supply of secondary air flow into the exhaust jet, yielding a 5 dB noise reduction during take-off.

10-002

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STATUS OF AIRCRAFT NOISE POLLUTION

Inglewood, CA, City of Inglewood, FEB 1971, 2p.

The FAA measures aircraft noises in terms of effective perceived noise decibels (EPNdB). Ninety EPNdB would be termed noisy, 100 EPNdB, very noisy; and 110 EPNdB, extremely noisy. Each increase of 10 EPNdB would be judged to sound approximately "twice as loud." Present noise levels near the airport due to jet aircraft range from 90 to 120 EPNdB.

The prediction of 50 to 75% reduction is based on the following factors:

1) The FAA regulation requires new generation aircraft to be approximately half as loud (10 EPNdB quieter) than present generation aircraft. The 747 is covered by the new regulation and meets its requirements, but it will take 15 to 20 years before most of the present noisy generation of aircraft has been phased out.

2) In the shorter time frame of 5 years, there is hope for a reduction if a retrofit program is carried out on existing aircraft.

3) With community pressure and perhaps some technological breakthroughs, it may be possible to achieve a 20 EPNdB reduction within 20 years.

Criteria for residential development near an airport with a large number of flights are: If the noise level exceeds 100 EPNdB, development would not be satisfactory; if the noise level is in the 90-100 EPNdB range, development is marginal, and should only be undertaken with strict sound proofing requirements in the initial building design.

10-003

Man, A.

Israeli Medical Corps

NOISE POLLUTION

In: Marinov, U., The Environment in Israel, Israel National Committee on Biosphere and Environment

Jerusalem, 1971, 60 p. (p. 27-29)

A brief account is given of particular noise sources, anti-noise laws, and noise control organizations in Israel.

Because of the country's mild climate, the population is outdoors-oriented, and spends most time inside with windows open. Environmental noise thus leads to psychoacoustic irritation, although not usually to a loss of hearing.

Major sources of noise are buses and motorcycles, workshops in residential areas, and industrial plants, and loud discotheques and other places of entertainment. The textile, cement, and metal industries are the noisiest in Israel, and produce sound levels above the criteria considered harmful to the ears. Aircraft noise is becoming an increasingly serious problem. Agricultural machinery is also beginning to create noise problems. In addition, almost every young man and many young women have been exposed to shooting or explosions during military service and later in the reserve service.

A non-specific anti-noise law, the Kanowitz Law, now in existence is being amended and standardized. By-laws have also been passed in regard to industrial noise and directives have been issued concerning hearing-loss compensation.

Governmental institutions which deal with noise problems include: the Unit for the Prevention of Air Pollution and Radiation Hazards of the Ministry of Health; the Unit for Prevention of Noise Hazards of the Israeli Medical Corps; the Ministry of Labour; the Institute of Standards; and a governmental committee assigned to ammend the Kanowitz Law. Academic institutions include the Acoustic Department of the Technion in Haifa and the Department of Electronics at the Weizmann Institute in Rehovot. There are also a number of private organizations serving as advisors on noise problems to various industries and construction companies.

10-004

EPA ANALYSIS OF NOISE PROBLEMS POINTS WAY TO FUTURE LEGISLATION

Automotive Engineering

Vol 80 No 4:28-35, 1972

A discussion of the Report to the President and Congress on Noise by the Environmental Protection Agency is reviewed. The Report presents a summary of the present noise problem and status of legislation, and the solutions and directions that engineers and legislators will probably be taking over the next 15 years.

Aircraft noise, followed by highway noise, has received the greatest Federal attention in transportation noise abatement. At present, Federal regulations are still in the development stage for retrofitting aircraft for noise control, controlling sonic boom, and certifying SST and STOL/VTOL-type aircraft.

The EPA survey reveals that many states have enacted noise control legislation--nine states in the first six months of 1971 alone. Laws are incorporating specific decibel limits. Florida, New York, Illinois, Hawaii, and North Dakota now have departments with the authority to set noise standards. California regulations require the airport operator to monitor take-off and landing noise and to set a noise impact boundary around the airport.

Five states have set limits on total vehicle noise based on subjective standards. Five states require mufflers on motorcycles. California, Colorado, and Minnesota have set overall limits on these vehicles that become tougher with time. Five states currently require mufflers on boats. Snowmobiles are receiving more attention, with Maine and Wisconsin requiring mufflers and Montana, New York, Colorado, and Massachusetts setting limits on new snowmobiles (the latter two states also regulate snowmobile operating noise).

The noise reductions obtained with new aircraft largely stem from improvements in engine bypass ratios, fan designs, and new designs for inlet and discharge ducts. However, because of the large numbers of older aircraft in use, most aircraft now in use exceed the Federal Avioation Regulation limits for new aircraft.

The noise produced by highway vehicles stems from three major causes: tires and gearing, the engine and related accessories, and aerodynamic and body noise. Despite their larger engines and tires, newer vehicles are quieter than older vehicles. Diesel powered trucks are 8-10 dB noisier than gasoline-powered trucks, and 12-18% noisier than automobiles. One engine manufacturer estimates a $1,500 increase in the $5,000 base price of a 250-hp diesel engine to drop noise 10 dBA.

Recreational vehicles--motorcycles, snowmobiles, all terrain vehicles and pleasure boats often reach levels of 92 dBA. Typical noise levels contributed by the various subsystems in a motorcycle range from 59-69 dBA at 20 mph to 78-86 dBA at 60 mph. Most motorcycle noise reductions have been achieved by exhaust system changes. Snowmobile noise stems primarily from poorly muffled exhaust systems. Current models generally are in the 77-86 dBA noise band. Both inboard-and outboard powered pleasure boats range from 65-105 dBA at 50 ft, with exhaust systems being the major noise contributor.

Typical noise levels measured 50 ft from construction equipment range from 72-96 dBA for earthmoving equipment from 75-88 dBA for materials handling equipment, and from 70-87 dBA for stationary equipment. In almost all of this equipment, the engine is the primary source of noise.

EPA concludes that for engine-powered equipment, the greatest noise reduction may be obtained by quieting the engines.

PROGRAM PLANNING

10-005

Munich /West Germany/

MUNICIPAL-POLITICAL ASPECTS OF ENVIRONMENTAL PROTECTION IN MUNICH

Kommunal Politische Aspekte des Umweltschutzes in Muenchen

Arbeitsbericht zur Fortschreibung des Stadtentwicklungsplanes Nr 3

Munich, 1971, 163p.

Since JAN 4, 1971 Munich's council group presented six proposals with 40 individual points for an effective Environmental Protection Plan for the city. A greater publicity program, improvement of measurement systems, restrictions on individual traffic, introduction of exhaust-free vehicles, restriction of certain refuse, better supervision of water and vegetation resources and a catalogue with special preventive measures are being planned. Proposals are established on the basis of studies of these measures.

A general inquiry and survey of all the big cities in the German Federated Republic helped to set up this working group and establish these plans.

According to the proposal #255 (der Gesamtdeutschen Partei) of JAN 9, 1971, the following is planned:

1) A network throughout the city with separate detectors for automatic measurement of traffic flow and air and noise pollution.

2) Constant observations of the influence of traffic on health, independent of weather, season and time (daily) factors.

Special noise measures are proposed to include: strict supervision of all construction work, consultation with builders, and investigation of new construction.

Improvement of traffic flow on national and state highways and main arteries of the city and construction of park and greenbelts and other means of traffic directions are anticipated.

A street directory of the city district is planned with the description of its present situation, excluding the strictly residential areas.

The Office of Economy is responsible for the measurement of landing and take-off noise at the Munich airport.

For noise-reduction purposes the city council recommends the following measures:

1) No flight paths over the city (especially supersonic).

2) No over city flights by old airplanes.

3) Restriction on the number of helicopter observation flights.

An inquiry was conducted which showed that 63% of residents of heavily populated areas complained about noise. A noise level ranging from 30 - 90 Phon can cause insomnia, disturb rest resulting in a reduced concentration span, decreased productivity, irritability and nausea, affect the vegetative nervous system, cause gastritis and colitis, increase metabolism, lessen proper circulation and also cause arteriosclerotic changes, as well as psychic illness. Levels above 90 Phon cause physiological damages such as hearing loss or other hearing problems.

According to the proposed prognosis the vehicular traffic will increase about 55% by 1985. This means an increase of 1 - 2 dBA, and because the speed will increase, 4 dBA will be added. Physiologically this means that the noise-level of street-traffic will increase about 50%. In addition, a 70% increase in large aircraft in civil flights can be expected.

Special emphasis is put on public-opinion and media, such as the press, television and radio to inform the general public and arouse greater interest.

Munich teachers and scientists are asked to form workshops to introduce interdisciplinary courses in the field of environment. Presently only the biological aspects are encompassed in the environmental curriculum.

A commission selects short films about various themes of environmental protection. These films are offered weekly to the local theater. Amusement taxes serve to finance these films. A 4% budget increase in social products is suggested.

In order to have greater enforcement of the existing laws, increased fines and other penalties (especially in respect to water-pollutants) are recommended. Enforcement measures and further research is encouraged concerning restrictions on city overflights, stricter supervision over construction noise, improvement of damping materials and devices and other preventative measures like greenbelts, earthbanks, and sunken highways for traffic. In this respect, recommendations for public transportation are proposed.

In order to set all the proposals into action, formation of project groups is necessary. Presently there are 11 of them dealing with various aspects of environmental protection.

10-006

Schenker-Spruengli, O.

Schweizerische Liga Gegen den Laerm, Zurich /Switzerland/

PROGRESS OF NOISE ABATEMENT IN SWITZERLAND

Fortschritte der Laermbekaempfung in der Schweiz

Laermbekaempfung

No 3:27-28, 1969

After the Noise Abatement League of Switzerland was formed and achieved considerable progress in its efforts, the government came to its support and endorsed in October 1957 the Federal Expert Commission for Noise Abatement. This commission for Noise Abatement, composed of 52 experts from the various seicntific fields, was divided into 5 sub-commissions:

1) medical, accoustical and technical principles;
2) motor vehicles, railways and ships;
3) aviation noise;
4) construction and industrial noise, sound protection in residences, etc.;
5) judicial problems.

After five years of study a comprehensive report was published in 1962.

The League has conducted education programs on noise abatement. An exemplary one is the Conference of City Police Directors held in 1962 in which more than 150 communities participated. As a result an instructional course for law enforcement officers was held in 1963 in Zurich. The League has conducted numerous technical conferences, exhibits and demonstrations on the technical and practical aspects of noise abatement.

Greatest progress has been in the enforcement of standards and regulations. Noise Abatement Commissions have been formed in many cities in the various cantons. Police-operated noise abatement offices have been established in many Swiss cities; the Zurich office is considered an outstanding one.

The present major program is the national campaign against civil supersonic jets.

10-007

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NOISE MEASUREMENT CONDUCTED BY THE PARCEL POST OFFICE IN HAMBURG

Laermmessungen bei der Paketpost in Hamburg

Kampf dem Laerm

Vol 19 No 1:6, 1972

Measurements taken to determine the noise impact of a new Parcel Post Office in Hamburg are discussed. Parcel Post Offices can have an impact on the noise level of a city, making location of such a facility an important factor.

The construction of a modern Parcel Post Office has begun in Hamburg in the vicinity of the train station Hamburg-Altona. The area is surrounded by 3 thoroughfare streets on which residences are located.

The Federal Post Office took noise measurements even before the construction of the office, and it plans to continue with later tests to determine the noise the Parcel Post Office will contribute.

In order to draw a comparison of the noise levels before and after the Parcel Post activity, measurements of equivalent continuous noise levels were taken into account. In this way it will be possible to distinguish the constantly fluctuating levels.

PROGRAM PLANNING

10-008

Munich /West Germany/

On: LOCAL POLITICAL ASPECTS OF ENVIRONMENTAL PROTECTION IN MUNICH

Kommunalpolitische Aspekte des Umweltschutzes in Muenchen

Arbeitsbericht zur Fortschreibung des Stadtentwicklungsplanes Nr. 3

Munich, 1971, 163p. (p. 55, 68-70)

A draft paper discusses proposals for prospective noise laws for the city of Munich in light of draft norms for the Federal Republic of Germany.

No noise-measures have been established as yet in Munich. Single noise sources are investigated solely when there is a complaint. So far only a system for aviation noise-measurements has been set up.

Presently the Federal German Republic is compiling general norms. The draft encompasses the following noise levels:

Area	Day (dBA)	Night (dBA)
Strictly industrial areas	70	70
Predominantly industrial area	65	50
Mixed area	60	45
General residential areas	55	40
Strictly residential area	50	35

The law against aviation noise would contain two noise-projection zones.

Zone I - noise exposure over 75 dBA
Zone II - noise exposure over 67 dBA

Traffic noise ordinance would limit noise levels as follows:

Passenger car - max 84 dBA
Trucks - max 89 dBA
Motorcycles - max 84 dBA

All measurements are taken at a 7 meter distance.

During night hours (between 10 pm through 6 am) all trucks would be restricted in most areas with the exception of the city's main arteries and purely industrial areas. (Proposals No. 255/6DP #3A, No. 285/6PP #2).

Since APR 1, 1971 flight take-offs are limited between 8 pm to 6 am, with the exception of mail and freight carriers (No. 255/6DP #1).

Overflights of cities for purposes of advertisement or observation are considered unnecessary and should be eliminated. (No. 285 GDP #3).

As to industrial noise, a federal law is planned to enforce noise reduction techniques in all kinds of machinery and equipment.

In spite of increased costs, measures should be taken to continue and improve building techniques. Careful planning of residences and other structures is also recommended.

10-009

Brown, L.

THE PERMITTED NOISE LEVELS FOR HEAVY VEHICLES ON OPEN ROADS ALREADY EXCEED THE NOISE LEVELS FOR JETS AT HEATHROW

Municipal Review

Vol 42 No 493:149-150, 1971

A retrospective study covering two years of admissions to a psychiatric hospital shows that there is a significantly higher rate of admission, especially in certain diagnostic categories, from inside an area of maximum noise arising from the Heathrow Airport than from outside this area.

Such information has lead to greater concern over noise in Great Britain. The realization, based on scientific research, has hit that noise is not just an irritant, but is definitely a mental and physical health hazard.

Some noises are accepted as a part of everyday life, while there are others that we simply get used to. But in our rapidly advancing technological society, noise levels are advancing also, and there is no getting used to them.

The Noise Abatement Society (NAS) was formed in Great Britain in 1959. An independent and non-political pressure group, it receives no financial or other help from the government. Both corporate and individual memberships are included, and over 600 local authorities are members.

The society encourages authorities to pass by-laws of noise levels and makes efforts to persuade industry to develop quiet equipment. In another activity, the Society last year aided London in holding a "Quiet Week" and an exhibition of silencing equipment.

In its troubleshooting capacity, the NAS will aid any authority that considers noise a major environmental problem. The officers know the official procedures and the correct channels through which to go for a solution to the problem.

PROGRAM PLANNING

Mr. Geoffrey Holmes, Technical Adviser to the NAS and Chief Public Health Inspector, Royal Borough of New Windsor, has very definite views of the problem of noise control and abatement. He estimates that at least 40% of his work is concerned directly with problems of noise and the community.

For instance he relates the problem of traffic noise to its routing, such as the time when the opening of a new bridge caused traffic to go straight into the town of Windsor. The Public Health Department had just completed a survey which showed tht 35% of the midday traffic consisted of heavy lorries. Noise levels rose more than 10 dB over those laid down by the Wilson Committee. In fact, the permitted noise levels for heavy vehicles already exceed those for night jet flights at Heathrow Airport. In addition a "canyon effect" produced by traffic in narrow streets could raise the noise level 6 dB greater, exceeding the daytime aircraft noise limits. Mr. Holmes' solution to traffic noise is to confine lorries to specified routes.

Taking action on a traffic noise problem, Mr. Holmes was confronted with the situation in which a residential road was being used by heavy traffic as a short-cut to the docks. By merely writing to the companies whose lorries were using the route and explaining the discomfort they caused the neighborhood, Mr. Holmes won his case. The firms cooperated by re-routing their lorries.

He took a similar stance with regard to aircraft noise at Windsor. The noise is worst during the three months of the year when, because of strong winds, aircraft must come in and go out by way of the borough. The problem is that if minimum noise routes are not followed the noise can be quite loud.

Convinced that some aircraft were not following minimum noise routes, Mr. Holmes sent a report of his suspicions to the Board of Trade. As a result, two major airlines were found to be ignoring the routes. Since then, the situation has been much improved. At present noise committee meetings being held at the Board of Trade have representatives from the airlines but not from the local authorities.

Looking at America there is apparently a lack of governmental concern. Boeing is so concerned that it has made a mathematical model for evaluation of the various means of reducing aviation noise. Tests have shown that any technological changes will be complicated and expensive, and in Mr. Holmes' view, the only solution is to keep people and aircraft apart by proper airport planning.

The NAS, together with other concerned organizations, has agreed that the third London Airport should be located at Foulness. If situated inland, they conclude, it would sterilize and spoil a large area of countryside. Besides inland siting would create dangerous problems in air traffic control.

Airport expansion is not London's problem exclusively; it is the concern of municipal airports as well. Mr. Holmes says, one wonders if sufficient regard is being paid to the people and districts surrounding these airports. Airport noise is more of a problem than traffic noise. The big jet is very annoying because of the high frequency element in the noise. At least if heavy noise was confined to certain routes the noise would be localized, but no such remedy can be taken with aircraft."

10-010

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NOISE REDUCTION IN PUBLIC PASSENGER TRANSPORTATION, ROLLING STOCK AND INSTALLATIONS

Laerminderung bei Betriebsmitteln und-anlagen des oeffentlichen Personennah - verkehrs

Kampf dem Laerm

Vol 18 No 5:127-130, 1971

The German Federal Traffic Minister Leber, while speaking at a session on subway and motor vehicle construction, made an appeal to employ all possible means for noise reduction.

The manufacturers and the public transit concerns have tested various noise reducing measures, such as sound-damping materials and construction techniques.

Experiments were held in 10 plants on 30 railed vehicles, street-cars and subway cars. Polishing of the tracks results in the most noise level reduction, but spraying the tracks with water and sand not only quiets the ride, but also assures a much safer braking power.

It was observed that heavy snow is an excellent noise-reducing agent. It is suggested that a similar artificial type of covering would be an excellent abatement measure.

Chemical processes are being applied to abate the "multitonal whines" of overhead tracks in the interim before they are totally replaced. In addition, 70 to 100 cm high sound protection walls are being constructed as noise reducing devices. One chemical abatement method, curve lubrication, has proved ineffective.

The investigation of the tunnel construction in Munich, where the tunnel is deeper and the

DATA

vehicles wider, disclosed that the thicker tunnel walls contributed considerably toward noise reduction.

Use of trolley-cars (O-Bus) declined in 1971 in favor of the more economical Diesel-bus, which is too loud because of its motor and tires. The Electro-bus (E-Bus), a totally electrical bus, made its appearance recently; it is economically less feasible than the O-bus. Since fiscal considerations dictate the present Diesel-Bus, casing and damping measures to solve at least the present noise situation are strongly recommended.

11-001

Pintor, I.

Orszagos Munkaegeszsegugyi
Intezet, Budapest /Hungary/

HEALTH PROBLEMS OF NOISE
IN MAN'S ENVIRONMENT

A Zaj Egeszsegugyi Problematikaja
az Ember Kornyezeteben

Orvostudomany

Vol 22 No 2:241-245, 1971

Noise measurements were recorded in Budapest in schools, medical institutions, and in the areas surrounding industrial plants and airports.

Measurements were taken of outside noise, chiefly from traffic, in 15 Budapest school buildings, 13 of which were in the inner city, one on the main traffic artery, and one on the outer edge of the Capital in quiet surroundings. Measurements were taken two or three times in each school, from 8 am to 4 pm, for a total of eight hours per school. The dBA levels and octave band levels were measured. Noise was measured 2.5% of the time, or up to 1.5 minutes in an hour. With one exception, the noise level of the classrooms facing the street in inner city schools exceeded medically sound limits. Classrooms facing the courtyard were observed 15 to 25 dBA lower in noise pressure level.

Studies to determine the amount of noise entering hospitals from the outside, chiefly vehicular traffic noise, showed that rooms facing the street had a noise level approximately 40 dBA greater, in certain cases, than rooms on the courtyard. The noise level of the hospitals far exceeded health norms, especially in the 50 to 250 Hz octave band. Only the suburban Korany Tuberculosis Institute had a lower noise level. (See Figure 1.)

Noise Level at 2nd Surgery Clinic (2SC) and Nat'l Korany TB Inst (NKTBI) Measured in Octave Bands with Windows Open and Closed

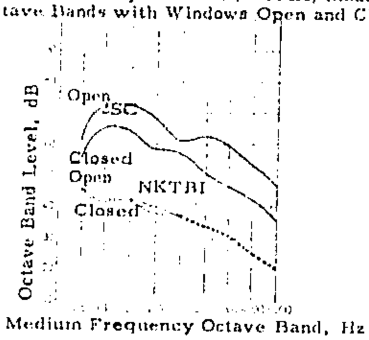

Figure 1.

Noise measurements were taken in the area of the Goldberger Textile Printing plant which lies in the Obuda reconstruction area in which a new residential community is being developed. Houses are to be built 40 to 50 meters from the north and east sides of the plant. The purpose of the tests was to serve as preliminary data for noise protection in the new houses and for noise abatement measures to be executed in the plant. Prevailing noise levels at various times of the day were measured at 91 points on the streets bordering the plant. Base noise was measured when the plant was shut down. Most measurements were taken at 1.5 meters above the street. While the plant was in operation, the noise level on the north side was about 30 dBA above the allowable daytime limits and about 40 dBA above the allowable nighttime limits.

Noise measurements were taken at the Budapest-Ferihegy International Airport to establish the present noise level and to project the aircraft noise effect of a planned second runway on nearby residents. Measurements were taken on a direct line between the runway and the Capital, mostly between 840 and 4200 meters from the end of the runway. Four other measurement points outside this area were also used. Data were compiled on the noise produced by 90 various types of aircraft during take-off and landing. Data were recorded on the maximum level measured during an overflight, the duration of the noise, the number of planes and the time of day.

DATA

Maximum noise level was measured in octave bands and expressed in PNdB (annoyance index). An evaluation was made on the basis of the West German Storindex Q which recommended compatible land use planning for the airport area.

11-002

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Berzinya, A. K.
Audere, A. K.

Rizhskiy Meditsinskiy Institut, Riga /USSR/

ON HEALTH CHARACTERISTICS OF THE NOISE BACKGROUNDS IN RIGA

K Sanitarno-Gigiyenicheskoy Kharakteristike Shumovogo Fona v g. Rige

Meditsina

Vol 286 No 7:134-137, 1971

Surveys and measurements were carried out to determine the intensity of noise in Riga. Measurements were made on the main thoroughfares and residential areas, and questionnaires dealing with various aspects of noise were passed out to the public.

According to the data gathered, motor vehicle noise ranged from 70-130 dB, industrial noise 45-120 dB, and construction noise 50-58 dB.

Transport noise seems to be the greatest offender, commencing with aircraft noise (over-city flights) 100-120 dB, trucks 70-100 dB, street-cars 75-110 dB, buses 60-90 dB, trolleys 70-75 dB, motorcycles 85-120 dB, motor bikes 90-115 dB. Maximum noise levels were reached from 7-10 am and 4-5 pm. Cobblestone streets are about 15-35 dB noiser than asphalt-paved streets.

The degree by which noise penetrates into the surrounding buildings depend on the sound insulation of such structures:

- Greenery in front of building seems to reduce the noise-level by 5-15 dB,
- Windows facing away from the street can eliminate the noise level by 15-25 dB,
- A good construction of windows and doors can reduce the noise level by 7-30 dB.

The survey seems to indicate that transport noise is considered the greatest source of annoyance (67% of cases).

The following table shows the percentage of noise annoyance level:

	Percentage of Annoyance		
Source of Noise	At Work	On Street	At Home
Industrial	11.07	14.20	11.69
Construction	7.41	8.54	1.08
Street Traffic	8.62	29.48	66.73
Truck	2.7	29.48	16.32
Streetcar	5.01	4.45	43.66
Bus	0.82	5.01	6.05
Trolley	0.09	1.39	0.23
Trains	0.11	7.30	8.31
Aircraft	0.3	3.77	3.80
Recreation	0.01	0.68	1.85
Home Equipment	0.0	0.02	2.01
Stores	1.3	0.71	3.12
TOTAL	28.82	64.8	97.69

Complaints seem to increase when the noise level exceeds 50 dB.

11-003

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HYGIENIC ASSESSMENT OF THE NOISE OF HEAVY DUTY VEHICLES

Gigyenicheskaya Otsenka Shuma Tyazhelykh Putevykh Mashin

Gigiyena i Sanitariya

Vol 35 No 11:98-100, 1970

A hygienic assessment of the noise of heavy duty vehicles in the USSR is presented.

The Bruel and Kjaer Sound level meter, which makes third octave measurements, was used to make cab and exterior (at 1,3,5 and 7 meters) readings of several dozen tracked vehicle types.

Diesel engine reading of 113-130 dB and work area readings of 90-120 dB were taken. The frequency bands were chiefly middle and high. Diesel cab levels up to 102-104 dB were recorded; other cab levels ranged from 96-113 dB; all are above the limits of the existing standard.

Noise levels for other vehicles and their work areas are reported and compared. All levels exceed the existing standards.

DATA

It is recommended that sound insulating elements in cabs be increased by multilayer construction of the cabs; that noise insulation of hoods be increased by 2-2½ times; that exhaust mufflers be installed on diesels; that sound damping of diesel engines be increased; and that cabs be vibration-insulated.

11-004

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On: A SURVEY OF NOISE LEVELS ON BOARD PLEASURE BOATS

Sound and Vibration

Vol 6 No 2:28-29, 1972

A survey of noise on board 17 pleasure boats ranging in length from 8 to 50 ft under normal operating conditions showed that noise levels typically render speech communication and radio monitoring virtually impossible and threaten hearing loss in cases where there is prolonged daily exposure. There is also a risk of accidents due to unheard spoken commands. There was no clear relationship between boat size and noise levels, nor between type of construction material and noise levels.

Measurements were taken under four conditions: 1) quietest location on board at idling or trolling speed; 2) quietest location at cruising speed (calm and open water, slowest speed at which boat would plane or manufacturer's recommendation); 3) noisiest location at cruising speed; 4) noisiest location at maximum speed.

Noise levels ranged from 60 dBA in the front cabin of a 36 ft cruiser at trolling speed to 104 dBA in the rear seat of a 15 ft open boat with a 35 hp outboard at maximum speed. (Figure 1.)

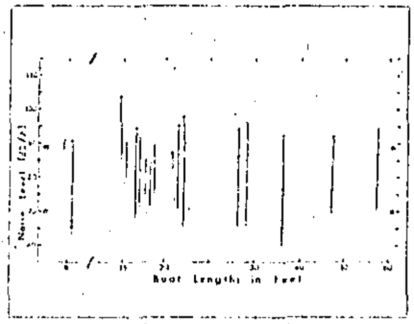

Figure 1—Noise levels of various pleasure boats as a function of length, operating condition, and measurement location.

	Range (dBA)	Typical (dBA)
Trolling speed		
quietest location	60-79	70
Cruising speed		
quietest location	73-89	79
noisiest location	80-96	84
Maximum speed		
noisiest location	85-104	93

For references purposes, 70 dBA is the level above which face to face speech communication becomes difficult at distance of a few feet, and 89 dBA, the level above which it is difficult or impossible to be understood at a distance of a few inches. Noise levels above 89 dB were observed in 13 of the 17 boats at maximum speed and in 8 boats at cruising speed. Monitoring of radio-telephones was difficult, and was routinely attempted in only two of the eight boats so equipped. On these two boats, the speaker was turned up so loud that the level of radio static noise measured at the operators' heads was 94 dBA. These two operators, both members of the Coast Guard Auxiliary, reported that when not on patrol they did not ordinarily monitor their radio-telephones. The operators of the boats tested were willing to accept the noise as a minor nuisance when it was below the 85-90 dBA level, but higher noise levels were complained about.

Sleep interference was not mentioned as a problem because the boats were not slept on while underway.

With the exception of one noisier 15 ft open boat, noise levels seemed to vary little with boat length in any of the four types of measurement conditions, evidently because the larger engines in larger boats offset the effects of greater distances and more intervening partitions. Nine boats were fiberglass, five were wood, and three were aluminum, but construction material did not seem to affect noise levels.

The following measurement conditions were observed: slow response on portable sound level meter; microphone fitted with windscreen; microphone held at head level of seated person at from two to nine locations per boat, including heads and helmsman's positions; all boats equiped with stock engines, with mufflers installed on three boats; all boats operated in ordinary fashion: engine covers in place, cabin hatches open, head doors closed, normal equipment including seat cushions and matresses in place.

Noise levels were also measured within one foot of an outboard engine or inside the engine compartment of an inboard; these ranged from 100 to 115 dBA, thus constituting a serious hearing loss threat to mechanics regularly servicing marine engines while they are running.

There are about 8,000,000 power pleasure boats in the U.S. Even if the risk of hearing loss to the operators is ignored, the risks of poor speech communication (loss of a total boat and its occupants because of missed voice commands

DATA

or warnings) is not acceptable. The range of cruising speed noise levels found in these boats is similar to that found in airline jet aircraft cockpits (81-96 dBA). Standards suggested for cockpit noise (by R. B. Stone, Aerospace Medicine 40,989-993,SEPT, 1969) are 90 dBA maximum and 85 dBA for normal cruising; these would guard against hearing loss and insure close-range speech communication, although with difficulty. Such standards are directly applicable to power boats.

11-005

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LESS NOISY CONSTRUCTION OPERATION

Laermarmer Baubetrieb

Oesterreichischer Arbeitsring fuer Laermbekaempfung Industrie-Richtlinie

2nd ed., Vienna, No. 111, APR 1970, 11p.

It is the task of technology to offer unlimited safe working conditions to the worker in all types of operations.

The best means for noise reduction is to take measures right at the source, by means of screening, encasing, etc. Noise levels are listed for various construction machines measured at 1 meter, ranging from 75-85 dBA for a socket wrench to 120-125 dBA for a compressed air pile driver. At 7 meters the noise level should be 15 db lower.

Since noise levels are much more disturbing during the night, construction work should be avoided and if it is absolutely necessary, it should be executed only with quieter equipment.

These are some of the recommended noise levels:

Area	Permissible Noise Levels Day (dBA)	Night (dBA)
Quiet area (residential, village)	50	40
Downtown area	60	50
Industrial area	65	55

Noise reduction methods are given for particular individual pieces of equipment. For instance, whenever possible, combustion engines should be replaced by electrical motors. For all equipment such as concrete mixers, hammers, etc. the same is recommended. All internal combustion engines may be equipped with special effective sound dampers for the exhaust area, as well as the induction side.

Maintenance is an important factor of noise abatement. All plates should always be well fastened and the sound dampers and gears always clean. Correct lubrication preserves machinery and helps to reduce noise. Bi-annually, all machinery should be inspected and overhauled to insure that all of the noise-preventive measures are operating properly.

For huge equipment, tents and shields are recommended as noise reducing devices. Shields, of course, can dampen the noise only against one direction. In order to be effective they must be at least 3 x 3 sq. m and consist of materials such as iron sheet with 5-8 cm fiber wool behind perforated sheet metal; such outfitting can reduce the noise level by 5 dB.

Tents consisting of plastic mats with mineral fiber filling or foam filling can reduce the noise level by 10 dB. Huts of light wood construction can achieve noise reduction of 20 dB.

In planning a construction operation all of these measures must be taken into consideration by the firm and the architect involved in order to avoid any unnecessary and undesirable noise levels and conditions.

11-006

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ATTENUATION OF AIRCRAFT NOISE BY WOOD-SIDED AND BRICK-VENEERED FRAME HOUSES

Springfield, VA, NTIS, N70-32694, 1970, 37p.
HC: $3.00 MF: 95 cents

Attenuation characteristics of a typical brick veneer house and a typical wood-sided house were measured for aircraft noise during the course of a NASA study of the subjective evaluation of aircraft noises. The different types of aircraft, a four engine propellor-driven Lockheed 1049G, and a four engine turbofan jet CV-880 were used as the noise sources. They flew runs directly over the houses on straight and level flights at altitudes of 1200 and 2000 feet, respectively. It was found that in any one-third octave band of frequencies, the maximum noise outdoors did not occur at exactly the same time as the maximum level indoors. Attenuation could thus be defined in several different ways. The best descriptor of the effect of the test house structure on the aircraft noise, measured inside the house, was found to be

DATA

house attenuation defined on a 1/3 octave band basis by the difference between an outdoor band maximum and an indoor band maximum, without regard for when these maxima occur. Eight indoor locations, two for each of four rooms, were used. Measurements were collated so that four estimates of attenuation were available for each room. From these estimates, average attenuations in each band were calculated, and these average values were used in turn to plot house and room attenuation characteristics.

The two one story houses were tested with windows and doors closed and with completely furnished rooms--carpets, drapes, and the normal complement of tables, chairs, etc.

The following table shows samples of typical results of attenuation for the houses (peak measure statistics, data from four flybys):

Place	A-weighted level Avg., dBA	Std. dev., dBA
BRICK VENEER		
Dining room	22.6	3.0
Living room	20.9	4.5
Bedroom No. 1	27.1	2.6
Bedroom No. 2	25.6	1.1
WOOD-SIDED		
Dining room	20.7	0.7
Living room	19.1	1.1
Bedroom No. 1	24.3	1.9
Bedroom No. 2	17.3	2.6

Results evaluated in PNdB were within 1-2 dB of the results expressed in dBA. The house attenuation numbers obtained in this study correlated within 2 dB of those given in SAE document AIR 1081 (1969) for houses in Boston, New York, Los Angeles, and Miami, with various numbers of rooms.

A measure of how useful the attenuation data were for predicting indoor noise levels was made by weighting outdoor data with the attenuation characteristic for each room to compute the estimated indoor levels. A comparison between the estimated and actual values showed that the attenuation data are useful for indoor noise prediction purposes.

11-007

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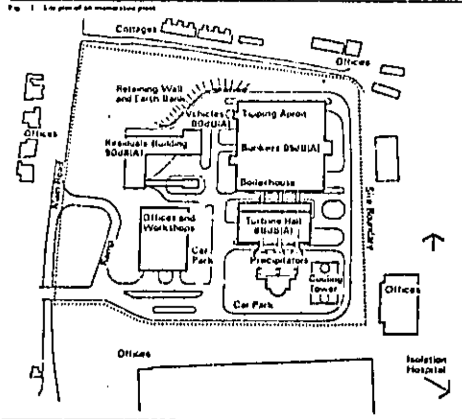
INDUSTRIAL NOISE: REFUSE TREATMENT PLANT

Urban Design Bulletin (London)

No 2, 1970

The Greater London Council will use a standard method of calculating probable community annoyance caused by industrial noise in planning a series of government-owned industrial plants. In the course of its design work on refuse treatment plants, it has published design guidelines illustrating how a hypothetical plant might be planned (Figure 1).



The standard method used is British Standard BS 4142:1967, upon which the International Standards Organization (ISO) draft Resolution 1996 is closely patterned. This standard states that complaints may arise if a new noise source is introduced to an area, resulting in a rise in excess of 10 dBA over the existing background noise levels, measured just outside the nearest residential buildings. However, in sensitive areas a possible increase of 5 dBA should be viewed with caution, because of other possible insidious rises in background noise levels.

In calculating the noise of a proposed plant, the level at the site boundary must be adjusted for duration, presence of pure tones, and periods of louder or more disturbing noise. The adjusted calculated level is then compared to the background level to judge if the plant will be suitable. If background levels can not be measured, a basic criterion of 50 dBA may be used, which is then corrected according to the type of district (ranging from purely residential to industrial).

In planning the refuse treatment plant, designers relied on noise survey data from three existing plants and one French plant, as well as information derived from manufacturers (see figure 2).

They then used a variety of methods to plan a plant that would meet BS 4142.

First, noisy processes are concentrated within a building with walls as imperforate as possible and with adequate acoustic insulation.

DATA

Windows are minimal in area, on the side of the building away from nearby noise-sensitive areas only, and sealed. Second, noisy processes are located within the site in such a way as to minimize their noise emissions in a particular direction, in this case, in the direction of a hospital to the southeast. Other buildings act as shields, and one retaining wall and earth bank is provided to shield the noise from extensive unloading activity by dump trucks.

Plant Noise Levels — Fig. 2.

a External Measurements

Plant	Location	Noise level	Site
1. Refuse vehicle starting	at 7.5 metres	84 dB(A)	C
2. Refuse vehicle on level ground, steady speed	at 7.5 metres	80 dB(A)	C
3. Refuse vehicle on slope, steady speed	at 7.5 metres	83 dB(A)	C & D
4. Forced draught fan	at 3 metres	76 dB(A)	C
5. Induced draught fan	at 3 metres	71 dB(A)	C
6. Cooling tower	at 30 metres facing louvres	69 dB(A)	M
7. Cooling tower	at 130 metres facing louvres	60 dB(A)	M
8. Cooling tower	at 270 metres facing louvres	54 dB(A)	M
9. General plant noise* (mostly de-duster)	at 110 metres from wall	52–53 dB(A)	C
10. General plant noise*	at 300 metres from plant	45–46 dB(A) (Hum of de-duster clearly audible)	C
11. General plant noise* (mainly fan noise)	at 50 metres from plant	57 dB(A)	D
12. General plant noise*	at 100 metres approx.	53 dB(A)	P
13. Residuals (conveyor and chute)	at 10 metres	75 dB(A)	D
14. Several vehicles discharging	at 15 metres from entrance (outside reception hall)	62 dB(A)	C
15. Magnetic separators + clinker & fly ash conveyor	at 10 metres	87 dB(A)	P
16. Pulveriser only	at 10 metres	70 dB(A)	F
17. Vibratory feeder	at 10 metres	81–82 dB(A)	F
18. Pulveriser with vibratory feeder in operation	at 10 metres	79–83 dB(A)	F

b Internal Plant Noise†

Plant	Location	Noise level	Site
1. Metal press	at 3 metres	84–86 dB(A) (mostly clangs)	C
2. Cardboard press	at 3 metres	86–88 dB(A)	C & D
3. Induced draught fan in reverberant conditions	at 3 metres	91 dB(A)	D
4. Collection vehicle, tipping	at 3 metres approx.	90–92 dB(A)	D
5. Water pump, reverberant conditions	at 3 metres	91 dB(A)	D

c Internal Environmental Noise Levels

Predominant noise source	Location	Noise level	Site
1. 3 vehicles discharging	Reception hall	88–91 dB(A)	C
2. One conveyor plus	In elevator room on 'bridge'	87 dB(A)	C
3. Conveyor	In elevator room on 'bridge'	79 dB(A)	C
4. General plant noise*	Inside separation and sorting room	83–91 dB(A)	C
5. General plant noise*	Incineration room	79–82 dB(A)	C
6. General plant noise*	Incineration room (by control desk)	80 dB(A)	D
7. Refuse feed chute	Inside incineration room	100 dB(A)	D
8. 4 boilers in use	Inside boiler house	81 dB(A)	P
9. Turbines	Inside turbine hall	88 dB(A) (mainly whine)	P

Measuring notes

C – Castle Bromwich Refuse Disposal Works

D – Direct Incineration Plant, Derby

P – Usine d'Issy les Moulineaux, Paris

M – Manufacturers' information

F – Folkstone Road Refuse Pulveriser, London, E 6

11-008

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NOISE SITUATION IN TYPEWRITER TECHNIQUE

Zur Laermsituation in der Schreibmaschinentechnik

Feingeraetetechnik

Vol 18 No 11:510-516, 1969

Methods used by the office-equipment industry of the German Democratic Republic to reduce noise-levels are discussed. Numerous noise-measurements were carried out on typewriters. For this purpose, a cabin 3.5 x 4.5 m. and about 2.5 meters high was employed and measurements were taken 1 meter from the noise source by means of the precision impulse-audiometers type PSI 101 and PSI 202 installed by VEB RFT Measuring Electronics, Dresden.

The machines were placed on a 650 mm high table covered with a plate of 500 x 500 x 20 mm size consisting of 200 mm thick foam and 15 mm thick felt materials. By this means, only the typewriter noise is captured. The distance between microphone and the source is 4 m.

The type of stroke and the speed play an important role in the measurement. The range of the speed and the troke stresses the difference in typing. A normal text can vary up to 6 dB.

It is thus recommended that the same typist be used in determining the noise-level measurements.

It was determined that for a significant difference of about 2 dB between 2 mean values, 10 individual measurements are required to achieve about a 95% accuracy.

The main source of typing noise is the impact of the type bar on the recoil ring and the type impact on writing-roll. Speed plays an important role in the above.

Measures taken to combat this type of noise are to compress felt material with load around the recoil ring.

DATA

The noise caused by manipulating the space-bar can range from 10-25 dB: in portable typewriters, about 20 dB; office typewriters, 25 dB, and electric typewriters, about 20 dB.

The next source is shifting, which again can range from 10-20 dB. Investigations were made on portable-typewriters with plastic casing and electric typewriters with metal casing. The parts of the absorbers consist of Moos-rubber layers.

The movable parts of the machine should be made of lighter material instead of heavy ones. Damping by means of plastic and metal casing seems so far to be most useful.

Impulse-Noise Measurements

Type of Machine	Range of Noise Level	Mean Value
Portable Typewriter	78....83 dBAI	83 dBAI
Office Typewriter	87....89 dBAI	88 dBAI

Impulse-Noise Measurements

Function	Standard Typewriter	Electric Typewriter
Typing Noise	82 dBAI	85 dBAI
Space Bar	60 dBAI	67 dBAI
Shifting	60 dBAI	62 dBAI
Carriage Hoist	60 dBAI	77 dBAI
Idling Noise	60 dBAI	35 dBAI

11-009

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NOISE SOURCE DEFINITION - EXTERIOR PASSENGER VEHICLE NOISE

New York, Society of Automotive Engineers, 1972, 8 p.

Recent studies have indicated that the passenger vehicle is a major contributor to the annoyance of traffic noise. A test series was conducted at the Ford Michigan Proving Grounds on a concrete surface. The purpose of the test program was to determine the contribution of each car noise source. A 1970 high and low power sedan and a high and low-power sporty compact were used in the test.

The results of the test show that, for wide open throttle conditions, engine/exhaust noise predominates, being 14 dBA above the other noise sources. Adding another muffler in series resulted in a sound level reduction of 6 dBA. The engine contributes about 50% of the total noise below 500 Hz. Tire/road noise is the major source above 500 Hz. The contributor of the cooling fan to the total exterior vehicle noise at cruise is negligible at all frequencies. This conclusion was true for all engine/vehicle combinations tested except the low power sedan at 65 mph. The tires used in this study were typical, original equipment, bias-belted tires.

The most immediate reduction in levels is required for trucks, with a reduction of exhaust noise as the first goal. A reduction of 16 dB corresponds to eliminating 97% of the noise energy emitted. Additional data are needed to determine the true variation of tire/roadway noise with speed and thus formulate more accurately the noise generation model for this source of noise.

11-010

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THE PROBLEM OF LOW INTENSITY IMPULSE NOISES IN HOSPITALS

Zagadnienie halasow impulsowych niskiej intensywnosci w szpitalu

Przeglad Lekarski

Vol 25 No 2:255-258, 1969

An investigation was carried out in Poland on the major acoustical problem of hospitals and their construction. Part of its was based on measurements and on the replies to a questionnaire sent to 465 physicians engaged in 25 various departments of 22 hospitals. Of the inquiries, 47.5% involved clinical hospitals, 23.5% regional and the rest municipal hospitals. The time of this particular survey was the fall-winter season when all the windows had to be closed.

Many noise sources (38) were investigated and some of them compiled into charts on noise impulses.

DATA

Noise Source	Levels (dBA)
1. Trolley-street car 2. rush hour 3. street noise 4. slamming of doors 5. walking in heavy boots 6. ambulance sirens	50-80
7. squeaking floor 8. visiting hour	50-60

Noise Source	Level (dBA)
1. Radio & TV 2. Refuse removal 3. School 4. Recreational areas	up to 90
5. Cleaning 6. Dormitory (for nurses & medics) 7. Calls in the halls	60-85

All the studies were based on the Chochotto criterion. Hospitals are built inadequately and require much better insulation and architectural design, since what is considered to be tolerable noise level for a healthy individual is unbearable and damaging for a patient. The study showed that impulse noise levels in the hospitals exceeded norm PN-63/B-02151.

Hospital	Freeway	Distance (feet)	Noise Level, dBA (windows open)
Queen of Angels (7th floor)	Hollywood (11,000-11,600 vehicles/hr)	400	67*
Deaconess (7th floor)	3rd Ave (1500 vehicles/hr)	400	55
S.F. County (4th floor)	Bayshore (5,000-13,000 vehicles/hr)	300	60
Loretto	Congress (5,000-8,000 vehicles/hr)	200	60
St. Lukes (2nd floor)	Congress (8,000-10,000 vehicles/hr)	150	61

* hospital on hill above freeway

For purposes of comparison, data on two air conditioned buildings with sealed windows are: 48 dBA at 300 feet (6th floor); 43 dBA at 150 feet (2nd floor). With the windows open, the noise levels were in the 60 dBA range; this is 5-7 dBA higher than what would be expected for residential under similar conditions. The possible reasons for the higher levels in hospitals are first, that these particular freeways may have had a higher volume of truck traffic; second, that there was an unobstructed sound path; or third, that background noise generated inside the hospital was not taken into account.

11-011

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On: NOISE INSIDE HOSPITALS FROM FREEWAYS

In: Lane, S, Freeway and Highway Noises: an Information Base for Urban Development Decisions

Springfield, VA, NTIS, PB 204434, 1971, 90p. (p. 36-38)

Data were obtained on noise levels in Los Angeles hospital rooms, most of which were upper rooms facing a freeway and with a direct view of the freeway. The ground distances from the hospitals to the freeways ranged from 140-400 feet.

12-001

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SONIC BOOM EXPOSURE EFFECTS I.1: INTRODUCTION

Journal of Sound and Vibration

Vol 20 No 4:477-484, 1972

The workshop on sonic boom exposure effects was convened at Saltsjobaden, Sweden, SEPT 7-9, 1971.

GENERAL

The sonic boom can affect the health of man directly or indirectly. The prospects are relatively bright for technical developements which will limit the exposure to acceptable levels, and which will allow the establishment of an exposure control system. Considerable research efforts have been and are being spent to understand the effects of exposure to sonic booms. The workshop was held in the knowledge that the sonic boom is a basic type of acoustic stimulus affecting structures, animals and humans. Consequently the results achieved from the workshop on sonic booms should also be applicable to a range of industrial and other environments where sudden bursts of noise are present.

The distinction between performance tests and development tests must be emphasized. A performance test is carried out to determine whether or not a product in development has met its acoustical objectives or specifications. A development test is conducted by engineering personnel to guide the design of the noise control features that must be incorporated into the new product.

Noise control techniques can be applied to almost any product, but not without an economic penalty. If noise control is an afterthought, the economic penalty is frequently excessive. Early application of noise control in a project may minimize cost for the quietizing features. The conclusion is drawn that technological factors are no longer placing a limit on the control of product noise.

12-002

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PRODUCT NOISE AND ITS CONTROL

At: American Association for the Advancement of Science, 138th Meeting, Philadelphia, DEC 29, 1971

Poughkeepsie, IBM Acoustics Lab., 1971, 14 p.

The methods used in a product noise control program are discussed. The program stresses:
1) the right tools to do the job,
2) the appropriate skills of trained personnel,
3) the motivation to develop a quietized product and, 4) an early start on the engineering aspects of noise control.

The development of a quietized product requires the skills of a team of noise control engineers, an engineering specialty requiring both formal training and practical experience.

The motivation to develop a quietized product is embodied in the acoustical objectives and specifications for the product. Experience has shown that without quantitative criteria to guide the development of a new product, the desired result is seldom achieved.

The fourth ingredient of a successful program is an early start on the engineering aspects of noise control. To achieve the most effective noise reduction at minimum cost, noise control features must be carefully planned and incorporated into the design of the new product as early as possible. An evaluation of the new product should be made by skilled noise control engineers.

12-003

THE DIN OVER MUFFLING NOISE

Business Week

APR 8, 1972, p. 32

Under force of the Occupational Safety and Health Act, standards have already been set which limit the amount of noise to which workers are exposed. The field of product design, except for airplanes, however, is totally void of any such standards, and as a result it is the consumer who pays the price for noisy equipment. In its report on noise under the Clean Air Act of 1970, the EPA pinpointed construction equipment, trucks, motorcycles and off-the-road vehicles for chief focus. State and city regulation against noise have appeared, and some are getting tougher. California, for instance, will drop its 88 dBA limit on cars and trucks to 83 dBA by 1975 (measured at 50 feet). Most manufacturers favor EPA action to keep an unwieldy patch work of local regulations from spreading. The cost of noise abatement and control will not be cheap. With all the muffling and vibration damping necessary for a 10 dB decrease in noise, one manufacturer estimates that the price of a $5,000 diesel would go up $1500. Another estimate is that it will cost an additional $30-$50 per car and up to $125 per truck for auto makers to meet California's 1973 limits of 86 dBA.

One aspect of more Federal legislation also bothers manufacturers. The auto makers, in particular, are concerned that the government may not coordinate its demands on noise, air pollution, and safety. For example, catalytic air cleaning devices may compete with sound deadners for limited space in cars.

GENERAL

A second noise source, tires, becomes the dominant source above approximately 35 mph, and noise regulations may eventually focus on it.

12-004

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THE "NOISE THERMOMETER": A LARGE-DISPLAY SOUND LEVEL METER

At: Acoustical Society of America, 82nd Meeting, Denver, OCT 22, 1971

Ottawa, National Research Council, 1971, 10 p.

A large-display sound level meter to be used for educating the public as an aid to enforcing noise laws is described. A prototype of such a display has been developed by the National Research Council (NRC) of Canada and tested on the NRC's grounds and by the city of Edmonton, Alberta.

Although much anti-noise legislation is based on measurements in dBA, the average citizen often lacks even an approximate subjective interpretation of quantitative limits expressed in dBA.

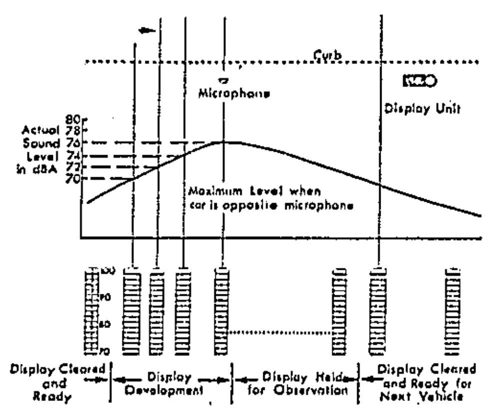
The complete display is called a "noise thermometer" and consists of an 8 ft tall display sign and a remote microphone unit. The acoustic input is converted into a column of lights that looks similar to the column of mercury in a thermometer. The display registers from 70-100 dBA in 2 dBA steps. As the sound level rises as a vehicle approaches the microphone, the display develops in 2 dBA increments. The maximum level is sensed and the full display is retained for approximately 4 seconds to enable the driver to observe the level produced by his vehicle (Figure 1).

Silhouettes attached beside the column of lights indicate maximum levels permitted by state or local law for various classes of vehicle. However, if the law is complex (for example, specifying different levels at different speeds), use of the silhouettes is not advisable.

The microphone is situated at a distance from the traffic that is relevant to the local noise regulation. Within the microphone housing is a sound level meter (Bruel and Kjaer model 2205) that functions only as a microphone and amplifier for the circuitry housed within the display; however, the meter can be used as a check on the calibration of the display. The circuitry of the display is such that the onset time is similar to that of a sound level meter on "fast" response. But the response to transient signals is slightly faster than a sound level meter on "fast," resulting in an exagerated reading for highly impulsive sounds such as those generated by many motorcycles and some unmuffled trucks. This error is in a desirable direction and should not be corrected. The display will operate with an accuracy of ± 2 dBA within a temperature range of 45-90 degrees F.

The "noise thermometer" was used during the summers of 1969 and 1970 within the NRC grounds in Ottawa. Many potential offenders of the Ottawa City By-Law were observed travelling to the test site to check out their vehicles, and some motorcyclists even performed modifications on the spot.

In Edmonton, Alberta, the display has been used over 1 million times in five months to publicize the city's new anti-noise legislation. During the first six weeks of the campaign, the site of the "noise thermometer" was changed frequently, with the news media publicizing each change and restating the purpose for the device. One source of concern had been that a possible slowing-up of traffic in the vicinity of the "noise thermometer" would lead to congestion and an unsafe interruption in the traffic flow. However, although the device attracted increased traffic, no serious congestion has been reported.



GENERAL

12-005

Zimmerman, M. D.

THE POLLUTION PANIC HITS HOME

Machine Design

Vol 43 No 24:19-21, 1971

Environmental noise has been doubling every 10 years and the noise levels in domestic quarters are beginning to approach those in factories. Kitchen and household appliances contribute to the indoor and outdoor noise environment of the home. Makers of household appliances are already working to quiet such noisy products as blenders, exhaust fans, mixers, garbage disposers, and dishwashers.

Methods for controlling the noise levels of such appliances include vibration-damping mounts, insulating fiberglass shields, lower motor speeds, and the relocation of noisy components within machinery. The use of rotary heat exchangers in air conditioners may increase.

Strict noise ordinances exist in Memphis and Coral Gables. Chicago set a maximum permissible noise level for new outdoor power equipment sold in the city at 74 dBA.

12-006

Rajchert, W.

Warsaw, Ul. Lwowska 5

CONFERENCE ON THE THEME OF NOISE ABATEMENT

Konferencja nt. Zwalczania Halasu

Problemy Rozwoju Budownictwa

Vol 5 No 6:49-50, 1970

A conference on Noise Control sponsored by the Committee on Acoustics of the Polish Academy of Sciences, the Ministry of Heavy Industry and the Polish Acoustical Society was held in Warsaw, 9-12 SEPT, 1970.

Besides domestic members, there were also representatives from France, U. S., Sweden, Hungary and Italy. In total, there were over 300 particpants representing the industrial, science and research fields.

The daily plenary sessions included themes on pathophysiological and acoustical trauma, critical assessment of noise, critical measurements and noise control in industry, noise abatement devices and the effects of noise on economic losses in national economy.

A paper on Problems of Noise Measurements in Construction Machinery was presented by Dr. K. Szymanski. The discussion which followed clearly stressed industry's obligation to lower the noise levels in machinery.

During the conference, Bruel and Kjaer of Denmark presented an exhibit of all their measuring equipment, and the Gullfiber Company of Sweden displayed their acoustical and vibration insulating materials.

It was advocated that all new equipment and machinery should have noise level labeling already enforced for construction machinery.

It was agreed upon the noise conferences should be convened systematically, perhaps every 3 years.

12-007

Allen, C. H.

Bolt, Beranek, and Newman, Inc.
Cambridge, MA

THE CONSULTANT'S ROLE IN NOISE CONTROL

Noise/News

Vol 1 No 2; 33-33, 1972

The role of the noise control consultant obviously must be that of a problem solver, but it also must be that of counselor, educator and advisor. He must see to it that noise control efforts will be conducted toward realistic goals that are compatible with the law and with the on-going objectives of the client. A great advantage of the noise control consultant is his experience and his freedom to recommend a number of alternative solutions.

There are not enough noise control engineers to solve existing industrial problems, either as independent consultants or as additions to industrial staff; so it will fall to industry in the end to solve most problems with in-house personnel. In the interim, the consultant can provide solutions to the most immediate problems and at the same time use these problems as means for educating the client's staff.

The most progress is made when a consultant, familiar with noise control materials, methods, and means, works intimately with members of the client's staff, who know the requirements imposed by production and process control. Only then can solutions be expected to be compatible with space, costs, operating personnel, and long-range production goals.

Often an independent voice is needed to aid in deciding internal questions to support a position in a court of law. The consultant can serve here as an unbiased expert.

12-008

THE GREAT OFFENSIVE OF THE "NOISE SPIES"

Grossoffensive der Laermspione

Die Presse

Vienna, SEPT 18, 1971

An article reports on an international noise conference of 100 noise experts, held in Vienna. The Congress was promoted by the International Standards Organization and organized by the Austrian Standards Institute with the assistance of Professor Bruckmayer of the Technical University of Graz and Dr. Judith Lang of the Noise Control Institute of the Technical Industrial Museum of Vienna.

The Congress plans to produce a noise catalogue and set bases for legal measures which should effectively protect individuals from noise-induced health hazards. The main chapter shall contain thorough coverage of aviation noise, as well as noise from heating and refrigeration equipment, and include protective devices. It shall also deal with the necessary guidelines on all noise sources.

As a first step toward effective noise protection the experts plan to carry out more precise measurements and set up noise level survey charts.

The most important task of the Congress is to formulate International Norms.

GLOSSARY

The following explanations of terms are provided to assist the reader in understanding some terms used in this publication:

A-WEIGHTED SOUND LEVEL -- The ear does not respond equally to frequencies, but is less efficient at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce, or weight, the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dB. A popular method of indicating the units, dBA, is used in this Digest. The A-weighted sound level is also called the noise level. Sound level meters have an A-weighting network for measuring A-weighted sound level.

ABSORPTION -- Absorption is a property of materials that reduces the amount of sound energy reflected. Thus, the introduction of an "absorbent" into the surfaces of a room will reduce the sound pressure level in that room by virtue of the fact that sound energy striking the room surfaces will not be totally reflected. It should be mentioned that this is an entirely different process from that of transmission loss through a material, which determines how much sound gets into the room via the walls, ceiling, and floor. The effect of absorption merely reduces the resultant sound level in the room produced by energy which has already entered the room.

ABSORPTION COEFFICIENT -- A measure of sound-absorbing ability of a surface. This coefficient is defined as the fraction of incident sound energy absorbed or otherwise not reflected by the surface. Unless otherwise specified, a diffuse sound field is assumed. The values of sound-absorption coefficient usually range from about 0.01 for marble slate to almost 1.0 for long absorbing wedges such as are used in anechoic chambers.

HARMONIC -- A sinusoidal (pure-tone) component whose frequency is a whole-number multiple of the fundamental frequency of the wave. If a component has a frequency twice that of the fundamental it is called the second harmonic.

HEARING DISABILITY -- An actual or presumed inability, due to hearing impairment, to remain employed at full wages.

HEARING HANDICAP -- The disadvantage imposed by a hearing impairment sufficient to affect one's efficiency in the situation of everyday living.

HEARING IMPAIRMENT -- A deviation or change for the worse in either hearing structure or function, usually outside the normal range; see hearing loss.

HEARING LOSS -- At a specified frequency, an amount, in decibels, by which the threshold of audibility for that ear exceeds a certain specified audiometric threshold, that is to say, the amount by which a person's hearing is worse than some selected norm. The norm may be the threshold established at some earlier time for that ear, or the average threshold for some large population, or the threshold selected by some standards body for autiometric measurements.

HEARING LOSS FOR SPEECH -- The difference in decibels between the speech levels at which the "average normal" ear and a defective ear, respectively, reach the same intelligibility, often arbitrarily set at 50%.

HERTZ -- Unit of measurement of frequency, numerically equal to cycles per second.

IMPACT -- (1) An impact is a single collision of one mass in motion with a second mass which may be either in motion or at rest. (2) Impact is a word used to express the extent or severity of an environmental prpblem; e.g., the number of persons exposed to a given noise environment.

ACCELEROMETER (ACCELERATION PICKUP) -- An electroacoustic transducer that responds to the acceleration of the surface to which the transducer is attached, and delivers essentially equivalent electric waves.

ACOUSTICAL POWER -- See sound power.

ACOUSTICS -- (1) The science of sound, including the generation, transmission, and effects of sound waves, both audible and inaudible. (2) The physical qualities of a room or other enclosure(such as size, shape, amount of sound absorption, and amount of noise) which determine the audibility and perception of speech and music.

AIRBORNE SOUND -- Sound that reaches the point of interest by propagation through air.

AIR FLOW RESISTANCE -- See flow resistance.

AMBIENT NOISE LEVEL -- The ambient noise level follows the usage of the word "ambient" throughout the environmental sciences (except acoustics). That is, the ambient noise level is that level which exists at any instant, regardless of source.

ANALYSIS -- The analysis of a noise generally refers to the examination composition of the noise in its various frequency bands, such as octaves or third-octaves bands.

ANECHOIC ROOM -- An anechoic room is one whose boundaries have been designed (with acoustically absorbent materials) to absorb nearly all the sound incident on its boundaries, thereby affording a test room essentially free from reflected sound.

ANTINODE (LOOP) -- A point, line, or surface in a standing wave where the vibration or sound pressure has maximum amplitude.

ARTICULATION INDEX (AI) -- A numerically calculated measure of the intelligibility of transmitted or processed speech. It takes into account the limitations of the transmission path and the background noise. The articulation index can range in magnitude between 0 and 1.0. If the AI is less than 0.1, speech intelligibility is generally low. If it is above 0.6, speech intelligibility is generally high.

AUDIO FREQUENCY -- The frequency of oscillation of an audible sine-wave of sound; any frequency between 20 and 20,000 Hz. See also frequency.

AURAL -- Of or pertaining to the ear or hearing.

AUDIOGRAM -- A graph showing hearing loss as a function of frequency.

AUDIOMETER -- An instrument for measuring hearing sensitivity of hearing loss.

BACKGROUND NOISE -- The total of all noise in a system or situation, independent of the presence of the desired signal. In acoustical measurements, strictly speaking, the term "background noise" means electrical noise in the measurement system. However, in popular usage the term "background noise" is also used with the same meaning as "residual noise."

BAFFLE -- A baffle is a shielding structure or series of partitions used to increase the effective length of the external transmission path between two points in an acoustic system. For example, baffles may be used in sound traps (as in air conditioning ducts) or in automotive mufflers to decrease the sound transmitted while affording a path for air flow.

BAND -- A segment of the frequency spectrum.

BAND CENTER FREQUENCY -- The designated (geometric) mean frequency of a band of noise or other signal. For example, 1000 Hz is the band center frequency for the octave band that extends from 707 Hz to 1414 Hz, or for the third-octave band that extends from 891 Hz to 1123 Hz.

BAND PRESSURE (OR POWER) LEVEL -- The pressure (or power) level for the sound contained within a specified frequency band. The band may be specified either by its lower and upper cut-off frequencies, or by its geometric center frequency. The width of the band is often indicated by a prefatory modifier; e.g., octave band, third-octave band, 10-Hz band.

BOOM CARPET -- The area on the ground underneath an aircraft flying at supersonic speeds that is hit by a sonic boom of specified magnitude.

BROADBAND NOISE -- Noise with components over a wide range of frequencies.

C-WEIGHTED SOUND LEVEL (dBC) -- A quantity, in decibels, read from a standard sound-level meter that is switched to the weighting network labeled "C". The C-weighting network weights the frequencies between 70 Hz and 4000 Hz uniformly, but below and above these limits frequencies are slightly discriminated against. Generally, C-weighted measurements are essentially the same as overall sound-pressure levels, which require no discrimination at any frequency.

COINCIDENCE EFFECT -- The coincidence effect occurs when the wavelength of the bending wave in a panel coincides with the length of an incident sound wave at the angle at which it strikes the panel. At any particular frequency, this effect can occur only if the wave in air is traveling at a particular angle with respect to the surface of the panel. Under this condition a high degree of coupling is achieved between the bending wave in the panel and the sound in the air. When the coincidence effect occurs, the transmission loss for the panel is greatly reduced. See also critical frequency.

COMMUNITY NOISE EQUIVALENT LEVEL -- Community Noise Equivalent Level (CNEL) is a scale which takes account of all the A-weighted acoustic energy received at a point, from all noise events causing noise levels above some prescribed value. Weighting factors are included which place greater importance upon noise events occurring during the evening hours (7:00 p.m. to 10:00 p.m.) and even greater importance upon noise events at night (10:00 p.m. to 6:00 a.m.).

COMPOSITE NOISE RATING -- Composite noise rating (CNR) is a scale which takes account of the totality of all aircraft operations at an airport in quantifying the total aircraft noise environment. It was the earliest method for evaluating compatible land use around airports and is still in wide use by the Department of Defense in predicting noise environments around military airfields.

COMPOSITE NOISE RATING -- (Cont'd)

Basically, to calculate a CNR value one begins with a measure of the maximum noise magnitude from each aircraft flyby and adds weighting factors which sum the cumulative effect of all flights. The scale used to describe individual noise events is perceived noise level (in PNdB); the term accounting for number of flights is $10 \log_{10} N$ (where N is the number of flight operations), and each night operation counts as much as 10 daytime operations. Very approximately, the noise exposure level at a point expressed in the CNR scale will be numerically 35-37 dB higher than if expressed in the CNEL scale.

CONTINUOUS SOUND SPECTRUM -- A continuous sound spectrum is comprised of components which are continuously distributed over a frequency region.

CRITERION -- A criterion, in Federal environmental usage, is a statement of the cause and effect relationship between a given level of pollutant and specific effects on human life.

CRITICAL FREQUENCY -- The critical frequency is the lowest frequency at which the coincidence effect can occur. At this frequency the coincidence angle is 90°, that is, the sound wave is traveling parallel to the surface of the panel. Below this frequency, the wavelength in air is greater than the bending wavelength in the panel.

CUTOFF FREQUENCIES -- The frequencies that mark the ends of a band, or at which the characteristics of a filter change from pass to no-pass.

CYLINDRICAL DIVERGENCE -- Cylindrical divergence is the condition of propagation of cylindrical waves that accounts for the regular decrease in intensity of a cylindrical wave at progressively greater distances from the source. Under this condition the sound-pressure level decreases 3 decibels with each doubling of distance from the source. See also spherical divergence.

CYLINDRICAL WAVE -- A cylindrical wave is a wave in which the surfaces of constant phase are coaxial cylinders. A line of closely spaced sound sources radiating into an open space produces a free sound field of cylindrical waves. See also cylindrical divergence.

CYCLES PER SECOND -- A measure of frequency numerically equivalent to Hertz.

DAMAGE RISK CRITERION -- A statement of noise levels (including frequency, duration, intermittancy, and other factors) above which permanent hearing loss of at least a specified amount is likely to be sustained by a person (to a given degree of probability). See also hearing loss, criterion.

DAMPING -- The dissipation of energy with time or distance. The term is generally applied to the attenuation of sound in a structure owing to the internal sound-dissipative properties of the structure or owing to the addition of sound-dissipative materials.

DECIBEL -- The decibel (abbreviated "dB") is a measure, on a logarithmic scale, of the magnitude of a particular quantity (such as sound pressure, sound power, intensity, etc.) with respect to a standard reference value. (0.0002 microbars for sound pressure and 10^{-12} watt for sound power).

DIFFUSE SOUND FIELD -- The presence of many reflected waves (echoes) in a room (or auditorium) having a very small amount of sound absorption, arising from repeated reflections of sound in various directions. In a diffuse field, the sound pressure level, averaged over time, is everywhere the same and the flow of sound energy is equally probable in all directions.

DIRECTIVITY INDEX -- In a given direction from a sound source, the difference in decibels between (a) the sound-pressure level produced by the source in that direction, and (b) the space-average sound-pressure level of that source, measured at the same distance.

DIRECTIVITY PATTERN -- The directivity pattern of a source of sound is the hypothetical surface in space over which the sound pressure levels produced by the source are constant. See also directivity index.

DOPPLER EFFECT (DOPPLER SHIFT) -- The apparent upward shift in frequency of a sound as a noise source approaches the listener (or vice versa), and the apparent downward shift when the noise source recedes. The classic example is the change in pitch of a railroad whistle as the locomotive approaches and passes by.

DUCT LINING OR WRAPPING -- Usually a sheet of porous material placed on the inner or outer wall(s) of a duct to introduce sound attenuation and heat insulation. It is often used in air conditioning systems. Linings are more effective in attenuating sound that travels inside along the length of a duct, while wrappings are more effective in preventing sound from being radiated from the duct sidewalls into surrounding spaces.

EFFECTIVE PERCEIVED NOISE LEVEL (EPNL) -- A physical measure designed to estimate the effective "noisiness" of a single noise event, usually an aircraft fly-over; it is derived from instantaneous Perceived Noise Level (PNL) values by applying corrections for pure tones and for the duration of the noise.

ELECTROACOUSTICS -- The science and technology of transforming sound waves into currents in electrical circuits (and vice versa), by means of microphones, loudspeakers, and electronic amplifiers and filters.

FAR FIELD -- Consider any sound source in free space. At a sufficient distance from the source, the sound pressure level obeys the inverse-square law (the sound pressure decreases 6 dB with each doubling of distance from the source). Also, the sound particle velocity is in phase with the sound pressure. This region is called the far field of the sound source. Regions closer to the source, where these two conditions do not hold, constitute the near field. In an enclosure, as opposed to free space, there can also sometimes be a far field region if there is not so much reflected sound that the near field and the reverberant field merge. See also reverberant field.

FILTER -- A device that transmits certain frequency components of the signal (sound or electrical) incident upon it, and rejects other frequency components of the incident signal.

FLOW RESISTANCE -- The flow resistance of a porous material is one of the most important quantities determining the sound absorbing characteristics of the material. Flow resistance is a ratio of the pressure differential across a sample of the porous material to the air velocity through it.

FOOTPRINT (NOISE) -- The shape and size of the geographical pattern of noise impact that an aircraft makes on the areas near an airport while landing or taking off.

FREE SOUND FIELD (FREE FIELD) -- A sound field in which the effects of obstacles or boundaries on sound propagated in that field are negligible.

FREQUENCY -- The number of times per second that the sine-wave of sound repeats itself, or that the sine-wave of a vibrating object repeats itself. Now expressed in Hertz(Hz), formerly in cycles per second (cps).

FUNCTION -- A quantity which varies as a result of variations of another quantity.

FUNDAMENTAL FREQUENCY -- The frequency with which a periodic function reproduces itself, sometimes called the first harmonic. (see also harmonic).

GAUSSIAN DISTRIBUTION (Or NORMAL DISTRIBUTION) -- A term used in statistics to describe the extent and frequency of deviations or errors. The outstanding characteristics are a tendency to a maximum number of occurrences at or near the center or mean point, the progressive decrease of frequency of occurrence with distance from the center, and the symmetry of distribution on either side of the center. In respect of random noise, each fluctuation of amplitude is an occurrence, whether above or below the mean level; the peak value of each fluctuation is the error and the distribution of errors with time is Gaussian.

GRADIENT -- A variation of the local speed of sound with height above ground or other measure of distance causing refraction of sound. It is most commonly caused by rising or falling temperature with altitude or by differences in wind speed.

IMPACT INSULATION CLASS (IIC) -- A single-figure rating which is intended to permit the comparison of the impact sound insulating merits of floor-ceiling assemblies in terms of a reference contour.

IMPACT SOUND -- The sound arising from the impact of a solid object on an interior surface (wall, floor, or ceiling) of a building. Typical sources are footsteps, dropped objects, etc.

INFRASONIC -- Of a frequency below the audio frequency range.

INVERSE-SQUARE LAW -- The inverse-square law describes that acoustic situation where the mean-square pressure changes in inverse proportion to the square of the distance from the source. Under this condition the sound-pressure level decreases 6 decibels with each doubling of distance from the source. See also spherical divergence.

ISOLATION -- See vibration isolator.

JET NOISE -- Noise produced by the exhaust of a jet into its surrounding atmosphere. It is generally associated with the turbulence generated along the interface between the jet stream and the atmosphere.

L_{10} LEVEL -- The sound level exceeded 10% of the time. Corresponds to peaks of noise in the time history of environmental noise in a particular setting.

L_{50} LEVEL -- The sound level exceeded 50% of the time. Corresponds to the average level of noise in a particular setting, over time.

L_{90} LEVEL -- The sound level exceeded 90% of the time. Corresponds to the residual noise level.

LEVEL -- The value of a quantity in decibels. The level of an acoustical quantity (sound pressure or sound power), in decibels, is 10 times the logarithm (base 10) of the ratio of the quantity to a reference quantity of the same physical kind.

LINE SPECTRUM -- The spectrum of a sound whose components occur at a number of discrete frequencies.

LIVE ROOM -- One characterized by an unusually small amount of sound absorption. See reverberation room.

LOUDNESS -- The judgment of intensity of a sound by a human being. Loudness depends primarily upon the sound pressure of the stimulus. Over much of the loudness range it takes about a threefold increase in sound pressure (approx. 10 dB) to produce a doubling of loudness.

LOUDNESS LEVEL -- The loudness level of a sound, in phons, is numerically equal to the median sound pressure level, in decibels, relative to 0.0002 microbar, of a free progressive wave of frequency 1000 Hz presented to listeners facing the source, which in a number of trials is judged by the listeners to be equally loud.

MACH NUMBER -- The ratio of a speed of a moving element to the speed of sound in the surrounding medium.

MASKING -- The action of bringing one sound (audible when heard alone) to inaudibility or to unintelligibility by the introduction of another sound. It is most marked when the masked sound is of higher frequency than the masking sound.

MASKING NOISE -- A noise which is intense enough to render inaudible or unintellibilible another sound which is simultaneously present.

MEAN FREE PATH -- The average distance sound travels between successive reflections in a room.

MEDIUM -- A substance carrying a sound wave.

MICROBAR -- A microbar is a unit of pressure, equal to one dyne per square centimeter.

MICROPHONE -- An electroacoustic transducer that responds to sound waves and delivers essentially equivalent electric waves.

NEAR FIELD -- See far field.

NODE -- A point, line, or surface where a wave has zero amplitude.

NOISE -- Any sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying.

NOISE CRITERION (NC) CURVES -- Any of several versions (SC, NC, NCA, PNC) of criteria used for rating the acceptability of continuous indoor noise levels, such as produced by air-handling systems.

NOISE EXPOSURE FORECAST -- Noise exposure forecast (NEF) is a scale (analogous to CNEL and CNR) which has been used by the federal government in land use planning guides for use in connection with airports.

In the NEF scale, the basic measure of magnitude for individual noise events is the effective perceived noise level (EPNL), in units of EPNdB. This magnitude measure includes the effect of duration per event. The terms accounting for number of flights and for weighting by time period are the same as in the CNR scale. Very approximately, the noise exposure level at a point expressed in the NEF scale will be numerically about 33 dB lower than if expressed in the CNEL scale.

NOISE INSULATION -- See sound insulation.

NOISE ISOLATION CLASS (NIC) -- A single number rating derived in a prescribed manner from the measured values of noise reduction. It provides an evaluation of the sound isolation between two enclosed spaces that are acoustically connected by one or more paths.

NOISE LEVEL -- See sound level.

NOISE AND NUMBER INDEX (NNI) -- A measure based on Perceived Noise Level, and with weighting factors added to account for the number of noise events, and used (in some European countries) for rating the noise environment near airports.

NOISE POLLUTION LEVEL (L_{NP} or NPL) -- A measure of the total community noise, postulated to be applicable to both traffic noise and aircraft noise. It is computed from the "energy average" of the noise level and the standard deviation of the time-varying noise level.

NOISE REDUCTION (NR) -- The noise reduction between two areas or rooms is the numerical difference, in decibels, of the average sound pressure levels in those areas or rooms. A measurement of "noise reduction" combines the effect of the transmission loss performance of structures separating the two areas or rooms, plus the effect of acoustic absorption present in the receiving room.

NOISE REDUCTION COEFFICIENT (NRC) -- A measure of the acoustical absorption performance of a material, calculated by the averaging its sound absorption coefficients at 250, 500, 1000, and 2000 Hz, expressed to the nearest integral multiple of 0.05.

NORMAL DISTRIBUTION -- See Gaussian distribution.

NOYS -- A unit used in the calculation of perceived noise level.

OCTAVE -- An octave is the interval between two sounds having a basic frequency ratio of two. For example, there are 8 octaves on the keyboard of a standard piano.

OCTAVE BAND -- All of the components, in a sound spectrum, whose frequencies are between two sine wave components separated by an octave.

OCTAVE-BAND SOUND PRESSURE LEVEL -- The integrated sound pressure level of only those sine-wave components in a specified octave band, for a noise or sound having a wide spectrum.

OSCILLATION -- The variation with time, alternately increasing and decreasing, (a) of some feature of an audible sound, such as the sound pressure, or (b) of some feature of a vibrating solid object, such as the displacement of its surface.

PARTIAL NODE -- A partial node is the point, line, or surface in a standing wave system where there is a minimum amplitude differing from zero.

PEAK SOUND PRESSURE -- The maximum instantaneous sound pressure (a) for a transient or impulsive sound of short duration, or (b) in a specified time interval for a sound of long duration.

PERCEIVED NOISE LEVEL (PNL) -- A quantity expressed in decibels that provides a subjective assessment of the perceived "noisiness" of aircraft noise. The units of Perceived Noise Level are Perceived Noise Decibels, PNdB.

PERIOD -- The duration of time it takes for a periodic wave form (like a sine wave) to repeat itself.

PERMANENT THRESHOLD SHIFT (PTS) -- See temporary threshold shift.

PHASE -- For a particular value of the independent variable, the fractional part of a period through which the independent variable has advanced, measured from an arbitrary reference.

PHON -- The unit of measurement for loudness level.
Phon = $40 + \log_2$ sone.

PINK NOISE -- Noise where level decreases with increasing frequency to yield constant energy per octave of band width.

PITCH -- A listener's perception of the frequency of a pure tone; the higher the frequency, the higher the pitch.

PLANE WAVE -- A wave whose wave fronts are parallel and perpendicular to the direction in which the wave is travelling.

PNdB -- See perceived noise level.

PRESBYCUSIS -- The decline in hearing acuity that normally occurs as a person grows older.

PURE TONE -- A sound wave whose waveform is that of a sine-wave.

RANDOM INCIDENCE -- If an object is in a diffuse sound field, the sound waves that comprise the sound field are said to strike the object from all angles of incidence at random. See also Gaussian distribution.

RANDOM NOISE -- An oscillation whose instantaneous magnitude is not specified for any given instant of time. It can be described in a statistical sense by probability distribution functions giving the fraction of the total time that the magnitude of the noise lies within a specified range.

RATE OF DECAY -- Rate of decay is the time rate at which the sound-pressure level (or other stated characteristic, such as a vibration level) decreases at a given point and at a given time after the source is turned off. The commonly used unit is decibels per second.

REFRACTION -- The bending of a sound wave from its original path, either because it is passing from one medium to another or because (in air) of a temperature or wind gradient in the medium.

RESIDUAL NOISE LEVEL -- The term "residual noise" has been adopted to mean the noise which exists at a point as a result of the combination of many distant sources, individually indistinguishable. In statistical terms, it is the level which exists 90 percent of the time. (Acousticians should note it means the same level to which they have customarily applied the term "ambient.") See also background noise.

RESONANCE -- The relatively large amplitude of vibration produced when the frequency of some source of sound or vibration "matches" or synchronizes with the natural frequency of vibration of some object, component, or system.

RESONATOR -- A resonator is a device that resounds or vibrates in sympathy with some source of sound or vibration.

RETROFIT -- The retroactive modification of an existing building or machine. In current usage, the most common application of the word "retrofit" is to the question of modification of existing jet aircraft engines for noise abatement purposes.

REVERBERANT FIELD -- The region in a room where the reflected sound dominates, as opposed to the region close to the noise source where the direct sound dominates.

REVERBERATION -- The persistence of sound in an enclosed space, as a result of multiple reflections, after the sound source has stopped.

REVERBERATION ROOM -- A room having a long reverberation time, especially designed to make the sound field inside it as diffuse (homogeneous) as possible. Also called a live room.

REVERBERATION TIME (RT) -- The reverberation time of a room is the time taken for the sound pressure level (or sound intensity) to decrease to one-millionth (60 dB) of its steady state value when the source of sound energy is suddenly interrupted. It is a measure of the persistence of an impulsive sound in a room and of the amount of acoustical absorption present inside the room.

ROOM CONSTANT -- The room constant is equal to (a) the product of the average absorption coefficient of the room and the total internal area of the room, divided by (b) the quantity one minus the average absorption coefficient.

ROOT-MEAN-SQUARE (RMS) -- The root-mean square value of a quantity that is varying as a function of time is obtained by squaring the function at each instant, obtaining the average of the squared values over the interval of interest, and taking the square root of this average. For a sine wave, multiply the RMS value by $\sqrt{2}$, or about 1.43, to get the peak value of the wave. The RMS value, also called the effective value of the sound pressure, is the best measure of ordinary continuous sound, but the peak value is necessary for assessment of impulse noises.

SHIELDING -- The attenuation of a sound by placing walls, buildings, or other barriers between a sound source and the receiver.

SINE-WAVE -- A sound wave, audible as a pure tone, in which the sound pressure is a sinusoidal function of time.

SONE -- The unit of measurement for loudness. One sone is the loudness of a sound whose level is 40 phons.

SONIC BOOM -- The pressure transient produced at an observing point by a vehicle that is moving past (or over) it faster than the speed of sound.

SOUND -- See acoustics (1).

SOUND ABSORPTION COEFFICIENT -- See absorption coefficient.

SOUND ANALYZER -- A sound analyzer is a device for measuring the band pressure level or pressure-spectrum level of a sound as a function of frequency.

SOUND INSULATION -- (1) The use of structures and materials designed to reduce the transmission of sound from one room or area to another or from the exterior to the interior of a building. (2) The degree by which sound transmission is reduced by means of sound insulating structures and materials.

SOUND LEVEL (NOISE LEVEL) -- The weighted sound pressure level obtained by use of a sound level meter having a standard frequency-filter for attenuating part of the sound spectrum.

SOUND LEVEL METER -- An instrument, comprising a microphone, an amplifier, an output meter, and frequency-weighting networks, that is used for the measurement of noise and sound levels in a specified manner.

SOUND POWER -- Of a source of sound, the total amount of acoustical energy radiated into the atmospheric air per unit time.

SOUND POWER LEVEL -- The level of sound power, averaged over a period of time, the reference being 10^{-12} watts.

SOUND PRESSURE -- (1) The minute fluctuations in atmospheric pressure which accompany the passage of a sound wave; the pressure fluctuations on the tympanic membrane are transmitted to the inner ear and give rise to the sensation of audible sound. (2) For a steady sound, the value of the sound pressure averaged over a period of time. (3) Sound pressure is usually measured (a) in dynes per square centimeter (dyn/cm^2), or (b) in newtons per square meter (N/m^2). $1\ N/m^2 = 10\ dyn/cm^2$ 10^{-5} times the atmospheric pressure.

SOUND PRESSURE LEVEL -- The root-mean-square value of the pressure fluctuations above and below atmospheric pressure due to a sound wave; expressed in decibels re a reference pressure of 0.0002 microbars (2×10^{-5} Newtons per square meter).

SOUND SHADOW -- The acoustical equivalent of a light shadow. A sound shadow is often partial because of diffraction effects.

SOUND TRANSMISSION CLASS (STC) -- The preferred single figure rating system designed to give an estimate of the sound insulation properties of a partition or a rank ordering of a series of partitions. It is intended for use primarily when speech and office noise constitute the principal noise problem.

SOUND TRANSMISSION COEFFICIENT -- The fraction of incident sound energy transmitted through a structural configuration.

SOUND TRANSMISSION LOSS (TRANSMISSION LOSS) (TL) -- A measure of sound insulation provided by a structural configuration. Expressed in decibels, it is 10 times the logarithm to the base 10 of the reciprocal of the sound transmission coefficient of the configuration.

SPACE-AVERAGE SOUND PRESSURE LEVEL -- The space-average sound-pressure level is the sound pressure level averaged over all directions at a constant distance from the source.

SPECTRUM -- Of a sound wave, the description of its resolution into components, each of different frequency and (usually) different amplitude and phase.

SPEECH-INTERFERENCE LEVEL (SIL) -- A calculated quantity providing a guide to the interfering effect of a noise on reception of speech communication. The speech-interference level is the arithmetic average of the octave-band sound-pressure levels of the interfering noise in the most important part of the speech frequency range. The levels in the three octave-frequency bands centered at 500, 1000, and 2000 Hz are commonly averaged to determine the speech-interference level. Numerically, the magnitudes of aircraft sounds in the Speech-Interference Level scale are approximately 18 to 22 dB less than the same sounds in the Perceived Noise Level scale in PNdB, depending on the spectrum of the sound.

SPEED (VELOCITY) OF SOUND IN AIR -- The speed of sound in air is 344 m/sec or 1128 ft/sec at 78^{o}F.

SPHERICAL DIVERGENCE -- Spherical divergence is the condition of propagation of spherical waves that relates to the regular decrease in intensity of a spherical sound wave at progressively greater distances from the source. Under this condition the sound-pressure level decreases 6 decibels with each doubling of distance from the source. See also cylindrical divergence.

SPHERICAL WAVE -- A sound wave in which the surfaces of constant phase are concentric spheres. A small (point) source radiating into an open space produces a free sound field of spherical waves.

SPL -- See sound pressure level.

STANDARD -- (1) A prescribed method of measuring acoustical quantitites. Standards in this sense are promulgated by professional and scientific societies like ANSI, SAE, ISO, etc., as well as by other groups. (2) In the sense used in Federal environmental statutes, a standard is a specific statement of permitted environmental conditions.

STANDING WAVE -- A periodic sound wave having a fixed distribution in space, the result of interference of traveling sound waves of the same frequency and kind. Such sound waves are characterized by the existence of nodes, or partial nodes, and antinodes that are fixed in space.

STEADY-STATE SOUNDS -- Sounds whose average characteristics remain constant in time. An example of a steady-state sound is an air conditioning unit.

STRUCTUREBORNE SOUND -- Sound that reaches the point of interest, over at least part of its path, by vibration of a solid structure.

SUBHARMONIC -- A sound component of frequency a whole-number of times less than the fundamental frequency of the sounds' complex wave.

TAPPING MACHINE -- A device that produces a standard impulsive noise by letting weights drop a fixed distance onto the floor. Used in tests measuring the isolation from impact noise provided by various floor-ceiling constructions.

TEMPORARY THRESHOLD SHIFT (TTS) -- A temporary impairment of hearing capability as indicated by an increase in the threshold of audibility. By definition, the ear recovers after a given period of time. Sufficient exposures to noise of sufficient intensity, from which the ear never completely recovers, will lead to a permanent threshold shift (PTS), which constitutes hearing loss. See hearing loss, threshold shift, threshold of audibility.

THIRD-OCTAVE BAND -- A frequency band whose cut-off frequencies have a ratio of 2 to the one-third power, which is approximately 1.26. The cut-off frequencies of 891 Hz and 1112 Hz define a third-octave band in common use. See also band center frequency.

THRESHOLD OF AUDIBILITY (THRESHOLD OF DETECTABILITY) -- The minimum sound-pressure level at which a person can hear a specified sound for a specified fraction of trials.

THRESHOLD SHIFT -- An increase in a hearing threshold level that results from exposure to noise.

TONE -- A sound of definite pitch. A pure tone has a sinusoidal wave form.

TRAFFIC NOISE INDEX (TNI) -- A measure of the noise environment created by vehicular traffic on highways; it is computed from measured values of the noise levels exceeded 10 percent and 90 percent of the time.

TRANSMISSION LOSS -- See sound transmission loss.

TRANSDUCER -- A device capable of being actuated by waves from one or more transmission systems or media and supplying related waves to one or more other transmission systems or media. Examples are microphones, accelerometers, and loudspeakers.

TTS -- See temporary threshold shift

ULTRASONIC -- Pertaining to sound frequencies above the audible sound spectrum (in general, higher than 20,000 Hz).

VIBRATION ISOLATOR -- A resilient support for machinery and other equipment that might be a source of vibration, designed to reduce the amount of vibration transmitted to the building structure.

WAVEFORM -- A presentation of some feature of a sound wave, e.g., the sound pressure, as a graph showing the moment-by-moment variation of sound pressure with time.

WAVEFRONT -- An imaginary surface of a sound wave on its way through the atmosphere. At all points on the wavefront, the wave is of equal amplitude and phase.

WAVELENGTH -- For a periodic wave (such as sound in air), the perpendicular distance between analogous points on any two successive waves. The wavelength of sound in air or in water is inversely proportional to the frequency of the sound. Thus the lower the frequency, the longer the wavelength.

WHITE NOISE -- Noise whose energy is uniform over a wide range of frequencies, being analogous in spectrum characteristics to white light. White noise has a "hishing" sound. See also broadband noise.

WRAPPING -- See duct lining or wrapping.

ABBREVIATIONS

AAT	Auditory Awakening Threshold
ADIZ	Audible Noise Sensitive Warning
AI	Acceptability Index
AI	Articulation Index
APNL	Average Peak Noise Level
BS	British Standards
CDR	Composite Damage Risk
CL	Comfort Level
CNEL	Community Noise Equivalent Level
CNR	Composite Noise Rating
CPNL	Continuous Perceived Noise Level
DIN	German Industrial Norm (Deutsche Industrie Norm)
DME	Distance Measuring Equipment
DRC	Damage Risk Contours
ECPNL	Equivalent Continuous Perceived Noise Level
EDRL	Effective Perceived Noise Level
EEG	Electroencephalogram
EMG	Electromyogram
ENG	Electronystagmograph
ENI	Environmental Noise Index
EPNDB	Effective Perceived Noise
FSTC	Field Sound Transmission Class
GNL	General Noise Level
HL	Hearing Level
HNL	Hourly Noise Level
Hz	Hertz
ICE	Internal Combustion Engine
IDL	Intelligibility Disturbance Level

ILS	Instrument Landing System
INR	Impact Noise Rating
IPNL	Integrated Perceived Noise Level Loudness Level
LL	Loudness Level
LOA	Level of Optimum Articulation
MAT	Minimal Aversion Threshold
MEL	Mean Energy Level
MPL	Multiple Pure Tones
NAC	Noise Abatement Climb
NC	Noise Criterion
NIC	Noise Isolation Class
NIPTS	Noise-Induced Permanent Threshold Shift
NNI	Noise Number Index
NPL	Noise Pollution Level
NR	Noise Rating
NRC	Noise Reduction Coefficient
PNDB	Perceived Noise
PNL	Perceived Noise Level
PSD	Power Spectral Density
PSF	Comparison Peak Overpressure
PTS	Permanent Threshold Shift
PWL	Sound Power Level
RECAT	Regulatory Effects on the Costs of Automative Transportation
REIL	Runway End Indicator Lights
REM	Rapid Eye Movement
RMS	Root Mean Square
ROPS	Roll-over Protective Structures
RRL	Road Research Laboratory

RT	Reverberation Time
SAE	Statistical Energy Analysis
SENEL	Single Event Noise Exposure Level
SFC	Space Flight Center
SIL	Speech Interference Level
SIN	Spatially Incoherent Noise
SPL	Sound Pressure Level
SST	Supersonic Transport
STC	Sound Transmission Class
STL	Sound Transmission Loss
STOL	Short Take-off and Landing
TACV	Tracked Air Cushion Vehicles
TL	Transmission Loss
TLV	Threshold Limit Value
TNI	Traffic Noise Index
TPU	Transmission Preference Unit
TTS	Temporary Threshold Shift
UAN	Useful Auditory Area in Noise
VASI	Visual Approach Slope Indicator
VTOL	Vertical Take-off and Landing
V/STOL	Vertical Short Take-off and Landing
WECPNL	Weighted Equipment Continuous Perceived Noise Level

ACRONYMS

AAAS	American Association for the Advancement of Science
AAIN	American Association of Industrial Nurses
AAOM	American Academy of Occupational Medicine
AAOO	American Academy of Ophthamology and Otolaryngology
ACGIH	American Conference of Governmental Industrial Hygienists
AES	American Engineers Society
AES	Audio-Engineering Society
AGMA	American Gear Manufacturers Association
AHAM	Association of Home Appliance Manufacturers
AIAA	American Institute of Aeronautics and Austronautics
AICB	International Association Against Noise (Association Internationale Contre le Bruit)
AIHA	American Industrial Hygiene Association
AIHS	American Industrial Hearing Services
AIMA	Acoustical and Insulating Materials Association
AIP	American Institute of Planners
AIPE	American Institute of Plant Engineering
AMA	Automobile Manufacturers Association
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASACOS	Acoustical Society of America Committee on Standards
ASEE	American Society for Engineering Education
ASHA	American Speech and Hearing Association
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers

ASQC	American Society for Quality Control
ASTM	American Society for Testing Material
ATA	American Trucking Association
BBN	Bolt, Beranek, and Newman
B & K	Bruel & Kjaer
BOCA	Builders Official Conference of America
BRS	Building Research Station
BSI	British Standards Institution
CAGI	Compressed Air and Gas Institute
CCH	Committee on Conservation of Hearing
CEI	International Electrotechnical Commission
CERN	European Organization for Nuclear Research
CHABA	Committee on Hearing, Bioacoustic and Biomechanics
CIMA	Construction Industry Manufacturers' Association
CLASB	Citizen's League Against the Sonic Boom
CONCAWE	International Study Group for Conservation of Clean Air and Water/Western Europe/
CSTB	Scientific and Technical Center for Building Construction (Centre Scientifique et Technique du Batiment-Paris)
CTA	Chicago Transit Authority
DAL	German Noise Abatement Society (Deutscher Arbeitsring fuer Laermbekaempfung)
DOT	Department of Transportation
ECAC	European Civil Air Conference
ECE	Council of Europe
ECE	Economic Commission for Europe
EEC	European Economic Community
EMA	Engine Manufacturers' Association
ERIC	Educational Resources Information Center

ERIC/CEF	Educational Resources Information Center/Clearinghouse on Educational Facilities
FAA	Federal Aviation Administration
FAI	International Aeronautical Federation (Federation Aeronautique Internationale)
FHA	Federal Housing Administration
HUD	Housing and Urban Development (Dept. of)
HVI	Home Ventilating Institute
IAC	Industrial Acoustics Company
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICBO	International Conference of Building Officials
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IES	Institute of Environmental Sciences
IFHP	International Federation for Housing and Planning
IIHT	Institute in Industrial Hearing Testing
IITR	Illinois Institute of Technology Research
ILO	International Labor Office
IMA	Industrial Medical Association
INCE	Institute of Noise Control Engineering
IRAD	Independent Research and Development Program
ISA	Instrument Society of America
ISO	International Standards Organization
JAMA	Journal of American Medical Association
LBS	Noise Abatement Office/Zurich, Switzerland/ (Laermbekaempfungsstelle)
LEAA	Law Enforcement Assistance Administration
LIA	Lead Industries Association

MAC	Metropolitan Airports Commission
MASAC	Metropolitan Airports Sound Abatement Council
NAC	Noise Abatement Committee
NAHB	National Association of Home Builders
NAS/NAE	National Academy of Sciences/National Academy of Engineering
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NCTCOG	North Central Texas Council of Governments
NEMA	National Electrical Manufacturers Association
NIOSH	National Institute for Occupational Safety and Health
NIPCC	National Industrial Pollution Control Committee
NMBTA	National Machine Tool Builders Association
NSBE	Northwestern Students for a Better Environment
NSC	National Safety Council
OAL	Austrian Noise Abatement Society (Oesterreichischer Arbeitsring fuer Laermbekaempfung)
OCMA	Oil Companies Materials Association
OECD	Organization for Economic Cooperation and Development
OSHA	Occupational Safety Health Administration
OST	Office of Science and Technology
PAN	Polish Academy of Sciences (Polska Akademia Nauk)
PHS	Public Health Service
PNEUROP	European Committee of Manufacturers of Compressed Air Equipment
RMA	Radio Manufacturers Association
SAE	Society of Automotive Engineers
SESA	Society for Experimental Stress Analysis
SIA	Swiss Association of Engineers and Architects (Schweizerischer Ingenieur-und Architekter-Verein)

SUI	Sound and Vibration Institute
WHO	World Health Organization
VDI	Association of German Engineers (Verein Deutscher Ingenieure)

LIST OF SOURCES

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READER RESPONSE FORM

This form is designed to give readers an opportunity to comment and make suggestions concerning this pilot publication. Please feel free to elaborate in the space provided under No. 9.

1. The most useful part of Noise Facts Digest for me was (mark with an "X"):
   The least useful part was (mark with an "O"):

   - ☐ Chicago article
   - ☐ Information system article
   - ☐ Glossary
   - ☐ EPA Hearings abstracts
   - ☐ Journals and reports abstracts
   - ☐ Abbreviations and Acronyms

2. Of the twelve abstract categories, I was most interested in (check more than one if necessary):

   - ☐ Emission and suppression
   - ☐ Physiological
   - ☐ Psychological/sociological
   - ☐ Economic aspects
   - ☐ Building acoustics
   - ☐ Measurement
   - ☐ Planning and siting
   - ☐ Legislation/standards
   - ☐ Enforcement
   - ☐ Program planning
   - ☐ Data
   - ☐ General

3. Environmental noise control is ______% of my job.

4. The index was

   - ☐ Satisfactory
   - ☐ Too detailed
   - ☐ Difficult to use because of poor subject terms
   - ☐ Not detailed enough

5. The level of the material is

   - ☐ Too technical
   - ☐ Satisfactory
   - ☐ Not technical enough

6. How did you use Noise Facts Digest? (check more than one if you like.)

   - ☐ General information
   - ☐ Current awareness
   - ☐ As a reference to specialists
   - ☐ Actually applied some of the information to a particular problem I am working on. (In what field?______________________________)
   - ☐ Did not use

7. I would like to get future issues. ☐ Yes ☐ No

8. I could supply material for future issues. ☐ Yes ☐ No

9. Specific comments and suggestions: ______________________________

   ____

   ____

   ____

10. Name ____________________ Position ____________________

    Organization ______________________________

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