

# ES&H manual

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## Environment, Safety, and Health

### Volume II

#### Part 18: Pressure/Noise/Hazardous Atmospheres

## Document 18.6 Hearing Conservation

Recommended for approval by the ES&H Working Group

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**Hearing Conservation\***

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## 18.6

### Hearing Conservation

#### 1.0 Introduction

Noise is the perception of pressure waves in the air caused by a vibrating source. The ears transduce this mechanical energy to electrochemical impulses that are transmitted to the brain, resulting in the perception of sound. This document sets forth requirements for reducing noise and protecting employees who may be exposed to excessive noise levels. These requirements are based on the Occupational Safety and Health Administration Hearing Conservation Program described in 29 CFR 1910.95 and 29 CFR 1926.52 and the threshold limit values (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH). The standards for noise that disrupts speech communication and applicable for the safe performance of work are derived from the speech interference levels described in the Work Smart Standards reference, *Handbook of Noise Measurement*.

The Laboratory's Hearing Conservation Program involves

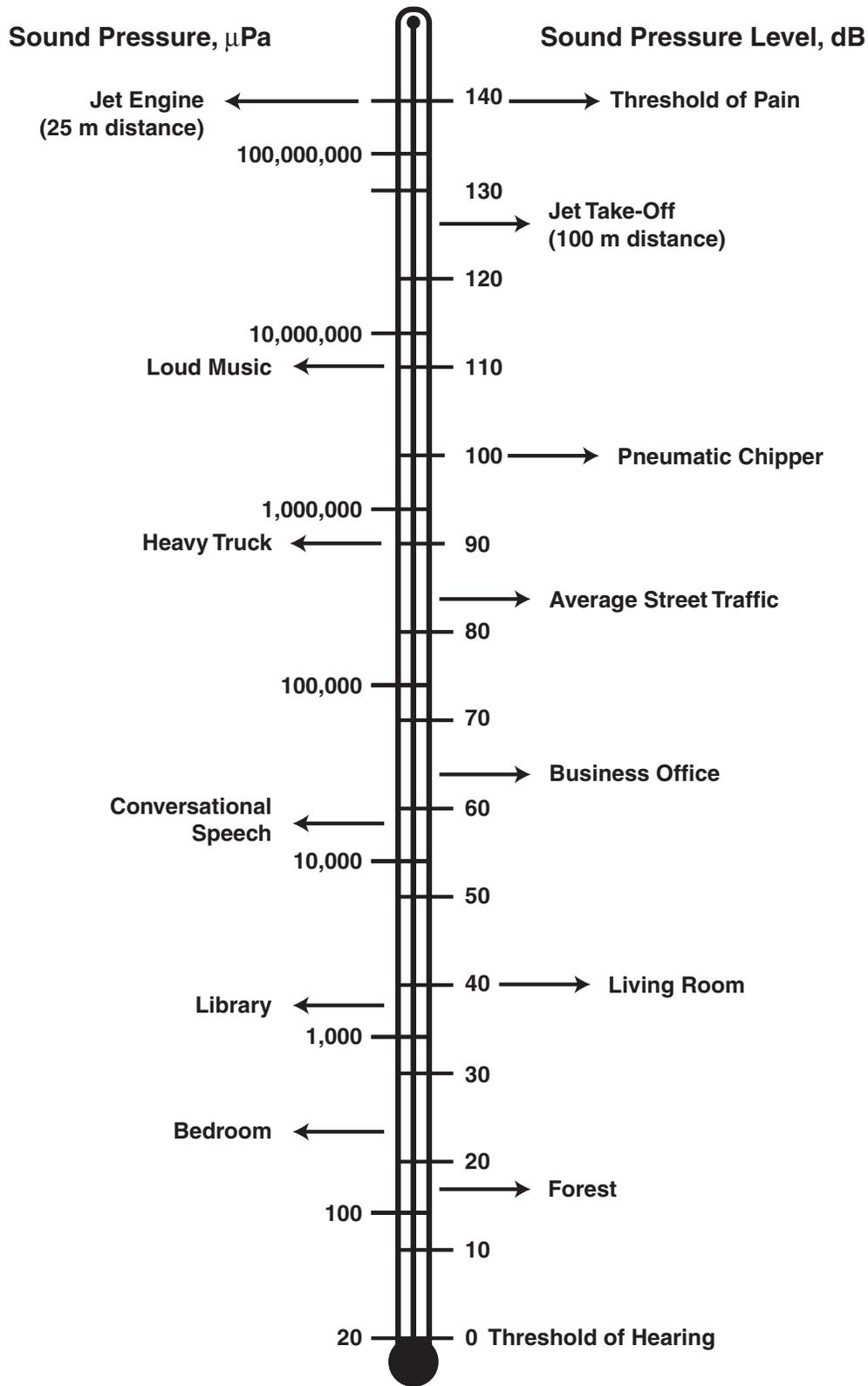
- Identification of exposed personnel (monitoring).
- Implementation of noise-reducing engineered and administrative controls.
- Audiometric testing (baseline and annual).
- Training.
- Use of hearing protectors (plugs, ear muffs).

This document applies to all LLNL workers who may be exposed to excessive noise levels in both construction and nonconstruction work.

#### 2.0 Hazard

Exposure to excessive levels of noise can result in permanent hearing loss, acuity, development of tinnitus (i.e., ringing of the ears), a possible increase in blood pressure, and stress-related problems. Noise may also cause annoyance or difficulty in communicating or working effectively and safely. A general guideline is that if you need to raise your voice to communicate with a co-worker at a normal conversation distance, then you may be in a noise hazard area.

Figure 1 shows the sound pressure levels on the decibel and log scales for various types of equipment and areas where such noise levels may be encountered.



**Figure 1. Sound pressure levels for various types of equipment and areas where noise may be encountered.**

### 3.0 Controls for Reducing and Preventing Noise Exposure

This section contains criteria for evaluating noise in work areas and measures (engineered controls, administrative controls, and protective equipment) for reducing worker exposure to excessive levels. Appendix A describes the general process for controlling excessive noise.

#### 3.1 Noise Exposure Limits

##### 3.1.1 Eight-hour, Time-weighted Average (8-Hour TWA) Exposure Limits

The ACGIH has established a standard of 85 dBA (sound pressure in dB related to 20  $\mu$ Pa measured on the A-weighted scale) over an 8-hour day. Exposure to transient noise louder than 85 dBA is permitted, as long as the average exposure for the entire day is less than 85 dBA. Table 1 shows the relationship between noise levels and permitted exposure periods.

**Table 1. Threshold limit values for noise.<sup>a</sup>**

	Duration/day	Sound level, dBA <sup>b</sup>
Hours	24	80
	16	82
	8	85
	4	88
	2	91
	1	94
Minutes	30	97
	15	100
	7.50 <sup>c</sup>	103
	3.75 <sup>c</sup>	106
	1.88 <sup>c</sup>	109
	0.94 <sup>c</sup>	112
Seconds	28.12 <sup>c</sup>	115
	14.06 <sup>c</sup>	118
	7.03 <sup>c</sup>	121
	3.52 <sup>c</sup>	124
	1.76 <sup>c</sup>	127
	0.88 <sup>c</sup>	130
	0.44 <sup>c</sup>	133
	0.22 <sup>c</sup>	136
	0.11 <sup>c</sup>	139

<sup>a</sup> No exposure to continuous, intermittent, or impact noise in excess of a peak C-weighted level of 140 dB.

<sup>b</sup> Sound level in decibels are measured on a sound level meter, conforming as a minimum to the requirements of the American Standards Institute Specifications for Sound Level Meters, S1.4 (1983), Type S2A, and set to use the A-weighted network with slow meter response.

<sup>c</sup> Limited by the noise source, not by administrative controls.

### 3.1.2 Ultrasound Exposure Limits

The ACGIH has established standards for exposure to very high audible frequencies (upper sonic) and frequencies above the range of human hearing (ultrasonic) (10 kHz to 100 kHz, as measured at the mid-frequency of the third octave band). Table 2 shows the TLV for ultrasound.

### 3.1.3 Permissible Speech Interference Level

In some cases, noise may not exceed standards established to protect hearing, but may interfere with the safe conduct of work. For example, nuisance noise can prevent effective communication between two or more people working together. It also can prevent workers from hearing or understanding safety instructions or other critical communications.

Most of the information conveyed through speech is in the mid-frequencies, from about 500 to 2000 Hz, which are used to determine how noise will interfere with speech. Noise levels above 60 dB can make telephone conversation difficult. Refer to the *Handbook of Noise Measurement* for the appropriate permissible speech interference levels (PSIL).

**Table 2. Threshold limit values for ultrasound.**

Mid-frequency of third octave band (kHz)	One-third octave band level in dB (re 20 $\mu$ Pa)	
	Ceiling Values	8-hour TWA
10	105 <sup>a</sup>	88 <sup>a</sup>
12.5	105 <sup>a</sup>	89 <sup>a</sup>
16	105 <sup>a</sup>	92 <sup>a</sup>
20	105 <sup>a</sup>	94 <sup>a</sup>
25	110	—
31.5	115	—
40	115	90
50	115	—
63	115	—
80	115	—
100	115	—

<sup>a</sup> Subjective annoyance and discomfort may occur in some individuals at levels between 75 and 105 dB for frequencies ranging from 10 kHz to 20 kHz, especially if they are tonal in nature. Hearing protection or engineered controls may be needed to prevent subjective effects. Tonal sounds in frequencies below 10 kHz might also need to be reduced to 80 dB.

The Work Smart Standard upon which this document is based does not address noise in areas such as shops, laboratories, warehouses, or similar operational areas. These areas should be reviewed on a case-by-case basis to determine the appropriate PSIL. Consider the work in progress and the potential risk to workers. A lower PSIL may be appropriate for highly complex tasks where communication is of paramount importance; a high PSIL is appropriate for lower risk tasks. Contact the area ES&H Team industrial hygienist for guidance in applying this standard.

### **3.1.4 Nuisance Noise**

Noise may be annoying because of its level, frequency, or aspects of its modulation. A noise may not be very loud, but its frequency may be high enough to cause headaches in susceptible individuals. Alternatively, a noise may not be that loud but may start and stop suddenly. This can disturb concentration or startle exposed personnel. Because there are no guidelines for annoying noise, each case must be examined independently to attempt to alleviate the irritation. The PSIL may be used as guidance in these situations.

## **3.2 Engineered Controls**

The best way to limit noise exposure is to alter the noise-producing equipment or change the environment to reduce noise levels. Examples include replacing old, noisy equipment; increasing sound dampening around noisy equipment; and improving muffler design. Engineered controls shall be formally considered before other types of controls are implemented. Contact your area ES&H Team for assistance in reviewing the options for engineered controls.

## **3.3 Administrative Controls**

### **3.3.1 Measuring Noise**

Work supervisors of individuals who are exposed to loud noise must notify the area ES&H Team. The ES&H Team industrial hygienist or health and safety technician usually performs noise measurements to identify areas or specific operations that produce excessive noise or to evaluate a worker's exposure to noise throughout an 8-hour day. The results of the measurements are used to determine which, if any, controls are appropriate to reduce worker exposure to noise.

### **3.3.2 Modifying Work Schedules**

Noise exposure can be limited by altering work schedules. For example, a worker scheduled to work on several pieces of noisy equipment should perform his/her noisy

tasks over several days so that the average exposure each day does not exceed the permissible limit.

### **3.3.3 Posting Signs/Labels**

Caution labels or signs should be posted on equipment or in areas where it has been determined that noise levels may exceed 85 dBA. These signs should notify the worker of a potential noise hazard and specify the conditions under which hearing protectors are recommended or required. Caution labels and signs are particularly important where workers' duties require them to move among different locations or to use a variety of tools. The purpose and meaning of the signs shall be included in the training aspect of LLNL's Hearing Conservation Program.

### **3.3.4 Medical Surveillance**

Medical surveillance examinations are conducted to monitor the hearing acuity of workers exposed to noise levels exceeding the limits established in Section 3.1.1. Medical surveillance is not routinely required for workers who are exposed to nuisance noise. The Health Services Department generally performs medical surveillance only for LLNL workers. Non-LLNL employees should receive medical surveillance through their employer. Equipment and training provided to LLNL workers may be available to some non-LLNL employees.

Payroll supervisors are required to enroll LLNL workers exposed to noise above the limits established in Section 3.1.1 in the Hearing Conservation Program administered by the Health Services Department. This program shall meet all the requirements of 29 CFR 1910.95 and include

- Annual training on the health effects of noise exposure and instructions on how to fit and wear hearing protectors.
- A baseline exam and annual follow-up audiometric testing.

The Health Services Department will schedule audiometric testing and advise workers how to wear hearing protectors or avoid noisy environments for 14 hours before the test. If this test shows that a worker may have suffered a significant threshold shift, The Health Services Department may schedule a retest within 30 days and consider the results of this test as the annual audiogram. The Health Services Department will determine if the shift is occupational or non-occupational and notify the worker in writing within 21 days of the determination. If the shift is occupational, the Health Services Department will

- Refer the worker to the Hazards Control Department for possible re-evaluation of his/her workplace.

- Fit and train the worker in the use of hearing protectors if none is used, and notify the worker's payroll and work supervisor that the worker must wear hearing protectors.
- Assess the worker's level of knowledge in the types and use of hearing protection to augment knowledge deficits, that is, if the worker is already using hearing protectors. If the worker needs hearing protectors with greater attenuation, the Health Services Department will inform the worker's payroll supervisor and the ES&H Team industrial hygienist. Then it shall be the responsibility of the work supervisor to provide such hearing protectors.

The Health Services Department may also require the worker to undergo further clinical audiological evaluation or otological examination if it is determined that such an evaluation or examination is necessary, or if the Health Services Department suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

### **3.3.5 Training**

For each worker who is enrolled in the Hearing Conservation Program, the Health Services Department shall demonstrate and train workers in the use of various hearing protectors at the initial medical surveillance appointment. Supervisors shall provide hearing protectors to all workers in the program and require them to use these devices while noise levels remain excessive.

Workers who are exposed to noise levels equaling or exceeding the 8-hour time-weighted average of 85 dBA or the peak level of 140 dBC must take Course HS4360 CBT, "Noise." This course is offered by the Hazards Control Department Safety, Education, and Training Section and covers the following

- The effects of noise on hearing.
- When and/or where hearing protectors are required.
- The purpose of hearing protectors.
- The advantages, disadvantages, and attenuation of various types of protectors.
- Instructions on how to select, use, fit, and care for hearing protectors.
- The purpose of audiometric testing, including an explanation of the test procedures.

Additional training and follow-up annual retraining (Course HS4361) shall be provided by the Health Services Department at the time of annual audiometric testing.

### 3.4 Hearing Protectors

Hearing protectors (e.g., ear plugs, canal caps, and ear muffs) shall only be used after engineered and administrative measures have been implemented, when feasible, and further protection is still needed. They also may be used during the design and fabrication of suitable enclosures, sound damping materials, and isolation.

Whenever workers are subjected to noise exceeding the limits established in Section 3.1.1, the Hazards Control Department will assist in the design of feasible administrative and engineered controls and will re-evaluate the worker and his/her work area after implementation of the controls. If these controls fail to reduce the noise levels below the limits established in Section 3.1, then hearing protection may be used to protect workers.

The work supervisor shall provide workers affected by noise with earplugs or earmuffs as needed. (Document 11.1, "Personal Protective Equipment," in the *ES&H Manual* contains selection, training and use criteria). The work supervisor may select hearing protectors for workers affected by noise at levels up to 95 dBA, but should contact the ES&H Team industrial hygienist to select the appropriate type of hearing protector for areas where exposure above 95 dBA is possible. In all cases, hearing protectors must provide adequate attenuation to prevent exposure to excessive noise levels.

Hearing protectors have a "noise reduction rating" (NRR) number provided by the manufacturer. The NRR is a general guide to the level of noise reduction (in decibels) the protector provides in laboratory test situations if it is fitted and worn properly. To determine the noise reduction of a hearing protector used in the workplace, subtract 7 dB from the NRR. For example, hearing protectors with a NRR = 23 dB would provide a noise reduction of 16 dB when used in the workplace (23 dB - 7 dB = 16 dB).

Hearing protectors may also have a "noise reduction rating (subject fit)" or NRR (SF) number, which may be used without any correction.

## 4.0 Responsibilities

General responsibilities for all workers are described in Document 2.1, "Laboratory and ES&H Policies, General Worker Responsibilities, and Integrated Safety Management," in the *ES&H Manual*. Specific responsibilities for noise prevention are listed under each title.

### 4.1 Workers

- Contact your supervisors if noise levels in the workplace are of concern.

- Use hearing protectors where required and adhere to requirements listed on signs identifying noisy areas.
- Participate in required medical exams, required training and demonstrations on how to properly fit protectors offered by the Health Services Department, and required training offered by the Hazards Control Department.

#### **4.2 Work Supervisors**

- Notify the ES&H Team when there is concern about noise levels.
- Ensure that the noise level of equipment to be acquired is considered in the purchasing process.
- Ensure that engineered controls (e.g., enclosure and sound dampening), and administrative controls (e.g., adjusted work schedules) are used, when feasible, to limit employee exposure to equipment that generates potentially hazardous noise levels.
- Enforce the use of hearing protectors where required.

Payroll supervisors are responsible for enrolling workers found to be exposed to noise levels that exceed the permissible limits in LLNL's Hearing Conservation Program.

#### **4.3 Facility Points of Contact**

- Identify areas where potentially hazardous levels of noise may be found.
- Notify personnel of these areas.
- Ensure that engineered controls (e.g., enclosure and sound dampening) are used, when feasible, on equipment that generates potentially hazardous noise levels.

#### **4.4 Hazards Control Department**

- Review Laboratory operations to determine if there is a potential for exposure to hazardous or annoying levels of noise.
- Evaluate workers' concerns regarding noise levels in the workplace.
- Maintain an adequate collection of noise-monitoring equipment, including sound-level meters, octave-band analyzers, dosimeters, and calibrators to assess worker exposure.

- Conduct noise surveys to establish the noise levels at various work sites. Post the appropriate signs in specific areas and operations or on equipment that may expose workers to noise equaling or exceeding 85 dBA.
- Where feasible, conduct dosimetric noise surveys on workers who may be exposed to noise levels that exceed the permissible limits.
- The Hazards Control Department will notify payroll and work supervisors in writing of workers who are confirmed to be exposed routinely or intermittently at levels equaling or exceeding the 8-hour time-weighted average of 85 dBA, regardless of the use of hearing protectors. Notification will include a statement regarding the payroll supervisor's responsibility to enroll the worker(s) in LLNL's Hearing Conservation Program (medical surveillance, training, fitting) and the work supervisor's responsibility to implement feasible engineered controls and, if necessary, provide hearing protectors. A copy of the notice will be provided to the Health Services Department.
- Assist with designing engineered controls to reduce worker exposure to noise.
- Provide Course HS4360 CBT to workers who may be or have been exposed to noise that exceeds the applicable standards.
- Select the most appropriate type of hearing protectors for workers exposed to noise at levels above 95 dBA.

#### **4.5 Health Services Department**

- Establish and maintain an audiometric testing program in accordance with 29 CFR 1910.95.
- Provide workers with annual training (Course HS4361) on the health effects of noise exposure, instructions on how to fit and wear hearing protectors, and a baseline examination and annual follow-up audiometric testing. These are all part of LLNL's Hearing Conservation Program.
- Notify the Supervisor of the need to re-evaluate work sites of workers with apparent work-related significant threshold shifts.

#### **4.6 Plant Engineering**

- Ensure that the stipulations and exposure limits described in this document are included in specifications and contract documentation for work to be performed by subcontractors.
- Adequately maintain infrastructure equipment to minimize the generation of noise.

## 5.0 Work Standards

29 CFR 1910.95, "Occupational Noise Exposure" (except for the PEL section).

29 CFR 1926.52, "Occupational Exposure to Noise in Construction" (except for the PEL section).

ACGIH, TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents, 1998 (excluding TLVs for Chemical Substances, Ergonomics, Ionizing Radiation, and Lasers).

Peterson, A., *Handbook of Noise Measurement*, Chapter 4.18, "Masking—I Can't Hear You When the Water's Running," GenRad, Inc., 9th edition (1980).

DOE Order 440.1A, "Worker Protection Management for DOE Federal and Contractor Employees," Attachment 2, "Contractor Requirement Document," Sections 1–11, 13–18 (delete item 18.a), 19 (delete item 19.d.3) and 22.

## 6.0 Resources for More Information

### 6.1 Contacts

Contact the appropriate organization or group for further information on the following:

- Health Services Department—Audiometric testing
- Area ES&H Team—Exposure monitoring
- Safety, Education, and Training Section of the Hazards Control Department—Training

### 6.2 Lessons Learned

For lessons learned applicable to noise and hearing conservation, refer to the following Internet address:

[http://www-r.llnl.gov/es\\_and\\_h/lessons/lessons.shtml](http://www-r.llnl.gov/es_and_h/lessons/lessons.shtml)

## Appendix A

### Process for Controlling Excessive Noise Levels

The process for controlling excessive noise levels is shown in the accompanying flowchart.

