



► OCCUPATIONAL HEARING CONSERVATION

Historical Highlights in the Evolution of National Standards for Occupational Safety & Health

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In 1998, the National Institute for Occupational Safety and Health (NIOSH) published a revised noise criteria document.¹ The original noise criteria document published in 1972 had set the tone for subsequent occupational noise exposure regulations from governmental bodies, including the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA), and for hearing conservation efforts by health and safety professionals. The revised recommendations were devised to increase the preventiveness of occupational hearing conservation programs.

Background

The U. S. Department of Labor first began regulating noise under standards of limited applicability, the most noted being the *Walsh-Healy Public Contracts Act* of 1936 that applied only to companies with contracts of \$10,000 or more with the federal government. Pursuant to Walsh-Healy, on September 20, 1968, the Department of Labor proposed regulations that would limit noise exposure to 85 dBA for an *eight-hour time-weighted average* (TWA8) calculated with a 5 dB exchange rate. Interested parties were invited to submit oral and written testimony. On January 17, 1969, the Secretary of Labor promulgated the standard that permitted a 92 dBA TWA8 until January 1, 1971 if an effective hearing conservation program was established to protect

the hearing of workers, and if after the deadline the noise level was reduced to 85 dBA TWA8. The regulation required engineering controls to be implemented first and allowed use of hearing protectors only if feasible engineering controls could not lower the noise level to 85 dBA TWA8.² The Standard was to take effect on February 17, 1969, but on February 14 the effective date was postponed until May 17, 1969. When the revised regulation was published on May 20, 1969, the maximum permissible exposure level had been increased to 90 dBA TWA8 with no comment.³

The 91st Congress (S 2193, December 29, 1970) passed the *Occupational Safety and Health Act*.⁴ OSHA was created from this act and was placed in the Department of Labor, while NIOSH was placed in the Department of Health, Education and Welfare (now the Department of Health and Human Services). OSHA was charged with developing and enforcing occupational safety and health regulations. NIOSH was charged with providing the scientific information to support the regulations, including the development of criteria documents that reviewed the known science to date. Based on that science, NIOSH was to make recommendations as to the maximum acceptable exposure levels for chemical, biological and physical agents and for procedures to prevent exposure or reduce the adverse health and safety effects of exposure. Congress directed the Secretary of Labor to promulgate, without notice or hearing, the pre-existing federal standard to all employers affecting interstate commerce. Subsequently, the Secretary of Labor reissued the Walsh-Healy Noise Standard as a mandatory OSHA requirement with an effective date of August 27, 1971.⁵ Because there were no mechanisms for public comment and no parties sought judicial review, the standard went into effect as planned.

Following the *OSH Act*, NIOSH published recommended criteria for a

noise standard in 1972.⁶ Key elements were: 85 dBA TWA8 recommended exposure limit, noise sampling and noise control guidance, use of periodic audiometry, use of hearing protection for overexposed workers and training for workers exposed at, or above, the recommended limit.

In 1974, OSHA proposed a revision of the occupational noise standard that mostly responded to the NIOSH recommendations.⁷ A 90 dBA TWA8 *permissible exposure limit* (PEL) was recommended until an 85 dBA PEL TWA8 became feasible. OSHA also proposed hearing conservation programs that were to be initiated at 85 dBA. The proposed regulation allowed hearing protector use in lieu of feasible engineering and administrative controls "if an employee's exposure occurs no more than one day a week."

In 1974 and 1975, OSHA held two sets of hearings which sparked debate about whether to drop the PEL to 85 dBA TWA8 and whether to require engineering and administrative controls as primary means of compliance. The U.S. Environmental Protection Agency (EPA) objected to the recommended standard, stating that it did "not protect the public health and welfare to the extent required and feasible." Further, the EPA believed "that the reduction to 85 dBA is an important step toward this goal."⁸ Despite the delays in promulgating a new standard which the discussions caused, many companies adopted the 1972 NIOSH recommendations or the 1974 OSHA proposed methods in anticipation of the issuance of a regulation.

In 1978, the EPA released the *Hearing Protector Labeling Rule*.⁹ The rule required that all hearing protection devices sold in the U.S. be tested according to the *experimenter-fit* method of the ANSI standard on determining real-ear attenuation at threshold.¹⁰ The *Noise Reduction Rating* (NRR) based on the test results was to be placed on each protector's



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label. In 1982, the EPA ceased funding for the Office of Noise Abatement and Control and, while the labeling regulation remains, there is no identified surrogate to enforce the regulation.

There was no further regulatory activity in the area of occupational noise until January 16, 1981, when OSHA released the *Hearing Conservation Amendment (HCA)* to the Occupational Noise Standard.¹¹ The HCA defined what OSHA considered to be an effective *occupational hearing conservation program (OHCP)*. The HCA was extremely detailed and thorough and required regular noise monitoring, engineering controls, hearing protection selected according to the EPA NRR, audiometry, worker training and record-keeping. Most portions of the regulation were to take effect on April 15, 1981.

The HCA included a complex definition of significant threshold shift that depended upon whether the worker had pre-existing hearing loss. Finding a permanent significant threshold shift required issuance of hearing protectors to workers not already wearing them, retraining of workers already using hearing protection, worker notification of the threshold shift and referral for a clinical audiological or otological evaluation.

In addition, permanent significant threshold shift had to be recorded on the OSHA Form 200 log if the shift was determined to be work-related. Employers use the OSHA Form 200 log to record all occupational accidents and illnesses. The Form 200 provides OSHA with insight into the success of any company's health and safety program and supports compilation of statistics for industries. Noise-induced hearing loss is categorized as due to repetitive exposures, the same category as carpal-tunnel syndrome.

On January 20, 1981, the effective dates of the HCA were delayed indefinitely. On August 16, 1981, portions of the HCA were made effective. The standard retained retesting as necessary to confirm threshold shift as well as the need to be fitted with hearing protectors or retrained in their use. The instructions for audiological or otological follow up, the instructions to

record permanent significant threshold shift on the OSHA Form 200, and the requirement for biennial monitoring of noise levels were stayed.

The portion defining permanent significant threshold shift was also stayed until March 1983. On March 8, 1983, the remaining portions of the hearing conservation amendment were released.¹² Threshold shift was now referred to as *Standard Threshold Shift (STS)*, defined as a change in hearing from the baseline audiogram of 10 dB or greater in either ear for the 2000, 3000, and 4000 Hz pure-tone average, the same definition used in the 1974 proposed rule. Age corrections could be applied to STS calculations. Additionally, the HCA relied on the EPA NRR for selecting hearing protectors.

On December 19, 1983, OSHA issued a compliance directive (CPL 2-2.35A) that effectively removed the necessity for companies to employ engineering noise control solutions. It directed that noise control efficacy be evaluated in terms of reasonability (including the annualized cost of installing controls) and permanency (the estimated cost for engineering controls relative to the estimated annual cost of a HCP multiplied by the approximate life of the controls in years).¹³ OSHA also directed that, if noise exposure levels were less than 100 dBA TWA8 and a successful HCP could be demonstrated, engineering noise control feasibility studies were not necessary. A successful program was defined as one where no STS has been detected and adequate hearing protectors are utilized.

Since the issuance of the CPL, a debate has arisen over what the meaning of "no" is. Does "no STS" mean "no STS at all" or "no more STS than would be expected from a population of demographically similar workers who were not exposed to occupational noise" or something else in between? CPL 2-2.35A also recognized that the EPA NRR was an inflated value because it requires use of an experimenter-fit method. Labeled NRR's had been found to overestimate the noise reduction workers actually received. Consequently, in CPL 2-2.35A, OSHA required derating the NRR by 50% when determin-

ing if the noise exposure levels could be reduced sufficiently with hearing protectors without requiring engineering and/or administrative noise controls.

In November 1984, in response to a suit brought by the Iron and Steel Industry that claimed the HCA required employers to be responsible for their workers' noise exposures off the job, the entire hearing conservation amendment was ruled unconstitutional and vacated by the 4th District Federal Court in Richmond, VA. Many companies that had begun to implement hearing conservation programs stopped all activity. In October 1985, the Federal Court of Appeals overturned the judgement and the HCA became enforceable again.

From 1985 to the present, the OSHA Occupational Noise Standard and the HCA have been in effect and enforced by OSHA. The standard only applies to the manufacturing sector. Construction, agriculture, mining, fishing and the service sectors are not covered except as they fall under OSHA's general industry clause. Oil and gas extraction are expressly exempted by the HCA. Noise in mines is regulated by MSHA and these regulations vary by type of mine operation.

In 1987, OSHA requested comment on reducing the frequency of hearing testing from annual to biennial. Comments were collected, but no action was taken.¹⁴ In 1990, MSHA requested comments on eight items that were key to developing a new noise standard for all of mining to replace the segmented standards that were then in place.¹⁵

In 1991, OSHA issued instructions to area directors to begin citations for failure to record on the OSHA Form 200 STS of 25 dB or greater when calculated against the original baseline audiogram; age correction was optional. OSHA also directed that the 10 dB STS value be used for monitoring the effectiveness of the HCP and for intervening to prevent additional loss of hearing. This two-criterion system resulted in confusion. Companies that had been responding to the 10 dB STS now had to recalculate the 25 dB recordable STS reporting purposes on the OSHA Form 200. In some states that had already

1936: Walsh-Healy Public Contracts Act

1968: Dept. of Labor (DoL) proposes regs relative to 85 dBA TWA8.

1970: Occupational Safety & Health Act (creating OSHA and NIOSH).

1974: OSHA proposes revisions including 90 dB TWA8 PEL and HCPs to be administered at 85 dBA.

1978: Hearing Protection Labeling Rule released by EPA.

1982: EPA ceases funding of Office of Noise Abatement and Control which had regulated NRRs.

A TIMELINE OF OCCUPATIONAL HEARING STANDARDS

1969: DoL publishes maximum PEL as 90 dBA TWA8

1972: NIOSH publishes rec. criteria standard including an 85 dBA TWA8.

1974-75: OSHA holds hearings that spark debate on reducing PEL to 85 dBA.

1981: OSHA releases *Hearing Conservation Amendment (HCA)*, defining OHCPs (only portions of HCA become effective).



required recording STS, the recording requirement was left at 10 dB, while in others the requirement was adjusted to the new federal level of 25 dB.

In 1996, MSHA responded to its 1990 request for comments and published a proposed noise standard and hearing conservation regulation.¹⁶ The PEL of 90 dBA TWA8 and the hearing conservation program elements mirrored those of the OSHA regulation, including mandating a hearing conservation program for all workers exposed to 85 dBA TWA8 or above. Unlike OSHA, which allows inclusion of hearing protector attenuation for calculations of noise exposure levels due to CPL 2.235A, MSHA's proposed rule would prohibit incorporating noise reduction from hearing protection when computing miners' noise exposure levels and determining how much engineering noise control would be necessary. To date, however, the final rule has not been released.

In 1997, OSHA published a proposed rule to replace 29 CFR Part 1904 Recording and Reporting Occupational Injuries and Illnesses.¹⁷ The rule would require recording significant threshold shift on the new OSHA Form 300. While it appears that there is little support for the age-corrected 25 dB STS criterion, it is unclear what criteria OSHA will ultimately select when the revision is released.

During the 1990s, NIOSH released four publications that shifted focus away from regulatory compliance toward effective interventions to prevent occupational hearing loss. The first was *A Practical Guide to Effective Hearing Conservation Programs in the Workplace*.¹⁸ This document was written without regard to the OSHA regulation, reflecting instead the experiences of a panel of hearing conservation experts from public, private and university sectors in terms of which types of actions were effective in preventing hearing loss and which were not. The guide was written for people who might have the role of hearing conservation program manager without the benefit of formal training or expert consultants. As developed, any

program implementing all of the recommendations in the *Guide* would be in compliance with the regulation.

The second was *The NIOSH Compendium of Hearing Protective Devices*.¹⁹ This contained information on every hearing protector sold in the U.S. as of mid-1994, including attenuation data and feature tables for the devices. For a few devices, the subject-fit (or real-world) data were included in a special table. The compendium allowed hearing conservation program managers to select hearing protectors that would best protect their workers on the basis of information about features such as material type for earplugs and headband type for earmuffs. Unfortunately, laboratory subjects are not asked about "comfort" and "wearability," and the compendium doesn't list either as features.

The third publication was *Preventing Occupational Hearing Loss—A Practical Guide*.²⁰ In this revision of the earlier *Guide*, NIOSH shifted focus from hearing conservation to hearing loss prevention. Instead of documenting program failures signified by permanent worsening of hearing, active interventions to prevent such shifts were encouraged. Audiometry became a tool for intervention (i.e., finding threshold shift while it was still temporary) instead of a tool for identifying those who have lost more hearing. Training was expanded from didactic presentations to interactive training that showed employees how to recognize potentially hazardous noise and how to make informed choices about the use of hearing protection when noise controls are not available. Because prevention is proactive, there is zero tolerance for hearing loss. Thus, discussions about how much STS is acceptable in an effective hearing conservation program are irrelevant because there shouldn't be any STS attributable to workplace noise.

Fourth, NIOSH published *Criteria for a Recommended Standard—Occupational Noise Exposure, Revised Criteria 1998*, incorporating the concepts from the 1996 *Guide*.¹ The revised criteria document retained the 1972 recommended exposure level of 85 dBA, but

changed the exchange rate from 5 dB to 3 dB, thus equating an eight-hour TWA to an eight-hour Leq—the average sound pressure level measured over time with an integrating sound level meter. The criteria documents detailed methods for implementing audiometric testing as a prevention tool and redefines significant threshold shift as a change of 15 dB twice at any test frequency (500-6000 Hz) for the same ear and frequency. The document recognized that the laboratory method required by the EPA for testing hearing protectors overstates the achievable protection in the workplace and recommended derating the NRR depending upon protector type based real-world studies. When data from a new subject-fit laboratory test method are available, or when checking the actual protection received by each worker is possible, derating will no longer be required.

1999 Onward

Currently, two major regulations, along with several other limited-scope regulations, protect workers from noise-induced hearing loss. For general industry, there is 29 CFR 1910.95, the *OSHA Noise Standard and Hearing Conservation Amendment*.¹¹ For defining the effectiveness of hearing protectors there is the *EPA Hearing Protector Labeling Rule*, CFR Title 40, sub chapter G, 211, subpart B—Hearing Protective Devices.⁵ The noise standards for the construction industry as well as the noise standards for various mining venues are limited in scope with no definition of a hearing conservation program.

OSHA's *Recording and Reporting Occupational Injuries and Illnesses Rule* was scheduled for release in 1998, but has now been delayed until early 2000. MSHA's *Health Standards for Occupational Noise Exposure in Coal, Metal, and Nonmetal Mines* was initially scheduled for release in 1998, but has been delayed indefinitely. The causes of delays are many, ranging from technical, where the agency may be awaiting a critical piece of supporting information, to

1983: Remaining sections of HCA released including guidelines on STS. Later in year, OSHA releases CPL 2-2.35A which effectively removes need for employment of engineering control solutions.

1991: OSHA advises directors to issue citations for failure to record STS on Form 200.

1998: NIOSH publishes *Criteria for a Recommended Standard—Occupational Noise Exposure, Revised Criteria 1998*.

1984: HCA is ruled unconstitutional by 4th Dist. Court in Richmond, VA. This ruling is overturned in 1985 and HCA and Occupational Noise standard remain in effect to present.

1990: NIOSH releases *A Practical Guide to Effective Hearing Conservation Programs in the Workplace*. This is followed in 1996 by *Prevention of Occupational Hearing Loss—A Practical Guide*.

1996: MSHA publishes proposed noise standard and hearing conservation regulation.

2000?: Scheduled release for OSHA's *Recording & Reporting Occupational Injuries & Illness Rule*.

NIOSH 1998 Revised Noise Criteria

The NIOSH 1998 revised noise criteria document presents what NIOSH considers to be effective for the prevention of occupational hearing loss as a template for regulatory reform and the establishment or modification of companies' programs.¹ NIOSH recommendations apply equally to construction, mining, agriculture and other venues as well as the traditional manufacturing sector. The key NIOSH recommendations for an effective hearing loss prevention program are:

- **Recommended Exposure Level (REL):** 85 dBA Leq8 (eight-hour time-weighted average based on a 3-dB exchange rate also expressed as TWA8Leq.)

- **Exposure Ceiling:** No exposure shall exceed 140 dBA

- **Hearing Loss Prevention Program:** Required when exposure equals or exceeds the REL.

- **Noise Exposure Assessment:** Required when exposure equals or exceeds the REL.

- **Initial Monitoring:** At initiation of the Hearing Loss Prevention Program.

- **Periodic Monitoring:** Every two years or within three months of substantive change of facility, process or routines.

- **Instrumentation:** Dosimeters or sound level meters.

- **Engineering and Administrative Controls and Work Practices:** Primary methods of reducing workers' exposures to below the REL. Use of administrative controls shall not result in exposing more workers to noise.

- **Hearing Protectors:** Required when workers are exposed to noise that equals or exceeds the REL. Double protection recommended when exposures exceed 100 dBA TWA8Leq

- **Variable NRR Derating:** Earmuffs derate in NRR by 25%. Slow-recovery formable earplugs derate by 50%. All other earplugs derate by 70%.

- **Subject-Fit Method:** May be used in

lieu of derating if the manufacturer provides a secondary label with subject-fit NRR.

- **Medical Surveillance—Audiometry:** Pure-tone threshold testing at 500, 1000, 2000, 3000, 4000 and 6000 Hz in each ear. Testing at 8000 Hz is encouraged as well.

- **Baseline:** Pre-employment or within first 30 days of employment - preceded by 12 hours of quiet.

- **Monitoring:** Annually for all workers exposed to 85 dBA TWA8Leq or greater; semi-annually for workers exposed to 100 dBA TWA8Leq or greater.

- **Immediate Retest:** Optional recheck when the monitoring audiogram detects a threshold shift that equals or exceeds 15 dB at any frequency (500-6000Hz) in either ear; will reduce substantially the number of confirmation audiograms necessary.

- **Confirmation Audiogram:** Required within 30 days of monitoring audiogram when 15 dB shift is noted, as described above (unless shift is not present for immediate retest). Given under the same conditions as the baseline audiogram.

- **Significant Threshold Shift:** When a change in HTL as compared to baseline in either ear exceeds 15 dB at 500, 1000, 2000, 3000, 4000 or 6000 Hz is repeated on a subsequent audiogram for the same ear(s) and frequency(ies).

- **Follow-up:** Response to validated significant threshold shift involves recording in worker's record, revising baseline, refitting and retraining worker, and consideration of assignment to a less noisy area.

- **Exit Audiogram:** Within 30 days of leaving employment or removal from job, under the same conditions as the baseline audiogram.

- **Training:** Annually for all workers who are exposed to noise at or above the REL.

- **Topics:** The physical and psychological effects of noise and hearing loss; hearing protector selection, fitting, use, and

care; audiometric testing; and the roles and responsibilities of both employers and workers in preventing noise-induced hearing loss.

- **Format:** May vary from formal meetings to informal on-the-spot presentations. One-on-one training is particularly suitable, especially at the time of the annual audiogram.

- **Program Evaluation Criteria:** Analyze records to look for calibration errors, defective earplugs, susceptible groups of workers; monitor rate of significant threshold shift.

- **Recordkeeping:** Exposure records and surveillance records for length of employment plus 30 years.

The customers for NIOSH recommendations by statute are OSHA and MSHA. In practice, the Department of Defense and many corporations have initiated program changes consistent with the NIOSH criteria document recommendations. Most developed countries have also adopted the NIOSH recommendations. And, for exposure the Threshold Limit Values of the American Council of Governmental Industrial Hygienists mirror the NIOSH recommendations.²²

OSHA, MSHA and other federal agencies are not required to initiate rule making in response to a new NIOSH criteria document. They are, however, required to consider the NIOSH recommendations once they begin the rule-making process. While the upcoming MSHA Health Standards for Occupational Noise Exposure in Coal, Metal, and Nonmetal Mines may not adopt all or any of NIOSH's recommendations, the agency must explain its rationale for such decisions.

Until OSHA and EPA open the regulatory process for revision, NIOSH's 1998 recommendations will have no regulatory impact. Consequently, American industry will be driven by regulatory compliance instead of by prevention. ♦

administrative, where the agency is working to assure acceptance of the regulation without legal challenge upon its release.

There has been no response from the EPA to the recommendation of the Hearing Protector Task Force of the *National Hearing Conservation Association (NHCA)* to use a NRR based on the new subject-fit method, ANSI S12.6-1998, *Method for Determining Real-Ear Attenuation at Thresholds for Hearing Protectors*.²¹ The EPA has no noise program and it is unlikely that the Agency will reopen the hearing protector labeling regulations. ♦

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