

Effective prevention of hearing loss in miners

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In the October 1998 issue of the Holmes Safety Association Bulletin, NIOSH authors Mark Stephenson and Carol Merry wrote the article **Hearing loss among miners and measures to protect hearing** which focused on the extensiveness of hearing loss among miners and the use of hearing protection to prevent hearing loss. While the primary importance of engineering controls in preventing hearing loss was discussed, since miners do not generally have control over their work environment or assignments, the article focused on the importance of consistent use of hearing protection. In this article, all aspects of a comprehensive approach to the prevention of hearing loss in miners will be covered. The discussions will do the following:

- describe application of the hierarchy of controls in preventing hearing loss in miners,
- give an example for each type of control measure and its impact,
- explain the major provisions, beyond the hierarchy of controls, of the recent NIOSH document entitled **Criteria for a Recommended Standard: Occupational Noise Exposure, Revised Criteria 1998** relative to a hearing loss prevention program, and
- summarize important points on control of noise exposure for every miner to remember.

Noise in the work environment and miners' behaviors

Mining is a capital intensive industry which requires utilization of large

equipment in most facets of operations. Miners are well aware of noisy areas in or around equipment, including extraction machinery such as draglines, power shovels, longwall shearers, and continuous mining machines; powered haulage equipment such as load-haul-dumps, shuttle cars, large trucks, and continuous haulage units; roof bolting machines; jackleg drills and stopers; auxiliary equipment such as compressors, fans, and pumps; size reduction equipment, etc. They are not well aware of the insidious nature of progressive hearing loss, which is permanent, but they are generally aware of what levels of noise are hazardous and what measures can be taken to reduce their personal noise exposure. Behaviorally, however, there are many reasons why miners choose not to use hearing protection faithfully.

There are many cues in mining workplaces on which miners depend to extract ore, load and haul it, process it for market, and provide operational support safely. Listening for important noises in machine components which may indicate potential malfunction, for low-pitch "groans" of strata above the immediate roof in retreat mining, and for important communications from co-workers are examples. Also, it is human nature to want to finish personal conversations even after equipment has restarted following a pause in operations. Additionally, some miners simply do not like to have plugs in their ears or extra weight from ear muffs on their caps.

Since it is very difficult to control human behavior continuously, and since short periods of exposure to high noise levels on a regular basis can cause hearing loss, it is important that noise, first and foremost, be engineered out of the workplace. In a mine with hazardous noises removed or with noise controlled at its source, it would not be important to wear hearing protection at all times to prevent hearing loss. It is not always possible to engineer all exposures out of the work environment though, and thus a hierarchy of control methods is used to successively address them.

Hierarchy of controls

In order to prevent occupational hearing loss effectively under many different work situations and conditions, a comprehensive program must be employed incorporating noise control measures based on a hierarchy of control. The most effective control is placed highest in the hierarchy. According to effectiveness, the hierarchy of control measures follows:

- engineering control,
- administrative control,
- control of work practices, and
- control by use of protective equipment.

Each of the different types of control will be described next, and an example of each, with its impact, will be given.

Engineering control—If potentially harmful noise levels can be engineered out of the workplace, then hazardous exposures to miners would be virtually eliminated and

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mine-related noise-induced hearing loss would be a thing of the past. That is why the use of control measures is given highest priority. Examples of engineering controls would be:

1. using equipment designed to operate quietly by use of materials which absorb acoustic energy,
2. using mufflers on tools like stoppers,
3. using shock absorbers or vibration mounts to control vibration,
4. isolating the miner from the noise source using a cab or specially-constructed room,
5. construction of other barriers between the noise source and the miner, and
6. employing a maintenance system which maintains lubrication and tightens vibrating components on machines.

If the noise level near a machine where a miner works is reduced from 90 dBA to 84 dBA, then there is reduced exposure for the miner and the long-term impact is reduced occupational noise-induced hearing loss. If, however, the noise level can only be reduced from 100 dBA to 90 dBA using best engineering controls, then additional control measures can be invoked to further reduce the noise to less than the NIOSH Recommended Exposure Limit (85 dBA). The additional control measures will be described next.

Administrative control—Even when the best available engineering controls for a particular mining situation have been employed, miners may still be exposed to hazardous noise levels. The next most effective method to control exposure is administrative controls taken by management.

Under the NIOSH *Criteria for a Recommended Standard: Occupational Noise Exposure, Revised Criteria 1998*, the maximum time a miner may be exposed

to a given noise level above 85 dBA is specified. In applying administrative control, management may control the time of exposure for each miner over a full shift by switching miners among jobs or tasks. By doing so, however, management must ensure that multiple miners are not exposed beyond maximum time limits.

An example application follows using the NIOSH noise-exposure recommendations. If a miner works near a machine at a location that realizes 88 dBA, a maximum of four hours of exposure would be allowed. After four hours, the task could be suspended until the next shift or another miner could be assigned to finish the task during the last four hours of an eight-hour shift.

Control by changing work practices—If best available engineering and administrative controls have been implemented, then further control of noise exposure to a miner in a work situation may be attained by changing work practices. This could be accomplished by moving a miner farther from the noise source, under certain conditions, or by modifying job tasks such that the miner is not exposed to noise levels beyond time limitations.

Noise intensity diminishes as a person moves farther from the noise source (by a law of physics); but this relationship doesn't generally apply in a closed space near a large noise source. Thus in the underground mining environment, it would be difficult to achieve a substantial reduction of noise exposure even if, for example, remote control were used to operate a continuous mining machine. The situation is different in many work environments at surface mines or plants/mills. If a miner works in an open area, then significant reduction in noise exposure can be realized by

moving farther from the noise source. In some settings, it may be possible to operate a machine remotely and place a transparent barrier between the miner and the noise source, which can be very effective in reducing noise exposure.

When a miner is exposed to multiple noise sources, a noise survey can be taken to determine which sources in his work cycle caused the exposure. Once the noise sources have been pinpointed, say in a coal preparation plant, then management can ensure that the miner does not perform tasks for too long a period near the sources. In this way, overall compliance can be achieved.

Control by use of hearing protection—After all other controls have been applied, if the work environment still exceeds noise standards, then the only remaining noise exposure control method is the use of hearing protection. Even if other controls have been implemented, miners should still wear hearing protection in noisy areas. Details on the selection and use of hearing protectors were covered in the October 1998 Holmes Safety Association Bulletin article by Drs. Stephenson and Merry.

Even if hearing protectors are available, important guidelines must be followed for miners to accept them and wear them consistently (also covered in the October article). Further, the effectiveness of a hearing protector depends on its characteristics and how the miner wears it. It is important to realize that noise reduction ratings (NRRs) of hearing protectors may differ substantially, a specified NRR for a given protector may be overstated for different conditions of use, and some protectors are much more effective than others.

Other major provisions of a hearing loss prevention

program

Besides the hierarchy of controls described above, the NIOSH noise criteria document recommends standards for a hearing loss prevention program including noise exposure assessment, medical surveillance, hazard communication, training, program evaluation criteria, and recordkeeping. Each is explained briefly next. NIOSH encourages miners to participate actively in hearing prevention programs, which can effectively monitor their hearing and ensure that timely preventive actions are taken to protect their hearing over a working career.

Noise exposure assessment—In the noise criteria document, NIOSH recommends that employers be required to conduct assessments of noise-exposed miners using a specific American National Standards Institute standard. Noise exposure is to be measured without regard to use of hearing protectors. Initial monitoring is required to determine miners who will be included in the hearing loss prevention program, while periodic monitoring of the noise, at least every two years, is required for those sources of hazardous noise.

Medical surveillance—In the noise criteria document, NIOSH recommends that “employers shall provide audiometry (hearing exams) for all workers whose exposures equal or exceed 85 dBA as an 8-hour” time-weighted average, which places them in a hearing loss prevention program. The audiometry includes the following:

- a baseline audiogram before employment or within 30 days after employment for all workers who must be enrolled in the hearing loss prevention program,
- annual audiometric monitoring tests for all miners enrolled in the hearing loss prevention program, with an optional retest when

the monitoring audiogram detects a change in a hearing threshold level in either ear that equals or exceeds 15 dB at 500, 1000, 2000, 3000, 4000, or 6000 Hz,

- a confirmation audiogram within 30 days after a monitoring audiogram detects a threshold shift in hearing,
- a review by an audiologist or a physician if a persistent threshold shift has occurred,
- the recording of the threshold shift as a significant threshold shift if the review validates it, along with establishment of a new baseline audiogram,
- employer action to protect the affected miner from further hearing loss, and
- an exit audiogram for a miner who is leaving employment or whose job no longer involves noise exposure.

During the above-described process, miners shall be notified of findings. During review, in cases where hearing loss is found to be not occupationally related, miners shall receive counseling for future actions.

Hazard communication—In the noise criteria document, NIOSH recommends that clearly-visible warning signs be placed at the entrance to or near work areas where noise exposures exist. It also recommends that all miners who are exposed will be informed of the potential consequences of noise exposure and the methods to prevent noise-induced hearing loss.

Training—The NIOSH noise criteria document recommends that employers shall institute a training program in occupational hearing loss prevention for all noise-exposed miners. The employer must also ensure miner participation in the program, and the training program must be provided annually for

each miner in the hearing loss prevention program.

Program evaluation criteria—Also recommended is a requirement for the effectiveness of the hearing loss prevention program to be evaluated at the individual miner level and annually on a programmatic level.

Recordkeeping—NIOSH further recommended that employers establish and maintain records on exposure assessment and medical surveillance.

Remember:

- **With hazardous noise exposures engineered out of the work place, there is little likelihood that occupational hearing loss will occur.**
- **If hazardous noise exposures persist after best available engineering controls have been implemented, then occupational hearing loss can be minimized by limiting the time of exposure to noise in the workplace.**
- **If engineering and administrative controls are not effective or are unfeasible, the next most effective measure to control hearing loss is change of work practices to reduce the time of exposure.**
- **Finally, properly-fitted, correctly-worn, and appropriately-selected hearing protection should always be used in the presence of a hazardous-noise workplace. Wear hearing protection: They're your ears!**