

## “CAN YOU HEAR ME NOW?”

### How to Preserve Hearing in the Concrete and Masonry Repair Environment

**C**oncrete and masonry repair, restoration, and strengthening involve tasks that produce dust, vibration, debris, and noise. These tasks generally involve altering an existing structure or substrate so as to provide an improvement or enhancement of the functionality or aesthetics of the structure. Concrete and masonry are generally hard surfaces that require aggressive mechanical means for demolition, surface preparation, and replacement. These procedures, including chipping, blasting, cutting, grinding, sawing, and pumping, use equipment and tools that generate loud noises, which can cause hearing loss.

#### WHAT WE KNOW ABOUT HEARING LOSS

Hearing loss is one of the most pervasive problems in today's occupational environment, affecting workers across a broad spectrum, including manufacturing, construction, transportation, agriculture, and the military. Approximately 30 million American workers are exposed to hazardous noise levels. At present exposure limits, one in four will develop a permanent hearing loss as a result of their occupational exposure to these hazards. The gradual progression of hearing loss due to noise may be less dramatic than an injury resulting from a workplace accident, but it is a significant and permanent issue for the affected individual. Loss of hearing denies people sensory experiences that contribute to the quality of their lives. For some, loss of hearing

may impede their ability to be gainfully employed. The good news is that occupational hearing loss is preventable.<sup>1</sup>

When an individual's 8-hour, time-weighted average (TWA) exposure to sound exceeds 90 decibels (dB), OSHA requires that feasible engineering and/or administrative controls be used. If such controls fail, personal protective equipment (PPE) should be provided and used to reduce sound exposure. However, OSHA Section 1910.95(c)(1)<sup>2</sup> goes on to say that “the employer should administer a continuing, effective hearing conservation program whenever the employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels...” While employers must provide engineering controls and/or PPE when sound levels exceed 90 dB, they must also administer a continuing, effective hearing conservation program when the sound exposure equals or exceeds 85 dB (“action level”) in an 8-hour period.

#### EXPOSURE LEVELS

The loudness of sound is measured in dB. The sound intensity with an “A” contour filter is called dBA. The filter adjusts the measurement to account for the way in which the ear responds to different frequencies of sound.<sup>3</sup> But what does 85 or 90 dB really mean? The following table shows common sounds and their associated sound levels.<sup>4</sup>

This is the second in a series of papers developed by ICRI Committee 120, Environmental Health and Safety, to provide information that the industry can use to improve the awareness of common job-site hazards while providing guidance on regulatory requirements and recommendations for solutions. The initial white paper, “Silica in the Repair Environment: What You Need to Know about the Issues and Solutions,” was published in the September/October 2009 *CRB*.

This paper focuses on hearing conservation. It describes how the ear works and how hearing can be damaged, with specific emphasis on tasks that are common to the repair industry; Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) regulations related to hearing; and recommended means of protecting the hearing of the workers, inspectors, and other parties.

ICRI Committee 120 is committed and dedicated to enhancing the safety and health of the worker while minimizing the impact on productivity, along with environmental considerations. We believe that a well-planned project, staffed with an informed workforce trained in the methods of occupational safety and health, will achieve a high level of productivity and quality.

20 dB	Ticking watch
30 dB	Quiet whisper
40 dB	Refrigerator hum
50 dB	Rainfall
70 dB	Washing machine
80 dB	Alarm clock (2 ft [0.6 m] away)
85 dB	Average traffic
100 dB	Blow-dryer
105 dB	Power mower, chainsaw
110 dB	Screaming child
120 dB	Rock concert, thunderclap
130 dB	Jet engine plane (100 ft [30.48 m] away)

Noise exposure for various work tasks within the construction industry has been measured as shown in Table 1. Tasks are shown in order of increasing average noise level.<sup>5</sup>

In addition, exposure to various tools was also measured and is presented in Table 2. Tools are shown in order of increasing average noise level.<sup>5</sup>

The average noise levels exceeded 85 dBA (the OSHA action level) for every tool used.

## HOW YOUR EAR WORKS

The ear is a very complex and delicate structure that can be damaged by loud noise. The most important structures involved in hearing are shown in Fig. 1. The outer ear may provide a modest (10 dB) amplification of sounds at the upper range of speech-processing frequencies. The middle ear provides an additional 20 to 30 dB of mechanical amplification by coupling the eardrum to the oval window into the fluid-filled inner ear. The 20 to 30 dB of amplification is approximately the difference in sound intensity between a whisper and normal conversation.<sup>6</sup>

The inner ear plays a vital role in the transformation of these mechanical vibrations into electrical impulses—or signals—which can be recognized and decoded by the brain. When the vibrations reach the cochlea through movement of the bones in the middle ear, the fluid within it begins to move, resulting in a back-and-forth motion of tiny hairs (sensory receptors) lining the cochlea. This motion results in the hair cells sending a signal along the auditory nerve to the brain. The brain receives these impulses in its hearing centers and interprets them as a type of sound.<sup>6</sup>

Hearing loss can be permanent if loud sounds damage or destroy the delicate ear cells in your inner ear, called *cilia*. Once these cells are damaged or destroyed, they cannot be repaired.

## YOU CAN PROTECT YOUR HEARING

Noise-induced hearing loss is 100% preventable but, once acquired, hearing loss is permanent and

TABLE 1: WORK TASKS

Task	Average noise level, dBA	Maximum noise level, dBA
Layout	80.1	103.1
Manual material handling	82.7	106.5
Interior finish	85.2	110.5
Operating forklift	85.3	114.6
Finishing concrete	85.3	114.7
Grouting	86.1	116.0
Wood framing	86.5	112.8
Placing concrete	91.5	116.6
Formwork	92.1	115.8
Rigging	92.6	128.6
Demolition	99.3	112.1
Chipping concrete	102.9	120.3

TABLE 2: TOOLS

Tool	Average noise level, dBA	Maximum noise level, dBA
Screw gun, drill motor	85.8	112.5
Hand power saw	87.9	107.3
Chop saw	88.2	114.2
Hammer, mallet, and sledge	90.2	116.4
Rotary hammer	95.8	113.4
Chipping gun	103.0	119.2

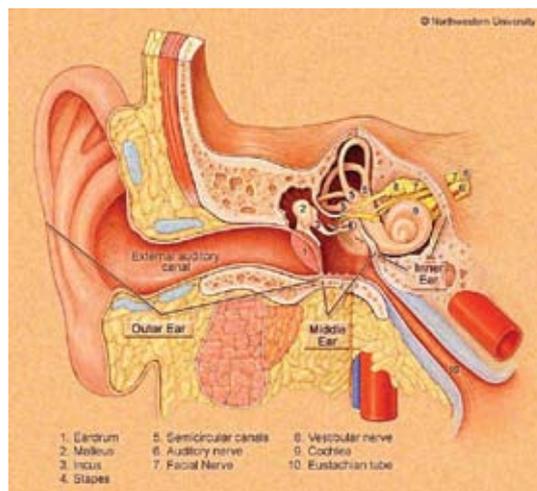


Fig. 1: Inner ear anatomy<sup>6</sup>

irreversible. Therefore, prevention measures must be taken by employers and workers to ensure the protection of the worker's hearing.

Hearing loss prevention programs are required by federal and state occupational safety and health agencies. Companies that do not comply with appropriate regulations are liable for citations and fines. Most employee compensation insurance carriers also advocate hearing loss prevention programs, and companies that do not protect their

employees from hearing loss may find their premiums increasing. Aside from the legal and economic factors, conscientious employers will want to protect their employees from an unnecessary loss of hearing. Today, there is no reason why hearing impairment needs to be the outcome of a noisy job. A good hearing loss prevention program is good business. It promotes good labor relations because employees know that management is concerned, and this type of concern may translate to improved productivity and product quality. Indeed, noise itself can have an adverse effect on productivity. For complex jobs and those requiring concentration, studies show that greater efficiency is linked to lower noise levels. Also, the ease and accuracy of communication is improved as noise levels are lowered. These benefits should prove to be cost-effective for management.

The conservation of hearing leads to the conservation of valuable employee resources. Studies of companies that perform noisy work that have implemented hearing loss prevention programs show reductions in injury rates, illnesses, and lost time. Versatility, adaptability, and promotability of employees are likely to be maintained when employees retain good hearing. Finally, morale may also benefit, which should lead to greater employee satisfaction and retention.<sup>1</sup>

### HEARING CONSERVATION PLAN

A good hearing conservation plan generally consists of these identifiable elements<sup>1</sup>:

- Monitoring hearing hazards;
- Engineering and administrative controls;
- Audiometric evaluation;
- Personal hearing protective devices;
- Education training;
- Recordkeeping; and
- Program evaluation.

As with many safety initiatives, the level of commitment displayed by management is directly

**TABLE 3: PERMISSIBLE NOISE EXPOSURES**

Duration per day, hours	Sound level—dBA slow response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

related to the overall effectiveness of the program. A strong commitment to a hearing loss prevention program can be shown by following these policies<sup>1</sup>:

- Strive for excellence in the program rather than just meeting minimal requirements;
- Ensure that management and supervisors support hearing loss prevention goals and actively contribute to a safety climate that encourages and enables employees to engage in good hearing health practices;
- Integrate the program into the overall company safety and health program;
- Educate and motivate employees so that hearing loss prevention practices become an integral part of their behavior on and off the job;
- Designate a key person to coordinate implementation of the program;
- Strive for simplification and continuity of the program’s operating procedures;
- Involve employees in the process of developing and implementing hearing loss prevention programs;
- Establish quality assurance practices to make sure that all information used in the program is accurate and current; and
- Review the program’s effectiveness no less than annually and make modifications when needed.

### REGULATORY REQUIREMENTS FOR HEARING CONSERVATION

OSHA provides regulatory requirements for providing an effective hearing conservation program.<sup>7</sup> This requirement states that “in all cases where sound levels exceed the values shown herein a continuing, effective hearing conservation program should be administered.”

Section 1910.95(b)(1)<sup>2</sup> states: “When employees are subjected to sound levels exceeding those listed in this table, feasible administrative or engineering controls should be used to lower sound levels. If such controls fail to reduce sound levels within the levels of Table (3), personal protective equipment (PPE) should be provided and used to reduce sound to acceptable levels. It should be noted that noise levels above 140 dB can cause hearing loss after just one exposure.”

Section 1910.95(c)(1) goes on to state, however, that “the employer should administer a continuing, effective hearing conservation program whenever the employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels.” So while you must provide engineering controls and/or PPE when sound levels exceed 90 dB, you must administer a continuing, effective hearing conservation program when the sound exposure equals or exceeds 85 dB (“action level”) in an 8-hour period.

A **hearing conservation program** should consist of the following:

1. **Monitoring:** If an employee's exposure is equal to or exceeds an 8-hour TWA, the employer should develop and implement a monitoring program.
2. **Employee notification:** The employer should notify each employee exposed at or above 85 dB of the results of the monitoring.
3. **Audiometric testing program:** The employer should establish and maintain an audiometric testing program by making audiometric testing available to all employees whose exposures equal or exceed an 8-hour TWA of 85 dB.
4. **Baseline audiogram:** Within 6 months of an employee's first exposure at or above the action level (85 dB), the employer should establish a valid baseline audiogram against which subsequent audiograms can be compared. The baseline should be established at the time the employee is hired to avoid any dispute as to the timing of hearing loss. At least annually after obtaining the baseline audiogram, the employer should obtain a new audiogram for each employee exposed at or above 85 dB. Each employee's annual audiogram must be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a change has occurred.
5. **Hearing protection devices:** Employers should make hearing protectors available to all employees, at no cost to the employees, who are exposed to noise levels in excess of 85 dB or greater. Employers must ensure that hearing protectors are worn by an employee who:
  - (a) Is exposed to sound levels exceeding those in Table 1 (90 dB);
  - (b) Is exposed to 85 dB or greater and who has not had a baseline audiogram established within the first 6 months of employment; and
  - (c) Has experienced hearing loss as described in the OSHA standards.
6. **Review effectiveness of hearing protection devices:** Hearing protectors must reduce employee exposure to 90 dB or less. The adequacy of hearing protection effectiveness must be reevaluated whenever employee noise exposures increase to the extent that the hearing protection provided may no longer be adequate.
7. **Training program:** The employer should train each employee who is exposed to noise at or above 85 dB and the training program should be repeated annually. Training should include:
  - (a) The effects of noise on hearing;
  - (b) The purpose of hearing protectors and the advantages, disadvantages, and noise reduction of various types;
  - (c) Instructions on selection, fitting, use, and care; and

(d) The purpose of audiometric testing and an explanation of the test procedures.

8. **Recordkeeping:** The employer must maintain an accurate record of all monitoring and employee exposure measurements and audiometric tests.
9. **Record retention:** The employer must retain records required for at least the following periods:
  - (a) Noise exposure measurement records must be retained for 2 years; and
  - (b) Audiometric test records must be retained for the duration of the affected employee's employment.

## ENGINEERING AND ADMINISTRATIVE CONTROLS

When sound levels exceed 90 dB, engineering and administrative controls should be enacted to reduce the noise level exposure to the employees.

### ENGINEERING CONTROLS

Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard (Fig. 2). This may include erecting barrier or baffle walls to attenuate the noise and may also include effectively isolating the noise-producing element, such as a compressor or noisy equipment, from the work area. Demolition or other noisy equipment can be modified to include a muffler to reduce the noise output of the device. Robotic equipment may also be used to isolate the operator from the noise produced by the equipment and the impact of that equipment on the substrate.

### ADMINISTRATIVE CONTROLS

Administrative controls are changes in work procedures, such as written safety policies, rules, supervision, schedules, and training, with the goal of reducing the duration, frequency, and severity of exposure to hazardous situations and may include managing the exposure of the employee by limiting the amount of time the employee is working in the noisy environment. This could be



Fig. 2: Restricting access to work areas with fencing

accomplished by rotating employees performing a certain noisy task or removing employees not directly involved with the performance of the task from the affected work area.

For example, the amount of exposure to noise and the potential for hearing impairment can be reduced by limiting the access of individuals to the noisy work areas. When tasks involving chipping, cutting, grinding, and drilling are occurring, it is desirable to limit access to the work area to those actually performing the work. By limiting the access and controlling the work, the contractor can better ensure that the proper PPE is used and that those individuals who do not need to be in the work area are far enough away from the noise source to limit their sound intensity exposure. The work area should be clearly separated from public areas by fencing, barricades, screening, or other boundary-forming devices. Appropriate signage warning of noise hazards and requirements for hearing protection should be erected around the work site.

## HEARING PROTECTION DEVICES

When engineering and administrative controls are not feasible in lowering noise exposure, hearing protection devices must be used.

### TYPES OF HEARING PROTECTORS

There are a variety of hearing protection devices available. The most commonly used in construction applications are earmuffs, expandable foam

earplugs, premolded reusable earplugs, and ear bands. Selection is based on several factors, including the expected noise exposure levels and the equipment's noise reduction rate (NRR). An NRR is a rating system that was intended to act as a simple guide for consumers and professionals to choose hearing protection devices. The NRR is the measurement, in decibels, of how well a hearing protector reduces noise as specified by the Environmental Protection Agency—the higher the NRR number, the greater the noise reduction. While wearing hearing protection, your exposure to noise is equal to the total noise level minus the NRR of the hearing protectors in use. The NRRs for the hearing protectors listed in the following were obtained from NIOSH.<sup>8</sup>

**Earmuffs**—These devices (Fig. 3) fit against the head and enclose the entire external ear. They are attached to a band that fits over the head or behind the neck or have a clip that attaches directly to a hardhat. Earmuffs generally provide an NRR between 20 and 30 dB and are often used in conjunction with earplugs to protect the employee from extremely loud noises. Earmuffs may not properly protect people with long hair, beards, sideburns, or glasses because they will not seal properly against the head.

**Expandable foam earplugs**—These (Fig. 4) are designed to fit snugly into the ear; when compressed and inserted correctly, they will expand to fill the ear canal and seal against unwanted noise.



Fig. 3: Earmuffs



Fig. 4: Foam earplugs



Fig. 5: Reusable earplugs



Fig. 6: Ear bands

Expandable foam earplugs offer an NRR of 20 to 33 dB. They are comfortable, easy to use, and very portable. They are inexpensive and can be purchased with or without attached cords. Expandable foam earplugs take more time and effort to insert correctly. Other types of ear protection may be more appropriate if it is necessary to remove protection frequently during a work shift.

**Premolded reusable earplugs**—Premolded earplugs (Fig. 5) are made from silicone, rubber, or plastic. They are available in a variety of sizes and have an NRR value range of 15 to 27 dB. Premolded earplugs are inexpensive, reusable, washable, and portable.

**Ear bands**—Ear bands are also known as “canal caps.” They are formable foam or premolded earplugs attached to a band that can be worn behind the neck, under the chin, or over the head. There is a wide selection of ear bands available with NRR values ranging from 15 to 27 dB, with most falling in the low to mid-20s range. Ear bands are convenient for people who move in and out of noisy environments, as they are easily removed and left to hang around the neck. They are not a good choice for continuous exposure.

## CHOOSING A HEARING PROTECTOR

Beyond the NRR, choosing the right hearing protector depends on several factors<sup>9</sup>:

- **Good seal:** Sound reduction is dependent on blocking any air leakage that will allow sound to bypass the hearing protector and enter the ear. For this reason, the hearing protector must fit properly, whether over the ear or in the ear.
- **Comfort:** Both comfort and convenience are important if the device is to be used consistently. The ease of placing and removing the device, as well as environmental factors, such as the presence of dirt or chemicals, must be considered.
- **Communication:** Hearing protectors often make communication difficult by reducing and distorting sounds. Employees who are hearing-impaired due to their protective equipment may prefer earmuffs so that they can lift up the muffs to hear speech rather than having to receive detailed face-to-face instruction.

It is important that employees maintain an awareness of general job-site hazards when wearing hearing protection, as the hearing protection will mute voice communication and other job-site sounds.

## MAINTAINING A HEARING PROTECTOR

Expandable foam earplugs must be replaced on a daily basis or whenever they become soiled. Using an unclean earplug may lead to an ear infection. Employees should be issued their own earmuffs; however, if earmuffs are used by more than one

employee, the earmuffs should be cleaned frequently. Earmuffs should be cleaned with soap and water. Earmuffs should be inspected regularly for signs of wear and tear; should defects appear, the device should be replaced. Premolded earplugs should be cleaned daily or as they become soiled or contaminated.

## HEARING LOSS PREVENTION MAKES FOR A BETTER WORKPLACE

The tasks associated with concrete and masonry repair often entail using tools, equipment, and procedures that require significant amounts of energy to alter the building material that requires the repair. Energy is required to drive the tools and equipment and is released upon impact with the substrate. This process produces high levels of noise, which can, with time and repeated exposure, cause permanent hearing damage.

The good news is that hearing loss is *not* an inevitable result of working in the construction industry. There are numerous options for controlling the noise levels absorbed by the ear. Noise exposure limits have been established by OSHA and NIOSH and hearing conservation requirements are well-defined. It is the responsibility of industry leaders to ensure that their employees are aware of the hazards associated with high noise levels and the solutions that are available to reduce the sound levels experienced in the ear of the employee. Hearing loss is preventable, and a well-executed hearing conservation plan will ensure that this type of injury does not affect an individual’s quality of life.

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