

Audiometric Testing Reference Guide for MSHA's Occupational Noise Exposure Standard

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Introduction - How to Use This Publication

This document is presented in a question and answer format with the questions asked from the perspective of the mine operator.

Who should use this publication?

This publication is intended to be a useful guide for all mine operators, contractors, audiologists, physicians and other persons who conduct or evaluate audiometric tests to meet the requirements of 30 CFR Part 62.

What is the purpose of this guide?

This audiometric testing guide provides mine operators with examples of validated scientific methods and/or equipment specifications for testing the hearing sensitivity of miners.

Many sources, including Occupational Safety and Health Administration (OSHA) regulations, American National Standards Institute (ANSI) standards, national consensus guidelines from professional organizations, and scientific journals, were consulted in developing this guide. Methods to comply with either the testing requirements of the OSHA Hearing Conservation Amendment (HCA) or U.S. military requirements for an audiometric testing program would fulfill MSHA's requirements.

How can I find what I need quickly?

The Table of Contents can be used to locate topics of interest. Technical terms are explained throughout the document.

If I follow the guidance in this document, will I be in compliance with the audiometric testing requirements of MSHA's noise standard?

Section 62.171 requires that audiometric testing be conducted in accordance with scientifically validated procedures. While this manual provides a few examples of such procedures, other methods may be acceptable. Mine operators are encouraged to have their physicians, audiologists, and qualified technicians use the latest scientific methodology to determine the hearing sensitivity of miners. Physicians and audiologists determine the proper testing for the technician to follow.

MSHA recognizes that new techniques and instrumentation are constantly being developed and that current consensus standards are often updated.

What are the requirements for background sound pressure levels of audiometric testing rooms?

Before accurately measuring the sensitivity of a miner's hearing, the background sound pressure level of the audiometric test room must be known.

The sound pressure level must be low enough not to interfere with measuring a miner's threshold of hearing. The OSHA HCA contains criteria for the background sound pressure levels in audiometric test rooms. ANSI has issued a standard that is more stringent on background sound pressure levels in audiometric test rooms. These requirements are found in ANSI Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms, S3.1-1991. Both criteria are in terms of octave band sound pressure levels from 500 Hz to 8000 Hz.

According to OSHA, the background sound pressure level should be measured with instrumentation conforming to ANSI Type 2 sound level meters and Class II requirements for octave band filters. These requirements are found in ANSI Specification for Sound Level Meters, S1.4-1971(R1976) and ANSI Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets, S1.11-1971 (R1976). ANSI has updated these standards. S1.4 was updated in 1983 and reaffirmed in 1997. S1.11 was updated in 1986 and reaffirmed in 1993.

Please be aware that not all sound level meters are capable of measuring the low sound pressure levels. The instruction manual(s) for your sound level meter and microphone needs to be consulted.

What are the specifications for equipment used to conduct audiometric testing?

ANSI has issued instrumentation specifications for audiometers. According to OSHA, manual audiometers must comply with ANSI Specification for Audiometers, S3.6-1969 which was updated in ANSI S3.6-1996.

An audiometer meeting either standard is acceptable. Further, ANSI specifies that pulse-tone audiometers must have a tone on-time of at least 200 milliseconds.

Self-recording audiometers shall comply with the following requirements:

a. The chart upon which the audiogram is traced shall have lines at positions corresponding to all multiples of 10 dB hearing level within the intensity range spanned by the audiometer. The lines shall be equally spaced and shall be separated by at least 1/4 inch. Additional increments are optional. The audiogram pen tracing shall not exceed 2 dB in width.

b. It shall be possible to set the stylus manually at the 10 dB increment line for calibration purposes.

c. The slewing rate for the audiometer shall not be more than 6 dB/sec except that an initial slewing rate greater than 6 dB/sec is permitted at the beginning of each new test frequency, but only until the second subject response.

d. The audiometer shall remain at each required test frequency for 30 seconds (± 3 seconds). The audiogram shall be clearly marked at each change of frequency and the actual frequency change of the audiometer shall not deviate from the frequency boundaries marked on the audiogram by more than ± 3 seconds.

e. It must be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram, such that the audiometric tracing crosses the line segment at least six times at that test frequency. At each test frequency the threshold shall be the average of the midpoints of the tracing excursions.

Must audiometric testing equipment be calibrated periodically?

In order for audiometric test results to be valid, they must be obtained using calibrated audiometers. Prior to conducting a day's audiometric testing, the audiometer needs to be checked for proper functioning. Besides the daily calibrations, audiometers need to undergo laboratory calibrations.

The daily calibration consists of a person with known stable hearing thresholds listening to the audiometer's output at each frequency to ascertain that the output is free from distorted or unwanted sounds. The cords to the earphones should be manipulated while listening to the signal to make sure the signal is not broken or intermittent. If the audiometer does not produce good signals then the audiometer needs to be removed from service and needs to be repaired.

If the results of the audiometer deviates by 10 dB or more from the person's known threshold, then the audiometer needs to undergo an acoustical calibration before using the audiometer to test a person's hearing sensitivity.

Instead of testing a person with known stable hearing thresholds, a simulator may be used. Manufacturers produce simulators for the daily calibration of audiometers. If there is a deviation by 10 dB or more, then the audiometer needs to undergo an acoustical calibration.

The annual acoustical calibration requires specialized acoustical test equipment. This calibration checks the sound pressure level output and the linearity of the audiometer. Both the acoustical and exhaustive calibrations are very technical and are beyond the capabilities of most organizations. OSHA requires that the audiometer be acoustically calibrated annually and an exhaustive calibration be conducted once every two years.

To obtain an acoustical or exhaustive calibration, the mine operator should contact the audiometer's manufacturer for calibration. The audiometer's manufacturer can recommend qualified companies that can perform these calibrations. The manufacturer can also advise the mine operator on the proper shipping techniques.

What frequencies of hearing sensitivity must an audiometric test include?

The qualified technician, audiologist, or physician tests the hearing sensitivity of each miner enrolled in the Hearing Conservation Program who agrees to the testing. The test frequencies must include 500, 1000, 2000, 3000, 4000, and 6000 Hz. Other frequencies may be included at the discretion of the qualified technician, audiologist, or physician.

Are there standardized procedures for conducting audiometric testing?

Yes, audiometric test procedures can be found in ANSI Method for Manual Pure-Tone Threshold Audiometry, ANSI S3.21-1978 (R1997). Computerized or self-recording audiometers should be used according to their manufacturer's instructions.

When should a miner's baseline audiogram be revised?

Section 62.170(c) requires that an annual audiogram be regarded as a revised baseline audiogram when a physician or audiologist determines that there has been a significant permanent shift in hearing threshold because:

- ! there was a significant improvement in the miner's hearing threshold as compared to the baseline audiogram; or
- ! there was a significant worsening in the miner's hearing threshold as compared to the baseline audiogram.

For an improved audiogram, if the average of thresholds for 2000, 3000, and 4000 Hz for either ear shows an improvement of 5 dB or more from the baseline value and the improvement is present on one test and persistent on the next test, then the record should be identified for review by the audiologist or physician for potential revision of the baseline for persistent improvement. The baseline for that ear should be revised to the test which shows the lower (better hearing) value for the average of the thresholds at 2000, 3000, and 4000 Hz unless the audiologist or physician determines and documents specific reasons for not revising. If the values for the three-frequency average are identical for the two tests, then the earlier test becomes the revised baseline.

What conditions found by an audiometric test require referral of the miner for further evaluation?

The following criteria specify conditions that would require audiometric referral. These were developed by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS).

For baseline audiograms:

- (1) an average hearing level at 500, 1000, 2000, and 3000 Hz greater than 25 dB in either ear; or
- (2) a difference in average hearing level between the better and worst ear of more than 15 dB at 500, 1000, and 2000 Hz or more than 30 dB at 3000, 4000, and 6000 Hz.

For annual audiograms: a change for the worse in average hearing level in either ear compared with the baseline audiogram of more than 15 dB at 500, 1000, and 2000 Hz or more than 20 dB at 3000, 4000, and 6000 Hz.

The AAO-HNS also recommends referral for the following medical reasons:

- (1) a history of ear pain; drainage; dizziness; severe persistent tinnitus; sudden, fluctuating, or rapidly progressive hearing loss; or a feeling of fullness or discomfort in one or both ears within the preceding 12 months; or
- (2) visible evidence of cerumen (ear wax) accumulation or a foreign body in the ear canal.

In addition, if it is determined that the miner's hearing appears to be asymmetrical, that is, one ear is getting worse much faster than the other, it is recommended that persons whose hearing thresholds at any test frequency differ by 40 dB or more between ears be referred to an audiologist. This is to be sure to catch things like acoustic neuroma or other non-noise induced problems as early as possible.

SOURCES OF ASSISTANCE

Mine operators should consult the Yellow Pages for audiologists and physicians to conduct audiometric testing. Also, acoustical engineers in your area may be found in the Yellow Pages. Acoustical engineers can evaluate noise exposures and recommend appropriate control measures. Besides the local phone book, the Internet can be used to find qualified personnel. Additionally, information is available on noise-induced hearing loss, hearing conservation, audiometric testing services, and related issues from other governmental agencies, professional associations, and academia. Names, mailing addresses, and web site addresses for several of these organizations are listed below. Some of these organization's web sites provide links to other web sites on noise and hearing conservation.

Mine Safety and Health Administration

Technical Support

Physical and Toxic Agents Division

PO Box 18233

Cochrans Mill Road

Pittsburgh, PA 15236

412-386-6980

<http://www.msha.gov/techsupp/pshtcweb/ptad.htm>

National Institute for Occupational Safety and Health (NIOSH)

Publications and Technical Information and Assistance

(9:00 - 4:00 daily, EST)

1-800-35-NIOSH

(1-800-356-4674)

Fax: 513-533-8573

<http://www.cdc.gov/niosh/homepage.html>

Occupational Safety and Health Administration (OSHA)

U.S. Department of Labor

200 Constitution Ave., NW.

Washington, DC 20210

<http://www.osha.gov>

PROFESSIONAL ASSOCIATIONS

Mention of the following organizations does not constitute endorsement of them by MSHA or a validation of the information they present.

American Conference of Governmental Industrial Hygienists

1330 Kemper Meadow Dr.

Suite 600

Cincinnati, OH 45240

Office: 513-742-2020

Fax: 513-742-3355

<http://www.acgih.org>

American National Standards Institute

11 West 42nd Street

New York, NY 10036

Office: 212-642-4900

Fax: 212-398-0023

<http://www.ansi.org>

American Society of Safety Engineers

1800 E. Oakton Street

Des Plaines, IL 60018

847/699-2929

<http://www.asse.org>

Council for Accreditation in Occupational Hearing Conservation (CAOHC)

611 East Wells St.

Milwaukee, WI 53202-3816

Office: 414-276-5338

Fax: 414-267-3349

http://www.caohc.org/related_websites.html (for links to related web sites)

American Academy of Otolaryngology-Head and Neck Surgery

One Prince Street

Alexandria, VA 22314-3357

Office: 703-836-4444

<http://www.entnet.org>

American College of Occupational and Environmental Medicine

1114 N. Arlington Heights Road

Arlington Heights, IL 60004

Office: 847-818-1800

<http://www.acoem.org>

National Hearing Conservation Association (NHCA)

9101 E. Kenyon Ave.

Suite 300

Denver, Co 80237

Office: 303-224-9022

Fax: 303-770-1812

<http://www.hearingconservation.org> (home page and links to their listing of professional service organizations) and <http://www.hearingconservation.org/links.htm> (for links to related web sites)

American Industrial Hygiene Association

2700 Prosperity Avenue

Suite 250

Fairfax, VA 22031

Office: 703-849-8888

Fax: 703-207-3561

<http://www.aiha.org>

American Speech-Language-Hearing Association (ASHA)

10801 Rockville Pike

Rockville, MD 20852

Office: 1-800-638-8255

Fax: 301-897-7355

<http://www.asha.org>

National Council of Acoustical Consultants

66 Morris Avenue, #1A

Springfield, NJ 07081-1409

Office: 973-564-5859

Fax: 973-564-7480

<http://www.ncac.com>

National Safety Council

1121 Spring Lake Drive

Itasca, IL 60143-3201

Office: 630-285-1121

Fax: 630-285-1315

<http://www.nsc.org>

Oklahoma State University

Department of Environmental Safety and Health

<http://www.pp.okstate.edu/ehs/links/noise.htm> (this web site is their online safety library of noise and hearing conservation information)

University of Wisconsin-Whitewater

<http://facstaff.uww.edu/bradleys/ohc/home.html> (this is their occupational hearing conservation home page which provides links to many other sources of educational materials and information)