

HEARING CONSERVATION MEDICAL PROGRAM

NASA Lewis Research Center
Occupational Medicine Service

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Background

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Hearing impairment can occur in one or both ears, and can be the result of infections, obstructions, trauma, prolonged exposure to noise, toxic agents, advancing age, and many diseases. Hearing loss can be broadly categorized into two types of impairment: conductive or sensorineural.

Occupational hearing loss due to prolonged exposures to noise at the workplace is due to sensorineural damage, specifically to the inner and outer hair cells of the organ of Corti within the cochlea of the inner ear. The hearing loss may be temporary or may become permanent, depending on the extent of damage to the hair cells and the ability of those hair cells to rejuvenate after repeated exposure of an unprotected individual to hazardous levels of noise. Classically, an individual exposed to prolonged noise loses hearing in the higher frequencies and, as the exposure to noise continues, the hearing loss worsens in these higher frequencies and extends into the adjacent lower frequencies. Initial deterioration of hearing may not be apparent to the individual. Often by the time there is subjective awareness of any loss, the impairment is affecting the frequencies less than 3000 Hz to 4000 Hz (the upper ranges of common human speech), and the impairment may be substantial and irreversible. Once the exposure to noise ceases, further damage is arrested.

Noise is defined as a sound which is undesired by the recipient. However, sounds that can cause sensorineural hearing do not always have to be perceived as undesirable, especially when an individual is exposed to excessive noise in recreational situations (e.g., rock music). Therefore, qualifying a sound as being undesirable before it is classified as noise can be misleading because a sound may be considered by the individual as desirable and yet still able to inculcate damage.

The criteria for safe noise levels are not clear-cut, and the present recommendations have been based on studies involving exposures to continuous noise. It is unclear whether this data is applicable for intermittent exposures to both continuous

and impulse noise. Individuals have different tolerance levels to noise before there is permanent damage, so the current limits to noise exposure are set with the intention of protecting 90 percent or more of an exposed population (90 percent sensitivity rate).

Ideally, hearing loss due to noise exposure should be entirely preventable, especially in an occupational setting where there is available hearing protection, education, supervision, and audiometric surveillance.

Purpose

The purpose of the medical aspects of the Hearing Conservation Program at the NASA Lewis Research Center is to:

1. Identify any Lewis employee who is currently exposed to excessive noise levels or who may be exposed to excessive noise levels because of the nature of the employee's job.
2. Educate that employee about the nature of noise exposure and the risk of incurring permanent hearing impairment if exposed for prolonged periods of time to excessive noise without proper hearing protection.
3. Protect any employee identified as either exposed to excessive noise or at risk of exposure with approved hearing protection.
4. Monitor those employees who either have been exposed to or who are at risk of exposure to excessive noise by obtaining an extensive past medical, recreational, and occupational history and then performing annual audiometric exams to detect any early signs of hearing impairment.
5. Report to the Industrial Hygiene Office the names and workplaces of any employees who demonstrate a reproducible age-adjusted audiometric threshold shift (when compared to the baseline audiometry), unless the employee was originally referred to OMS by Industrial Hygiene, so that appropriate noise monitoring can be carried out and any appropriate engineering or design modifications can be implemented.

Medical Surveillance

The complete Hearing Conservation Program includes:

1. Noise monitoring
2. Posting of noise hazard areas
3. Issue and use of approved hearing protection
4. Audiometric testing (annually)
5. Records keeping
6. Education of workers and supervisors.

Items 1 and 2 are the responsibility of the Industrial Hygiene Office; items 3, 4, and 5 are the responsibility of the Occupational Medical Service; and item 6 is a responsibility jointly shared between Industrial Hygiene and the Occupational Medical Service.

Measurement of potentially hazardous noise levels will be conducted by the Industrial Hygiene Office when any information, observation, or calculation shows that an employee may be exposed to a noise level **in excess of 80 dB TWA** (8-hour time-weighted average). This is defined as the action level (AL) for noise exposure. The permissible exposure limit (PEL) for noise is dependent on duration of exposure and is best summarized in Table 1.

**Table 1. Permissible Exposure Limits (PEL)
for Continuous Noise**

Duration (hours)	dB
16	80
8	85
4	90
2	95
1	100
0.5	105
0.25	110
0.125	115

It is optimal to keep noise exposures at or below the action level whenever possible. Any area with noise levels that exceed the PEL of 85 dB TWA will be clearly marked as a "Noise Hazard Area." Employees who work in these areas will be entered into the Medical Hearing Conservation Program if they are exposed to continuous noise at or above the AL of 80 dB TWA for at least 30 days out of a year. Similarly, the PELs for repeated impact noise to which an employee may be exposed and which would require exposed employees to be entered into the Hearing Conservation Program are listed in Table 2.

Table 2. Permissible Exposure Limits for Impact or Impulsive Noise

Sound Level (dBP)*	Permitted Number of Impacts/Day
140	100
130	1,000
120	10,000

*Decibels peak sound pressure level

Other new employees who are placed in a work environment that is a documented noise hazard area will automatically be placed in the Hearing Conservation Program.

Medical monitoring for the Hearing Conservation Program will consist of two sections: the Preemployment/Baseline Exam and the Annual Follow-up Exam.

The Preemployment/Baseline Exam includes four components:

1. Baseline Audiogram. All audiograms must be done after the individual has not been exposed to any noise exceeding 80 dB for at least fourteen (14) hours prior to the audiogram. The baseline audiogram will be part of all preemployment physicals on all new employees regardless of potential exposure to noise during the course of their employment at NASA.

2. Physical Examination, with special attention to the head, ears, nose, and throat, looking for pathology that may interfere with audiologic performance.
3. Work History. A detailed former work history with particular attention paid to exposure to any loud noises, use of hearing protection, and any documented hearing impairment.
4. Recreational history, with special attention to potential exposure to loud noises (e.g., hunting, target shooting, use of chain saws, lawn mowers, vacuum cleaners, etc.) and personal use of hearing protection.

The Annual Follow-Up Exam includes four components:

1. Repeat audiogram, again requiring 14 hours of no exposure to noises louder than 80 dB prior to the administration of the audiogram.
2. Limited physical exam, with particular attention to the head, ears, nose, and throat.
3. Interval history, including noise exposure at work and outside of work and use of hearing protection.
4. Education, including review of the effects of noise on hearing; noise control principles; the purpose of hearing protection; the proper selection, fitting, placement and care of the hearing protection; indications for hearing protection; and an explanation of the audiogram and the necessity of the individual's continued participation in medical surveillance.

Specific guidelines for the audiometric test equipment shall meet the specification, maintenance, and use requirements of ANSI S3.6 and 29 CFR 1910.95, Appendix C for pulsed-tone, self-recording audiometers. All personnel administering audiograms will be certified by the Council for Accreditation in Occupational Hearing Conservation (CAOHC). Interpretation will be done by a licensed medical doctor who is well versed in the reading and interpretation of audiograms.

A standard threshold shift (STS) is defined as an average hearing threshold shift of at least 10 dB at 2000, 3000, and 4000 Hz in either ear. If this occurs when

compared to the baseline audiogram, then the audiogram will be repeated within 30 days after the individual has not been exposed to any noises louder than 80 dB for the 14 hours prior to the administration of the audiogram.

When a permanent threshold shift is detected, the follow-up review will include:

1. Hearing Protection. The employee will be provided (and fitted as necessary) with hearing protectors and trained in their use when hearing protectors are not currently being used. When hearing protectors are already in use, the employee will be refitted with hearing protectors offering greater sound attenuation.
2. Hazardous effects of noise will be reviewed and the need for adequate hearing protection emphasized.
3. Inspection of the employee work area will be done by the Office of Industrial Hygiene and/or Safety to determine if work practices or changes in the equipment or procedures have increased the noise hazard. Abatement actions will be instituted as necessary.
4. Employee reassignment to a work area in a low noise area will occur if necessary to prevent any further noise-induced hearing impairment.

Referral to an audiologist is indicated when there is:

1. Average hearing threshold level at 500, 1000, 2000, and 3000 Hz greater than 25 dB.
2. Single frequency loss greater than 55 dB at 3000 Hz or greater than 30 dB at 500, 1000, or 2000 Hz.
3. Difference in average hearing threshold level between the better and poorer ear of more than 15 dB at 500, 1000, and 2000 Hz, or of more than 30 dB at 3000, 4000, and 6000 Hz.
4. Reduction in hearing threshold level in either ear from baseline or previous monitoring audiogram of more than 15 dB at 500, 1000, or 2000 Hz, or of more than 30 dB at 3000, 4000, or 6000 Hz.
5. Any variable or inconsistent responses or unusual hearing loss curves.

Referral to an otolaryngologist or qualified physician is indicated when there is:

1. The presence and persistence of ear pain, drainage, dizziness, severe persistent tinnitus, sudden or fluctuating hearing impairment, rapidly progressing hearing loss, a feeling of fullness or discomfort in one or both ears, unusual or inconsistent audiometric findings or a history of these conditions within the past twelve (12) months.
2. Where an employee has received an otologic evaluation previously on the basis of failing any of the above criteria and ear pain, draining, dizziness, or severe persistent tinnitus develops; or if a significant change in hearing level is observed.
3. Where the OMS medical professional suspects that a medical pathology of the ear is present regardless of whether the pathology is presumed to be due to or independent of the use of hearing protection

If hearing protection is recommended, then the protectors must attenuate employee noise exposure to a noise level of 85 dB TWA or less. If an employee demonstrates a standard threshold shift (STS), then hearing protectors must attenuate noise levels to 80 dB TWA.

All records of the Hearing Conservation Program will be kept confidential and yet always be available to the patients if they so desire.

References

1. *NASA Health Standard on Hearing Conservation*. July, 1990 (unpublished).
2. *Lewis Operational Safety Manual*, September 1, 1981, Chapter 4, Part B, "LeRC Hearing Conservation Program."
3. Zenz, Carl. *Occupational Medicine, Principles and Practical Applications*. 1988: 274-315.
4. *Code of Federal Regulations 29*, 1910.95: 176-187.

