Noise Health Hazards in the Air Force

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DURING the past 10 years the public has become concerned with the effects of noise. Noise is an unavoidable byproduct of modern power producing machinery. It is a byproduct of force, energy converted to sound. Production of power in prodigious amounts is necessary to effective military aircraft. Inevitably, such power generates noise at extremely high levels.

Industry, too, has encountered noise problems. Within the plant a noisy environment possibly affects efficiency and may damage hearing. Imperfect hearing and nervous strain also reduce the normal margin of safety. Noisy mixers, washers, or vacuum cleaners encounter sales resistance. Noisy products or operations raise acute objections in residential areas. Noise is disparaged as a nuisance, for interference with communications, for damage to hearing, and for other possible effects on health, efficiency, or safety.

The problem is indeed broad. It directly affects the daily lives of the majority. Many excellent papers have covered technical aspects of noise and its control. In this short paper, I shall not attempt to repeat more than the minimum necessary for dealing with my subject, which is only presented as an introduction to the topic.

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For this purpose "noise health hazard" is defined as those aspects of noise for which the Medical Service of the United States Air Force has a responsibility. Noise is defined as any undesirable sound, a sound that interferes with a desirable activity. However, such interference has to be specified. A given sound is not equally effective in masking speech, in interfering with sleep, or in producing permanent hearing loss.

The medical service's responsibilities cover seven major areas:

- Establishment of engineering criteria for noise control.
- Environmental noise surveys.
- Advice on control procedures.
- Evaluations on effectiveness of control programs.
- Personnel protective measures.
- Audiometric examinations.
- Education programs, both on and off the Air Force base.

The engineering aspects of the noise health hazard can best be described by a brief discussion of these responsibilities.

Establishment of Engineering Criteria

Engineering criteria for noise control are basic to any discussion of the noise problem. The establishment of a single criterion to cover all conditions is not possible. Therefore, a separate criterion must be considered for at least three areas, namely, (*a*) damage risk, (*b*) speech communication, and (*c*) residential living.

In each area there are unknown factors which complicate the establishment of these criteria. Notwithstanding these unknowns, decisions that involve the interaction of noise and man must be made. The following criteria are based primarily on the Wright Air Development Center (WADC) Technical Report (*1*).

Establishment of Damage-Risk Criteria

Personnel exposed to noise at damage-risk levels may suffer hearing losses (*2*). Safe levels would permit personnel to work regularly 8 hours a day for years without serious probability of such damage. Factors to be considered include a wide variation in susceptibility among individuals, duration of exposure, and, especially, the noise spectrum. The damage-risk criteria utilized, it is felt, will assure safety for the majority of exposed personnel. The criteria are given as the maximum permissible noise levels in specific frequency bands. There are eight octave bands used in the frequency range 20–10,000 cycles per second. The maximum allowable sound pressure in each of these bands is shown in the accompanying chart. These values apply to exposure with no ear protection and to continuous daily exposure. An overall sound level is not adequate as a criterion because the damaging action of noise is related to the frequent distribution of the pressure and not to the overall level.

Notwithstanding this, there are overall levels which are of such intensity as to produce known effects. For example, 150 and 160 decibels, regardless of how short the exposure, will produce damage to hearing; exposure to intermittent noises of overall levels of 100 to 130 decibels may cause temporary deafness which may persist for several hours.

Criteria for Speech Communication

The ability to communicate by voice varies in requirements from essential for personnel safety to ease of conducting a personal conversation. The following extract from the WADC technical report (*1*) presents a discussion of this variation together with the limitations of a criterion.

"In many areas, efficient performance of task is often dependent upon the ability of people to talk to each other. Whether the environment is a conference room or a machine shop, noise conditions should be adjusted to permit communication suitable to the task that is to be performed. The type of communication desired may be of varying kinds, from conversation in a normal voice, at say 20 feet, to shouting danger signals at a distance of 6 inches from the listener's ear. The acceptable levels of the masking noise are dependent, therefore, upon the particular task involved and upon the degree to which speech communication is important in the performance of these tasks, or in the maintenance of adequate morale among employees. In establishing each communication criterion, account is taken of not only the level of the masking noise, but also the vocabulary to be used in the communication, the voice level, the distance from the speaker to the listener, etc. Of primary importance is the spectrum of the masking noise. The concept of the SIL (speech interference level) was originally based on data derived from experiments with continuous masking noise. If the noise is irregular or interrupted in time, the intelligibility is affected in a way in which the SIL does not predict. At the present time, there are insufficient data to delineate the limits of intensity, shape of spectrum, and time character of the noise within which the application of the SIL is valid. It is fortunate, however, that the masking noises encountered in most practical situations have a reasonably smooth spectrum and a uniform time character. In such situations, the SIL does provide a reasonably good approximation of the effectiveness of a noise in masking speech. The validity of the use of the SIL is justified by many observations in the field. With these limitations in mind, it can be concluded that the ability to communicate by voice in the presence of noise is determined essentially by four factors:

"1. The SIL of the masking noise.

"2. The voice level used by the talker.

"3. The distance from the talker's mouth to the listener's ear.

"4. The nature of the vocabulary used in communications."

Therefore, criteria for speech communications vary with the type of communications required, established at four levels. The chart is a plot of these criteria.

On the chart, SC–75 indicates overall sound levels in the 8 bands with an index of 75 (the arithmetic mean of the levels in frequencies of 600–1200, 1200–2400, and 2400–4800). At this level, minimum speech communications require a very loud voice at 1 foot.

At SC–65, intermittent communication is possible with a raised voice at 2 feet, very loud voice at 4 feet, and shouting at 8 feet.

At SC–55, continuous communication in work areas, such as business, secretarial, or control rooms, requires a normal voice at 3 feet, raised voice at 6 feet, and a very loud voice at 12 feet.

At SC–45, a normal voice serves at 10 feet in such locations as private offices or conference rooms.

Criteria for Residential Living

The reaction of people to a noise in their home is the most difficult criterion to establish. There are many and varied factors which influence a public reaction, the proper evaluation of which requires experts. The following brief quotation from the WADC technical report serves to outline the problem involved:

"There are essentially two aspects to the analysis of the inter-reaction between an intruding noise and human being exposed to the noise. A physiologist would call these aspects stimulus and response. The stimulus function can, as a first approximation, be defined by a physical description of the noise to which the human beings are exposed. It may, however, also be necessary to describe the physical characteristics of noise to which a particular group of people have been exposed in the past, in order to evaluate the degree to which they have become adjusted to a noisy environment. The response of residents is measured through expressions of annoyance, complaints, or even through legal action. Our task is to be able to predict their response from knowledge of the stimulus function, past and present. The many factors involved in the establishment of residential criteria preclude their discussion in detail in this paper. I would like to mention a few of the considerations which must be taken into account. Experience has shown that there are at least seven large independent characteristics of a noise stimulus that control the response behavior of a community exposed to the noise, namely:

"1. *Spectrum character.* A noise spectrum that contains audible pure tone or single frequency components appears to be more annoying than a spectrum that is reasonably continuous.

"2. *Peak factor.* A noise that is reasonably continuous in time, at least over periods of a few seconds or more, is assumed to be less annoying than an impulse-type of noise.

"3. *Repetitive character.* In addition to the short-time peak factor discussed above, the repetitive factor of the intruding noise influences a neighborhood reaction to a large degree.

"4. *Level of background noise.* Residents in areas with low background level are more likely to react to intruding noise of fairly low level than those in areas in which the background noise partially masks the intruding noise.

"5. *Time of day.* Most residents agree that intruding noise is more tolerable in the daytime than during the evening.

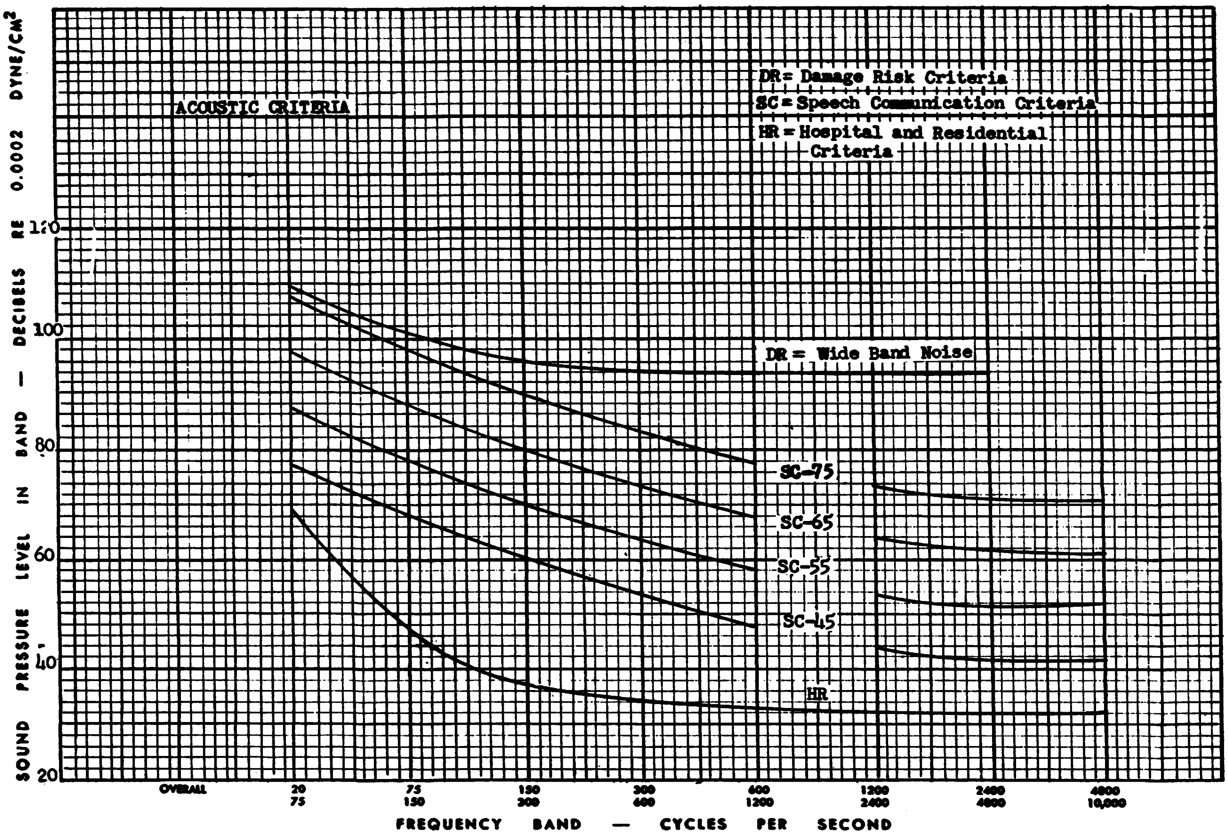
"6. *Adjustment to exposure.* Experience has shown that residents can adjust to a varying extent to an intruding noise after repeated exposures.

"7. *Other factors.* In addition to the physical factors listed above, factors of a psychological nature influence neighborhood reaction to an intruding noise, though by no means to a constant degree. Such questions as continuation of the noise and public relations between the community and those causing the noise may modify the noise rating to a marked extent."

Environmental Noise Surveys

A noise survey, in essence, is the same as any engineering survey. It requires advance planning to assure that the goal is amply stated, that adequate and properly calibrated equipment and personnel are available. The many variables in a noise survey preclude the establishment of a set procedure equally applicable to all conditions. It is imperative that the engineer planning the survey take into account the peculiarities of the particular problem. Certain guiding principles apply to all surveys.

Noise levels in frequency bands covering proposed criteria for damage risk, speech communication, and residential living.



Of particular importance are records of ambient temperature and humidity, of wind velocity and direction, of the location of facilities and time of testing, of types and serial numbers of equipment with particular reference to microphones and cables used, and, finally, of the individual observers making the measurements. General aspects of the survey are:

A description of the area to be surveyed with ample data concerning the facility. For example, a survey of an office area, hospital, or any interior should note the dimensions and type of surfaces, location and type of doors and windows, type of seal on the doors and windows, and type of use for which the facility is designed. In an area survey, the map should include all residential areas or industrial facilities.

The next major step in the survey is the location of the primary source of the noise. Descriptions of the source of noise should definitely be included with a time schedule of noise production over a 24-hour period, as well as other data pertinent to the cause of the noise or factors which might increase noise from the primary source. The location and adequate data should be provided on each secondary source of noise. The orientation of the microphones with respect to a noise source should be specified in all cases, as well as other peculiarities which affect a noise reading such as temperature of microphone, maintenance and calibration tests of equipment, and temperature and humidity of the environment on the day and at the time the readings are made.

In the selection of equipment it is well understood that microphones should be appropriate to the task. Certain microphones are designed for low sound levels, others for high sound levels. One may be designed for low frequency selectivity, another for high frequency. Cables and the use of cables on the surveys call for similar discrimination. In general, where short cables are used, most microphones can be used without a corrective factor. Where a long cable is necessary, a correction will generally be required. These are but a few of the variables encountered in a noise survey.

Before an engineer attempts a survey, he should avail himself of data as a guide to selection of sound measuring equipment. Uniform practices for the measurement of aircraft noise are contained in the Aircraft Technical Committee Report No. ARTC–2 (*3*).

Advice on Corrective Action

In general the control of the source of noise is under the direction of the operator. As a consultant to the operator, the sanitary and industrial hygiene engineer submits recommendations for the correction of noise hazards. The engineer is not limited as to any particular aspect of the control program; his advice and recommendations should cover all aspects in which he is technically competent. Engineers in the Medical Service of the Air Force recommend sites for engine test cells, engine runup areas, and barracks or office buildings in relation to sources of noise. Other recommendations include soundproofing measures for buildings which must be in a noisy environment.

In many instances engineers have been able to eliminate or materially reduce noise at the source. This is particularly true of industrial noises or noises emanating from an operating procedure which can be controlled at the source. As to the aircraft engine, since the noise is directly related with the power produced, it is not feasible to reduce the noise at the source, although research is pursued with that objective. Noise is reduced in part through improved performance of aircraft engines, particularly where rough burning of engine fuels has been eliminated. It has been possible also to reduce the noise of the explosion on the afterburner of the jet aircraft.

Where noise cannot be eliminated or sufficiently reduced at the source, the engineer recommends, as a prime measure, the use of acoustic material. Other methods include changing the relative position between source of the noise and those affected—structural changes to reduce vibration noises, or construction of sound barriers. Corrective action in noise control parallels other environmental conditions. It calls for application of all available disciplines. Each problem must be studied of itself, with the aim of arriving at the most economical and feasible solution.

Personnel Protective Measures

The engineers of the Medical Service of the Air Force have a prime responsibility to assure that the corrective action taken following the location of a noise hazard is adequate and effective. The responsibility here is primarily the protection of personnel. In addition, it is an evaluation to assure that the economical method will suffice.

Personal protective equipment for personnel is limited by obstacles in design. At the present time, the most effective ear defender is a properly fitting earplug. The use of earmuffs and helmets, which with earplugs give some additional protection, is limited by the nature of the seal. All personnel exposed to a hazardous noise level must be fully acquainted with the need for the protection afforded by properly fitted ear defenders. Engineers owe it to the personnel to see that such equipment is available.

In addition to the personal protective equipment, personnel protection is secured through previously noted control measures. Specific examples include a properly designed control booth for operators at engine test cells and sound suppression in control towers, classrooms, and barracks.

The engineer through his contacts in his daily work is an ideal member of the medical service to impress on supervisors as well as workmen the importance and necessity of wearing earplugs and other ear defenders in a noisy environment. In addition, they can serve as ambassadors in acquainting the personnel, both on and off the base, with noise hazards and corrective steps.

Engineers of the medical service must see that properly designed and equipped audiometer rooms are available for audiometric examinations of personnel exposed to high noise levels. In designing an audiometer room, consideration must be given to its environment. Operating agencies desire the room to be located in the immediate industrial area to save time of personnel. Such a location places an additional burden and expense on the acoustical design. The engineers, through their surveys, establish the areas where personnel are exposed to hazardous noise levels. Such surveys determine the audiometric testing cycle.

This brief review reveals the scope of the problem of noise in modern living. In many areas, knowledge is incomplete, but current and future research may reduce the uncertainties.

REFERENCES

(*1*) Handbook of acoustic noise control. Wright Air Development Center Report 52–204. Vol. 1. Physical acoustics by R. H. Bolt, L. L. Beranek, and R. B. Newman; Vol. 2. Noise and man by W. A. Rosenblith, K. N. Stevens, and staff (Bolt, Beranek, and Newman). Wright-Patterson Air Force Base, Ohio, Wright Air Development Center, 1952.

(*2*) Parrack, H. O.: Noise—Air base planning. Report No. SC-BAU-51-2. Wright-Patterson Air Force Base, Ohio, Wright Air Development Center, 1951.

(*3*) Aircraft Research and Testing Committee: Uniform practices for the measurement of aircraft noise. Aircraft Technical Committee Report No. ARTC-2. Washington, D. C., Aircraft Industries Association, 1952.

1956 Community Health Week

March 18–24, 1956, has been designated Community Health Week, to be headlined under the banner "Let's Do More About Health." The National Health Council and the United States Junior Chamber of Commerce are the sponsoring organizations.

The success of the initial observance of Community Health Week in March 1955 led the sponsoring organizations to their decision to repeat the performance. Last spring, 180,000 Jaycees across the country helped to arrange health fairs and rally the people to attend. Their efforts inspired television and radio shows as well as newspaper features and special news sections telling the people about needs of local health services and the health resources to look for in their own community.

The United States Junior Chamber of Commerce will have available after January 1 a work kit which it has produced as a guide for those engaged in organizing activities for a community health week. The kit will be distributed to Jaycee chapters requesting it from the Tulsa, Okla., headquarters of the junior chamber. In communities without Jaycee chapters, local affiliates of national organizations may request kits from the National Health Council, 1790 Broadway, New York 19, N. Y.

The contents of the kit, prepared by members of the staff of the National Health Council and its member agencies, include leaflets describing "Newspaper Health Supplements," "Health Fairs," and "Movies Tonight"; a checklist of projects which a community may launch during health week, such as accident prevention campaigns, establishment of preschool clinics, fluoridation of municipal water supplies; and a list of National Health Council member agencies to facilitate community cooperation.