NOISE FACTS DIGEST

June 1972

for the

US ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL
WASHINGTON, DC 20460

CONTRACT 68-01-0512
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 last year. These witness statements provide the reader with an 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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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
(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*

<table>
<thead>
<tr>
<th>Categories</th>
<th>Investigations Made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice Cream Trucks</td>
<td>13</td>
</tr>
<tr>
<td>Buses</td>
<td>3</td>
</tr>
<tr>
<td>Trucks</td>
<td>125</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>82</td>
</tr>
<tr>
<td>Automobiles</td>
<td>80</td>
</tr>
<tr>
<td>Air Conditioners</td>
<td>190</td>
</tr>
<tr>
<td>Exhaust Fans</td>
<td>97</td>
</tr>
<tr>
<td>Chicago Transit Authority</td>
<td>23</td>
</tr>
<tr>
<td>Construction</td>
<td>151</td>
</tr>
<tr>
<td>Hornblowing</td>
<td>77</td>
</tr>
<tr>
<td>Scavengers (privately operated refuse trucks)</td>
<td>142</td>
</tr>
<tr>
<td>Musical Instruments</td>
<td>109</td>
</tr>
<tr>
<td>Miscellaneous Noises</td>
<td>214</td>
</tr>
<tr>
<td>Gas Stations</td>
<td>34</td>
</tr>
<tr>
<td>Factory Noises</td>
<td>113</td>
</tr>
<tr>
<td>Lawn Mowers</td>
<td>2</td>
</tr>
<tr>
<td>Loudspeakers</td>
<td>95</td>
</tr>
<tr>
<td>Doorman Whistles</td>
<td>11</td>
</tr>
<tr>
<td>Car Washes</td>
<td>9</td>
</tr>
<tr>
<td>Church Bells</td>
<td>25</td>
</tr>
<tr>
<td>Vibrations</td>
<td>55</td>
</tr>
<tr>
<td>Refrigeration Units (Trucks)</td>
<td>8</td>
</tr>
<tr>
<td>Dust Collectors</td>
<td>3</td>
</tr>
<tr>
<td>Burglar Alarms</td>
<td>7</td>
</tr>
<tr>
<td>Airplanes</td>
<td>3</td>
</tr>
</tbody>
</table>

(Subtotal) 1,685

Railroad Noise 60

Total 1,745

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**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

<table>
<thead>
<tr>
<th>Type of District</th>
<th>Where Measured</th>
<th>Limits [For Monitoring Purposes]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business &amp; commercial</td>
<td>At boundaries of the lot</td>
<td>62 dBA</td>
</tr>
<tr>
<td>districts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>At boundaries of the lot</td>
<td>55</td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--Restricted Manufacturing</td>
<td>At zoning district boundaries</td>
<td>55 On boundary with a residential district</td>
</tr>
<tr>
<td></td>
<td></td>
<td>62 On boundary with a business-commercial district</td>
</tr>
<tr>
<td>--General Manufacturing</td>
<td></td>
<td>58 On boundary with a residential district</td>
</tr>
<tr>
<td></td>
<td></td>
<td>64 On boundary with a business commercial district</td>
</tr>
<tr>
<td>--Heavy Manufacturing</td>
<td></td>
<td>61 On boundary with a residential district</td>
</tr>
<tr>
<td></td>
<td></td>
<td>66 On boundary with a business-commercial district</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Category</th>
<th>Noise Limit in dBA, Measured at 50 Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles</td>
<td>88</td>
</tr>
<tr>
<td>Trucks (over 8000 lbs. gross weight)</td>
<td>88</td>
</tr>
<tr>
<td>Cars &amp; other vehicles</td>
<td>86</td>
</tr>
<tr>
<td>Construction &amp; industrial equipment, including bulldozers, drills, loaders, power shovels, cranes, derricks, motor graders, paving machines, off-highway trucks, ditches, trenchers, compactors, scrapers, wagons, pavement breakers, compressors, and pneumatic equipment—pile drivers not included.</td>
<td>94</td>
</tr>
<tr>
<td>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.</td>
<td>88</td>
</tr>
<tr>
<td>Equipment for repeated use in residential areas such as lawnmowers, small lawn &amp; garden tools, riding tractors, &amp; snow removal equipment.</td>
<td>74</td>
</tr>
<tr>
<td>Snowmobiles</td>
<td>82</td>
</tr>
<tr>
<td>Dune buggies, all terrain vehicles, go-carts, mini bikes.</td>
<td>86</td>
</tr>
</tbody>
</table>

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 defendants 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 Enforcement 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 re-checks 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 appears in court, which is a great deterrent 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 been 79 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 taxicab 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 violators.
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 negligible 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 transportation 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 foot of residential buildings between 9:00 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 citizenary concerned enough to pick up the phone when necessary. As the statistics show, a successful public awareness campaign 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 canvas members of the industrial community, because it is often possible to find industrial spokesmen sympathetic to the legislation who can be asked to testify.

* 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 indispensable 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 material 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 Sup. 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).
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00-001
Hagan, J.
Bangston, I.
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 problem 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 95.5 dBA to 90.2 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 many 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 1950 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
Jacobs, H. 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 those 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 Horimans 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
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 500,000 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 are 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 inflammable which creates a definite fire hazard. It is necessary to weigh the tradeoffs in serviceability, affect on reliability, safety and cost.

Engineers are working on a long-range basis on components such as engines, hydraulic pumps, gears 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 db 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 $502 million annually, for a reduction of 5 to 12 db.

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.

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

Wahl, F. H.
Wahl, Haydon and Associates, Ltd.
New Orleans, LA

Witness Statement
Public Hearings on Noise Abatement and Control
Atlanta, Jul 8, 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 conditions 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 situation 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 is 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.

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 Lakewood Section of the Uptown Model Cities Area" (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 Lakewood 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 approaching cars and that noise from the elevated trains of the Chicago Transit Authority (CTA) frightened them. It was concluded that noise from the CTA was 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 Keogh-Hoey 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 batte. EPA should adopt STC levels for building materials that will reduce noise levels below the 80 dBA level.
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Third, EPA should perform additional research on the effectiveness of baffles and concrete supports which are used for noise abatement around rT 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 1970s. New airport capacity is spilled 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 Intrastate 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
Spurk, 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 dB are a nuisance.

To implement the provisions of the ordinance, a bubble hop 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 were complaints are equal to or in excess of the 95 dB '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.
EPA HEARINGS

00-010

Report, H. M.
Federal Highway Administration,
Washington, DC
Zip 20591

On: CONTROL OF HIGHWAY RELATED NOISE

Witness Statement
Public Hearings on Nal-007ment and Control
Chicago, Jul 29, 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 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. Hot Salsa mixer motor vehicle noise would not be a matter 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 officer. 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 aural theater 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 official 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 noise or compatibility, 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 these enormous tasks with the enactment of the Federal-Aid Highway Act of 1970. One of those tasks is the development of guidelines to ensure 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 in 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 analysis of any 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
The exhaust stack must be sited closer to the ground so that low barriers will be more effective. Pavement surfaces must be developed that are both quiet and safe.

A fast road capability is needed which could be used when all other techniques are inadequate or unacceptably. Possible approaches might include modifying to purchase noise attenuation or noise rights, the outright purchase of a property, or installation of noise abatement.

DO-010

Rinehard, R. F.
Street, R. L.

International Harvester Company, Chicago, IL

On: HIGHWAY TRANSPORTATION NOISE

Witness Statement

Public Hearings on Noise Abatement and Control

Chicago, JUL 26, 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: exhaust noise, cooling fan, engine air intake, engine mechanical and combustion, and tire and wind noise.

If certain sound sources are eliminated for example, the 68 dBA exhaust noise by a theoretically perfect muffler, the total noise level would only drop to 68 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 noise 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) Shelves 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 of 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 early, significant sound reduction 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.

DO-011

Walker, O.

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.
In contrast to older dwellings, the modern dwelling with its lightweight construction, open plan design and multitudes 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 within the dwelling and 66% 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 efficacy of local government, left to its own devices, 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 stressors 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.

Examples of involvement of architects and building contractors in construction techniques to reduce sound transmission are presented. Some suggestions for activities of EPA in this field are outlined.

A new residential apartment was described as having "revolutionary soundproofing" that nullifies the noise within the new old tenement buildings. One floor hearing walls have a 25-32 db rating that other walls have 35-36 db and poorly designed.

In another case, a hospital, the patient's machinery was not properly isolated. After years of professional help was sought and the problem corrected very swiftly.

Another example is post-functioned concrete using this method of construction, floors can be thin and support the weight, the buildings vibrate slightly, everyone blamed someone else. It cannot be 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 cordelist to a metal plenum system to a nonporous gasket.

EPA could disseminate available information on architectural design or 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 homes, such as the nonporous gasket. Some EPA money is needed through which homebuilders could be reached, since they are the environment builders. If the builders could be reached through some simplified type of demand correction mechanism, they could be put into effect very quickly. This is a great concern.

Wagner, R. L.
North Texas Council of Governments
On: REGIONAL AIRPORT PLANNING
Witness Statement
Public Hearing 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
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North 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 the airport's environs. An airport sound exposure map was prepared. A brief summary of the significance of the sound zones depicted on that map was prepared for use by local officials concerned with land development in the zones 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 out 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 NITC is the Cooperative Mapping Program, in which a number of model codes and ordinances and guidelines for soundproofing are being developed 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 officials 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 protection activities at each of these levels. Appropriately $5,000,000 per year would provide an average of $25,000 to each of the 245 standard metropolitan areas. Accrued funding of this type would establish a sound foundation and a start toward deliberate, continuing environmental protection activity at the regional level.

C. D. Parratt, M. 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 systemic application of those 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 Hudson, 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 of 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 environment 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 commonplace as the planning for residential, industrial and commercial areas and transportation facilities.

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 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 measurement 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
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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 adequately, 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 appetite 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 $50,000,000 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 proposal 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 limit 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

Humphreys, 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 healthy 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 50,000 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 includes: 1) the establishment of uniform decibel limits on all recreational vehicles, whether manufactured in the United
A staterent 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 a major concern. Noise reduction is not as simple as adding an enclosing exhaust muffler or building ductor 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 not 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 make 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 competitors to be considered. If this 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 and not penalized to satisfy a few.

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, uncompromised by an obnoxious environment, is of key importance. The concept of differential use and noise zoning is encouraged. In this manner, certain areas, for example, would be zoned for such vehicles, settling in each case realistic decibel limits.

Lincoln, Ill.
Outboard Marine Corp.
Mlwaukee, Wi
Enr.: 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 an enclosing exhaust muffler or building ductor 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 not conform to regulations will suffer severe penalties.

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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 this demand, productivity per worker has increased markedly. In 1960, one farm worker produced enough food for 20 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 of 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 close to the source as possible.

It is felt that the goal with agricultural machinery should be to reduce noise levels 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
EPA HEARINGS

The noise standard in residential areas is measured from 25 feet and has been in effect since February 1970. In Boulder, over 1000 vehicles have been repaired or modified to meet the Boulder standards. It is predicted that unless quieter motorcycles are produced and other methods are found to reduce the exhaust, much of this nation will become off limits to them. The noise level must be brought lower than 60 dBA. Trucks are allowed 88 dBA at 25 feet and do not use residential streets at night. Industry has been amazingly flexible and responsive to legal requirements. Individuals, once educated, and just as responsible, can make a difference. 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 160 was initially in violation; presently, it is one out of 30.

Construction noise in most cases has been mostly corrected. Most of the excessively noisy equipment was loud, 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 50 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

Ruber, 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, 1971

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 hearing loss first appeared in the junior-high age group. Of these, 60% suffered a hearing loss progression of 10 db. About 3 times as many males as females suffered from this hearing loss pattern.

The greatest percentage of children with hearing loss came from farms where large farms, using heavy equipment were located and where many were engaged in hunting. In a less significant situation, where farms were small and not mechanized, the children showed much less hearing loss until fire truckers became available on a year round basis. The percentage of children showing noise induced 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, individually 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, L. D.
Institute for Rapid Transit

Delay, Cauther 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 authorities 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 roll 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 aural structures which are replacing transit's old "tnt" 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 elevated lines where additional acoustical privacy is required.

9) Acoustical design criteria for ventilating fan selections 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 goals 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.
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.

EPA HEARINGS

McCollum, M.
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 noise detector used with traffic lights to control flow of traffic. Its 10,000 Hz signal is in the upper level of human hearing found in nearly all children and many young women. At the least, 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 considered for automotive safety will initiate 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 100%, while in August, 1971 they were 99%. On a very conservative scale this extrapolates into a national figure of 55,000,000 per year just showing noise complaints. These figures suggest that noise is increasing without respect to population growth or people are changing their attitudes and complaining more or less.

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 29, 1971

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

The short-term physiologic responses to noise and stress similar to those found with emotional stress in animals and man. The similarities have been documented by recording changes in blood pressure, pulse pressure, heart rate, perspiration, widening of the pupils, changes in total 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 short-acting (adrenaline-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 diurnal 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, bandwidth and rate of change of the noise, the amount of activity 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 when an awareness of an emotional or physiologic response is present, the listener will manifest most of the physiologic responses noted above.

Clearly the willingness of an individual to characterize perceptual stress is not a 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 general, the same hormonal and central nervous system pathways are involved. No experiment has yet shown a demonstrable difference between noise and pathologic effects. However, when stress of central nervous system pathways of animals was held to the same level of physiologic response as soon in humans with 70-80 dB white noise, many neurophysiologic changes 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 a large response to noise. Studies on 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 on human exposure constitute the greatest weaknesses in any attempt to reject noise as the cause of 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 5 times larger adrenocorticoid 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 noisy areas. Admission rates for this group were significantly elevated (still higher) in the noisy areas. Those studies are interesting because they both demonstrated 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, excitation or anger, diet or biochemical stresses such as atmospheric load or smog?

Clearly such research would be multifaceted, 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.
EPA HEARINGS

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 1971 with jurisdiction to investigate, control and abate noise in Boston. A report on noise was prepared by Bolt, Baranek, 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, presented closely after the Chicago ordinance. A public hearing has been held, comments reviewed, and the regulations drafted. The draft 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 city, 55 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 are in form of certificate 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 $12,000 per year to this noise abatement activity.

A certification requirement for motor vehicles of 75 dBA, at 50 feet, to be put 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.
Bury Shopping Center Day School, Alexandria, VA

On: STUDENT RECOMMENDATIONS FOR NOISE CONTROL

Witness Statement
Public Hearings on 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, quarry 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 of the secondary and primary school level.

00-029
Goldhore, 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 prevent a state from jurisdiction to protect its citizens from environmental insults. The Federal Government does not have the manpower, or database, 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 the regulations should, however, serve as a national minimum, not as a model for the states. Thus, those states which wish, can adopt more stringent regulations, and enforce them. This pattern is important if New Jersey is to clean up its severe environmental problems. State 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 California, 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 pollution from more remote 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 fails down on the job.

Other sections of the bill were discussed briefly.

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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 $130,000 of which $50 would come from the local jurisdictions. This was refused, but suggestions were made for negotiation and redission.

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 noise problem, 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 national policy 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 $317,150. 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.

00-030

Lantz, 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.

00-031

Kruml, F. H.

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
express annoyance at a specific vehicle noise
event, they felt that it was a situation the
driver could control, such as tire squeal, hot
rodding, and similar operations.

C. Annoying noise sources are relatively close
to the auditive, 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 not aware 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 opportunities.

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 born
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 recommenda-tions:

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

B. 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.

EPA HEARINGS

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, D.C., 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 or 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 BLM
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,
e着重 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 where, 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
EPA HEARINGS

used for buildings 11 to 25 at project cost compared to the machinery used on highways (197) and civil works < land (199). It can 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 in urban sites construction.

Government, in general, particularly 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 1965 to 36 percent in 1967. It is generally believed that this trend will continue".

On a trial basis, it would appear that the 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 a 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 ANSI. 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 labeling 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, DB 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 or local government perspective.

00-033

Singer, A. A.


11. QUIET HOUSE PROGRAMS

Witness Statement

Public Hearings on Noise Abatement and Control

Washington, D.C., Sept. 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 and place acoustical performance in relation to construction, the background noise levels, and the subjective responses 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 in 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 $100. Many were interested, but few willing to pay. The builder then scaled the package down to $50, 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 $100. These houses ranged in price from $20,000 to $30,000.
The most significant acoustical problems are those between apartments, while noise sources within the home or apartment are of less concern and exterior noise is least disturbing. In apartment buildings, structure-borne transmission is the cause of most disturbance, particularly impact noise, which is the same reason they are developed within units and transmitted between units. Airborne noise is not as significant a problem as it was 10 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 systematically 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 "quiet" 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 sources 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, given practically attainable performance levels are established.

One of the recent attempts to provide good urban environment is HUD's establishment of interim standards for evaluation of community noise. Because this is only a first step and its effects have yet to be 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.
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 that they may evaluate the equipment in relation to noise.
EPA HEARINGS

Bricken, D.
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 systematically apply known technology to control the presently controllable aspects of jet aircraft, namely, operations. Control of flight paths, flight scheduling, 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 on-airplane noise monitoring system operates 24 hours a day. The system, Ecologic, serves as a tool for the airport to administer its program of managing aircraft noise. The system consists of 9 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 exposure as prescribed 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

growing bulwark 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, traffic noise, 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 national traffic noise abatement strategy. The recommendations of the task force stress the necessity of vehicle noise emission standards and effective enforcement mechanisms 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, 86 dBa; trucks less than 200 hp, 92 dBa; heavy trucks (more than 200 hp), 99 dBa. These limits recently agreed to by the Common Market countries are: passenger cars, 92 dBa; trucks (over 5.5 tons), 99 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 minimising both body and tire noise as well as engine exhaust system noise.

A private company in the U. K. has announced the design of a diesel engine with noise emission characteristics 4 - 5 dBa lower than those of a conventional diesel of the same horsepower. In Germany, the firm of Miltich 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 3.2 L diesel engine which is 6 dBa quieter than 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 acoustic noise clearly predominates over the latter.
location is a processor consisting of an input-output buffer and computer for recording and manipulating the data for output to 2 display devices. The entire system 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. Continued surveillance and analysis of computer produced records allow the airport to obtain accurate statistical records of noise levels and changes in those levels. Thus the new 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 makes it difficult to develop equipment for widespread application.

Secondly, there is no clearcut jurisdiction for noise control at airports.

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

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 forgone. 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 net costs, that is, other goods and services forgone, are worth the reduction in noise. The reduction in noise will be the marginal benefit; the alternatives forgo 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 populous.
First, the need for objective standards which are achieved by a balancing process which takes 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 need for procedures and enforcement methods used to enforce them are 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 statutory and regulatory approaches to the problem, it is noted that each state, with the exception of Alaska, has adopted some legislative or regulatory schemes for the 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 "muffling the peace" approach with only a few instances of administrative or regulatory action.

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

The question of promotion was dominant in those hearings. Noise standards remain in some states from a low of 34 to a high of 90 db. There is a lack of consistency in enforcement methods. Some local governments have passed regulations 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 promotion. Also, because of the varieties in last methods, a uniform procedure should be established among the states of the federal government agency, preferably the Environmental Protection Agency. This agency, in turn, should be given the authority to delegate responsibilities 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.

Different states 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 any code enforcement officer, and controlling noise standards. It would be impossible for the public to understand and evaluate the necessity and difficulty for the industry to respond and comply with such standards. It is also important that only one agency within the federal government be charged with the responsibility for the promulgation of standards.

EPA HEARINGS

00-038

Baklin, R.

Bureau of Noise Abatement,
New York

On: MUNICIPAL NOISE CONTROL

Witness Statement

Public Hearings on Noise Abatement and Control
Washington, Dec 11, 1971

The groundwork for a comprehensive urban noise abatement program for New York City will be the subject of the study. When the study is completed, a methodology for measuring and controlling urban noise will be 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: 1) it establishes a number of noise sources, such as air conditioners, gas stoves, etc., 30 ambient noise level tests for the different communities of the city; and 3) enforcement section patterned after the recently passed Air Code, which will bring a new element of uniform action over the 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.
Currently the Board 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 three equipment certification officers, an acoustical engineer and two electronic technicians is predicted at a cost of $125,000 and $500,000 for the study and development program, make a total budget of about $600,000 for Fiscal Year 1974.5.

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 develop alternatives to automobile horn noise, and a silicon noise study. The city is proud 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 whenever 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-aborated 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

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 fell into three clearly defined categories as noise producers: pocket re-tread, cross-bar, and circumferential rib. Loudest are older re-tapped tires, particularly the pocket re-tread. 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 5-5 dBA when the tire is half worn. Some tire types show more noise fully worn than when half-worn. NBS data indicate that the difference in peak sound level between new and half-worn tires 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 contact 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 forces come 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 (6-9 dBA) and pocket re-tread tires (4-8 dBA). 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 dampening 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.

Fosca, V.
Automotive Engineering

INVESTIGATION OF SOME TRAFFIC NOISE RELATIONSHIPS
Vereinsblatt der Technischen Hochschule in Jassy, Str. F. I. N. Haus No 38, Iasi, R. S. Romania

Investigations of traffic noise in Jassy, Romania 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:

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Level in dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buses with diesel engine</td>
<td>91-93</td>
</tr>
<tr>
<td>Trucks with internal combustion engine</td>
<td>87-88</td>
</tr>
<tr>
<td>Automobiles</td>
<td>85-82</td>
</tr>
<tr>
<td>Street-cars</td>
<td>82-84</td>
</tr>
</tbody>
</table>

The measurements were conducted on 3 different types of main arteries, those with greenery, closed, and distant house-fronts. The first group had full trees on the side-with row between the street and houses; group II had some lawn and sparse shrubbery and group III had a closely congested houses and narrower streets.

Group I and II showed a small variance of 6 dBA 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 type of building can be used.
EMISSION & SUPPRESSION

01-003

Holmby, 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 the noise was generated by metal to metal contact at the travelling 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 at the travelling stripper pads and the stationary pad keepers. The application of the resilient material using pieces, rubber or leather less than a workday 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 location 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 0 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 travelling 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 ABRUPTION OF AVIATION NOISE IN RESIDENTIAL AREAS AROUND THE DUSSELDOFF AIRPORT, PART 2
Deutsche Ausgaben zur bekämpfung des Fluglarm in den Bundesreinen Wohngebieten des Flughafens Dusseldorf. Teil 2
Kampf Dem Larm
Vol 16 No 1:13-17, 1971

Part 2 of this article describes new technical measures for the abatement of aircraft noise in a Catholic elementary school Dusseldorf-Lohausen, in the vicinity of the Dusseldorf Airport.

Acoustical measurement taken by the Max-Planck Institute gave values of 100 dBA and 110 dBA for jet aircraft.

The noise level in the classrooms facing the west side with closed window was 85-95 dBA. Rubber sound absorbers were installed and quality materials were used in the construction.

After the windows were installed the sound level was lowered at least 15 dBA.

A 2 m wide and 1.40 meter high outer chamber (inner-room) consisting of bricks and mineral fiber tiles was constructed on both sides of the entrance with a window over the door. A double layered door consisting of 5 cm thick metal frame and a 3 cm thick wired 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 classrooms were reinforced with an outer sound-absorbing wall.

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

01-005

Roseneur, C. J.
Salter, C. M.
Bolt, Bereneck, and Newman, Inc., Cambridge, MA
NOISE OF PILE DRIVING EQUIPMENT

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 an pile.
EMISSION & SUPPRESSION

The vibratory hammers are either low frequency (30 Hz) with electric engines, or high frequency (20-150 Hz), powered by the unmodified 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

![Graph showing comparison of noise levels for different types of pile drivers]

Diesels are best suited for hard soils, whereas steam hammers are best used on soft soils. Diesels, diesel cranes, and fuel are more economical than steam. A sonic driver costs about 2-2.5 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 the art dictates the choice of equipment.

01-006
Price T.
Southampton Univ. /England/
ROAD TRAFFIC NOISE- ITS ORIGINS AND CONTROL

In: Janson, P. C., Conference in Connection with the International Air Pollution Control and Noise Abatement Exhibition, Joensuu, Sweden, SEP 1-5, 1971.
Joensuu, 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 40 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, 89-92; light commercial vehicles, 79-81; cars, 77-97. The legislated standards in the United Kingdom for these vehicles are 80, 85 and 90 respectively. Tests indicate that truck noise is predominantly controlled by the power unit. This increase of noise is 15 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 being performed by the machine.

Transmission noise ranges from 75-95 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 value 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
Warran, C. H.
Royal Aircraft Establishment, Farnborough /England/
Structures Dept.,
SONIC BOMB EXPOSURE EFFECTS 1.2: THE SONIC BOMB 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 these 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.

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

A 2-year study conducted by Polysanics 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 ways to the pipes being tested. Measurements of cumulative vibration drops over a large number of joints, as well as the per-joint reduction, were made. Polysanics 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. (Soft 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 14-hub neoprene gasket with stainless steel coupling provides vibration drops of as much as 11 db per joint at higher frequencies. Both types prevent direct metal-to-metal contact at joints.

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

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 a twofold purpose: 1) to obtain a statistical picture of: (a) 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.
EMISSION & SUPPRESSION

01-010
Goncharenko, V. P.
Staklostrum-Tovaryny Zaved, Odeschavlizoz
USSR
ON THE REDUCTION OF AUTOMOBILE AND TRACTOR NOISE
K Voprosy o Snizhenii Shuma Avtomobilley i
Traktorov
Gigieny Tsva Profesional'nye Zabolovaniya
Vol.14 No1 46-47, 1971

Soviet sound pressure meters with frequency
analyzers were employed to measure noise
levels at a 3 meter distance emitted from
vehicles travelling at speeds of 10 to 25 mph.
The range of readings was 74 to 109 db.
The total sound pressure level (85 db)
for trucks with frequency predominantely
35-500 Hz, was 90-107 db, while for light
weight cars it was 74-103 db with an average of
80 db. The "Dorozh" tractor ranged from
78-101 db, while heavier tractors and
bulldozers produced readings of 95-105 db at
frequencies above 600 Hz. In all cases the
existing standards were exceeded. Vehicle
interior readings were 70-85 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 Carden shafts, the fan,
the divided axe, the wheels and the tires.
Elastic-ferroelectric coatings made of perforated
materials must be more widely introduced, along
with antivibration coatings and soundproofing
shields. Existing 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 done 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-absorbing
materials.

01-011
Dobin, Ya. V.
Leningradsckii Institut Inzhenerov
Zhelezudozorotogo Transporta im. V. N.
Obraztsova, Leningrad USSR
NOISE REDUCTION FOR RAILWAY TRAFFIC AND
RIEOSTAT TESTS OF DIESEL LOCOMOTIVES
G Snizhenii Shuma pri Dizel'novozov i
Avtomobilakh Tsyklyly Szyvery
Vol. 34 No1 15-47, 1969

Soviet regulations prescribe the distances that
residential areas must be located from
railway tracks, depots and railroad-fast 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 regulation.

Realistically, means must be found to attenuate
the noise, both by insulation of the source
and by screening along the sound path. The
protective effect of brick shields built in
Law is limited.
The brick shield is 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
areas by 20 db, or a factor of four in terms
of subjective loudness, enabling the
regulations to be met.

01-012
Dobkin, P. C.
Ray, D. N.
Southampton Univ. (England)
Institute of Sound & Vibration Research,
Southamton 608 NH
LETTER TO THE EDITOR: EFFECTS OF LOUVERES 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 louveres positioned across their
intakes was studied in light of design of
lifting fans for vertical take-off aircraft
and ventilation systems.
EMISSION & SUPPRESSION

A rig configuration was chosen which was typical of the practical situations but which avoided detailed complexities of such systems. For the acoustic analog to informal, 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 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 ten assembly was performed for the louvers at 0 degrees for the shaft and rotor running at 600 and 12,000 rpm/in. Three microphone angles were considered: 0, 45, and 90 degrees. This assembly was operated first with and then without the rotor, determining the mechanical noise. Third-octave band spectra indicated that only above about 1000 Hz was there a significant difference (at 15 dB or more) in the sound pressure levels with and without the rotor.

Measurements were made of overall sound pressure levels for rotor speeds of 6000 and 12,000 rpm/in at ten-degree intervals of microphone position between 00 and 90 degrees. This was performed for ten louver angles from 0 degrees to 90 degrees.

A comparison of the airflow measurements 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 splitting effect on the flow to the rotor. This effect became more marked as the lower angle increased until a point was reached at about 90 degrees where the opposite affect of reduced main flow and acoustic blockage became effective equally, and beyond 90 degrees the amount of noise radiated from the intake decreased.

The overall noise level was found to be roughly non-directional for all lower angles. The distribution in angle of the radiated noise at the third-octave band containing the blade passing frequency was found to covary in a rather irregular manner.

01-013
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EVALUATION OF CITY TRANSIT BUS "EIP" KITS TO REDUCE EXHAUST SMOKE, DUST, NOISE, EMISSIONS AND NOISE

HC $3.00 MF 95 cents

The General Motors Environmental Improvement Program (EIP) retrofit was designed to be installed on all city transit buses with the cycle diesel engines for the reduction of air emissions and noise. Field testing has shown that EIP kits, properly installed and maintained, reduce visibly 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. Noise reduction performance might be attained, with no worsening of other performance parameters, if certain kit components were redesigned.

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

Exhaust 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 fuel tank. The EIP kit's improved motor mounts and air intake mufflers reduced interior noise levels slightly. The mount used additional rubber insulation between the engine crank and the cowl opening. 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 reasons that exterior noise tended to increase was the higher shift speeds needed to reduce the smoke produced at shift points.
EMISSION & SUPPRESSION

On first assuming the kits in late 1969, 61,050 Transit buses in the national fleet, the majority now of GM manufacture. The EIP kit or at least its most effective companion, the LSN injector, could be fitted in its entirety to the 24,000 "new look" buses produced since 1969. Buses fitted with EIP kit 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 $200, parts and labor. Including the kit at the factory in a new bus would cost about $500-550.

01-014

Hiles, D. V.

Hilton, R.

National Research Council of Canada, Ottawa, Ontario

ON: NOISE MEASUREMENTS OF LOGGING MACHINERY IN THE FOREST

Int: Hiles, D., An Acoustical Study of Machinery on Logging Operations in Eastern Canada

Ontario, National Research Council of Canada AR, 1971 4 p. (p. 17-21)

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 made at about 120 different logging operation machinery. Skidders and chain saws are the most common noise sources. Readings were made 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 operations 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 db (Fig. 1) and decibels (Fig. 2). For sound energy following the inverse square law the sound levels should decrease 22.5 db between 50 feet and 10 feet (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.
The human ear can certainly distinguish machine noise from background noise in the forest, even when the machine 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 (1.45 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 56 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 skidder 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 apiece.

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.

The propagation of sound waves in forests is investigated as an 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 dBA 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 all per mile.

<table>
<thead>
<tr>
<th>Relative Temperature (000 Hz)</th>
<th>2000</th>
<th>4000</th>
<th>6000</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% of Humidity</td>
<td>25</td>
<td>68</td>
<td>17</td>
</tr>
<tr>
<td>77% of Humidity</td>
<td>20</td>
<td>68</td>
<td>17</td>
</tr>
<tr>
<td>95% of Humidity</td>
<td>14</td>
<td>66</td>
<td>17</td>
</tr>
</tbody>
</table>

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.
The threshold of hearing (128 dB above 1000 Hz) could also be used as a criterion for these systems as the threshold of hearing is used as a criterion for human auditory perception. If the threshold of hearing is exceeded, then the noise will be perceived as unpleasant and annoying.

The results of the experiments conducted on the sound and vibration suppression systems are presented in Table 1.

The effectiveness of the noise suppression systems is evaluated by the reduction in the level of noise and vibration measured at the test site. The results show that the noise and vibration suppression systems are effective in reducing the noise and vibration levels at the test site.

The noise and vibration suppression systems are used to control the noise and vibration levels in the surrounding environment. The noise and vibration suppression systems are designed to meet the requirements of the noise and vibration control standards. The noise and vibration suppression systems are also used to reduce the noise and vibration levels in the surrounding environment.
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 considerably less than the noise levels 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.

Industry and government studies in response to all active, airborne 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 altering the engine installation or the aircraft
2) Changes in land utilization in airport communities
3) Changes in regulatory and operational procedures in the vicinity of airports.

Considerable work is now being done in industry and government programs to examine the effects of retrofitting the existing fleet of commercial jet transport aircraft to significantly reduce their community noise levels. The magnitude of noise reduction achieved 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. Equally important is the need for new noise regulations.

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 regulations. Traffic patterns and routes can be optimized over less populated areas. Glide slopes are steepened by 1 degree, significant noise reduction will occur. Finally, the glide slope intercept attitude can be raised. If all of these points were accomplished, Federal and local regulations would be responsible for a good deal of noise reduction.
EMISSION & SUPPRESSION

Operational procedures available to the airlines themselves could also affect 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. If position during approach and landing could be set at a lower angle, producing less noise. This would require additional runway drainage. Takeoff procedures could be modified by implementing a power cutoff at an acceptable altitude.

The effects of automotive noise on people can be divided into the subjective effects of annoyance, irritation, 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 infrastructures with noise is also often cited. In assessing 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 such noise level with the percentage of time which that level is exceeded. For example, 90 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:

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, isolation, and depression/elevation of the roadway will reduce noise levels. Construction of earth berms will also control noise considerably. Deposition of the roadway, on one case, resulted in a 13.5 dBA noise reduction.
EMISSION & SUPPRESSION

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

01-020

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Agricultural Division, Toxide
NOISE FROM CHEMICAL PLANT EQUIPMENT
Annals of Occupational Hygiene
Vol. 14 No. 2/91-99, 1972

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 centrifugal 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 diffusers and absorption silencers.

Efforts to silence the third problem, flarestacks have been disappointing so far. Noise is a function of the stack rate at nozzle, not the overall steam rate. Internal design of combustion is a negligible factor in noisiness. Use of perforated steam jets at different orientation resulted in a 7-9 dBA improvement; however, this is inadequate. Flow conditions at stack 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
Judy Kolesnjuk, a Zuj Ciakuniasreno
Ujtok Logja (Budapest)
Vol 23 No 2013-14, 1971

The Sika sound damper, based on a patent granted to physicist Domokos Harvath and mechanical engineer George Sardi, went into series production at the Sonny 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 gasses," is an enclosure bounded by walls consisting of multilayered film with dead space between the layers which are fitted with loose granular, porous or other vibration damping media. The invention has been in use in the OMS-MAVE Engine Testing Station since 1965. Noise has been reduced in the plant environment, and the attenuation of low frequency noise of 10 dBA 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 Ouda and Zsigo. Tests on prototypes of the MNK apartment house ventilation systems produced by the Ventilator Plant and equipped with the noise attenuation device show attenuation of 15 dBA. A 30-40 dB attenuation from 110 dB to approximately 75 dB was also achieved in exhaust noise from the compressor room of the Pecis 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.
EMISSION & SUPPRESSION

Effective noise reduction by means of a simple plane muffler was achieved for a piston-type air compressor installation located in a separate shed on a factory property, enabling the compressor installation to meet the Soviet norms for noise emitted by 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 piston-type 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 dB(A).

A simple cylindrical muffler attached to the air intake pipe proved effective for reducing noise for compressors of capacity up to 50 cc 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 16U-10/6 compressor (capacity 10 cubic meters per minute at eight atmospheres) was isolated by 12-15 dB over a wide frequency range.

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Figure 1. Cylindrical muffler for exhaust pipe.
1. Outer surface of muffler.
2. Sound absorbing material (density 15 kg/m³, layer thickness 100mm).
3. Layer of fiberglass 0.1mm thick.
4. Portations 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.

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01-023
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H. L. Bunchford, Inc., Troy, MI
NOISE AND THE SNOWMOBILE
In: Crocker, N., Proceedings of the Purdue Noise Control Conference, JUL 14-16, 1971
Lafayette, Purdue Univ., 1972, 564 p. (p. 71-79)

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, state legislators 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 dB(A).

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 acoustic foam was stuck to the exterior surface of the engine cooling.
3. Three-quarter inch embossed polyurethane acoustic foam was stuck to the interior surface of the instrument console.
4. A silencer was attached to the carburetor intake.
5. The four-wheel openings in the engine cowling were reduced to a minimum practical size.
EMISSION & SUPPRESSION

These modifications did not lower the noise level around the machine, but the noise 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.

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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 Jan. 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  83

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, rendering an even tougher problem–blade noise. The Chicago Code gives a maximum limit of 74 dBA at 50 ft effective Jan. 1, 1971, and this limit drops to 65 dBA by Jan. 1, 1975.

The two riding mowers tested had 4 cycle, aircooled, non-dynamically balanced engines producing 3600 maximum RPM. Vibration 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 more be removed during these tests, and that manufacturers eliminate them. A dynamically balanced 6 HP engine was 4 dBA quieter at our level than the standard mower engine. This engine would cost $12, or $3/dBA 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 4 dBA reduction, however. The absorption material was glassfiber blankets, 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:

<table>
<thead>
<tr>
<th>Engine speed (RPM)</th>
<th>Sound level at ear of operator (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3500</td>
<td>92</td>
</tr>
<tr>
<td>3125</td>
<td>91.5</td>
</tr>
<tr>
<td>2875</td>
<td>91.5</td>
</tr>
<tr>
<td>2550</td>
<td>88</td>
</tr>
<tr>
<td>2400</td>
<td>87</td>
</tr>
</tbody>
</table>

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

Caccavari, C.
Chicago Department of Environmental Control, IL
Engineering Div., Dept. of Environmental Control, 320 N. Clark St., Chicago, IL 60610
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 pile driving operation. The enclosure was constructed of an outer steel shell 1/16 inch sheet steel, coated with a damping compound to minimize the vibration of the shell (1 inch "Vibradamp") and lined with 1/4 inch 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 db in the WA-weighted level) to the rear of the pile driver, and a slight reduction to the side of the pile driver. (See Table.)

<table>
<thead>
<tr>
<th>Sound level</th>
<th>Without enclosure</th>
<th>With enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>At rear of enclosure (about 25 ft.):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak levels (dB)</td>
<td>123</td>
<td>109</td>
</tr>
<tr>
<td>RMS Peak (dBA)</td>
<td>106</td>
<td>99</td>
</tr>
<tr>
<td>RMS Peak (dBC)</td>
<td>108</td>
<td>101</td>
</tr>
<tr>
<td>At site of enclosure (about 25 ft.):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak level (dB)</td>
<td>113</td>
<td>110</td>
</tr>
<tr>
<td>RMS Peak (dBA)</td>
<td>107</td>
<td>103</td>
</tr>
<tr>
<td>RMS Peak (dBC)</td>
<td>108</td>
<td>109</td>
</tr>
<tr>
<td>Noise levels at the First National Bank site.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Further reductions could be achieved by improving the design of the enclosure, whose equipment did not extend far enough down and forward because of the presence of an angle iron support frame. The enclosure could be modified to allow it to extend 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, the size of openings in the enclosure could be further reduced. Finally, thinner 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 buffers were to be installed on all pile driver units, and a vibratory driver was to be used for erecting the sheet metal piles after the completion of the project.

The vibratory driver is a different type of pile driver that operates at speeds of 50 cycles per second. The vibratory driver's noise level, as measured at a second construction site, was 20 db lower 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 ineffective for the extraction of sheet metal piling in all types of soils.

01-026

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SONIC BOOM EFFECTS III: STRUCTURES AND TERRAIN

Journal of Sound and Vibration
Vol 20 No 4:505-509, 1972

Effects on structures due to pressure waves from explosions are well known and studied for a long time. Three general types of parameters determine the effect of sonic booms on 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 waves) and excites the structures and other objects. The effect of this ground motion is of the same order of magnitude as that caused by the passage of vehicles. The structural vibration induced by ground motion is for the most part due to excitation by the acoustic shock wave.

The effect of the ground motion on surface topographical features such as mines has been studied. But it should be noted that the amplitude of the ground motion caused by the sonic boom usually diminishes with depth.
EMISSION & SUPPRESSION

The noise effects of the boom on topographical features or on structures will come from the direct excitation by the acoustic shock wave, or from the acoustic features, such as wind, that sonic booms disturbance. A sonic boom could trigger a fall, but this would occur only in a small percentage of cases, and not necessarily occurring a fall. Damage to primary structure of dwellings or buildings may not be avoided. Structural damage can be caused by severe movements and by tension with any other structural part. Therefore damage to plaster, panels, suspended ceilings, and roofs can be caused by more serious than other structural damage. Damage capacity will depend on overpressures, but theoretically there is no overpressure level at which damage is impossible. Reliable boom characteristics on a certain structural part are normally not known clearly because the free field waveform is altered by the structure itself and by reflections from neighboring buildings.

In an Oklahoma City study with 1255 sonic booms having an average maximum intensity of about 70 N/m², there was no evidence of cumulative damage in the four test structures intensively studied throughout the program. By a suitable choice of an average of a crack width determined by an examination of their maintenance histories, it is possible that approximate 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 local overpressures, the time history of the boom shock waves, and the susceptibility of the structural elements. Glass panels and plaster are more susceptible than roofs which are not more susceptible and walls. In connection with an exposure to a sonic boom of very high intensity, in May 1970 over the German town of Wiesbaden, 320 damage claims were filed. Most involved damage to glass panels and slatted roofs where glass were shaken up. Some chimneys were damaged, some closed doors went off the hinges, and some panels were broken. No serious damage on the main house structures was recorded. Extensive criteria for statistical assessment to be developed. These can be based on both figures of damage claims and results from experimental investigations. In the case of a single boom with the intensity of 125 N/m², which exposes an urban community with a population of 500,000 people and 20 windows per capita, about 4 (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 or building elements or sections. Since there is some evidence that higher order modes can play an important part in the damage mechanism, it seems prudent that experimental generators produce frequencies that contain all frequencies found in a real sonic boom. Three times appear pertinent for general research. The first is glass, which features extensively in sonic boom claims in walls when 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.

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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 qualitative approaches to traffic and design problems which are available in highway engineering, noise is an area in which the boundaries between qualitative and quantitative assessments are frequently difficult. The motorway requires the segregation of vehicles from pedestrians; this allows the design as a ground level facility, an elevated structure, depressed in a cutting or in a tunnel. It is possible to minimize 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 reduction of noise in its vicinity, although the introduction of ramps and slip roads on gradients results 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 suburban highway is potentially the greatest single source of noise. (2) True 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, because of 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 order to 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) = 30 + 30 log (speed).  
- Motorway concrete: noise level (dBA) = 23 + 30 log (speed).  
- New asphalt: noise level (dBA) = 10 + 30 log (speed).

It is noted that the most effective reduction to solicitude 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 studying 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.

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MAN AND NOISE. STRESS AND RISK OF INJURY
In: Jansson, P. G., Conference in Connection with the International Air Pollution Control and Noise Abatement Exhibition, SDPT 1-46, 1971

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 all light-weight machines have noise levels of over 90 dBA. Since noise is known to produce harmful effects on man, a study was made on the physiological and psychological effects of noise on 70 female card punch operators.

Group I was exposed to sound levels of 75, 82, 88, 94 dBA 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 punching machines was 76 dBA. The other levels were produced by playing tape recordings of punching noise and superimposing this on the 76 dBA level. Preliminary findings show that only slight increases in physiological and mental stress were observed. No proportionality was established between the sound level in dBA and the mental and physiological 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 adrenaline and noradrenaline. Considerable individual differences were exhibited in reactions to the same noise stimulus.

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NOISE AND ACOUSTIC TRAUMA
NOISE LEVELS IN EISOOPODEGS IN NEW DELHI
Indian Journal of Medical Research
Vol 58 No 12:1756-1763, 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 85 dB. Background noise was typically 20-30 dB below 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 contributed 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 (Leppanen and Oliphant, Californian Medicine, Vol 107 (1967), p. 378), and that risk of acoustic trauma existed not only for the musicians, but also to habitués if they were particularly susceptible to such a noise trauma.

Noise measurements were conducted in a weaving plant to determine the effects of noise on workers. Two groups were investigated: Group I worked on a shuttle looms type TSFS, reaching noise levels from 100 to 113 dB, and group II operated microshuttle looms type STS, reaching noise levels from 105 to 109 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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East Germany

NOISE LEVEL MEASUREMENTS DURING A FISHING EXPEDITION

Schleppgeophysen Kambrand oder Fangrolle

Seewirtschaft
Vol 3 no 12/926-928, 1971

Noise measurements were conducted in East Germany on the fishing vessel "MuLi Grunau" during its 100 day expedition. Noise meter 101 of the Technische Vibrations 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 dock to 104 dBA at the main oil-diesel machine.

Recommended rooms for work places were considerably exceeded on "MuLi Grunau". Most complaints come from patients of the hospital, which is located on the dock 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
formazin ear plugs produced by Prozhevit
Plant Berlin or subwoofer hearing-
protection cotton from Linseur Thueringen.
The ear plugs reduce the noise level of
108 dB by 22 dB, and at level of 89 dB by
9 dB, at level of 93 dB only by 6 dB.
"Cotton" reduces the level of 89 dB by 14 dB
and that of 93 dB by 15 dB. At values
below 75 dB 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 peristaltic.
Seams often complain of digestive problems.
Also the vegetative nervous system is
affected, as well as pulsation frequency and
systolic blood pressure. Medical research
shows that the vegetative system does not
adapt itself to noise even though it
can be tolerated as a psychological
phenomenon.

was conducted for 5 or 6 days in each plant.
The noise level in the work area is 80 to
107 dB for 5.0 + or - 1.01 minutes and
alternates with pauses. In the operation of the
test stand at 1.46 minutes, during which
the noise level is 55-90 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
for 7 hours a day. The noise level exceeds the
limits prescribed by Health Form 750-60 at
April 30, 1969 by 14-16 dB (see Figure 11).

FIG. 1. Noise Spectrum of Test Stand in an
Aircraft Maintenance Enterprise
A - 1/2 Curve dB
1 - Test Stand No. 1; 2 - Test Stand No. 2

Subjects of the study were 6 male workers,
20-35 years old, and all worked on the same
test stand. All were physically healthy,
with normal hearing, and had done the job
for 3 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 0.02 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
pauses in test stand operation, a noise level
of 93 dB from adjacent test stands for 3.66
minutes affected them.

FIG. 2. Noise Spectrum Affecting Workers Tested
A - 1/2 Curve dB
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

02-005

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HYGIENIC EVALUATION OF INTERRUPTED NOISE IN
TESTING OF AIRCRAFT HYDRAULIC UNITS

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Zablovarn'ye
Vol 15 No 1, 1-2, 1971

Noise conditions were studied in areas for
testing hydraulic aviation units in four
aircraft maintenance plants. Noise type
type 2203 (6101 & 6102) and active 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
constant 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
PHYSIOLOGICAL

The following physiological and psychological measurements were recorded: selected air
audibility at 125, 250, 4000, and 6000 Hz
and bone audibility at 4000 Hz; critical
frequency of auditory fatigue; performance
in the black-red table psychophysiological
tasks; respiration rhythm; muscle fatigue;
functional state of cardio-muscular system by
measuring arterial pressure and pulse rate.
Studies were conducted at the beginning of
work, after 3 hours of 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 tachistoscope
change from 134 to 130,3 flickers per second;
indicators of muscle fatigue (E. Y. Pauwel's
method) decreased from 117.4 to 92.5 per
second; pulse rate decreased from 78.4 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 tests. Results of the
study prove that the intermittent noise
prevailing in the testing area is
physiologically adverse.

Another approach was a histological study of
laboratory animals that have been exposed to
noise with a peak intensity of 122 db SPL
over a 3 month period of time. Marked
sensory cell damage was noted 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
percept-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 (DRG). DRG 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 90 to 103 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. For a
prediction basis, noises greater than
92 db between 500 and 8000 Hz for
a period of one hour will produce as much
as a 43 db TTS in the area of 4,000 Hz in
10% of the exposed ears by measurable
shifts in another 10%, and a 50 db TTS in
the remaining 50%.

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
that 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.

In the past few years concern has risen over
the possible bad effects of rock and
roll music over long periods of time. 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
98% of 40 rock and roll musicians did not
show 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 3.9 years.
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 men and organisms that may be designated as 'nervous' 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 eyeblink 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 fields, and noise above 130 dB can cause memory and vigilance. Continuous oscillation 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 effectiveness of the 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 at a person's eye from a deep sleep can increase as much as 70-90 dB. However, the awakening reaction to noise that 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.

A study was made of the effects of amplified rock and roll music on hearing. Specialists pointed 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 overwhelming the senses.

It is not easy to show that ears are damaged by continued exposure to the blare of rock and roll, although it has been shown by court 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 4,000-16,000 Hz and (2) a pure tone screening test at 25 dB (C500) 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 (Rionac ERE-245) 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 lower than the 10,000-12,000 Hz range that would be expected. This could mean that the present time there is
PHYSIOLOGICAL

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 in public service like transportation facilities. "Sociocausis" denotes noise-induced hearing loss with emphasis on everyday noise and noise at work. Even limited exposures to off-job noise 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 (dishearteningly chosen 15 dBA stricter than the National Bureau standards for industry). The results suggest that people receiving frequent or prolonged exposures in everyday situations are liable to some risk of hearing loss. Even though daily exposures to everyday noise 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:

<table>
<thead>
<tr>
<th>Limiting Daily Exposure Times</th>
<th>Sound Level in dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than:</td>
<td></td>
</tr>
<tr>
<td>2 min</td>
<td>115</td>
</tr>
<tr>
<td>4 min</td>
<td>110</td>
</tr>
<tr>
<td>8 min</td>
<td>105</td>
</tr>
<tr>
<td>15 min</td>
<td>100</td>
</tr>
<tr>
<td>1/2 hr</td>
<td>95</td>
</tr>
<tr>
<td>1 hr</td>
<td>90</td>
</tr>
<tr>
<td>7 hr</td>
<td>85</td>
</tr>
<tr>
<td>4 hr</td>
<td>80</td>
</tr>
<tr>
<td>8 hr</td>
<td>75</td>
</tr>
<tr>
<td>16+24 hr</td>
<td>70</td>
</tr>
</tbody>
</table>

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.

Impulsive noise, peak sound level in dBA, can not be compared with levels in dBA. A relevant but not particularly protective criterion for impulsive noise exposure has been proposed by the Committee on Hearing and Biomechanics and Bioacoustics (CHABA) of the National Research Council. Peak sound level should not exceed 120-164 dBA, 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.

Musical 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 2 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 loss. It was conjectured that the intermittent nature of rock music, with on-time of 3 to 5 minutes and off-time of about 2 minutes, 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 levels (Figure 3). The hunter group consisted of sportsmen who had used...
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.

Gasoline power lawn-mowers (94-96 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 prolonged 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 highways, construction sites, and industrial plants. The intermittent nature of aircraft flyovers (87-103 dBA) usually makes them a minor hearing loss threat. Construction noise levels (82-95 dBA) are more continuous, can occur for periods exceeding the off-job criteria, and often, although supposedly temporary, exist for several years. Roadway noise (62-95 dBA) could be hazardous to hearing in areas where heavy traffic conditions last for more than 2 to 4 hours per day.
The Krakow 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 Krakow carried out noise measurements at the oil wells of P11. In the "Estonian" Mine in P11 noise levels ranged up to 114 dB when drilling machines were operated, the hips even reached 129 dB. The noise levels at the "New Tarnawa" Mine (Nowa Kurema) 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 nervousness.

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

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

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.

Somatic reactions to repetitive 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 eyelid and rapidly progressing to the legs. The time history of the total response ranges from 0.3 seconds for a mild response to 1.2 seconds for an intense reaction. There is also a great increase in autonomic and central nervous system activity. The eyelid response is the only reflex in the startle response that does not habituate.

Stimuli of medium intensity are likely to evoke the startle reflex response. The most characteristic reaction is a turning of the body or head toward the source, suppression of activity, increased muscular tension, and increased EEG activity also occur.

Startle response leads 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, but 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 90 dB, but have little effect or increase performance below this level. Whether this value also corresponds to the threshold for startle responses 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 perhaps, and peripheral
Physiological

Vasoconstriction which are approximately proportional to the increase in sound pressure level. Startle or defensive reflexes are accompanied by vasoconstriction in the head regions as well as in peripheral regions. Orienting responses are accompanied by peripheral vasoconstriction, but vasodilation at the hands. The predominant initial heart-rate changes associated with the orienting response is acceleration, while startle appears to evoke an initial acceleratory response.

Intensity is not the only parameter in impulsive acoustic stimuli. Minute 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.

Traffic performance has been investigated following bursts of 105-117 dB white noise presented against background noise of 45-88 dB. Performance impairment was least with the highest level of background noise and next when the noise was of 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 reactions (i.e., ratting 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.

09-012

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Effect of Noise Produced by Aircraft on the Population Residing in the Vicinity of an Airport

Vladislav A. Yuryev

A group of 200 subjects was exposed to noise from aircraft landings and takeoffs at an airport. The noise levels were measured at various points around the airport. The results showed that the noise levels were highest during takeoffs and landings, and decreased significantly during the day and night.

The noise levels were found to be highest during the day and night, and were lower during the early morning and late evening. The authors recommend a tightening of restrictions to 60 dB during the day and 75 dB at night.

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 dB during the day and 90 dB at night. The authors recommend a tightening of restrictions to 60 dB during the day and 75 dB at night.
PHYSIOLOGICAL

02-013

The Department of Laryngology of the Piotrow Hospital in Lodz carried out investigations to determine the effects of noise on the equilibrium. Tests were administered to 68 persons who were not exposed to noise. For control group purposes 12 healthy individuals were tested. Brief noises emitted from a loudspeaker were used to determine their effects on workers suffering from ear ailments. The results show that noise exposure caused vertigo, equilibrium imbalance and other vestibular disorders in some of the workers. The most common reaction observed was equilibrium difficulty. The noise levels during the examinations reached 95 dB.

The experiments consisted of audiometric measurements, the Barre and Romberg statistical tests for equilibrium, the Unterberger and Baflinski-Helio kinesthetic 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 infections 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

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 68 years of age; 59 of the group were women. The biggest age group, from 20-30 years old, contained 91 persons; the smallest group contained 12 persons.

Rusin 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 90 to 103 dBA.

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

Fatigue was felt by 20-30% 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 otoacoustic 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 smaller percentages of various sub-groups.
The physiological effects from intermittent noise exposure were studied. The subjects were divided into two groups, one exposed to intermittent noise and the other to continuous noise. The intermittent noise was played for 15 minutes and then stopped for 90 seconds, repeated every two minutes. The continuous noise was played continuously for 30 minutes.

No significant differences were found in the physiological responses between the two groups. However, the intermittent noise group showed a slight increase in heart rate and blood pressure compared to the continuous noise group. The intermittent noise group also reported a higher degree of annoyance and discomfort.

The results were analyzed using statistical methods, and the data was found to be significant in terms of the effects of intermittent noise on heart rate and blood pressure.
set of eggs exposed for the full period received over 500 booms. It had a hatch of
46.3% (control 64.2%). An extensive hatching failure of Dry Tortugas. Sixty
hatchlings have been found. Two reasons as to the effects of the boom were
suggested: death of eggs not exposed after abandonment of the colony by the
birds in panic flight after exposure, or physical damage to eggs not caused by a
sitting bird at the time of the boom.

Investigations on effects of sonic boom (average 72 n/2, maximum 265 n/2) on
tern animal behaviour and performance were made in 1960 at Edwards Air
Force Base in California.

The behavioural reactions to the sonic booms were considered minimal. Occasional
jumping, gulping, bellowing, and random movement were among the effects noted. The
poultry showed a clear response than the larger animals, especially in the early stages of
the tests. Occasional lying, running, crowing and cooing were noted.

French Army dogs subjected to sonic booms with high overpressures during
detection have been studied. A minor effect on the cardiac frequency and on the dogs' be-
ha viour was found. Certain dogs became frighten ed, tied and sometimes became aggres-
sive.

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
show pows, barking dogs and mine blasting noise in the area.

Differences in boom intensities (average 72
n/2, maximum 265 n/2) had no effect, repeated
booming produced no signs of increased
excitability and reproduction inBoom ed
and non-boomed mink was normal.

Wild deer studied at Fglin 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 50 n/2 caused a slight startle effect among
herds of reindeer, but only exceptionally were ongoing activities interrupted. As boom
levels increased up to 200 n/2 the reactions became
more noticeable but none of the lying of resting
animals ceased.

Only one sonic boom has been examined in detail. In this case, a boom of an
approximate overpressure of 100 n/2 gave an overpressure of 1 n/2 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 embryos during hatching
are studied in terms of embryo death or
cranial malformation. Experiments were
carried out with increasing boom intensity
(100 n/2, 200 n/2 duration; 500, 1000,
1500, 3000; etc.). Chick embryos in hatching
which were exposed to three sonic booms every
morning and three evening every day with
100 n/2; 200 n/2; 500 n/2; 3000 n/2; 1500 n/2;
were not affected. Chicks from these eggs were
normal.

Concerning wild animals the following statement
may be noted with a degree of confidence:
(1) sonic booms of overpressures above 100 n/2
have no direct, acute effects upon wild animals
or birds; (2) sonic booms of extreme
overpressures (above 20,000 n/2) may have the
potential to crack bird eggs, but this question
awaits an adequate experimental test; (3)
chronic 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 or
overpressures around 100 n/2 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
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Sudden, or Impact, noise causes a startle
response in humans and may also cause startle
induced accidents. Many 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 Stemmer and Startle that background
noise increases startle in rats. This is
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 indicator 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 or are a background level. The four startle stimuli were equal 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 of a point in the task cycle that was identical for all subjects, the instant at which the task cycle was restarted.

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>
<thead>
<tr>
<th>Background level (dB)</th>
<th>Startle</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>72</td>
</tr>
<tr>
<td>2.78</td>
<td>1.52</td>
</tr>
</tbody>
</table>

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.

A partial review of the literature on speech intelligibility 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 syllabic intelligibility at a noise level of 95 db and speech level of 90 db.

Intelligibility with the 3 aircraft noises was about 95% with white noise about 90%.

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.
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 to sonic booms 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.

3-003
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SONIC BOOM EXPOSURE EFFECTS III: WORKSHOP

Journal of Sound and Vibration
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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 workers as startle, snap, 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, attention and orienting responses, since their effects on performance could be qualitatively different. Stimulated response to performance were reported to occur at indoor boom peak overpressures as low as 0.12 N/m² but these appeared more likely to have resulted from the orientation response rather than the startle reflex.

The psychological evaluation of performance on complex perceptual motor tasks may occur after exposure to booms of moderate peak overpressures, 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, notably elderly people or persons with a nervous predisposition. Concerning daylights' estimates of the number of day sleepers in different communities, were considered essential.

In the nominal peak boom overpressure range of 60-100 N/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 and 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 existing strains in the structure itself. Although the damage itself is technically important, its psychological consequences in terms of a criterion for annoyance reactions should not be underestimated.

Based upon the available information on boom effects, the different areas of concern in the workshop the following suggestions for general sonic boom exposure criteria for outdoor environments have been compiled. Special caution should be exercised concerning the exact classification of criteria 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 dβ fast level or other technical parameters might be more suitable for other types of effects. In order to facilitate the comparison
A concurrent sociological study marked 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 inexperience in the questionnaires or to exposure itself.

The following observations were:

1) With the exception of private places, all sources of noise were noticed more by the citizens of Stockholm than in Ferrara; in the case of motor vehicle noise, the ratios were 92 and 65%, respectively.

2) Of those who noticed traffic noise, the percentage of those who were disturbed by it were 61 and 45%.

3) Of those who felt themselves disturbed, the percentage of those feeling greatly disturbed were 25 and 24%.

4) Of all respondents in Stockholm, 70% thought their neighbors were probably disturbed by traffic noise, in Ferrara, 58%.

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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ANNOUNCEMENT RE: TRAFFIC NOISE IN ITALY AND SWEDEN: A COMPARATIVE STUDY

Archives of Environmental Health
Vol 19 No 1:692-699, 1969

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

The 25 dB 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, male and type for windows open and closed, the mean values in Italy exceeded those in Sweden; for passenger cars the differences were 5.5 and 5.6 dB for closed and open windows, respectively.

03-005

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EDUCATIONAL ENVIRONMENT

Kyoikuk Kenkyuu

Koizumi: Yosoku to Taisaku
(p. 162-163)

The Japanese Ministry of Education made a nationwide survey of educational environments in public elementary and middle schools. The survey covered 8,256 schools (25.3% of total schools in Japan). Many had noise, air pollution and traffic safety problems. The sources are noise and, 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 student's opinions of the educational environment included 108,000
PSYCHOLOGICAL & SOCIOLOGICAL

7th grade students in 623 schools in 15 major cities. About 30% answered that the environment in their school vicinity was "bad" or "very bad." Noise was particularly mentioned, with vocal noise as the worst source of pollution.

The Osaka Educational Research Institute measured actual noise levels in "noisy" classrooms (Group A) and "quiet" classrooms (Group B) in 67 schools in Osaka. Mean values of noise levels for Group A was in the 56.0-60.0 dBA range with windows closed. This means that 62% 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 43 classrooms were questioned on noise, with 1,140 from "noisy" and 1,552 from "quiet" rooms. Noise bothered 505 of them. Only 6.3% said noise did not bother them.

The questionnaire responses showed the following problems in the students:

- Emotional irritation:
  1. cannot 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 questions, 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 anxious or get headache;
  2. become tired and uneasy;
  3. become sleepy and disturbed;
  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 50 dBA, but since 42% of the total city classroom, 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 irritating and emotionally upsetting.

A study by Osaka City of 572 students in the 5th and 6th grades found a definite effect of noise on mental performance (calculation, addition, subtraction, and multiplication). The Utanikapro (ultrasound method) was used in this test. The study reveals that noise increases mistakes and reduces the beneficial effects of lessons. Noise as a causative factor in mistakes was 1.5 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 90% 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. Taka of the Osaka Educational University studies noise effects on students' mental work in the classroom by reproducing tape-recorded automobile noise. The speaker was suspended from the classroom ceiling, and produce 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 addition, reasoning, composition and reproduction of numbers in mathematics, students in the 70 dBA classroom scored eight more 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 15,000 students in 651 schools throughout the country and reached similar conclusions.

03-006
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HEARING AID PERSONALITY: A REVIEW
Journal of Sound and Vibration
Vol 20 No 3: 285-290, 1972
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 intercorrelated. The anxiety group of measures may be regarded as comprising the various scales of anxiety, neuroticism, ego-strength, and fallacy-avoidance motivation, all of which are again intercorrelated, but show very little relationship to the introversion group of scales.

There is some evidence to suggest that the two groups influence different aspects of auditory perception, perhaps respectively related to different parts of the auditory pathway, although some interaction of scales within the two groups and certain complex auditory measures have 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 to the various autonomic responses evoked by these stimuli.

The relevance of these personality measures to psychoacoustical testing may be regarded as twofold. 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 a significant change when the mean results for the whole population are considered.

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SOUND BOOM EXPOSURE AND EFFECTS II: SLEEP EFFECTS
Journal of Sound and Vibration
Vol 20 no 4; 551-517, 1972

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

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 exposure habituation to sounds occurs, particularly when sounds are regular, frequent and not temporarily associated with any subsequent waking 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 Hz/2 (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 to 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 320 persons. More than 20% of the respondents to it reported symptoms of insomnia and drowsiness at night and during the daytime. The psychological and sociological aspects of the study are discussed.

Standardization of experimental techniques among laboratories is necessary. Simulators for sonic boom sleep research should ideally take account of both the acoustic and the respiratory responses of typical bedrooms. The acoustic response characteristics of the indoor environment produced by the simulator should be specified and measured. It is recommended that certain ECG measures of sleep stage be obtained. Response frequencies to stimuli occurring 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 stimulus 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 Tochi, Shinsuke Gyoobu, Eihiyo
Nisaburo Koishi, Eiichi Zoshiki Vol. 17, No 8:425-426; No 9:485-448

Traffic noise from midnight to 3:00 am in Nagasaki City was measured with equipment conforming to JIS 28731 equipment. The number of outdoor measuring points was 247 in residential areas, 86 in commercial areas, 40 in semi-industrial areas, 8 in industrial areas, and 40 in heavy traffic regions, for 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 3,401 residents in the vicinity of the 251 places. Mean values of noise levels were calculated for each point after the 50th lowest readings were shown out. The lowest values at 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, 33% complained of annoyance, relating to sleep disturbance from street noise. Their complaints included: loud noise, difficulty in falling asleep, waking up in the middle of the night, reduced waking time in the morning, and restlessness during daytime because of lack of sleep the night before. Of those 1,110 residents, 65 residents in the residential area (28%) of residents in that area, and 296 (40%) in the commercial area, and 62 (5%) 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 various traffic on nearby roads. The size of roads in Japan in decreasing order is national, prefectural, municipal, and private.

Fifty percent (50) residents of the residents in the vicinity of the national road in the city were annoyed by noise. So were 423 (60) in the vicinity of a prefectural road, 325 (70) in the vicinity of city streets, and 266 (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 Vol. 20 No 4:457-466, 1972

The effect of sonic booms in the light of potential SST development on a sleeping population is discussed.
In the course of several studies, 22 male and female subjects, ranging in age from 3-75 years, were subjected while asleep to simulated sonic boom equivalent to 84 dB at the subject's ear.

Results of these studies show several patterns according to age and sex. Children exhibit the least earing, 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 0.5 more frequently than old men with low sensitivity. Subjects were most prone to awakening during sleep stages 2 and NREM. Women were found to be more sensitive to noise than men in addition to being awakened much more easily by aircraft flyover noise than by simulated sonic booms.

PSYCHOLOGICAL & SOCIOLOGICAL

Studies were conducted at the Garvan Laboratory (USAF) on the effects of broad-band noise (2000-12,000 Hz) at 75-78 dB Intensity on sleep and the transitional state between sleep and wakefulness. Ten healthy subjects aged 25-36 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's cabin ventilating system (76 dB, frequency spectrum 600-2000 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 Dandridge.

Function 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, irritability, 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 (15-30 min). Three subjects took longer than 12 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. Those who fell asleep rapidly had strong and deep sleep. Those who did not fall   

Conclusions are:
1. The stay of man in a noisy setting can disturb the quality of sleep;
2. Unusual auditory adaptation to different frequencies can make broad-band noise soon more unpleasant to cosmonauts in flight;
3. The degree of restoration of disturbed function of the auditory analyzer is directly dependent on quality of sleep;
4. Capacity to withstand continuous noise should be a criterion for selection of cosmonauts;
5. They should be able to sleep well, and also the auditory analyzer must have some adaptation as well as sensitivity to tones and speech signals.

30-011
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On: BEHAVIORAL RESPONSES TO AUDITORY STIMULATION DURING SLEEP
Journal of Sound and Vibration
Vol 20 No 4:407-416, 1972

Although much research has been concerned with numerous aspects of sleep in man, little experimentation has been carried out to evaluate the long-term psychological 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 variations 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 to 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 boom 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 60.6 to 5.016/\( \text{sq ft} \) (50.18-129.25/\( \text{sq m} \)) for booms and 101 to 119 dBA 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 tends to lengthen in 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, 5 p.

The Automobile Manufacturer's Association sponsored a research project concerning the annoyance due to major vehicles. The heart of the research project was a social survey in Boston, Detroit and Los Angeles and physical measurements of community noise. The interviewers who cited annoyance with vehicular noise were usually the same, they were annoyed predominantly in the evening or during the night; and 25% of the respondents were annoyed because of sleep interference. Problems 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 judgments of noise levels. Squeaking 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, lane use, and traffic control may be necessary to reduce passenger car noise. By applying today's technology to a future truck, 1960 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 55 and 55 mph can be expected to be reduced to about 64 and 69 dBA respectively. At road load, tire and aerodynamic noise are typically equal to or greater than powerplant generated noise. Passenger car tires already have all the presently known tire noise reduction techniques applied to them.
03-013

PSYCHOLOGICAL & SOCIOLOGICAL

Docker, R. H.,
Poole, F. F.,
Kryder, K. D.

Stanford Research Inst., Menlo Park, CA

On: A STUDY OF SENSITIVITY TO NOISE

IC: 15.00 MP: 95 cents

The effects of certain kinds of impulse noises and typical nonimpulsive 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 160 subjects over a 6 month period. Typical noises included airplanes, sirens, vacuum cleaners, barking dogs, motorcycles, truck traffic, and freeway traffic. Heart rate 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 2.55 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 0.65 psf boom was rated less annoying than all other noises except for the 97 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 subiect 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 than 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 those 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.

Analyses of the physiological reaction to the noise indicated a definite heart acceleration in response to the simulated sonic boom. 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 at 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 indices 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

Koziolov M. I.

TRAFFIC NOISE INTENSITY IN USSR AND ITS HYGIENIC ASSESSMENT

Intensivnost Transportnego Shuma v Irukstke i ego Gigianckaya Otsomke

Gigiana I Sanitariva

No 8:29-35, 1971

In many large cities and growing communities, noise has become a major problem. Such a problem developed in Frutsk, 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 air planes (81-102 dBA), helicopters (73-92 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.
PSYCHOLOGICAL & SOCIOLOGICAL

In comparison with asphalt roads, newer four and six-lane roads, respectively, faulty engine parts emitted 5-6 dB more than well-tuned engines. The intensity of noise on narrow streets rated 5-6 dB higher than on wide roads. The local traffic noise was 30-32 dB, measured in urban apartments with windows closed between 1 and 4 mm, and the most 65-70 dB, between 8 mm and 12 mm.

In fruited noise caused by air traffic affects 84% of the area; 20.5% of the area is subject to noise levels of 60-100 dB 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 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 attitude towards traffic noise was in direct proportion to the age of the population. The most tolerant age group was under 20 years of age, with 15-25% registering complaints. The age group of 21-40 years of age had the strongest noise annoyance (56-67%), and those older than 61 had the strongest reaction (70-75%).

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, 70-90% found the noise disturbing; inhabitants from 3-6 years, 60-72%; from 6-12 years, 54-65%; 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 administrative 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
Bordy, P. H.
Columbia Univ.
School of Public Health and Administrative Medicine
On: EFFECTS OF NOISE ON THE COMMUNITY
At: American Association for the Advancement of Science, 13th Meeting, Philadelphia, PA, 1971

Noise intensity near airports and major highways may be approaching the health hazard exposure levels and may be contributing to hearing loss. Intense noise at an environmental structure has been found to increase a number of physiologic responses, such as cardiovascular, gastro-intestinal, and endocrine and control nervous system responses. Whether these physiologic reactions place some strain on the organism and if it continued over sufficiently long periods are unknown. Other causes of disease have 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 unverified structural vibrations are the most frequently reported disturbances. Variations in noise exposure generally account for 20-25% of the variance in human annoyance. Attitude, experience, and other human variables account for as much as two-thirds of the response differences. Continued British and American research surveys of residents living near airports indicates that about half of all persons with moderate psychological predispositions or attitudes of fear and aircraft operator annoyance report various annoyance at Composite Noise Rating (CNR) levels of 100 or greater. At the same noise exposure, over 75% of those persons with feelings of high fear and high annoyance report high annoyance, compared to only 32% of similarly exposed people with no fear and feelings of no annoyance.
PSYCHOLOGICAL & SOCIOLOGICAL

03-016
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HOSPITAL ENVIRONMENT
Byoich Kunkyo
In: Kagami Yusuke to Taisaku
Tokyo, Asahi Shinbunsha, 1971,
291st. pp. 164-171

Three doctors of the Kyoto City Hospital made a survey of 95 families and 293 clinics providing both out-patient and short hospital stay services to physicians
cite 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 dB; This DN was 15-25%
higher than DN for other types of effects. When noise level was more than 60 db,
emotional irritation was 55%. 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 50-60 db, Emotional
irritation is 36-48%. When the level is 50 db, the various DNs are much higher: 67% in doctor's conversation
with patients, doctor's rounds, and audiometry; 85% in listening to the
stethoscope; and 98% 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 db.

The frequency of lung and bronchial sounds is below 1000 Hz and in the 2000-2000 Hz
range for coughing. A stethoscope on the market today has a transmission loss of
50-70 db in the 2000-4000 Hz range.

Vibration of the rubber tube itself and permeability of noise through the rubber
tube from outside noise makes the stethoscope more difficult to use, particularly for city
doctors. When the background noise level increased from 30 dba to 35 dba, patients
required 30% more time to fall asleep and woke up earlier in the morning 10% of the
11th. The survey found that a main 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

The survey also found that when noise level exceeded 60 db, 60-65% of patients either
(1) complained by telling doctors that they wanted to recuperate at some other place,
(2) got angry, (3) became nervous. Also, 50% of patients complained that they could not
sleep, and had to shoot 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 any 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

03-017
Angivina, O. L.
Andersson and Angivina, Inc., E. Aurora, NY

PSYCHOLOGICAL FACTORS IN ACCEPTANCE OF NOISE

New York, Andersson and Angivina, 10p.
Emotional or subjective reactions to noise vary from one individual to another. Several psychological and personal factors 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 raid s during W.W. II will react much differently to stress 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 hammering 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.

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

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

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

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 particularly unchanging broadband noise. Performance changes brought about by exposure to continuous noise actually increase with the onset of 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, accentuates this effect, increasing the number of signals missed, not only at the end of the work period. Although noise does not affect the overall spread of 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 utilisation 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 acquired near the periphery of glides (18 degrees each side) are more likely to be correctly detected by noise than those in the center, which may show an improvement. In other words, noise to produce a structural change in the way in which attention is distributed over the
PSYCHOLOGICAL & SOCIOLOGICAL

Components of the task causing it to become
more stressful. This has the effect of
increasing 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 Ronan unacceptability scale,
a measure of introversion-extraversion, has
proven 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
neuropsychological work on the structure of the
various mid-brain arousal systems and their
control.

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 shick people than others. Complaints of
noise ranged from 56-73% of those polled;
64-92% of the inhabitants of panel
construction buildings complained of noise,
while 52-75% 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, the noise level increasing by
5 dB, the number of complaints increasing 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.

03-019

Naksholov, R. I.

Irkutsk, USSR

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

Sukhov, I. Popokovycheyev Dyadyuia
Shama, Sosderuyamogo Yodoprowodono-
Kanalizatsionnym Obrudovanuyam v Zduryakh
Vodosnajzmoiy i Sanitaruaya Takhniki

No 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 noise was measured during the
course of the study.

03-020

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Sanocki, B.

Akademia Medyczna, Lublin (Poland)/

Lublin, Poland

HEARING DAMAGE AND RESULTS OF CLINICAL AND
PSYCHOLOGICAL RESEARCH ON PERSONS WORKING IN
NOISE

Uwodzenie Sluchu Oraz Wniki Badan
Klinikcznych i Psychologicznych Opol
Pracyujacych w Haosie

Pamietnik XXVII Zjazdu Otolaryngologow
Polskich w Katowicach 1968 r.

Warsaw, P天真stowy Zakład Wydawnictw
Lechemickich, 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
capacity of perception.
Analysis of group 1 of the KIWI plant working between 2 and 4 years. In noise levels of 100 dB there was 10.3% of hearing loss, and a decrease in hearing sensitivity by an amount of 25-35 dB. In workers of 5 to 10 years the percentage 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%. In one worker the hearing loss was 46 dB. The blood pressure increase was from 3-5 mm Hg.

For the psychological tests, 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 1 was 280 msec and 103 msec after work. In respect to visual stimulus, the reaction time was 284 msec before work and 291 after work.

It was found that after 3 hours work in noise levels 80 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 85-103 dB, and that a temporary threshold shift of up to 13-18 dB occurs after work, but is recidified to a certain degree after a few hours rest. In the light of hemodynamic changes and psychological reaction, noise is definitely a negative factor.

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 320 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 52 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 5 had the highest complaint rate, as compared with workshop C, which had the lowest. There was no direct relationship between all types of complaints and actual noise levels, 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 as a physical noise level exists 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 complaints is not completely psychological either. A reasonable balance must be somewhere in between.

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.

03-021
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Sakamoto, K.
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THE UNDERSTANDING OF COMPLAINTS IN A NOISY WORKSHOP
Ergonomics
Vol 14 No 1:95-102, 1971

FIGURE 1. Changes in the Number of Complaints Before and After Administration of Placebo

85
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 affects 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 212 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 occurred 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 "dislike" 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.
Only 4% of the sample had ever made a complaint (6% in 1963). Complaints were generally that there was too much noise or that the 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 42% of the entire sample knew of it before moving in, and 86% of those living within 3 miles of the airport were aware.

The economic impact of aircraft noise was 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, 56% of the sample answered that they would be willing 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 found even with apathy, and complaints are almost negligible.

![Graph](image)

*Figure 3. "Usual" reactions to aircraft noise.*

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PSYCHOLOGICAL & SOCIOLOGICAL

03-023

Volkmann, A. M.,

Kurzweil, I. C.,

Taylor, A. I.

Addi-lim Scientific Research Institute of Hygiene in Railway Transport 1960/61

**The Assessment of Railway Traffic Noise by the Population (Questionnaire: Echo and Verbal Association Experiment)**

Doktor Miroslav Sama, Zavodi za zdravinjskozdravstveno

Transport (To Zavodi Operisnice Slovenske

Razstavitvenih Dostopov)

Vigiljona I Statništvo

No 3:20-32, 1971

Most 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 91% of the population filed complaints.

The neighborhood studied was broken down into 3 areas, and noise levels in dba recorded for each: 1 10-100 meters from railway lines, with a maximum measure of 91 dba; 2 150-150 meters, measured at 67 dba; and 3 250-200 meters, measured at 63 dba.

It was found that the most intense railway traffic occurred between 1 and 3 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 46 to 100 meters from the railroad tracks, 125 (87%) complained of intense discomfort and disturbance; 43-44% 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 traffic; 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 150 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
ECONOMIC ASPECTS

The time to general words, in all groups tested, this is in comparison to the control group, which showed a 3.6 second difference in reaction time. The group closest to the railroad tracks showed the most delayed reaction time. It was inferred from this study that high noise levels have detrimental effect on the central nervous system, and even a delay in response to verbal commands 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% answers "it will never be," "silence," and "not possible." To the key word "sleeplessness, responses were "often," "it never was," because of the train," "perverse 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>
<thead>
<tr>
<th>Distance from railroad tracks level with windows open</th>
<th>Latent verbal response time (in sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-100</td>
<td>44</td>
</tr>
<tr>
<td>150-160</td>
<td>61</td>
</tr>
<tr>
<td>250-280</td>
<td>63</td>
</tr>
<tr>
<td>Control Group</td>
<td>2.6</td>
</tr>
</tbody>
</table>

**TABLE I**

The cost of mufflers for most household 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 totaled over $300,000.

Brittles without noise control produce about 120 dBA at one motor, which can be reduced to 105 dBA at a cost increase of 10-15%. To 95 dBA at an estimated cost increase of 10-20%. The cost increase of reducing compressor noise from 110 dBA to 95 dBA or any reduction is about 10%. For smaller, gasoline engine driven units the cost increase is about 10-15%.

**04-002**

Ostergaard, P. D.

Ostergaard Assoc., West Caldwell, NJ

10 Glenwood Way

**INDUSTRIAL PLANTS BE ADEQUATELY QUIETED?**

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

West Caldwell, NJ, Ostergaard Assoc., 1971, 1p.

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 a pair of earplugs or ear muffis. The cost might run anywhere from $5.00 to $10.00 per pair of earplugs or ear muffs and this should provide around 20 to 30 dB of noise reduction. It is also cheap to provide some form of noise reduction in the critical frequencies, if the employee works 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 50 to 70 cents per day 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 that the costs will be something like 3 cents per sq ft 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 day. A complete enclosure around a piece of machinery will probably provide twice as much on a decibel scale as 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 machinery 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 sq ft per 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 the cost 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 designing 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".
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 £35,000 (supplied and fixed) and would 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 £604,000 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 noises 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 to take over the noise from a motorway. Of the five possible measures considered, three cost vastly more than they would save in amenity values and may be eliminated from further consideration. The remaining two possibilities appear to be worth while.

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 dB in the front offices. Simply closing the original window reduced this to 61 dB, which was easy enough to accept. However, when a secondary window was installed the level dropped to 54 dB 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 dB 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 building. Noises from such sources would tend to give rise to discussion among the occupants, whereas traffic noise coming from outside the building had an uniting effect and provided a bond between people in adjacent offices. Consequently it was decided to leave the windows unsashed. In addition a sum of money was earmarked for dealing with internal noise problems as they became apparent.

04-005

Hurlbut, R. L.
Inglewood Department of Environmental Standards
105 East Queen Street, Zip 90305

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 dBA compared to areas where aircraft noise exceeds 110 dBA.

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 midpoint of each census tract. Three possible correlations with noise levels were studied: residential land values, vacancy rate of

<table>
<thead>
<tr>
<th>Noise Level (dBA)</th>
<th>Land Value Increase (%)</th>
<th>Vacancy Rate Decrease (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1 Use of cost and performance rating.

A fact which is often missed is that noise is not necessarily a bad thing; sometimes it can be very desirable.
cortical dwelling units, and vacancy rate of all dwelling units. The first two correlations were significant at the 5% level.

\[
\begin{array}{|c|c|c|}
\hline
\text{variable} & \text{Regression equation} & \text{Significance} \\
\hline
\text{Residential land value} & y = 0.02x + 0.04 & 0.456 \\
\text{All dwelling vacancy rate} & y = 0.25x + 0.33 & 0.433 \\
\text{Rental dwelling vacancy rate} & y = 1.29x + 0.42 & 0.433 \\
\hline
\end{array}
\]

05-001
Sutowsky, J. E.
Goodfellow-DeBergen Assoc., Cedar Knolls, NJ
7 saddle rd., ZJ0 07927

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.

Carpet on floors should have a pile height of at least 0.156 inch and all furniture should be carried on a separate sponge rubber or felted pad or have an integral sponge rubber backing.

at least 0.156 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) is too low. By adding sound baffles of glass fiber panels, the 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) a ceiling treatment of glass fiber panels. Because ceiling fixtures are assumed to cover 25 percent of the ceiling area, their vight diffusers should be of the open rather than solid type.

Walls, partitions and columns should be covered with sound-absorbing materials such as fabric- or vinyl-covered perforated glass fiber panels. Carpeting can also be used if pile depth is at least 0.156 inch for 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 exposed personnel at different work stations and around noisy equipment. They should block noise most efficiently in the 250-500 Hz range, which is the cutest range of speech and business noise spectra. They should be at least 2.5 inches thick, have an imperious material in the middle to reduce noise propagation through the screen, and have equal thickness of sound-absorbing material on either side.

Background masking sound is produced electronically 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

05-007
Haubink, T. B.
United States Dept. of Agriculture, Seattle

EFFECTIVENESS OF SOUND ABSORPTIVE MATERIAL IN DRYWALLS

Sound and Vibration
Vol 4 No 5:10-15, 1970

Results of field measurements of four wall
specimens in a small apartment building showed
that polyurethane foam and mineral wool were
both effective sound absorbing materials in
wood-frame party walls. Light-weight walls
were thus provided with a Sound Transmission
Class (STC) number of 50 or more.

The foam used was the patented Isoclam
Process rigid. 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
forms in about one minute but continues to dry
for one or two days. The cellular characteristics
are 600 cavity cells. The foam is non-toxic,
self-extinguishing, non-corrosive, water-resistant,
and has a density of about 0.6 lbs per cubic foot.

The wall construction was double 24 in. studs
and plates with a space of 1/2 inch between both
studs and plates. This was faced with 5/8 in.
dihedron gypsum board.

The four different filler treatments and
their results were as follows:

<table>
<thead>
<tr>
<th>Field-tested STC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Wall filled with foam on both sides (5 in. thick)</td>
</tr>
<tr>
<td>2) Wall filled with foam on one side (7 in. thick) plus resilient channels under one gypsum facing</td>
</tr>
<tr>
<td>3) A 2 in. blanket of mineral wool in stud spaces on both sides of the wall (1/2 in. plus 1 in. sound deadening board under one gypsum lath)</td>
</tr>
<tr>
<td>4) Wall filled with foam on one side (2 in. thick) plus 1 in. sound deadening board under one gypsum lath</td>
</tr>
</tbody>
</table>

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 was
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 (<1 ft)
costs 30 cents per square foot and half-thick
foam (2-5 in.) costs 10 cents per square foot
installed.

Similar investigations, made on the floor ceiling
construction, showed that 6 in. of foam or 5
in. of mineral wool, together with the other
components of the construction, produced about
the same isolation. All measurements were
made according to ASHRAE standard 1356-67.

"Innovative Recommended Practice for Improvement
of Airborne Sound Insulation in Buildings."

05-003
Wygas, L. F.
Wygas Consulting Engineers, Downers Grove,
IL

5739 Lake Ave., Zip 60515

Sound and Vibration
Vol 5 No 3:19-21, 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
sound reduction near airports is more expensive
than "standard" construction. Building
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, new 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 aircrafts, the straight-line
distance to the nearest approach runway
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 normal activity, but includes ventilating noise, lighting noise, 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 reason. Limits of confidence (approximately 95%).

Max. permissible interior background levels in dBA

<table>
<thead>
<tr>
<th>Type of Building</th>
<th>Room</th>
<th>Max. Permissible Background Level in dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel</td>
<td>Bedrooms</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Meeting Rooms</td>
<td>50</td>
</tr>
<tr>
<td>Retail</td>
<td>Offices</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Lobby</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Shops</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Restaurants</td>
<td>60</td>
</tr>
<tr>
<td>Airport</td>
<td>Ticketing Areas</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Restaurants</td>
<td>60</td>
</tr>
<tr>
<td>Facilities</td>
<td>Main heating Room</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Loading Bath Areas</td>
<td>70</td>
</tr>
<tr>
<td>Office</td>
<td>Executive and Business Offices</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>General Office Areas</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Lobby</td>
<td>95</td>
</tr>
<tr>
<td>Shopping</td>
<td>Shelves</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Restaurants</td>
<td>60</td>
</tr>
<tr>
<td>Schools</td>
<td>Classrooms</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Gymnasiums</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Auditorium</td>
<td>60</td>
</tr>
<tr>
<td>Apartments</td>
<td>Bedrooms</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Kitchens</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Living Rooms</td>
<td>50</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Patient Rooms</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>&amp; Activity &amp; Social Nursing Rooms</td>
<td>55</td>
</tr>
</tbody>
</table>

Note 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 27 dBA (from Figure 1), and the interior background level for a bedroom should be no higher than 45 dBA (from the table), 45 minus 27 indicates a 42 dBA 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 ratings for interior partitions. For example, if 42 dBA external isolation was required, it could be provided by a window system with an STC 42 rating.

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 units, leading to severe acoustical leakage unless installation is closely supervised. Another drawback is spaced window systems is their expense, bulk and maintenance problems (installation). The laminated acoustical glazing consists of multiple layers of thin glass laminated with thick, soft layers of polymer-vinyl-phthalate plastic. The resulting total pane thickness ranges from 1.5 to over one inch.

<table>
<thead>
<tr>
<th>Sound Transmission Class (STC)</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Type</td>
<td></td>
</tr>
<tr>
<td>Single Strength</td>
<td>10</td>
</tr>
<tr>
<td>Double Strength</td>
<td>21</td>
</tr>
<tr>
<td>4&quot; Glass</td>
<td>26</td>
</tr>
<tr>
<td>4&quot; Glass</td>
<td>26</td>
</tr>
<tr>
<td>4&quot; Glass</td>
<td>31</td>
</tr>
<tr>
<td>4&quot; Glass</td>
<td>31-37</td>
</tr>
<tr>
<td>4&quot; Glass</td>
<td>32</td>
</tr>
<tr>
<td>4&quot; Glass</td>
<td>32</td>
</tr>
<tr>
<td>3&quot; Glass</td>
<td>35-37</td>
</tr>
<tr>
<td>3&quot; Glass</td>
<td>38-40</td>
</tr>
<tr>
<td>3&quot; Glass</td>
<td>38-40</td>
</tr>
<tr>
<td>3&quot; Glass</td>
<td>38-40</td>
</tr>
<tr>
<td>3&quot; Glass</td>
<td>38-40</td>
</tr>
</tbody>
</table>

In general, however, there should be no operable windows used, whether of the hoppers, 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 o-ring handles or catches; and close tightly under considerable pressure. Even better, they could be made only technically operable—that is, operable only by a custodian with a wrench.
In this report an engineer from Snab-Sonitalia, Sweden gives the motor manufacturer's viewpoint of the part played by production environmental pollution.

During the past ten years, the need for active measures in the field of environmental 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-engined 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 noise.

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. Injection 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 35 of the total number of vehicles in Sweden consist 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. Snab-Sonitalia has assigned a city bus with a noise level no higher than 50-70 dB(A) 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 the4000 lb collection truck and by the use of special insulation around the engine, radiator and exhaust handling unit, Snab-Sonitalia can reduce refuse collection vehicles with a working noise level of about 75 dB.

Heavy trucks can be driven quieter 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 nature and that technical and economic considerations are not ignored.
Building Acoustics

This size is not insignificant since it implies a reduction of 25-90% of the intensity actually heard.

Noise problems in industry cannot be solved by means of sound absorbing material alone, especially since the sound level near the source where the direct radiation dominates is unaffected by absorbents.

Much larger reductions can be achieved by means of sound-insulating construction that is effective. The most simple case 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, while a range of 7-15 db in thickness, sound insulations in the range 30-55 db can be achieved.

Sound screening arrangements can serve 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 such a way that 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 also so that one avoids exposing more individuals to noise for longer periods than one must. For industrial plants which have approaches of their activities out of doors, much can be gained by screening and by enclosing.

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 constructive planning stage.

Building planning in general and constructive design in detail are important here.

05-006

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Gurden, L. L.
International Business Machines, Endicott, NY

Acoustical Forms for Sound Absorption Applications

Sound and Vibration

Vol. 4 No 7:12-16, 1970

The physical and acoustical properties of polyurethane foam were investigated for sound absorbent applications for sound absorptive rooms. (Wedges, several 1 inch, are used on walls and ceilings of acoustical measurement chambers, to make the interior surfaces of the chamber as completely sound absorbent as possible, so sound is trapped back and forth in the space between the wedges, and practically none is transmitted back into the main chamber space.)

Polyurethane foams can give better acoustic 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.

Among the many types of foam on the market, varying in rigidity, polyurethane flexible foams can be employed into polyester and polyether types. The following table compares their physical properties:

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Polyether Foam</th>
<th>Polyester Foam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrolysis</td>
<td>More stable</td>
<td>More durable in dry environment</td>
</tr>
<tr>
<td>Ultraviolet</td>
<td>More stable, used almost exclusively by garment industry</td>
<td></td>
</tr>
<tr>
<td>Air flow</td>
<td>Max 40%</td>
<td>Max 60% open cells</td>
</tr>
<tr>
<td>Flammability</td>
<td>Neither type self-extinguishing, except with addition of fire retardant</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>More expensive</td>
<td>Less expensive</td>
</tr>
<tr>
<td>Fatigue</td>
<td>More durable, used for seat cushions</td>
<td></td>
</tr>
</tbody>
</table>

Air flow resistance is the most important parameter in determining the sound absorptive
MEASUREMENT

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 usual 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 8.0 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 as quickly, sulfur dioxide, and nitrogen 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 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 1/4 wavelength is shorter than the foam thickness. To increase absorption to 90%, wedge shapes may be used to make the bulk impedance increase between air and foam more gradual.

06-001
Oesterreichischer Lebensmittelzug
Lageplanung
1012 Vienna, Stadtwirtschaft/Österreich
TECHNICAL NOISE PROTECTIVE CONCEPTS AND MEASUREMENTS
Lauttechnische Begriffe und Messungen
DLI-Mitteilung
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 NBS every 2 years.

Measurements, as prescribed by the guidelines for personnel noise, should be taken at least 1.2 meters above ground when performed outdoors. Inside rooms, they should be taken at 1.2 meters above the floor, in the center of the room, and on or near people and objects, and the microphones should be located as far from the observer as possible. Weather conditions should be taken into account for outdoor measurements. For example, wind can influence the noise level by 10 dB.

Manufacturer IEC-1982, Filter Measur. Weight
Area for A curve

Bruel & Kjær
[Table]

Fonkel N. V.
[Table]

General Radio Co.
[Table]

Phono & Schwartz
[Table]

Philips N. V.
[Table]

L.E.A. (France)
[Table]
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 modal 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 repeatable and reproducible way. A simple, inexpensive technique is needed that may be used by the nonexpert. Therefore, an A-weighted sound level meter equipment, 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 absolute levels 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 level by public conveyances, motor vehicles, including recreational equipment, and construction and industrial machinery. The test site consists of a test outdoor area within 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 25 mph. The vehicle passes by in both directions, and only data from the last last 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 repeatability, the same method.
MEASUREMENT

is used for community noise readings, when a given model of equipment is being tested, different units of that model are tested until the number tested equals or exceeds two range in decimals 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 for use 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

Fuzyna, C.

TRAFFIC NOISE

Hotesy Komunikacyjne

In: Zagadnienia Akustyczne w Zabudowach Promyslowych

Warszawa Wydawnictwo Zabudowa Grodzka 1971

The author suggests installations of street microphones which will register average 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 124, 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 van compressors found in industrial plants. The document, "Pneumatic 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 (CMAC).
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 and meters 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 resulting from 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 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 2 cm 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 Soc. of Testing Materials and Standard Inst. (ASTM) for approval as a standard.

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 and the American Society of Heating, Refrigeration, and Air Conditioning Engineers are 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.

06-006

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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.

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, 21p., 5-6, 507
MEASUREMENT

A description of and results obtained from a four-point automatic noise monitoring system in Indio, California is presented. The system measures noise from aircraft taking off and landing at nearby Los Angeles International Airport. The four remote microphones are located on telephone poles crossing the 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 automatically drives the microphone equivalent to a sound pressure level of 0 dB.

At City Hall, information is displayed on a data exposure monitor that presents the total time that noise in the area around each microphone exceeds thresholds of 80, 90, and 100 dBA.

Other notes of data presentation are available.

1) An unweighted signal played on 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 a loudspeaker at a distance 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 unweighted noise is played on a graphic recorder which plots it against time, thus permitting calculation of CIEL Community Noise Exposure Lowell 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 yields results in dBA, CIEL, and EMU units. All of the results in dBA correlated within 2 dBA of Ingleside's data, showing that Ingleside's system correlates very well with more complicated measurement techniques.

Instruments used for sound measurement and the function of each are discussed. The basic instrument is the sound level meter. It consists of a non-directional 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-sound waves, as those produced by human voices, such as railroad, chemical plant noise, etc.

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 dBA, the B network for sounds between 55 and 65 dBA, and the C network for levels above 85 dBA.

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 analysers must be measured on the C scale.

The A network is added to or made up to 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. An octave band analysis must be performed when the source of the noise component must be identified for purposes of sound reduction, or some other reason.

For these analyses, all frequency, then octave, and then half-octave and third-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 bandwidth 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 occupation, noise at a machine 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, location 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 Magazine

Vol 76 No 5:12-13, 1971

Preventing community complaints about noise
from industrial sources is discussed. 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 Zel. 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.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>CORRECTION</th>
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<tbody>
<tr>
<td>Pure-tone components</td>
<td>+1</td>
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<tr>
<td>Wide-band noise</td>
<td>0</td>
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<tr>
<td>Impulsive</td>
<td>+1</td>
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<tr>
<td>Not Impulsive</td>
<td>0</td>
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<tr>
<td>Continuous exposures,</td>
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<td>to 1 per minute</td>
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<tr>
<td>10-65 exposures per hour</td>
<td>-1</td>
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<td>1-10 exposures per hour</td>
<td>-2</td>
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<tr>
<td>4-20 exposures per day</td>
<td>-3</td>
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<td>4-10 exposures per day</td>
<td>-4</td>
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<tr>
<td>1 exposure per day</td>
<td>-5</td>
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<tr>
<td>Very quiet suburban</td>
<td>+1</td>
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<tr>
<td>Suburban</td>
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<tr>
<td>Residential urban</td>
<td>-1</td>
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<tr>
<td>Urban near some industry</td>
<td>-2</td>
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<tr>
<td>Area of heavy industry</td>
<td>-3</td>
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<tr>
<td>Nighttime</td>
<td>0</td>
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</tr>
<tr>
<td>Extreme conditioning</td>
<td>-2</td>
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</tbody>
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The sum of the various corrections that is
applied to the original level rank to obtain
the corrected level rank. The expected
community response can then be predicted by
Figure 2.

NOTE CRITERIA (I.C. CURVES)

06-009
MEASUREMENT

A widely used set of noise criteria for various offices, conference rooms, residences, and the like was developed by Dr. Leo Beranek (Figure 3.3). 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.

Procedures should be taken when using NR 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 NR levels must be used with caution; whatever noise control must be engineered, active band data are necessary. Sound should be correlated on an active band basis only, and not by adding or subtracting overall levels.

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URBAN TRAFFIC NOISE: STRATEGY FOR AN IMPROVED ENVIRONMENT

An Organization for Economic Co-operation and Development report recommends international abatement measures for traffic noise. The sponsoring committee set the 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 abatement 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 research into quiet vehicles by specifying them in their procurements, and with progressively more stringent limits that will allow the research and development of quieter urban transportation modes which offer a long term solution to the problem. Highway engineering 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 noise barriers, control of traffic flow, to minimize noise from acceleration, zoning and landuse planning, location of new major roads to take advantage of existing natural acoustic barriers, non 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 now in large numbers in international trade, government regulation of vehicular noise limits should be international 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 problems of urban traffic noise, the 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 re-routing, limitation of night operation, improvement of traffic flow, transmission path modification such as road design, noise barriers, positioning 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, the Netherlands, Denmark, Norway, Sweden, Switzerland, and the United Kingdom.

Annex Two presents the directives of the EEC (ECO) and the Common Market concerning maximum noise levels from vehicles.
A discussion of the large number of complaints made about aircraft noise and its adverse 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. This objective of this study was to determine whether the relation between speech intelligibility and AI for time-varying aircraft noise is different than that for steady-state noise.

The results showed that, for a given AI, the time-varying noise masked speech less than the steady-state noise.

The magnitude of the difference depends on 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 than that for steady-state noise. There will be an appreciable disruption of contextual speech when the peak level of an aircraft flyover exceeds 80 dBA, as 5% (speech-interference level) of 68 dB, or an A-weighted sound-pressure level of 76 dB.

MEASUREMENT

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SPEECH INTELLIGIBILITY IN THE PRESENCE OF THE VARYING AIRCRAFT NOISE

Journal of the Acoustical Society of America
Vol 50 No. 2:426-434, 1971

This study shows some clarification of the adequacy of AI measures for rating hearing-loss risks for isolated noises which may display broad differences in spectral, temporal, or other acoustic features. Its specific intent was to test whether sound-level readings in AI could suitably depict the tendencies to hearing from exposure to noises differing greatly in spectral shape.

Three test noises having spectral slopes of 6 dB/Dec, 0 dB/Dec, and 46 dB/Dec provided the test conditions of interest. These three noises were presented at a constant 100 dB 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 control sessions. Figure 1 shows the spectral shape of the three noise at the prescribed 100 dB sound level. Also shown 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 sensitive against the energy contained in the noise with the 0 dB/Dec slope.

Temporary threshold shifts in hearing served to evaluate the effect of the different noise spectra on the ear. Such hearing thresholds were measured for pure-tone frequencies 250, 500, 1000, 2000, 4000, 6000, and 8000 Hz. Each tone was presented for 30 sec in which time the subject controlled the intramural from us to fluctuate about his threshold level for that sound. The attenuation rate was 6 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.
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 0.3 dBA.

However, significant interactions between noise spectra and pure-tone test frequencies were also found. At pure-tone frequencies below 2000 Hz, frequencies above 1000 Hz, the reverse was true: the 16 dBA/oct noise caused more threshold shift than the 0 dBA/oct noise which, in turn, caused more TTS2 than the -6 dBA/oct noise. The -6 dBA/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 the degrading effects on hearing relative to that caused by high-frequency sound. The +6 dBA/oct slope noise should be most harmful to hearing followed by the -6 dBA/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 averages the sound levels of octave bands with midfrequencies 500, 1000, 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.
MEASUREMENT

07-031

Department of Housing and Urban Development, Washington, DC

AIRPORT ENVIRONMENTS: LAND USE CONTROLS

This environmental planning paper presents a review of the problems, methods, and practices for solving a variety of airport 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 environment. As such, planning for compatible land use in the airport environs and planning for the airport itself should be integral parts of an overall comprehensive planning program.

The comprehensive plan for protection against noise pollution, such as the Federal Aviation Administration's Noise Compatibility Program, is expected to result in a reduction of aircraft noise levels in future years.

The conflicting pressures for both the further expansion of the air transportation system and the environment in the United States are so strong that further innovation of airport environs is almost inevitable.
PLANNING & SITING

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 Flugschäden

Ing Fluglarmteilung, Wiesbaden, MAR 17-18, 1969


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 financial aid 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 650 million and that of the military-airports 315 million. 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 70 dBA. In Zone I, runways 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 operators and in case of military airports, by the Federal government.

The cost estimated for the civil airports is from 10 to maximum 125.6 million, and those of the military airports between 57-7 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, airport 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.

07-005

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SOUND NtOISE AND DWELLINGS

Building Research Station Digest, No 135/1-7, 1971

Introduction of the "L10 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 façade 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. Average 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 level.

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 be taken into account that other buildings can reflect noise back to the otherwise shielded facade.

To be effective, trees 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 are 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 procedure may be useful for other free-flowing traffic.

07-005

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FREEWAY AND HIGHWAY NOISES: AN INTRODUCTION
BASE FOR URBAN DEVELOPMENT DECISIONS
Springfield, VA, NTIS, PB204434, 1971, 90p., HC: $5.00 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 must active opposition from the communities that would be affected. Criteria should be developed for compatibility of transportation routes with human activity;
PLANNING & SITING

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 a calculation of the number of residents near freeways.

Cars and trucks on freeways are then simulated as noise sources, and together with other considerations such as surface street traffic noise and noise reduction in buildings, the information is used to specify zones of intrusion. Data from other U.S. cities and from the United Kingdom are incorporated.

Much past work on subjective responses 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 activities. 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 degree of annoyance were chosen by the experimenter. 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 limits 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. This 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 the government and the transportation industries to account for the costs of noise production. A comprehensive decision/evaluation 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 42511971

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 is the keynote.

Ethical, 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 ethical schemes include creating quieter 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 have turned their minds to the local school boards, 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 55 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.

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PLANNING & SITING

21) It is simple to measure noise levels in JRA with simplex, low cost equipment, which can be operated by constant low enforcement personnel, or to automate such measurement quite simply.

21) 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 procedures 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, 1970

This discussion is centered on three types of roads: 1) through motorways; 2) urban main roads; 3) residential roads. In general, noise increases with the traffic flow, with the 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 dB 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/hr 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 traffic from 70 mph to 50 mph would reduce the sound level by about 10 dB. 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 of traffic at intersections, stoplights, 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 smoothing it out to achieve moderate but steady speeds, by the use of clearways, chokers 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 50 signalized intersections in central Glasgow were brought under computer control. Various control strategies were being tested, and results to date indicate an improvement of 10-15% 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 "jett" effects on cars caused by side winds.

Roads in Britain are rated at about one-quarter of the time, and indicated. At low speeds the reflection between the tire and the road surface is absorbed by the material and the fine texture of the surface, but as speeds increase a rough surface is required for adequate 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 runways 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 routes, 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 and limit 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 surfaces: need investigation from the point of view of noise.

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07-009

Kallus, M. O.

Minneapolis-St. Paul Metropolitan Airports Commission

JET NOISE AND ITS IMPACT

Airport Service Management

Vol 12 No 10:16-18, 1971

The evolution of the jet noise situation in the Minneapolis-St. Paul area (Hople-Chamberlain Field) and the efforts of the Minneapolis-St. Paul Airports Commission (M-NAC) to deal with it are described. Persistent and organized opposition to jet noise came in 1961-62, as exemplified by new stories reflecting public concern. In 1966, NAC 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 a minimum approach slope angle of 2.7 degrees (0.65°) and later at 3 degrees, advisory signs on the runways indicating 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 NAC 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 number of the aircraft. The NAC actively supported such legislation in the following period, writing to each member of the Minneapolis Congressional delegation and printing two members of the Senate Aviation Subcommittees on the noise problem faced by the airport operator.

In 1962 NAC created the Metropolitan Airport Sound Abatement Council (MASC) to provide continuous study of the problem and to advise NAC.

A positive feature of Hople-Chamberlain is that there are areas at the end of instrument runways far in excess of federal requirements (an mile or more; the FAA requires 2,000 ft). However, the volume of traffic at the airport has increased from 1.4 million passengers in 1956 to 4.5 million in 1967. Use of terminal air space will increase 10 times in the next 30 years.

Retooling of the present generation of jet aircraft is advised, because NAC studies indicate that the cost of noise reduction would be greater than the cost of retooling it one considers costs of alternative methods to reduce noise around airports. Alternate methods include expensive land acquisition continuous to present airports and reduction of airport capacity. The latter results in increased operational costs to airlines caused by delays in departing and arriving. It is suggested that the aviation industry and the general public share the cost of retooling. 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. How economic activities generated by the airport attract people who soon begin the crowd the airport surrounds.

There is presently widespread opposition to expansion of airport facilities. The noise of the jet engine is used as a catalyst for opposing airport development. Without closing of the jet engine noise, 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. 16:101-107, 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
plant 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:

- NGI-1: Procedural specification for limitation
  of noise in plant;
- NGI-2: Noise limitation for individual items of
equipment;
- NGI-3: Guide to the setting of limits and use of
  NGI-1 and NGI-2.

NGI-2 consists of the excerpts of NGI-1 of most
interest to suppliers bidding on petrochemical
plant projects. While manufacturers' representative
bodies often seek limits set in ODA for
simplicity, OCMA felt that at least octave band
data were needed for the effective design of
new plants.

Part 4 of NGI-1 contains a system for dividing
the entire plant area and environs into four
types of areas for the purpose of setting
limits:

C-general work area limits
R-restricted exposure work area limits
S-space and work interruption 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 NGI-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 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
sum 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 work 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 manufacturers.

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 ODA Specifications give
the plant operator the tools to accomplish
these two and three.

Insular 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

Anderson, G. S.
Gottmuller, F.

Boll, Baranek, and Newman, Inc.,
Cambridge, MA

ODA HIGHWAY PLANNING FOR MINIMUM NOISE

At: American Association for the Advancement of
Science, Philadelphia, Dec 29, 1971


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 Roadways in the District of Columbia should reduce noise impact from 97 dB dwelling units to 85; 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 $3,900,000 - 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 $3,900,000 if all sections of the highway network are constructed. Funding is available from the federal government for well-designed noise barriers. The problems of aesthetics 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.

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-conveyor when pipes are transferred, pipe assembly lines, and boring machines. They produced more than 10-30 dB 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 (25.5 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 the Federal Government Law of 55 dB during the night time. Measurements before and after the construction show the amount of reduction achieved.

<table>
<thead>
<tr>
<th>Measuring Place</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary Lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1 and 2)</td>
<td>65 - 73 dBA</td>
<td>57 - 59 dBA</td>
</tr>
<tr>
<td>1</td>
<td>62 - 71</td>
<td>52 - 55</td>
</tr>
<tr>
<td>Residential Areas (2 to 30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>66 - 71</td>
<td>53 - 58</td>
</tr>
<tr>
<td>4</td>
<td>64 - 69</td>
<td>53 - 56</td>
</tr>
<tr>
<td>5</td>
<td>64</td>
<td>53 - 57</td>
</tr>
<tr>
<td>6</td>
<td>65 - 72</td>
<td>53 - 57</td>
</tr>
<tr>
<td>7</td>
<td>71</td>
<td>53 - 57</td>
</tr>
<tr>
<td>8</td>
<td>65 - 72</td>
<td>53 - 57</td>
</tr>
<tr>
<td>Mean Values</td>
<td>65 - 72 dBA</td>
<td>54 - 57 dBA</td>
</tr>
</tbody>
</table>
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 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 (unsual 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 outdoor 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 sources may be more favorable.

The calculation for aircraft noise presumes 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 cannot be obtained. This method involves multiplying the number of night operations (10 pm - 7 am) by 1.7 and adding this to the number of daytime operations. The resulting number is used to locate 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 20 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 classification 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 is a function of the distances from the site to the centerlines of the nearest lane and the farthest lane; the effective distance road off of a mapogram; 2) the peak hourly flow of traffic vehicles per hour, both directions combined. In the simplest case, which assumes a mean vehicle speed of 40 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 distance 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 nighttime 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 5%, this factor must be taken into account. If the gradient is more than 5%, 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 cutters or fences and beams) 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 interpolated sets of families of curves, is 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 Walkway 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 to block the path between himself and the other man. The other man backs slowly away from the first man and 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

PLANNING & SITING
over a period of 10 seconds or more, no effect.
The distance between the two men is measured.
Several trials are taken, with the man
carrying each voltmeter, 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 p.m. and midnight), then the averaged
distances for the worst trial period may be
used to evaluate acceptability.

<table>
<thead>
<tr>
<th>Distance (ft)</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 70</td>
<td>Clearly Acceptable</td>
</tr>
<tr>
<td>7 - 25</td>
<td>Normally Acceptable</td>
</tr>
<tr>
<td>Less than 7</td>
<td>Clearly Unacceptable</td>
</tr>
</tbody>
</table>

07-013

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AUTOMOBILE AND TRUCK TRAFFIC NOISE INTRUSION
in: Luna, S., Freeway and Highway Noise:
An Information Book for Urban Development
Decisions
Springfield, VA, NTIS, PB 202434, 1971, 90p.,
(p. 8-2) 10: $1.00 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.

<table>
<thead>
<tr>
<th>Type of Sound Path</th>
<th>Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from center</td>
<td></td>
</tr>
<tr>
<td>line of near traffic</td>
<td></td>
</tr>
<tr>
<td>100 200 500</td>
<td></td>
</tr>
</tbody>
</table>

Shoudy flo Unobstructed 75dBA 70dBA 60dBA
traffic
(7:00-4:00)

In the Obstructed 62 57 55
near-side
avg. sound level

Freeway truck
traffic, Unobstructed 62 75 68
typical peak
sound levels

The results 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 urban
communities were taken into account, as well as
the following data from Ingolstadt, in the
Los Angeles area:

<table>
<thead>
<tr>
<th>Location</th>
<th>Min 40, Max 60</th>
<th>Ave. 48, Max 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle of residential Day</td>
<td>42-56 46</td>
<td>51-55 58</td>
</tr>
<tr>
<td>Periphery of area</td>
<td>Day 52-58 57</td>
<td>58-60 60</td>
</tr>
<tr>
<td>Residential area</td>
<td>Adjacent to main roads</td>
<td>5 am 37</td>
</tr>
</tbody>
</table>

Although adequate theories for noise reduction
of residential 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 25 dB with windows closed.

In Los Angeles, residential unit lots start at
least 100 feet from the center of the near
lane. There are about three blocks within
1000 feet (or 1/2 mile) of a freeway. Since
the average outdoor background noise level in
a quiet neighborhood is about 50 dBA, the
interior noise levels (windows closed) will be
about 40 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), estimates intrusion levels are
about 5 dB less than those given above.

With windows open, the interior background
level is about 40 dBA. 150 dBA outdoor
background noise level minus 10 dB noise
reduction of the residential building, again,
introducing 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, observable noise level contours obtained in a 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: Crockery, H., 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 main 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 is intense 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 fun covers and enclosures are used in noise control.

Control valves are responsible for nearly all the noise generally blamed on piping systems. Valve noise often persists for long distances. For valve 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 mass can escape through the pipes, or both, and probably explains why a normally insignificant 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 turbulent fluid zone just downstream of the nozzle. Combustion noise and picture noise are the major problems in elevated flares. Flare noise can be reduced to some extent by using multipurpose steam nozzles. The quicker the steam becomes thoroughly mixed with the inspired 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. Any source contributing 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

Malison, W. K.

NOISE FROM URBAN FLIGHTS

07-016

Valkins, G. R.

NOISE FROM URBAN MOTORS

Guidelines 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 not normally depressed;
(b) the edge of the pavement should be at least 20 meters from the nearest dwelling, if possible;
(c) if 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 in the almost 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 were studied so as to minimize any damaging effect on the environment. In London, 85% of the lengths of new motorways will follow existing linear features, and about 50 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 at hills 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. Primarily, the methods 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 obstacles, and the building being examined. The estimates cannot be precise and are generally made in 5 dB 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
PLANNING & SITING

suggest that in busy urban areas 20 dBA by day and 35 dBA by night should not be exceeded for more than 10% of the time inside dwellings. Methods of achieving these standards for existing buildings near motorways may range from providing operable 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 'silent' urban areas.

Before motorway M1 was opened into the northern suburbs in 1957, a survey in the residential Middle Hill and Hurst Green area 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 noise level in the area increased by 20 dBA in the region close to the motorway compared with the noise level which would be expected in the same area in the absence of the motorway.

At Hurst Green, immediately to the south of the motorway, the noise level inside some detached houses was 15 dBA higher than that existing in the same area in the absence of the motorway.

A noise survey was also made of houses in the area under investigation. Measurements were taken at 6 measuring points in order to determine the sound pressure level at the different points. The most striking results were found in Tunnel Avenue and Tunstall Hill, two roads parallel to the A1021. 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 A1021M, measurements were not complete. However, in several previously quiet roads consisting of older 3-4 storey houses, noise levels of up to 60 dBA were recorded by day outside windows.

The City hospital in Essen, Germany had to expand its refrigeration plant to provide air conditioning. The neighboring nuisances, who lived within 50 meters of the motorway, were located only 30 meters away. To comply with the prescribed standards. Noise Protection in a Large Refrigeration Plant located in a Residential Area

Laufrungsbericht Nr 2/53-35, 1970

The following table shows the number ofombok levels on the quietest houses in the area.

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07-017

Zeller H., Schapermann J.
Institut fuer Schall- und Klimaschutz, Essen (West Germany)
Kraemerweg 48

LAUFRUSSBERICHT NR. 2/53-35, 1970

The City hospital in Essen, Germany had to expand its refrigeration plant to provide air conditioning.

The neighboring nuisances, who lived within 50 meters of the motorway, were located only 30 meters away. To comply with the prescribed standards.

After the prospective cooler sites (A1M) 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 the different points are shown in the table below.

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In 1966 the Institute for Building Technique (ITD) in Warsaw conducted its first survey of traffic noise in Warsaw. Later the cities of Gusz and Poznan were included.

As a result, uniform measurement and noise maps and a catalog 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) Gusz at 300 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 1-2 pm, with hardly any variations between the time span, whether 30 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.

07-018
Sadowski, J.
Institut Techniki Budownictwa, Warszawa (Poland)
Ul. Wawelska 2
TRAFFIC NOISE IN WARSAW, GUSZ AND POZNAK
Untersuchungen Uber den Verkehrslarm in Warszawa, Dzisny and Poznan
Lombiekompanung
No 3:65-69, 1969

PLANNING & SITING

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 regulation 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 twofold purpose of the 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 these 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 subject 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 36 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 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.

07-018
Snedaker, M.
California State Dept. of Public Health
Los Angeles
Bureau of Occupational Health & Environmental Epidemiology
P. O. Box 30327, Terminal Annex
A CRITICAL LOOK AT AN AIRPORT CONTROL ORDINANCE
American Industrial Hygiene Association Journal
Vol 32 No 7:480-487, 1971

06-002
THE FIRST TRUCK RESTRICTION ON FEDERAL HIGHWAYS DURING NIGHTTIME
Erstes Lastwagenfahrverbub auf Bundesstraßen 'nach Nschtzeit'
Kemptown Lahr
Vol 10 No 6:166, 1971
LEGISLATION & STANDARDS

The first truck restriction on Federal highways was passed in West Germany. The law passed in 1983 pertains to highway 324 between Alsfeld and Homburg in North Hessen for night-time between 10 p.m. and 6 a.m., and restricts the passage of trucks over 4 tons.

Minister Harry explained that all attempts must be made to reduce noise at night to citizens living near Federal highways. It was also noted that since this restriction does not apply to other main routes in Hessen as well, consideration was given to the citizens instead of the freight industry. In this case because a parallel route was available that could be used by trucks instead of highway 324.

08-003

Goldstein, S. H.

Mitex Corp., McLean, VA

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; Mitex 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 effects of chronic exposure to loud noise as well as psychologically disturbing aspects of typical community noise which are not loud enough to be physically dangerous. This makes the standard intended to portray environmental quality rather than to reflect damage risk criteria. It is generally conservative with respect to noise-related ill effects, such as those specified by the Welsh-Milloy 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 standard deviations of 110 and 51.5, and 90 and 75. These composite distributions correspond to 8-hour periods for sleep, miscellaneous daily activities, and work, respectively. Alternative strategies for obtaining data for calculating the raised noise quality indices are discussed.

08-004

Dmitriev I. I.

Institute of Hygiene and Occupational Medicine

NEW HEALTH NORMS ON NOISE

By Boris Dzantievich Gurgenov

Gigiyona Iruka i Professional'nya Zabolevaniya

Vol 14 No 5:47, 1970

"Health norms and regulations on noise abduction in areas and rooms of industrial enterprises," No. 795-69, 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 previous documents and international recommendations. The document establishes permissible noise levels, conditions and specifications for monitoring 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 IAQ-42 Committee on Acoustics of the ISO. Rooms used for educational work (laboratories, design bureaus, etc.) have a maximum permissible noise limit equivalent to about 30 dBA; rooms for office work (typing pools, rooms with office calculators, etc.), 40 dBA; control consoles and observation rooms, 60 dBA; laboratories with noise sources, 70 dBA; and work areas in rooms and areas of industrial enterprises, 80 dBA. The norms allow for corrections for duration of the noise during this work shift and for the character of the noise (a correction of 5 dBA is allowed for tonal or impulsive noise measurable 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 recommendations 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 (Gosstroiz SSSR).

These are to be based on ergonomic requirements and not solely on established maximum permissible levels of noise.
08-005

Lesser, J.

Port of New York Authority, NY

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 1955, courts have been deciding questions of who owns the air above property. The Supreme Court decision on aircraft noise came in 1954, in the case of United States v. Cuyahoga

The court found in favor of Cuyahoga, ruling that the low aircraft altitudes caused trespass and nuisance. The owner and operator of the airport was held liable; the case did not involve possible liability of the airport operator.

In 1952 local government assumed 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 was upheld. A similar ruling was made in New Jersey in 1954. Three 1955 Court of Claims decisions, all on cases modeled after Cuyahoga, 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 Visitors awarded $12,500 to Griggs for the condemnation of his property as of the day in 1950 when the Pittsburgh Greater Airport opened.

Federal courts have held that before a property can be considered aeronautically invaded the landowner's airspace. On the contrary, some state courts have held that federal rights can constitute compensable takings within the meaning of constitutional standards. The burden of proof that property has been constitutionally appropriate is in dispute, as well as the nature of limitations.

The effect of the Griggs ruling was to affect property owners and not 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 $175,000 were awarded. Similar awards have been made in other states.

Local ordinances have generally been prohibited, but have promulgated regulatory action by airport authorities. Zoning laws by municipalities have not been much help in limiting aircraft noise, because when they attempt it, they condition property, they constitute a taking of private property without compensation.

The 1969 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 105 dBA measured at three statute miles from the start of take-off run, 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 aircraft to exceed 105 dBA at measuring points farther from the runway than originally proposed and contains a "trade-off" provision which would not mean that noise levels as high as 110 dBA would be permissible. Since the FAA's scale is constructed on logarithmic base, the difference between 105 and 110 dBA alone would reflect a 50 percent increase in annoyance. The "trade-off" provision would allow noiser take-offs and landings, for instance, if they were compensated for by a reduction in daytime noise. In addition, the rule was further diluted by exempting the initial group of approximately 150 Boeing 747s, the jumbo jets, from its controls. However, the FAA makes no claim that the rules are acceptable or unacceptable for particular airports.
LEGISLATION & STANDARDS

08-007

Hartturt, R. L.

Inglewood Department of Environmental Standards, CA

105 East Quinn St, Zip 90301

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 soundproofing 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 envisaged 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 dB contour need only normal housing construction to provide an acceptable noise environment indoors.

Areas in the 65-75 dB range require that the building construction provide a reduction of 15 dB, and those inside the 75 dB contour need a 35 dB reduction, which appears the practical limit without detailed soundproofing studies and design in each new construction at extreme increases in cost. Zones in the soundproofing ordinance bounded by the 65 and 75 dB 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 dB contour, but rather on those estimated for the year 1980.

New housing (and additions costing more than $10,000) in the 65-75 dB contour interval must provide at least 28 dB 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 windowing on external doors and windows, and a well-designed soundproofing enclosure. Prohibited outdoor wall openings to the exterior such as small windows. Also prohibited are built-in windows and skylights constructions unless the skylights provide overall reduction of at least 28 dB.

Requirements within the 75 DNL contour are for a noise reduction of at least 35 dB. Some regulations include those derived from the following mandatory: external doors of sealable acoustic design with an STC rating of at least 36 dB sealable acoustic glass-paned windows with an STC rating of at least 39 dB. For the outside having fiberglass lined fiel boxes. In addition to the normal grills. The use of exposed beam ceilings is prohibited unless special plywood and fiberglass acoustic 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 do not meet the 28 dB and 35 dB noise reduction requirements, according to the proposed ordinance. Details of field tests are to be specified.

08-008

Cuadra, E.

Environmental Protection Agency, Washington, DC

Office of Noise Control & Abatement

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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) they are intended to be meaningful to at least the untrained consumer vis-a-vis the consumer's intended use and other important factors; 2) the rating should be of sound quality; 3) it should 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 Helen Abatement and Control welcome the cooperation of the various professional societies in developing measurement standards, although a combination of voluntary action and regulation will mean better progress in noise control than regulation alone.

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 discomfort. 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 idea 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 564142 (British Standards Institution, 1971) 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 level (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 dB 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 nighttime 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 automobile traffic, dogs barking, and wind noise. Besides these factors, wide variations exist depending on local activity and noise from distant sources.

ANNALS OF OCCUPATIONAL HYGIENE


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 discomfort. 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.

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ACTIVITIES REPORT FOR 1971

Tätigkeitsbericht 1971

The Annual Report for 1971 of the Commission on Noise Abatement of the German Engineers Association details its activities in the field of noise abatement and control.

As of December 1971, membership in the Commission amounted to 200 voluntary workers. It is subdivided into subcommittees 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) Noise reduction in rail traffic.

The first colloquium of the Commission was convened in 1971 and covered the theme of "Noise Reduction in Rail Traffic."
The Commission on Industrial Noise met 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-committee on "Road Noise" held a colloquium entitled "Traffic Noise Reduction in Rail Traffic" on Feb 9, 1971. In Dusseldorf, with not only domestic but also international participation.

In Feb, 1971, the sub-group on "Road 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-committees 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 Dusseldorf. The main purpose of this conference was the discussion on the draft of the VDI 2719 guideline on "sound-proofing of windows," produced by the sub-committee by the same name. It was decided to read the draft and a spring 1972 publication data was set.

Other sub-groups dealing with elevators, heating systems, air-conditioning 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-committees on guideline draft VDI 2039 "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 correlate plant-measurement technology with DIN 45635: "Noise Measurement in Machines."

The VDI Commission on Noise Abatement made a private draft guideline on the "Prescriptive Measures toward Noise Reduction - General Principles" and "Prescriptive Measures toward Noise Reduction - General References."

The importance of this work was stressed in a meeting in Dusseldorf in a "Spotlight" project for the drafting of these guidelines. Part of the work is to be finished by mid-June 1972.

In the total the Commission has drafted over 20 guidelines, some of which have already been published.

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Engineering Division, Dept. of Environmental Control, 320 N. Clark St., Chicago, Ill 60610

A NEW COMPREHENSIVE CITY NOISE ORDINANCE


1 Lafayette, IN, Purdue Univ, 1972, 594p., (p. 202-203)

Chicago's quantitative noise ordinance, passed in 1957, set a national 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 the noise is the orchestral play of air conditioners, which are, at least, at the 30 ft distance. Trucks (+ any motor vehicle with gross weight of 8000 lb or more) travelling at 35 mph or less in the city must emit no more than 66 dBA (motorcycle) and 72 dBA (cars), respectively, at the 50 ft distance. Trucks (+ any motor vehicle with gross weight of 8000 lb or more) travelling at 35 mph or less must run no more than 66 dBA at 50 ft by the beginning of 1973, including noise from their auxiliary equipment.

In the month before the new ordinance went into effect, 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.
LEGISLATION & STANDARDS

Type of Equipment | Noise Limit at 50 ft
--- | ---
(1) Construction and industrial machinery—not including pile drivers, manufactured after: | |
1 Jan 1972 | 64 dBA
1 Jan 1973 | 68 dBA
1 Jan 1975 | 66 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 1980 | 65 dBA
Restrictions on the sale or leasing of recreational vehicles are as follows: | |
Data of Manufacture after: | Noise Limit at 50 ft
--- | ---
Snowmobile | |
1 Jan 1971 | 86 dBA
1 Jan 1972 | 82 dBA
1 Jan 1974 | 75 dBA
Any other vehicle, including dunebuggy, all-terrain vehicle, go-cart, mini-bike | |
1 Jan 1971 | 86 dBA
1 Jan 1973 | 82 dBA
1 Jan 1975 | 75 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 1975.

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 86 dBA at 50 ft. This limit will be tightened to 82 dBA at the beginning of 1975.

Measurement of all the limits listed above are to be made in accordance with SAE, 2AC, 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.

Noise 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 (see at 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 before.

Chicago Department of Environmental Control, IL
Engineering Division, Sup. of Environmental Control, 520 N. Clark St., Chicago, 60610

URBAN NOISE LEGISLATION

In: International Conference on Transportation and the Environment, Part II
May 31-July 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 rare severe problem, create a very intrusive noise...
problem because of lower background noise levels at night. Specialized truck noise problems occur when large numbers of powered vans stand idly in traffic with motors left running, and when scavenger refuse pickup trucks (engine noise plus noise from the packer unit) and all 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 only from pass-bys on the right of way, but also from switchyards, where diesel engines run night and day. A new noise problem is the loading of "piggy-back" trucks and 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

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Date of Manufacture</th>
<th>Noise Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Motorcycles</td>
<td>before 1 JAN 1970</td>
<td>92</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1970</td>
<td>88</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1973</td>
<td>85</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1975</td>
<td>84</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1980</td>
<td>73</td>
</tr>
<tr>
<td>2) Trucks (gross weight of 8,000 lbs. or more)</td>
<td>before 1 JAN 1973</td>
<td>88</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1973</td>
<td>84</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1980</td>
<td>73</td>
</tr>
<tr>
<td>3) Passenger cars, (and any other motor vehicle)</td>
<td>before 1 JAN 1973</td>
<td>88</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1973</td>
<td>84</td>
</tr>
<tr>
<td>Same</td>
<td>after 1 JAN 1980</td>
<td>73</td>
</tr>
</tbody>
</table>

The manufacturer, distributor, importer, or designated agent shall certify in writing to the Commissioner that his vehicles sold within the 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.

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>35 MPH or Less</th>
<th>Over 35 MPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Limit at 50 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance in Relation to Posted Speed Limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Trucks (gross weight of 8,000 lbs. or more)</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>before 1 JAN 1973</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>after 1 JAN 1973</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>2) Motorcycles</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>before 1 JAN 1978</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>after 1 JAN 1978</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>3) Passenger cars (and any other motor vehicle)</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>before 1 JAN 1973</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>after 1 JAN 1978</td>
<td>70</td>
<td></td>
</tr>
</tbody>
</table>

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 has reduced six decibel levels 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 cannot be handled with the motor vehicles codes, because the individual units can all meet the noise limits. However, in those 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 (mostly 50s) followed by cars and motorcycles. In addition, 1800 complaints were received by, 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 using the air conditioner to another location. In a case involving residential complaints about "piggy-back" unloading in a rail yard, a violation of the district zoning noise...
ENFORCEMENT

Restriction was found. Action was taken to enact a program to reduce noise, including removal of refrigeration units to a different area, and design and use of sound absorbent insulators for the diesel engine and mechanical areas of the locomotive. The program will gradually reduce noise from the railroad yard to the legal limit of 59 dB at the residential/manufacturing zone boundary line.

Excessive nightnoise has been controlled using the practice of the ordinance prohibiting use of any audible devices on a moving vehicle unless it is an emergency, and not while the vehicle is standing. This provision is also used to restrict excessive noise from the engine track.

A drawback to the present limits on noise of new vehicles is that the manufacturer may choose to use a multiplicity of local and state requirements. Uniform federal regulation of noise from new equipment would identify this problem, and still give local governments the option of setting more stringent requirements.

Local restrictions would need to be made over 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 tracks could meet federal limits. Finally, construction equipment could meet Federal standards individually, but when operating all at once, 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 bus transit systems with something quieter. Controlling this noise source will be a slower process, with the gradual purchase of quieter equipment and installation of quieter 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 railroads are 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.

Proposing Department of Transportation standards for noise from new expressways--recently revised to 70 dB at the property line--will be much more effective in protecting adjacent residential communities because the 70 dB number is too high. Noise problems ground existing airports occur because buildups of residential communities close to traffic patterns have been allowed. With present knowledge of airport noise, it should be possible to avoid similar problems in the future through land use planning. Information from the Federal Aviation Agency 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.

<table>
<thead>
<tr>
<th>Background</th>
<th>Frequent</th>
<th>Occasional</th>
<th>Zone Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night Day</td>
<td>Night Day</td>
<td>Night Day</td>
<td></td>
</tr>
<tr>
<td>30-40</td>
<td>45-45</td>
<td>50-55</td>
<td>A</td>
</tr>
<tr>
<td>45-60</td>
<td>55-65</td>
<td>65-70</td>
<td>B</td>
</tr>
<tr>
<td>50-60</td>
<td>60-70</td>
<td>70-75</td>
<td>C</td>
</tr>
<tr>
<td>60-70</td>
<td>65-75</td>
<td>75-80</td>
<td>D</td>
</tr>
<tr>
<td>70-75</td>
<td>70-80</td>
<td>80-90</td>
<td>E</td>
</tr>
<tr>
<td>70-80</td>
<td>80-90</td>
<td>90-100</td>
<td>F</td>
</tr>
</tbody>
</table>
A = Recreational areas
B = Quiet residential areas
C = Mixed areas
D = Commercial areas
E = Industrial areas
F = Main traffic arteries

Desirable Values: about 10 dBA less, however, not below 50 dBA
Background noise: mean values (average level, without peaks)
Frequent peaks: 740 sound peaks per hour
Low peaks: 1-6 sound peaks per hour

Also many other noises and ordinances were instituted for instance: the 1970 standards for vegetables 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.

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.

09-002

Smith, K. A.
University of South Florida, Tampa

NOISE CONTROL LEGISLATION IN FLORIDA
At: Noise Control Workshop, Harrisburg, PA, June 19, 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 mobile 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 vacant lot can be free to close when it 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.
ENFORCEMENT

In North Carolina, a farmer complained that aircraft taxi-overs and landings in the space directly above his chicken farm were an unconstitutional taking of his property (U.S. v. Chestnut). He was awarded damages under the inverse condemnation principle, which has been applied only against aircraft.

Airport laws must be aimed at preventing or controlling noise. Most of the traditional laws are zoning, anti-noise ordinances, and nuisance controls; none 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.

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 Central 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 5 hours of their teaching program on the environmental topic. For this purpose, a booklet was distributed to the teachers. The booklet was entitled, 'How we should save 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:

<table>
<thead>
<tr>
<th>Noise Source</th>
<th>1970</th>
<th>1971</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Traffic noise (various types of motor vehicles)</td>
<td>642</td>
<td>1,216</td>
</tr>
<tr>
<td>2. Construction</td>
<td>863</td>
<td>998</td>
</tr>
<tr>
<td>3. Commercial noise (incl. restaurants &amp; private clubs)</td>
<td>433</td>
<td>502</td>
</tr>
<tr>
<td>4. Other Noise Sources</td>
<td>577</td>
<td>585</td>
</tr>
<tr>
<td>Total</td>
<td>2,128</td>
<td>2,899</td>
</tr>
</tbody>
</table>

Out of 618 vehicles cited for noise violations in 1971, 27 were condemned; 123 inquiries concerning noise abatement measures were answered by mail; 102 interviews were granted; 15 frequency analyses were plotted; and 2007 inquiries were processed by phone. Only 8 of 2465 recorded actions could not be completely resolved.

10-001

Kilika, V.,

NOISE FROM THE SKY

Science and Engineering Newsletter of Novosti Press Agency
No. 11-1253:1-4

Current approaches toward solving the problem of aircraft noise in the USSR include introduction of a new generation of aircraft
PROGRAM PLANNING

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. 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 SSTs, 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 the runway. 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.

The prediction of 50 to 75% reduction is based on the following factors:

1) The ICAO regulation requires new generation aircraft to be approximately half as loud (10 EPNdB quieter) than present generation aircraft. The SST 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.

If 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 EPNdBA, 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 Military 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 outdoor-oriented and spends most of the time inside with windows open. Environmental noise thus leads to psychoacoustical 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 discoteques and other places of entertainment. The textile, cement, and metal industries are the noisiest in Israel, and produce sound levels above the criteria considered acceptable 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 Kerowitz 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 includes 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 amend the Kerowitz 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.

Five states have set limits on total vehicle noise based on subjective standards. Five states require mufflers on motorcycles. California, Colorado, and Minnesota have adopted 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 snowmobiles (for instance, in 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 intake and discharge ducts. However, because of the large numbers of older aircraft in use, most aircraft now in use exceed the Federal Aviation Regulation limits for noise aircraft. The noise produced by highway vehicles stems from three major causes: tires and engines, 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 12-15 dB noisier than automobiles. One engine manufacturer estimates a $1,000 increase in the $7,000 base price of a 250-hp diesel engine to drop noise 10 dB.

Recreational vehicles—motorcycles, snowmobiles, off-road vehicles and pleasure boats often reach levels of 92 dB. Typical noise levels contributed by the various subsystems in a motorcycle range from 55-59 dB at 20 mph to 75-86 dB at 60 mph. Most motorcycle noise reductions have been achieved by exhaust system changes. Snowmobile noise stems primarily from poorly muffled exhaust systems. Current recalls generally are in the 77-80 dB noise band. Both inboard-and outboard-powered pleasure boats range from 65-105 dB at 50 ft, with exhaust systems being the major noise contributor.

Typical noise levels measured 50 ft from construction equipment range from 72-94 dB for earthmoving equipment from 73-90 dB for material handling equipment, and from 74-97 dB 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.
10-005

MUNICIPAL-POLITICAL ASPECTS OF ENVIRONMENTAL PROTECTION IN MUNICH

Kommun Politische Aspekte des Umweltschutzes in Muinch

Arbeitsbericht zur Fortschreibung des Stadtentwicklungsgesetzes für 3


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 noises, 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 Federal 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 (day/night).

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 65% of residents of heavily populated areas complained about noise. A noise level ranging from 30 - 50 Phan can cause insanity, disturbance 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 Phan cause physiological damage such as hearing loss or other hearing problems.

According to the proposed proposals the vehicular traffic will increase about 55% by 1985. This means an increase of 1 - 2 db, and because the speed will increase, 4 db will be added. Physically this means that the noise level of street traffic will increase about 50%. In addition, a 10% increase in large aircraft in civil traffic can be expected.

Special emphasis is put on public-colonial and radio, 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 inter-disciplinary 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 10% 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-polluting) 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 measuring like soundbars, earthbanks, and tunnels 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

Scheibler-Sprunghil, G.
Schweizerische Ligo gegen den Larm, Zürich /Schwitzerland/
PROGRESS OF NOISE ABATEMENT IN SWITZERLAND
Fortschritte der Lärmschutzkommission in der Schweiz
Lärmschutzkommission
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 1962 the Federal Expert Commission for Noise Abatement. This commission for noise abatement, composed of 52 experts from the various scientific fields, was divided into 5 sub-commissions:

1) Medical, acoustical and technical principles; 2) Motor vehicles, railways and ships; 3) Aviation noise; 4) Construction and Industrial noise, sound protection in residences, etc.; and 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 result of an instructional course for law enforcement officers was held in 1963 in Zürich. 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
Lärmausagen bei der Paketpost in Hamburg
Kempter Laarm
Vol 19 No 16, 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 thoroughfares 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 Office activity, measurements of equivalent continuous noise levels were taken into account. In this way it will be possible to distinguish the constantly fluctuating levels.
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.

A retrospective study covering two years of
emissions to a psychiatric hospital shows
that there is a significantly higher rate of
emission, 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 led to greater concern
over noise in Great Britain. This realization,
based on scientific research, has hit the
noise 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
got 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. As 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 800 local authorities are
members.

The society encourages authorities to pass by-
laws of noise levels and noise efforts to
persuade industry to develop quiet equipment.
In another activity, the Society last year
alone London in holding a "Quiet Hour" and an
exhibition of silencing equipment.

In its troubleshooting capacity, the NAS
will aid any authority that considers noise a major
environmental problem. The officials 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 DMS and Chief Public Health Inspector, Royal Borough of New Windsor, has very definite views on 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 stated the problem of traffic noise in its routing, such as the flow when the opening of a new bridge caused traffic to be straightened to the town of Windsor. The Public Health Department had just completed a survey which showed that 35% of the midday traffic consisted of heavy lorries. Noise levels rose more than 60% above 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 "human effect" produced by traffic in narrow streets could raise the noise level 15% 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 was able to have the traffic rerouted on local roads.

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 all 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 observations 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. Feeling 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 IAS, 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 sitting would create dangerous problems in air traffic control.

Airport expansion is not London's problem exclusively. It is the concern of many local airports as well. Mr. Holmes says, one wonders if sufficient regard is 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 traffic was confined to certain roads the noise would be localized, but no such remedy can be taken with aircraft.

Scholten, K., Kundestrukturen 57-59, Cologne West Germany.


The German Federal Traffic Minister Boeker, who spoke at a session on urban and motor vehicle construction, made an appeal to employ all possible means for noise reduction.

The manufacturers and the public transport concourses have tested various noise reducing measures, such as sound-damping materials and construction techniques.

Experiments were held in 10 plants on 30 rolling vehicles, street cars and subway cars, polishing the track results in the most noise level reduction, but spraying the tracks with water and sand not only quells the roar, 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 deterrent measure.

Chemical processes are being applied to hopeful the "multiflora whisps" of overhead tracks in the interim before they are totally replaced. In addition, 20 to 100 cm high sound proofing walls are being constructed as noise reducing devices. One chemical abatement method, curve fabrication, has proved ineffective.

The investigation of the tunnel construction in Munich, where the tunnel is deeper and the
vehicles. It was disclosed that the thicker tunnel walls contributed considerably toward noise reduction.

Use of trolley-cars (T-Bus) declined in 1971 in favor of the more economical Diesel-bus, which is less noisy because of its smaller size and tires. The Electro-bus (C-Bus), a totally electric bus, made its appearance recently; it is economically less feasible than the T-Bus. Since fiscal considerations dictate the present Diesel-bus, curbing and damping measures to control at least the present noise situation are strongly recommended.

11-031

Pietro, I.

Ortszegs Munkasegyesseggyel
Internat., Budapest/Hungary

HEALTH PROBLEM OF NOISE
IN MAN'S ENVIRONMENT

A Taj Ernekezseggyel
Problamatikai
Orvostudomany

Vol 22 No 21241–245, 1971

Noise measurements were recorded in Budapest in schools, medical institutions, and in the streets surrounding industrial plants and airports.

Measurements were taken of outside noise, chiefly from traffic, in 15 Budapest school buildings, 15 of which were in the inner city, one on the main traffic artery, and one on the outer edge of the Capital in rural surroundings. Measurements were taken two or three times in each school from 6 a.m. to 4 p.m., for a total of eight hours per school. The dBA levels and octave band levels were measured.

Noise was measured at 2.55 ft above the floor, 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 to be 15 to 20 dbA lower in noise pressure level.

Studied 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, these rooms on the courtyard. The noise level of the hospitals far exceeded health norms, especially in the 50 to 70 dB range.

Only the suburban Canton Electro-bus Institute had a lower noise level. (See Figure 1.)

![Noise Level at 2nd Surgery Clinic (2SC) and NDK Institute (NDKI) Measured in Octave Bands with Windows Open and Closed](image)

Data

Noise measurements were taken in the area of the Gare WordPress Printing plant which lies in the colorful 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 50 db above the allowable day-night limits and about 40 db above the allowable nighttime limits.

Noise measurements were taken at the Budapest-Ferliegy 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 Capitol, mostly between 800 and 4000 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

The following table shows the percentage of noise annoyance levels:

<table>
<thead>
<tr>
<th>Source of Noise</th>
<th>At Work</th>
<th>On Street</th>
<th>At Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial</td>
<td>11.07</td>
<td>14.20</td>
<td>11.69</td>
</tr>
<tr>
<td>Construction</td>
<td>7.41</td>
<td>6.24</td>
<td>1.04</td>
</tr>
<tr>
<td>Street Traffic</td>
<td>8.65</td>
<td>26.91</td>
<td>0.68</td>
</tr>
<tr>
<td>Truck</td>
<td>2.7</td>
<td>24.68</td>
<td>16.32</td>
</tr>
<tr>
<td>Steamor</td>
<td>5.01</td>
<td>4.65</td>
<td>4.65</td>
</tr>
<tr>
<td>Bus</td>
<td>0.02</td>
<td>3.21</td>
<td>0.02</td>
</tr>
<tr>
<td>Trolley</td>
<td>0.05</td>
<td>1.30</td>
<td>0.22</td>
</tr>
<tr>
<td>Trains</td>
<td>0.11</td>
<td>7.30</td>
<td>0.31</td>
</tr>
<tr>
<td>Miners</td>
<td>0.3</td>
<td>3.77</td>
<td>3.60</td>
</tr>
<tr>
<td>Recreation</td>
<td>0.91</td>
<td>0.68</td>
<td>1.85</td>
</tr>
<tr>
<td>Home Equipment</td>
<td>0.9</td>
<td>0.82</td>
<td>2.91</td>
</tr>
<tr>
<td>Stores</td>
<td>1.8</td>
<td>0.71</td>
<td>3.12</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28.02</td>
<td>64.19</td>
<td>97.29</td>
</tr>
</tbody>
</table>

Complaints seem to increase when the noise level exceeds 50 dB.

11-003

Ivanov, N. I.; Starodumov, G. Yu.

Leningrad, USSR

HYGIENIC ASSESSMENT OF THE NOISE OF HEAVY DUTY VEHICLES

Glyuzdnecheskaya Otseka Shuma Tsyhanlykh
Pusenyn Naplia

Glyuzdnecheskaya Sanitarlye

Vol 35 No 11:5d-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 three octave measurements, was used to noise cab and exterior (at 1, 3.5 and 7 meters) readings of several dozen tracked vehicle types.

Diesel engine readings 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 56-113 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.

11-002

Maximum noise level was measured in octave bands and expressed in DNL (annoyance index). An evaluation was made on the basis of the Noise Pollution Control Handbook and was used for the airport area.

Liedberg, Z. Y.

Rashlyk Melsinskly Institute, Riga, USSR

On HEALTH CHARACTERISTICS OF THE NOISE BACKGROUNDS IN RIGA

K. Sannato-Glyuzdnecheskaya Kharakteristika
Shumovoy Fone v g. Riga

Veltinna

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 70-120 dB, industrial noise 45-120 dB, and construction noise 30-95 dB.

Transport noise seems to be the greatest offender, commencing with aircraft noise (100-120 dB), trucks 70-120 dB, street-cars 75-110 dB, buses 60-90 dB, tractors 70-75 dB, motorcycles 85-120 dB, motor bikes 90-115 dB. Maximum noise levels were reached from 7:00 am and 4-5 pm. Cobblestone streets are about 15-35 dB noiser than asphalt-paved streets.

The degree to which noise penetrates into the surrounding buildings depend on the sound insulation of such structures:

- Grooves 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).
It is recommended that sound insulating elements be incorporated by multipurpose construction of the cabins so that noise insulation of heads be increased by 10-20 times; that exhaust mufflers be installed on diesel engines; that sound damping of diesel engines be increased; and that cars be vibration-insulated.

11-004

Campbell R.A.

Veterans Administration Hospital, Miami

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 6 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 trolling or cruising speed; 2) quietest location at cruising speed (east and open water, slowest speed at which boat would plane or manufacturer's recommendations); 3) noisiest location at cruising speed; 4) noisiest location at maximum speed.

Noise levels ranged from 60 dBA in the front cabin of a 26 ft cruiser at trolling speed to 104 dBA in the rear seat of a 13 ft open boat with a 35 hp outboard at maximum speed. (Figure 1.)

Data

<table>
<thead>
<tr>
<th>Range</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>dB(A)</td>
<td>dB</td>
</tr>
<tr>
<td>Trolling speed</td>
<td>quietest location</td>
</tr>
<tr>
<td></td>
<td>cruising speed</td>
</tr>
<tr>
<td></td>
<td>noisiest location</td>
</tr>
</tbody>
</table>

For reference purposes, 70 dBA is the level above which loss to speech communication becomes difficult, 80 dBA is the level above which it is difficult or impossible to be understood at a distance of a few feet. Levels above 95 dBA were observed in 13 of the 17 boats at maximum speed and in 8 boats at cruising speed. Monitoring of radio-telephone was difficult, and was routinely attempted in only two of the eight boats so equipped; in those two boats, the speaker was turned up to sound that the level of radio static noise measured at the operator's head 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 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 considered a problem because the boats were not slept on while underway.

With the exception of one noisiest 15 ft open boat, noise levels tended to vary little with boat length in any of the four types of measurement conditions. When larger engines in larger boats offset the effects of greater distances and more interfering 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 one to nine locations per boat, including heads and helm seat's positions; all boats equipped with stick engines, with mufflers installed in three boats; all boats operated in ordinary fashion; engine covers in place; cabin hatches open, head doors closed, normal equipment including seat cushions and mattresses 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 risk of poor speech communication loss of a total boat and its occupants, because of missed voice commands
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 (61-96 dBA). Standards suggested for cockpit noise (by R. D. Stone, Aerospace Medicine 40, 799-803, Sept., 1969) are 90 dBA maximum and 85 dBA for normal cruising. These would guard against hearing loss and ensure close-range speech communication, although with difficulty. Such standards are directly applicable to power boats.

11-005a

Oesterreichischer Arbeitsbereich für Lärmbekämpfung, Vienna (Austria)
1012 Vienna, Steuerung 1, Austria
LESS NOISY CONSTRUCTION OPERATION

Oesterreichischer Arbeitsbereich für Lärmbekämpfung Industriell, Richtlinie

DATA

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, enclosing, etc. Noise levels are listed for various construction machines measured at 1 meter, ranging from 75-85 dBA for a socket wrench to 125-130 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:

<table>
<thead>
<tr>
<th>Area</th>
<th>Permissible Noise Levels Day (dBA)</th>
<th>Night (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet area</td>
<td>Residential, village 50 40</td>
<td>55</td>
</tr>
<tr>
<td>Industrial area</td>
<td>65</td>
<td>55</td>
</tr>
</tbody>
</table>

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 cushions should always be well filled and the sound dampers and spacers always clean. Correct lubrication preserves machinery and helps to reduce noise. Bi-annually, all machinery should be inspected and overhauled to ensure that all of the noise-preventive measures are operating properly.

For high equipment, targets 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 outfiiting can reduce the noise level by 3 dB.

Tests 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 undetable noise levels and conditions.

11-006

Young, J. R.

Stanford Research Institute, Menlo Park, CA

Sakurai Scientific Research Div., 23184 94025

ATTENUATION OF AIRCRAFT NOISE BY WOOD-SIDED AND BRICK-VENEERED FRAME HOUSES

HC: $3.00 NF: 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 propeller-driven Lockhead 10490, and a four engine turbofan jet CV-850 were used as the noise sources. The flow runs directly over the house 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 obtained 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 and story houses were tested with windows and doors closed and with completely furnished rooms—couches, 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 bands).

<table>
<thead>
<tr>
<th>Place</th>
<th>A-weighted level (Avg., DBA STD, max., min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRICK MIDDLE</td>
<td></td>
</tr>
<tr>
<td>Dining room</td>
<td>28.2</td>
</tr>
<tr>
<td>Living room</td>
<td>23.4</td>
</tr>
<tr>
<td>Bedroom 1</td>
<td>27.4</td>
</tr>
<tr>
<td>Bedroom 2</td>
<td>25.6</td>
</tr>
<tr>
<td>WOOD-SIDED</td>
<td></td>
</tr>
<tr>
<td>Dining room</td>
<td>20.7</td>
</tr>
<tr>
<td>Living room</td>
<td>19.1</td>
</tr>
<tr>
<td>Bedroom 1</td>
<td>24.3</td>
</tr>
<tr>
<td>Bedroom 2</td>
<td>19.3</td>
</tr>
</tbody>
</table>

Results, as given in Ref. 3, were within ±2 dB of the results expressed in dB. The house attenuation numbers obtained in this study correlated within 1 dB of those given in Ref. 1 for houses in Detroit, 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 were very useful for indoor noise prediction purposes.

The Greater London Council will use a standard method of calculating probable community annoyance caused by industrial noise in planning a variety 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 1966 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 5 dBA over the existing background noise levels, measured just outside the nearest residential building. 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 cannot be measured, a basic criterion of 5 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 impermeable as possible and with adequate acoustic insulation.
Windows are minimal in area, on the side of the building away from nearby residential areas only, and sealed. Second, noisy processus 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 the hospital to the southeast. Other buildings act as shields, and one remaining wall and earth bank is provided to shield the noise from extensive unloading activity by dump trucks.

<table>
<thead>
<tr>
<th>Part</th>
<th>Unit</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Noise source 1</td>
<td>N</td>
<td>80 dB</td>
</tr>
<tr>
<td>2. Noise source 2</td>
<td>N</td>
<td>80 dB</td>
</tr>
<tr>
<td>3. Noise source</td>
<td></td>
<td>60 dB</td>
</tr>
<tr>
<td>4. Traffic noise at 2 m</td>
<td>T</td>
<td>70 dB</td>
</tr>
<tr>
<td>5. Traffic noise at 1 m</td>
<td>T</td>
<td>80 dB</td>
</tr>
<tr>
<td>6. Traffic noise at 2 m</td>
<td>T</td>
<td>70 dB</td>
</tr>
<tr>
<td>7. Traffic noise at 3 m</td>
<td>T</td>
<td>60 dB</td>
</tr>
</tbody>
</table>

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 cabinet 2.5 x 5.5 x 5.5 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 PS 101 and PSI 202 installed by VEB RFT Mesuring 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 1 m.

The type of stroke and the speed play an important role in the measurement. The range of the speed and the stroke 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 90% accuracy.

The main source of typing noise is the impact of the type bar on the recall ring and the type impact on writing-ribbon. Sound plays an important role in this above.

Measurers taken to combat this type of noise are to compress felt material with lead around the recall 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 casings and electric typewriters with metal casings. The parts of the abstractions consist of non-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 casings seems to be most useful.

Impulse-Noise Measurements

<table>
<thead>
<tr>
<th>Type of Machine</th>
<th>Range of Noise Level</th>
<th>Mean Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable</td>
<td>78...83 dBA</td>
<td>83 dBA</td>
</tr>
<tr>
<td>Typewriter</td>
<td>87...90 dBA</td>
<td>88 dBA</td>
</tr>
<tr>
<td>Office</td>
<td>97...100 dBA</td>
<td>98 dBA</td>
</tr>
</tbody>
</table>

Impulse-Noise Measurements

<table>
<thead>
<tr>
<th>Function</th>
<th>Standard Typewriter</th>
<th>Electric Typewriter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typing Noise</td>
<td>62 dBA</td>
<td>60 dBA</td>
</tr>
<tr>
<td>Space Bar</td>
<td>60 dBA</td>
<td>67 dBA</td>
</tr>
<tr>
<td>Shifting</td>
<td>60 dBA</td>
<td>62 dBA</td>
</tr>
<tr>
<td>Carriage</td>
<td>60 dBA</td>
<td>77 dBA</td>
</tr>
<tr>
<td>Idle Noise</td>
<td>60 dBA</td>
<td>35 dBA</td>
</tr>
</tbody>
</table>

The results of the tests show that, for wide open throttle conditions, engine/exhaust noise predominates, being 14 dB above the other noise sources. Adding another muffler in series resulted in a sound level reduction of 6 dB. The muffler contributed about 50% of the total noise below 500 Hz. Tire/roadway 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 14 dB corresponding 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 a more accurate noise generation model for this source of noise.

11-009

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P.O. Box 2053-0237, 01210

NEW SOURCE DEFINITION - EXTERIOR PASSENGER VEHICLE NOISE


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.

As an investigation was carried out in Poland on the major acoustical problem of hospitals and their construction. Part of it 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, 73.5% 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.

11-010

Kozlowski, A.
Zaklad Projektowania Budynków Służby Zdrowia, PTT, Gdańsk, Poland
Poznan

THE PROBLEM OF LOW INTENSITY IMPULSE NOISES IN HOSPITALS

Zagadnienia hałasu impulsowym niskiej intensywności w szpitalach
Przegląd Lekarski
DATA

Noise Source | Levels (dBA)
---|---
1. Trolley-street car | 50-60
2. Rush hour | 50-60
3. Street noise | 50-60
4. Slamming of doors | 50-60
5. Walking in heavy boots | 50-60
6. Ambulance sirens | 50-60
7. Squeaking floor | 50-60
8. Visiting hour | 50-60

Noise Source | Levels (dBA)
---|---
1. Radio & TV | up to 50
2. Refuse removal | up to 50
3. School | up to 50
4. Recreational areas | up to 50
5. Cleaning | 60-85
6. Dormitory (for nurses & medical) | 60-85
7. Calls in the halls | 60-85

All studies were based on the Chacottho 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 impulsive noise levels in the hospitals exceeded norm Pmc+6/B-0015.

11-011

Lane, S. R.
California Univ., Los Angeles
School of Arch. and Urban Planning, Zip 90024
On: NOISE INSIDE HOSPITALS FROM FREEWAYS
In: Lane, S., Freeway and Highway Noise: an Information Base for Urban Development Decisions
Springfield, VA, NTIS, PB 284434, 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

Rylander, R.
National Inst. for Public Health, Stockholm
Dept. of Environmental Hygiene, 10402 Stockholm 60
SONIC BOOM EXPOSURE EFFECTS 1.1: INTRODUCTION
Journal of Sound and Vibration
Vol 30 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 developments 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. This 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.

12-002

Lange, W. W.

184 Acoustics Lab., Poughkeepsie, N.Y.
P. O. Box 590, Building 704,
2Zip 12022

PRODUCT NOISE AND ITS CONTROL

At: American Association for the Advancement of Science, 13th Meeting, Philadelphia, DEC 25, 1971


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 BUR DEN OF MUFFLING NOISE

Business Week

MAR 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 stipulated 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 85 dBA limit on cars and trucks to 65 dBA by 1975 (measured at 50 feet). Most manufacturers favor EPA action to keep an unwieldy patchwork 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 68 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 deadeners 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.

A large-display sound level meter to be used for educating the public as an aid in enforcing noise laws is described. A prototype of such a display has been developed by the National Research Council (NRC) of Canada and tested at 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 closely parallel the column of mercury in a thermometer. The display registers from 70-100 dBA in 2 dBA steps. As the sound level rises, the display develops in 2 dBA increments. The maximum level is sensed and the full display is illuminated 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 2405) 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 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 exaggerated 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. The concern of many 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.
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 quieter 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.

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 motors, there were also representatives from France, U.S., Sweden, Hungary and Italy. In total, there were over 300 participants representing the industrial, scientific and research fields.

The daily primary sessions included Thomas 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 stated industry's obligation to lower the noise levels in machinery.

During the conference, Ernst and Kijjer of Denmark presented an exhibit of all their measuring equipment, and the Cultivar 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 entered for construction machinery.

It was agreed upon the noise conferences should be convened systematically, perhaps every 3 years.

12-007

Allen, C. H.

Balt, Bronkow, and Newman, Inc.

Cambridge, MA

THE CONSULTANT'S ROLE IN NOISE CONTROL

Noise/News

Vol 1 No 2; 33-35, 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 adviser. He must see to it that noise control efforts will be conducted toward realistic goals that are compatible with the law and with the ongoing 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 fail 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-term 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 him as an unbiased expert.

12-008

THE GREAT OFFENSIVE OF THE "NOISE SPIES"

Grossoffensive der Laermplane

Die Presse

Vienna, SEPT 18, 1971

An article reports on an International noise conference of 103 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 Gruekmeyer 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.
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Acoustic Stimuli  12-001

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Noise Control Programs

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Munich

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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 audiometric 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 problem; 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 bonding 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.

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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.

L10 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.

L50 LEVEL -- The sound level exceeded 50% of the time. Corresponds to the average level of noise in a particular setting, over time.

L90 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 unintelligible 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.

MICRO BAR -- 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, PNG) 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.

\[ \text{Phon} = 40 + \log_2 \text{ sone} \]

PINK NOISE -- Noise where level decreases with increasing frequency to yield constant energy per octave of bandwidth.

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 1.41, 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 \(^2\) (dyn/cm\(^2\)), or (b) in newtons per square meter (N/m\(^2\)). 1 N/m\(^2\) = 10 dyn/cm\(^2\) = 10\(^{-9}\) 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 x 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°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 quantities. 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.

TRANSUDER -- 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 "hissing" 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
AFNL  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  Electromyophalogram
ENS  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
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ILS</td>
<td>Instrument Landing System</td>
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<tr>
<td>INR</td>
<td>Impact Noise Rating</td>
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<tr>
<td>IPNL</td>
<td>Integrated Perceived Noise Level Loudness Level</td>
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<tr>
<td>LL</td>
<td>Loudness Level</td>
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<tr>
<td>LOA</td>
<td>Level of Optimum Articulation</td>
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<tr>
<td>MAT</td>
<td>Minimal Aversion Threshold</td>
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<tr>
<td>MEL</td>
<td>Mean Energy Level</td>
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<tr>
<td>MLP</td>
<td>Multiple Pure Tones</td>
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<td>NAC</td>
<td>Noise Abatement Climb</td>
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<td>NC</td>
<td>Noise Criterion</td>
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<td>NIC</td>
<td>Noise Isolation Class</td>
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<td>NIPTS</td>
<td>Noise-Induced Permanent Threshold Shift</td>
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<td>NNI</td>
<td>Noise Number Index</td>
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<td>NPL</td>
<td>Noise Pollution Level</td>
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<td>NR</td>
<td>Noise Rating</td>
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<td>NRC</td>
<td>Noise Reduction Coefficient</td>
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<td>PNDB</td>
<td>Perceived Noise</td>
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<td>PNL</td>
<td>Perceived Noise Level</td>
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<tr>
<td>PSD</td>
<td>Power Spectral Density</td>
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<td>PSF</td>
<td>Comparison Peak Overpressure</td>
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<td>PTS</td>
<td>Permanent Threshold Shift</td>
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<td>PWL</td>
<td>Sound Power Level</td>
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<td>RECAT</td>
<td>Regulatory Effects on the Costs of Automotive Transportation</td>
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<td>REIL</td>
<td>Runway End Indicator Lights</td>
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<tr>
<td>REM</td>
<td>Rapid Eye Movement</td>
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<tr>
<td>RMS</td>
<td>Root Mean Square</td>
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<td>ROPS</td>
<td>Roll-over Protective Structures</td>
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<tr>
<td>RRL</td>
<td>Road Research Laboratory</td>
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<tr>
<td>Acronym</td>
<td>Definition</td>
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<tr>
<td>RT</td>
<td>Reverberation Time</td>
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<tr>
<td>SAE</td>
<td>Statistical Energy Analysis</td>
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<tr>
<td>SHEL</td>
<td>Single Event Noise Exposure Level</td>
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<tr>
<td>SFC</td>
<td>Space Flight Center</td>
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<td>SIL</td>
<td>Speech Interference Level</td>
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<td>SIN</td>
<td>Spatially Incoherent Noise</td>
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<td>SPL</td>
<td>Sound Pressure Level</td>
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<td>ST</td>
<td>Supersonic Transport</td>
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<td>STC</td>
<td>Sound Transmission Class</td>
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<td>STL</td>
<td>Sound Transmission Loss</td>
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<tr>
<td>STOL</td>
<td>Short Take-off and Landing</td>
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<tr>
<td>TACV</td>
<td>Tracked Air Cushion Vehicles</td>
</tr>
<tr>
<td>TL</td>
<td>Transmission Loss</td>
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<tr>
<td>TLV</td>
<td>Threshold Limit Value</td>
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<tr>
<td>THI</td>
<td>Traffic Noise Index</td>
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<tr>
<td>TPU</td>
<td>Transmission Preference Unit</td>
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<tr>
<td>TTS</td>
<td>Temporary Threshold Shift</td>
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<tr>
<td>UAH</td>
<td>Useful Auditory Area in Noise</td>
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<tr>
<td>VASI</td>
<td>Visual Approach Slope Indicator</td>
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<tr>
<td>VTOL</td>
<td>Vertical Take-off and Landing</td>
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<tr>
<td>V/STOL</td>
<td>Vertical Short Take-off and Landing</td>
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<tr>
<td>WEL</td>
<td>Weighted Equipment Continuous Perceived Noise Level</td>
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<td>Acronym</td>
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<tr>
<td>AAAS</td>
<td>American Association for the Advancement of Science</td>
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<td>AAHN</td>
<td>American Association of Industrial Nurses</td>
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<tr>
<td>AAOH</td>
<td>American Academy of Occupational Medicine</td>
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<tr>
<td>AAPAO</td>
<td>American Academy of Ophthalmology and Otolaryngology</td>
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<tr>
<td>ACGIH</td>
<td>American Conference of Governmental Industrial Hygienists</td>
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<tr>
<td>AES</td>
<td>American Engineers Society</td>
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<td>AES</td>
<td>Audio-Engineering Society</td>
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<tr>
<td>AGMA</td>
<td>American Gear Manufacturers Association</td>
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<td>AHAM</td>
<td>Association of Home Appliance Manufacturers</td>
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<td>AIAA</td>
<td>American Institute of Aeronautics and Astronautics</td>
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<td>AIAG</td>
<td>International Association Against Noise (Association Internationale Contre le Bruit)</td>
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<tr>
<td>AIHA</td>
<td>American Industrial Hygiene Association</td>
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<tr>
<td>AIHS</td>
<td>American Industrial Hearing Services</td>
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<td>AIMA</td>
<td>Acoustical and Insulating Materials Association</td>
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<tr>
<td>AIP</td>
<td>American Institute of Planners</td>
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<td>AIPE</td>
<td>American Institute of Plant Engineering</td>
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<tr>
<td>AMA</td>
<td>Automobile Manufacturers Association</td>
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<td>AMCA</td>
<td>Air Moving and Conditioning Association</td>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<tr>
<td>ARI</td>
<td>Air-Conditioning and Refrigeration Institute</td>
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<tr>
<td>ASA</td>
<td>Acoustical Society of America</td>
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<tr>
<td>ASACOS</td>
<td>Acoustical Society of America Committee on Standards</td>
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<tr>
<td>ASEE</td>
<td>American Society for Engineering Education</td>
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<td>ASHA</td>
<td>American Speech and Hearing Association</td>
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<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating and Air-Conditioning Engineers</td>
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<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<td>Acronym</td>
<td>Description</td>
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<tr>
<td>ASQC</td>
<td>American Society for Quality Control</td>
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<td>ASTM</td>
<td>American Society for Testing Material</td>
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<tr>
<td>AIA</td>
<td>American Trucking Association</td>
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<tr>
<td>BBN</td>
<td>Bolt, Beranek, and Newman</td>
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<tr>
<td>B &amp; K</td>
<td>Bruel &amp; Kjaer</td>
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<tr>
<td>BOCA</td>
<td>Builders Official Conference of America</td>
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<td>BRS</td>
<td>Building Research Station</td>
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<tr>
<td>BS1</td>
<td>British Standards Institution</td>
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<tr>
<td>CAGI</td>
<td>Compressed Air and Gas Institute</td>
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<tr>
<td>CCH</td>
<td>Committee on Conservation of Hearing</td>
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<tr>
<td>CEC</td>
<td>International Electrotechnical Commission</td>
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<tr>
<td>CERN</td>
<td>European Organization for Nuclear Research</td>
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<tr>
<td>CIABA</td>
<td>Committee on Hearing, Bioacoustic and Biomechanics</td>
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<tr>
<td>CIMA</td>
<td>Construction Industry Manufacturers' Association</td>
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<tr>
<td>CLASB</td>
<td>Citizen's League Against the Sonic Boom</td>
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<tr>
<td>CONCAWE</td>
<td>International Study Group for Conservation of Clean Air and Water/Western Europe/</td>
</tr>
<tr>
<td>CSTB</td>
<td>Scientific and Technical Center for Building Construction</td>
</tr>
<tr>
<td>CTA</td>
<td>Chicago Transit Authority</td>
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<td>DAL</td>
<td>German Noise Abatement Society (Deutscher Arbeitsring fuer Larmbekampfung)</td>
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<td>DOT</td>
<td>Department of Transportation</td>
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<td>ECAC</td>
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<td>Council of Europe</td>
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<td>ECE</td>
<td>Economic Commission for Europe</td>
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<td>EEC</td>
<td>European Economic Community</td>
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<td>EMA</td>
<td>Engine Manufacturers' Association</td>
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<tr>
<td>ERIC</td>
<td>Educational Resources Information Center</td>
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<tr>
<td>Acronym</td>
<td>Name</td>
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<tr>
<td>ERIC/CLF</td>
<td>Educational Resources Information Center/Clearinghouse on Educational Facilities</td>
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<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>FAI</td>
<td>International Aeronautical Federation (Fédération Aéronautique Internationale)</td>
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<td>FHA</td>
<td>Federal Housing Administration</td>
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<td>HUD</td>
<td>Housing and Urban Development (Dept. of)</td>
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<td>HVI</td>
<td>Home Ventilating Institute</td>
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<td>International Air Transport Association</td>
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<td>International Civil Aviation Organization</td>
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<td>ICBO</td>
<td>International Conference of Building Officials</td>
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<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
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SUI Sound and Vibration Institute

WHO World Health Organization

VDI Association of German Engineers (Verein Deutscher Ingenieure)
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Feingeraeteteknik

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READER RESPONSE FORM

This form is designed to give readers an opportunity to comment and make suggestions concerning this 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
   - Planning and siting
   - Physiological
   - Legislation/standards
   - Psychological/sociological
   - Enforcement
   - Economic aspects
   - Program planning
   - Building acoustics
   - Date
   - Measurement
   - General

3. Environmental noise control is _____ % of my job.

4. The index was
   - Satisfactory
   - Too detailed
   - 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 ____________________________________
    Organizational Division ____________________________
    Address _______________________________________