

Personal Safety Solutions for Hearing Conservation in Construction

Find useful information to help improve construction worker health and safety in environments with excessive noise. Explore how 3M can help you protect the hearing of workers with protective communication and hearing loss prevention solutions.



Every day, nearly one million workers globally suffer a workplace accident, and close to 6,300 people will die due to an occupational accident or disease—including many in the construction industry.¹ Through collaboration and science, we believe that together we can help change that.

Construction Safety. Backed by Science.

Head impact and eye injuries. Hearing and respiratory hazards. Falls from height and dropped objects. Construction workers face all of these and more day in and day out, so they rely on safety and health solutions from 3M to help keep them protected and comfortable.

Our approach goes well beyond providing quality personal protective equipment. With knowledgeable industry specialists committed to developing worker-inspired innovations, our team delivers new technology and in-depth training that can make a measurable impact on worker health and safety.



Technical service/application engineers and regulatory specialists worldwide



Countries with local standards professionals



Active patents on safety technologies



Training professionals & 15 training centers globally²



Introduction

Construction sites are loud. And yet often, they can be relatively quiet. Sounds and situations can change very quickly, and rarely are construction workers exposed to the same noise levels for the same amount of time from one day to the next.

Furthermore, construction sites tend to be very busy places with large vehicles and equipment moving around the worksite. Workers are challenged to remain alert to their surroundings while maintaining the ability to communicate with their coworkers.

About 51% of construction workers reported being exposed to hazardous noise and 14% have hearing difficulty.³ It's no mystery as to why people are taking a serious look at this issue. Reading the studies linked in this e-book will help you appreciate these statistics in their full context.

In certain situations, it can be challenging to find a hearing protection device (HPD) that will both help protect workers from hazardous noise while still allowing them to hear the critical sounds needed to perform their job safely and productively. In this eBook, we help you explore the auditory hazards, hearing protection and some innovative solutions that are available.

Table of Contents

Use the following pages to explore construction hazards related to noise, best practices for these applications and suggested PPE for each of your employees. It's important to remember that PPE should be considered the last line of defense in construction safety and health, as engineering controls (physical workplace changes) and administrative work practice controls should be established first to protect workers. When the safety and health of employees who work in loud environments is a priority, everyone on your team stands to benefit.

Working in Hazardous Noise on Construction Sites

Noise Hazards	5
Learn about construction worksite noise challenges, such as fluctuating, impulse and continuous noise.	

Best Practices	8
Discover ways to protect construction workers to help prevent hearing loss. Find information about practical measures to take today.	

Suggested PPE Options	12
Explore the personal protective equipment that can help make a difference in hearing conservation at your construction site.	

Communicating and Auditory Situational Awareness in Hazardous Noise on Construction Sites

Noise Hazards	15
Learn about working in high noise around cranes, moving equipment and paving operations.	

Best Practices	17
Discover ways to protect construction workers who are communicating in hazardous noise and surrounded by moving equipment. See new risk assessment techniques for your hearing conservation program.	

Suggested PPE Options	22
------------------------------	-----------

References	24
See references to sourced information.	



Working in Hazardous Noise on Construction Sites

When Noise Becomes a Problem

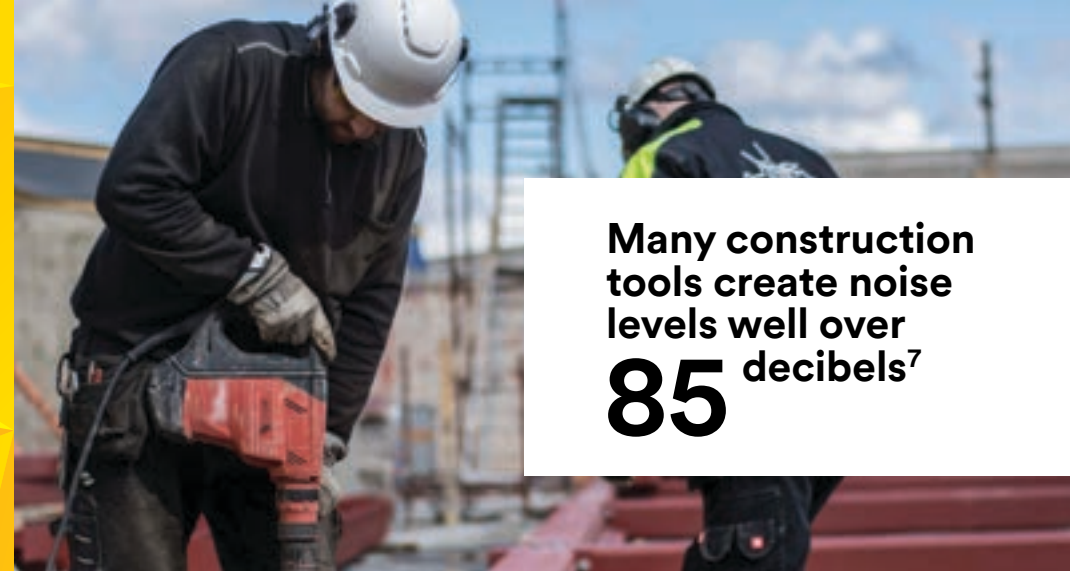
A longitudinal study found that 73% of construction workers were exposed to noise levels above the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit.⁴ With repeated exposure to hazardous noise, workers are at an increased risk of noise-induced hearing loss (NIHL). Remember, hearing loss can be permanent and can have a significant impact on a worker's quality of life, both on and off the job.⁵

How does this happen? As the American Industrial Hygiene Association points out, "Most construction tools and activities create noise levels well over 85 decibels... [This can include] highway and road construction; carpentry; power tool operations; pneumatic tool operation; heavy equipment operations; saws, drill and grinder operation; work near generators; sheet metal work; iron work; welding; operating engineer work; landscaping; residential

construction; and sand or abrasive blasting..."

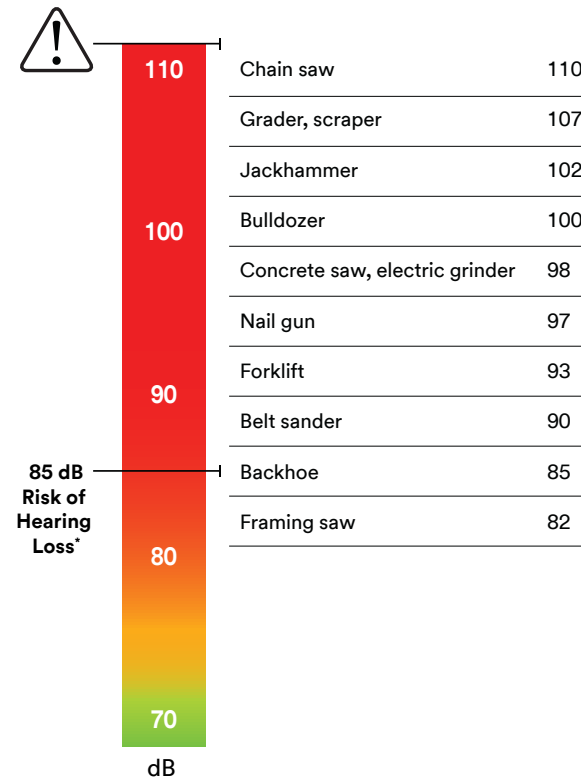
"Several [of these tools] can generate very high sound levels (130 to 140 decibels) that can cause damage to the ear instantaneously. Still, noise hazards tend to be overlooked on construction worksites: They are more often considered an annoyance or an obstacle to communication than an important health hazard. Noise-induced hearing loss is among the most common work-related illnesses in the United States. Each year approximately 30 million U.S. workers are exposed to noise loud enough to damage their hearing."⁶

73%
of construction workers
were exposed to noise
levels above the NIOSH
recommended
exposure limit.⁴



Many construction tools create noise levels well over **85** decibels⁷

Sound levels in Construction Operations, dBA^{7,8,9}



*Over an 8 hour TWA
(Time Weighted Average)

For more information visit the 3M Center for Hearing Conservation: www.3m.com/chc.

Minutes of carelessness per day significantly reduces the effect of hearing protection.

Hearing protectors need to be worn for the full time of noise exposure. Removing them for even a short time in a work day significantly increases the noise exposure. For example*, not wearing the hearing protector for one hour of an eight-hour work shift, essentially drops the effective protection from 30 dB to only 9 dB¹⁰. Minutes matter.

How much noise is too much?

There are many factors that impact how hazardous noise can be to your hearing. These include the noise level (or noise intensity), duration and exposure frequency. Any noise with a level at or above 85 decibels (dB or dBA) can be hazardous to a person's hearing.¹¹ A sound level meter makes it possible to accurately analyze the relative loudness of sounds using decibels as a measuring unit. A noise dosimeter is used to determine the average noise exposure over an 8-hour shift or over the duration of a particular task.

Many construction workers assume that noise is something they can simply get used to. Even when noise seems to be at a reasonable level, it can still lead to long-term damage. What some mistake as a higher tolerance to noise may actually be temporarily dulled hearing, or even permanent hearing loss. If you need to shout to communicate with a person

who is three feet away, it's likely that noise levels have surpassed 85 dBA.¹¹

Your ears may also provide signs of noise risks in your environment. Hearing a buzzing, ringing or whistling sound after being in noise may be a warning signal. This sensation is called tinnitus, and it indicates that the nerve cells of your inner ear may be irritated and overworked. Not only can tinnitus be annoying, it can become permanent.

Another warning sign is the muffling or softening of sounds after noise exposure. This may signal a temporary threshold shift. Going into loud environments without hearing protection repeatedly can turn this temporary health problem into a permanent one.

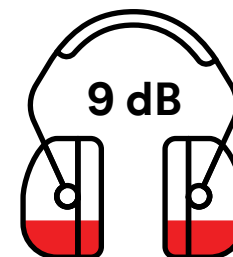


Effective protection drops when hearing protectors are not worn.

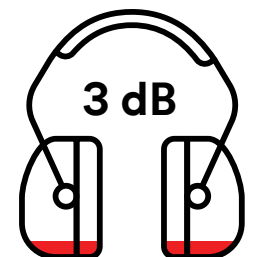
Worn 8 hours



1 hour not worn



4 hours not worn



*Exposure to 95 dBA of noise and using NIOSH Recommended Exposure Limit of 85 dBA and 3 dB exchange rate.

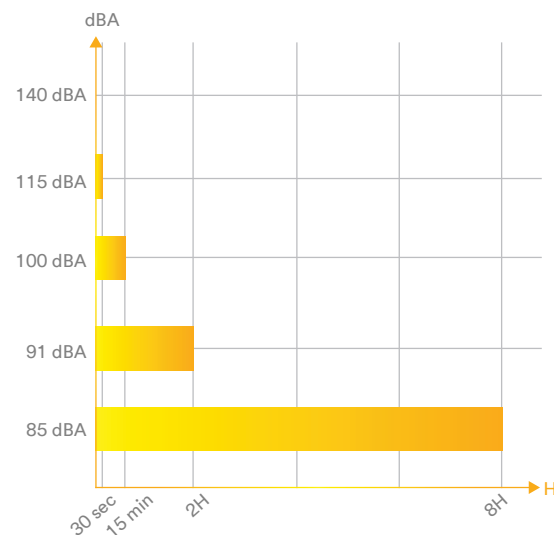


How quickly is the damage done?

Our hearing is vulnerable to hazardous noise. Hearing loss occurs when tiny hair cells in the inner ear are damaged.⁷ Hearing loss can be caused by a one-time exposure to an intense noise. Repeated exposure to sound greater than 85 dBA can cause permanent hearing loss and tinnitus—constant “ringing” in the ears. Not only does it impair the ability to hear other sounds, but noise exposure is also associated with headache, increased stress and fatigue.

It’s worth knowing that typically, hearing is damaged gradually. The accumulated damage may become perceptible after several years of working in noise. By then, the changes are likely to be irreversible. Fortunately, hearing damage due to noise is preventable.

NIOSH Daily Recommended Exposure Limits



Hearing loss affects more than hearing

We all love different sounds: the sound of a child’s laughter, a cat’s purring, a flowing river, a bird singing, music or a car’s finely tuned engine. All of us have just one sense of hearing, so we should protect it because hearing loss causes many additional consequences.

Hearing loss makes communication much harder. People with significant hearing damage often withdraw from the society, as they cannot participate fully, even in a simple conversation. It’s a life without bird songs that leads to loneliness and depression. Let’s protect our hearing to be able to listen to the sounds we love to hear.

Some employers have adopted the NIOSH Recommended Exposure Limit (REL) of 85 dBA TWA and a 3 dB exchange rate for estimating noise dose. The exchange rate is the change in sound level that results in a doubling of daily noise dose. To keep exposures under the daily dose as the sound level rises, the amount of time that workers can be exposed decreases, for example:

- At 85 decibels you may be exposed for 8 hours
- At 91 decibels you may be exposed for 2 hours
- At 105 decibels you may be exposed for less than 5 minutes
- At 115 decibels you may be exposed for only 28 seconds
- At 140 decibels immediate hearing damage and pain is possible

 **16%**

of US construction workers exposed to noise have hearing impairment in both ears¹²

 Approximately **7%**

of construction workers in the US have tinnitus¹³

Controlling Noise in Construction

Compared to general industry, controlling noise on construction sites may be more challenging for construction contractors. The work often occurs outdoors and may be impacted by weather. Loud moving equipment means that the location of a noise source moves around the site. Noisy tools result in significant sound levels and intensity fluctuations throughout the workday. Construction workers frequently receive hearing protection devices to help control exposures to loud equipment in a work area. However, personal protective equipment (PPE) should be used after engineering and administrative controls have been exhausted and proved infeasible. The Laborers' Health and Safety Fund of North America's (LHSFNA) [Controlling Noise on Construction Sites guide](#) offers several practical tips for contractors to implement.¹⁴

Practical and Effective Noise Control Methods on Construction Sites

Even though every project varies, and each day brings different tasks, reducing noise on construction sites remains a real possibility. Noise control solutions must be tailored for the situations often found in construction. Fortunately, there are a variety of ways by which construction equipment and worksite noise can be controlled. Engineering controls are considered the most effective way to modify a work area or equipment to reduce the noise levels. For example, consider using quieter equipment, retrofitting existing equipment with mufflers, damping materials or enclosing loud devices, installing barriers and maintaining noisy equipment. Administrative controls or work practice controls to help minimize exposures could include restricting access to noisy areas, shutting down loud equipment when it is not being used, moving workers farther away from the source of noise and job rotation.

Quieter equipment
may save up to

\$100

for every reduced dBA¹⁵



Six Tips for Controlling Noise on Construction Sites

The following is a list of ways to control noise levels in your worksites.*

1 Purchase Quieter Equipment

The National Institute for Occupational Safety and Health (NIOSH) suggests establishing a Buy Quiet program. Many manufacturers are making quieter tools. When purchasing new equipment, ask for quieter compressors, better made gears and other features that may reduce noise. To find helpful resources, consider reading NIOSH's [Buy Quiet](#) program overview page.

2 Modifying Existing Older Equipment

Older equipment can be modified with damping materials, sound panels or mufflers to help reduce sound levels. The US Bureau of Mines reported that one excavator was able to reduce the noise level from 80.5 dBA to 71.5 dBA with improved exhaust and intake muffling, fan disengaged and three sound panels around the engine.¹⁴

3 Maintenance

Keeping construction equipment in good working order not only makes it last longer, but also may help to make the work site quieter. Lack of maintenance can create or make noise hazards worse. For example, loose parts can create more noise because of scraping against other parts. Inadequate lubrication may cause grinding noises. It is especially important to properly maintain any noise control devices designed or added to machinery. Key areas that get noisier with use include: worn or chipped gear teeth, worn bearings, loose parts, poorly lubricated parts, imbalanced rotating parts, whistling noises from obstructed airways, blunt cutting blades, removal of mufflers, silencers, covers and isolators.¹⁴

4 Installing Sound Barriers

Placing barriers around noisy equipment on a construction site doesn't have to be complicated. Construction contractors can utilize commonly found materials such as plywood, stacks, block or spoils. It's also possible to build barriers with commercial panels. For further sound reduction, line the panels with sound-absorbing materials. The barrier's length should be greater than its height to maximize effectiveness. The barrier should be tall enough so that the noise-generating equipment is not visible and located as close as possible to the source of the noise or those that need to be protected.¹⁴

5 Set Up Noise Perimeter Zones

Establish noise perimeter zones (NPZ) as another administrative control to limit exposure to noisy processes or equipment to as few workers as possible. Determine which areas of the construction site have noise levels that are 85 dBA or above. The area can be roped off and marked "Noisy Area - Hearing Protection Required" in the same way that a "Hard Hat Area" is marked off. All workers who need to work within the zone must wear hearing protection, and the ropes help limit any workers not needed in this area.¹⁴

6 Work Activity Scheduling

Jobs can be rotated to help limit exposure time. Consider transferring construction workers from high noise exposure tasks to lower exposure tasks to help make the employee's daily noise exposure acceptable. If job rotation is not possible, it can be beneficial to adjust work scheduling to reduce the number of exposed employees in areas surrounding loud tasks, like pavement breaking operations. Another option is switching off noisy equipment when not in use and only run when necessary.¹⁴



*Not an exhaustive list.



Personal Protective Equipment Considerations

Is Dual Protection Required?

Many construction tasks such as jack hammering, scraping or piling can exceed 100 dBA. NIOSH recommends that workers whose 8-hour TWA exposures exceed 100 dBA or any workers who may be exposed to any single impulse noise level exceeding 140 dBA should wear dual hearing protection. Dual hearing protection is wearing both earmuffs and well-fitted earplugs simultaneously.¹⁶

When using two forms of hearing protection, regulators allow adding 5 dB to the highest Noise Reduction Rating (NRR) of the two devices. For example, if the earplug has an NRR of 30 and the earmuff has an NRR of 20, the resulting NRR of wearing both simultaneously is 35 dB.* Dual protection can help extend the time that a worker can work in high noise, however it may also reduce the worker's ability to hear warning sounds or communicate.

*U.S. EPA specifies the NRR as the measure of hearing protector noise reduction. However, 3M makes no warranties as to the suitability of the NRR for this purpose. 3M strongly recommends personal fit testing of hearing protectors. Research suggests that users may receive less noise reduction than indicated by the attenuation label value(s) on the packaging due to variation in fit, fitting skill, and motivation of the user. Refer to applicable regulations and guidance on how to adjust attenuation label value(s). It is recommended that the NRR be reduced by 50% to better estimate typical protection.



Dual hearing protection is wearing both earmuffs and well-fitted plugs simultaneously.

Fit Testing

Hearing protector fit testing is the measurement of the amount of noise reduction, or attenuation, a hearing protector provides while it is being worn by a specific individual. This real-world measurement is referred to as a "Personal Attenuation Rating" or PAR. The purpose of hearing protector fit testing using a Field Attenuation Estimation System (FAES), is to verify that the attenuation is adequate for the individual and to help validate hearing protectors that can be used successfully in his or her work environments. A laboratory-derived NRR rating is calculated from attenuation data from a panel of ten test subjects, whose hearing protector was fitted by the lab technician. Comparatively, PARs tell us how much attenuation a particular hearing protector model is providing when fitted in the actual user's ear, by the actual user.

US Federal OSHA has recommended fit testing as a best practice in hearing conservation since 2008. In Canada, according to Clause 9.6.1 of CSA Z94.2-14, a FAES can be utilized with individual workers for improved accuracy in HPD assignment.¹⁷ A new American standard was published (ANSI/ASA S12.71-2018) that contains criteria that equipment manufacturers should apply to their hearing protection fit-test systems to help ensure accurate measurements and transparent reporting of results.¹⁸ Evidence shows that use of fit testing can help identify workers who may be at risk of developing noise-induced hearing loss.¹⁹ With each new hearing protection recommendation, standard, regulation and eye-opening statistic, it's clear that fit testing is an excellent solution to help protect your workers. Learn more about the importance of this process in the [Fit Testing eBook](#).

Personal Protective Equipment Considerations

Why is Fit Testing Needed?

It comes down to the fact that no one shares the same set of ears. Everyone has their own unique ear canals—that's why there can be a large range in attenuation achieved by individuals in the workplace using the same model of hearing protector. Even if you give everyone a high NRR earplug, you should expect they won't all receive the same attenuation. Plus, there's the issue of inserting hearing protectors properly. One study found that out of 327 experienced users tested, 30% were not properly protected—putting them at risk of noise-induced hearing loss. It also found that 17% had to be retrained before achieving an adequate fit. Without fit testing and training, those workers could have suffered NIHL.²⁰

The positives are clear—fit testing can help enhance your hearing conservation program. Are there negatives? Not really, even if there's concern about the initial cost of implementation. Reducing incidents of noise-induced hearing loss not only saves money in the long run—it saves people's hearing—and that's priceless.

How Does Fit Testing Work?

There are different types of fit test systems, but in general, the worker selects the hearing protector normally used, and then it is tested on the worker to learn how much noise reduction it provides. Some of the systems are subjective, meaning that the worker must respond to a sound. Other systems are objective and don't depend on the worker's hearing or ability to take a test. The point is the attenuation or protection provided is determined for the individual worker the way the worker typically uses the tested hearing protector.

Research Supports Hearing Protector Fit Testing

Recent research shows many advantages to hearing protector fit testing, including:

1. Reduced likelihood of hearing loss²¹
2. Improved use of hearing protectors²²
3. Ability to evaluate attenuation when combined with other Personal Protective Equipment (PPE)²³

See [Why Hearing Protection Fit Protection Matters](#) video for more information.



Identify Workers at Risk

Even though turnover is traditionally high in the construction industry, it is still critical to identify workers who may be at risk for noise induced hearing loss. Fit testing can help you quickly identify workers at risk of under protection. With fit testing and training, they can improve their PAR and maintain it over time. In one study, the [3M™ E-A-Rfit™ Dual-Ear Validation System](#) was used to conduct fit tests on workers. Data was collected during two plant visits approximately six months apart. Participants included 327 workers—85% male with 10+ years of experience and 70% were 40 years of age or older. They had never experienced fit testing prior to this study. The study concluded that fit testing can help identify workers who are at risk for NIHL. Additionally, the study highlights the benefit of training individual workers on the correct use of hearing protectors.²⁴

See the [Fit Testing eBook](#) for more information.

Passive Earplugs and Earmuffs

Conventional Attenuation, Passive Earplugs and Earmuffs

The noise reduction provided by conventional attenuation devices is not affected by the noise exposure level. These are designed to provide the employee with a consistent amount of attenuation throughout the workday.

Disposable Foam Earplugs

The most widely used type of HPD. The soft foam is rolled into a compressed cylinder then inserted into the ear.

<i>Comfortable</i>	Conforms to the unique shape of ear canal
<i>Affordable</i>	Low price per pair
<i>Effective</i>	High noise reduction when worn correctly



3M™ E-A-R™ Classic™ Earplugs

Classic™ Earplugs meet wearer needs with soft, proprietary, energy-absorbing slow recovery foam and a cylindrical shape to help with in-ear comfort. Corded for easy short-term storage around the neck. Also available in [Small](#) and [Plus](#) size.



3M™ E-A-Rsoft™ Yellow Neons™ Earplugs

The 3M™ E-A-Rsoft™ Yellow Neons™ Earplugs feature a natural tapered shape and smooth texture for a more comfortable fit. Bright yellow color is designed to help make them easier to spot for compliance verification. Soft, slow-recovery foam helps make insertion easier. Available corded and uncorded.

Push-to-fit Earplugs

Soft foam tips with a flexible stem. No need to roll the foam tips before inserting into the ears.

<i>Easy to use</i>	Works well for employees who have difficulty rolling and inserting disposable foam earplugs
<i>Convenient</i>	Can be used when hands are dirty or when wearing gloves
<i>Comfortable</i>	Soft foam conforms to the unique shape of ear canal
<i>Cost effective</i>	Replace when signs of wear
<i>Effective</i>	Many models offer high noise reduction when inserted correctly



3M™ E-A-R™ Push-Ins™ Earplugs 318-1001, Corded, Poly Bag

The 3M™ E-A-R™ Push-Ins™ Earplugs are designed for hearing protection on noisy construction jobs. Fitting stems help for an easier insertion of the earplugs even when wearing gloves and help keep the earplug clean for workers with dirty hands. No roll-down required—all it takes is a push to insert the soft foam eartip into the ear canal. The EARform™ eartip has a smooth surface to help it slide easily into the ear canal. Noise reduction rating (NRR) 28db. CSA Class AL.

Reusable Earplugs:

Washable earplugs with flexible, elastic flanges attached to a stem.

<i>Less waste</i>	Can be reused many times
<i>Cost effective</i>	Replaced less often for lower cost long term
<i>Convenient</i>	Can be used when hands are dirty or when wearing gloves
<i>Versatile</i>	Material doesn't absorb moisture. Works well in wet conditions or when employees perspire heavily.
<i>Moderate attenuation</i>	Allows wearer to hear more sound when high Noise Reduction Rating (NRR) is not needed.



3M™ E-A-R™ UltraFit™ Earplugs

The 3M™ E-A-R™ UltraFit™ Earplugs are made with a triple-flange design to help contour to the different shapes and sizes of ear canals. This helps create a noise-blocking seal. Pliable material can be washed and reused, cutting down costs and extending the hearing protector's life.

Suggested PPE Options

► Working in Hazardous Noise on Construction Sites

Earmuffs

Earmuffs have rigid cups with soft plastic cushions that seal around the wearer's ears to block noise.

<i>Easy to use</i>	Most people learn to properly use them with little difficulty
<i>Convenient</i>	Quickly put on and take off hearing protection as needed
<i>Alternative to earplugs</i>	Some people prefer not to, or are unable to, wear earplugs



3M™ PELTOR™ X4 Earmuffs

The 3M™ PELTOR™ X Series Earmuffs are designed for comfort and moderate to high noise exposure during tough jobs where loud sounds are frequent. Available in Over-the-Head, Hard Hat Attached, and Behind-the-Head models, they are designed to adapt the requirements of the work. Featuring an adjustable cup that angles to help create a customized fit for the worker. Electrically insulated options available. The X4P3E hard hat attached has a Noise Reduction Rating (NRR) of 25 dB for moderate to high noise exposure. Low-profile cup design for improved compatibility with other personal protective equipment.

Banded Hearing Protector:

Soft foam or elastic tips held in place by a flexible band.

<i>Convenient</i>	Quickly put on and take off hearing protection as needed. Good choice for people who move in and out of noise.
<i>Versatile</i>	Wide variety of headband styles and types of ear tips
<i>Moderate attenuation</i>	Allows wearer to hear more sound when a high Noise Reduction Rating NRR is not needed



3M™ E-A-R™ Caboflex™ Model 600 Hearing Protector

3M™ E-A-R™ Caboflex™ band-style hearing protector features soft, conical tips that swivel for easier fitting and greater comfort. Silicone tips contain a foam core for an effective seal and good noise reduction. Flexible band can be worn under the chin for use with hard hats, ideal for construction workers with intermittent hearing protection needs.

Fit Testing Equipment:



3M™ E-A-Rfit™ Dual-Ear Validation System

The 3M™ E-A-Rfit™ Dual-Ear Validation System helps determine whether workers are receiving adequate protection from their hearing protector by measuring across 7 standard frequencies in under five seconds, providing a detailed report on the noise attenuation performance of earplugs or earmuffs and a pass or fail rating for each individual person based on the employee's personal attenuation rating and noise exposure.

[See demonstration.](#)

Communicating and Auditory Situational Awareness in Hazardous Noise on Construction Sites

Construction sites transition from extreme levels of noise to relative quiet, very quickly and quite often. Due to the extreme noise levels, safety managers commonly provide conventional passive earplugs and earmuffs with a high noise reduction rating (NRR) for their workers. While these hearing protectors can be an effective way to reduce exposure to hazardous noise, they provide the same amount of noise reduction regardless of the environmental sound level. So, when the noise quiets down, workers may have more noise reduction than necessary, which may lead to overprotection.

Overprotection occurs when HPDs reduce sounds well below what is considered to be hazardous and may limit the wearer's ability to detect sounds or understand speech critical to performing the job safely. This may reduce worker productivity, or even worse, create other safety risks. If workers are not able to clearly hear the important sounds associated with their job, an unintended consequence may be that they are tempted to fit their hearing

protectors intentionally poorly or remove them altogether. Wearing HPDs improperly or inconsistently, even for a short period of time, can be hazardous and could lead to a higher risk of permanent noise-induced hearing loss.

Moreover, hearing-impaired workers may be at a particular disadvantage when using high NRR, passive hearing protection because the added attenuation may further reduce their ability to detect sounds and understand speech. It is critical for people with hearing loss to protect their remaining hearing while also balancing their need to be connected to their environment. According to US Federal OSHA, "Hearing-impaired workers face many challenges in the workplace, including communication, identifying and using suitable hearing protection, and the use of hearing aids at work. Industrial hearing conservation programs may not fully address the specific needs of hearing-impaired workers for hearing protection and communication."²⁵



Industrial hearing conservation programs may not fully address the specific needs of hearing-impaired workers



Why is auditory situational awareness important?

Many types of heavy equipment use auditory cues to communicate warnings to nearby workers. On construction sites, a warning sound such as a truck's reversal beeping noise can help workers become more aware of their surroundings.

The Health and Safety Executive (UK Government Agency) investigated 11 incidents between 1998 and 2015 which involved fatalities. One of the key areas of focus in any investigation is the potential of ineffective audibility of warning signals which can lead to serious accidents. In addition to focussing on use and limitation of any items of PPE, the accident investigation team also examined whether the PPE issued was worn correctly.

In some instances, conventional hearing protectors with rising attenuation from lower to higher frequencies can degrade speech signal. There are sophisticated electronic hearing protectors that can vastly improve signal recognition and communication in noisy environments.

The American Industrial Hygiene Association Construction Committee recently published "[Focus 4 for Health](#)" stated, "Communication is important in construction, and sometimes specialized hearing protection is a good solution. Active hearing protectors (with electronics), flat attenuation plugs (which do not cut out speech communication as much) and earmuffs with built-in communication systems are available."⁶

For these reasons, it is important to consider advanced hearing protection and communication solutions to help assist workers with audibility and communication. When workers are able to hear the signals that help enhance safety, they are more likely to maintain proper physical distances.

Crane Operator and Signal Person Communications

For those operating cranes or directing vehicle traffic in a work zone, miscommunications between the equipment operator and the signal person can be deadly.

According to US BLS from 2011-2015, 25% of fatal accidents involving cranes occurred in construction.²⁶ The ASME/ANSI B30.5-2018, “Section 5.3.3: Signals,” contains important best practices for crane operators and signal persons. The standard requires that the crane operator maintain continuous communication with the signal person during the operation of the crane. If communication is broken, all crane operations must stop until communications are restored. The communication can be accomplished by standard hand signals or voice communications. Voice communications can be accomplished using radios, telephones or equivalent. Weather, sight distances and noise from the site or radio interference from other cranes can interfere with communications.²⁷

Consider providing the signal person with hearing protection devices that help provide protection from noise, enhance communication with the crane operator and helps enhance awareness of the crane’s moving parts.

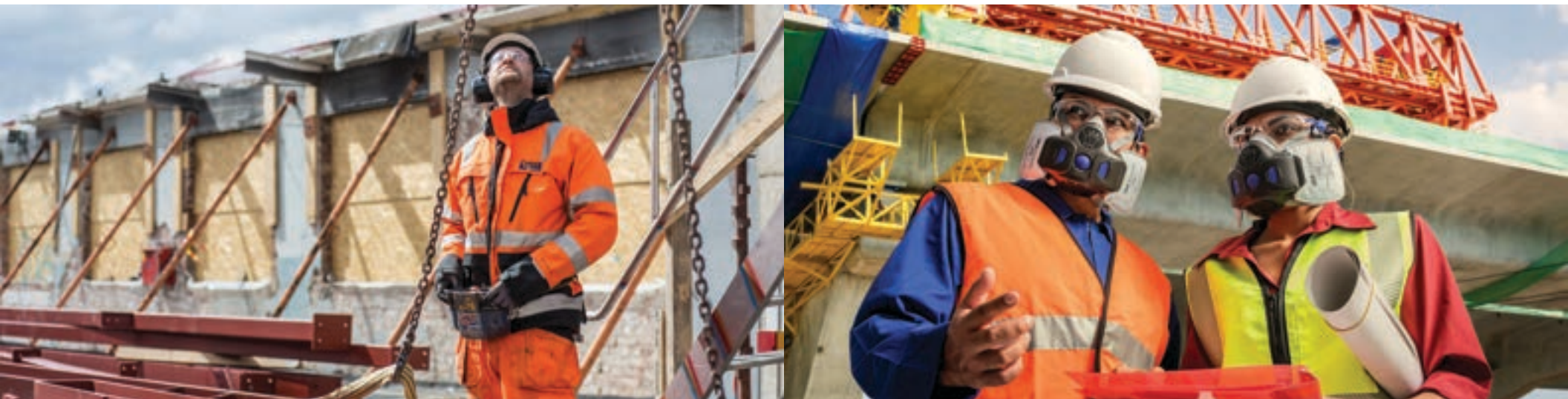
Communication Challenges During the COVID-19 Pandemic

Workers may need to work while physically distancing or while wearing face coverings. You are probably already aware that face coverings may pose communication challenges. But there are some recent studies worth noting.

Face coverings or masks make communication challenging in at least three ways:

- 1** A 2020 study conducted for healthcare environments highlights the first challenge. Masks can attenuate or reduce high frequencies. The amount of degradation depends on the mask, but there can be as much as a 12 dBA drop. This is especially significant because it is affecting the frequencies that most contribute to our ability to distinguish between consonant sounds, thus affecting our ability to understand speech.²⁸
- 2** Secondly, when we cover our faces, we lose our ability to see facial expressions and see each other’s lips. The American Speech-Language-Hearing Association urged the US Centers for Disease Control and Prevention to acknowledge the need for clear face masks for those who have hearing or other communication disorders.²⁹
- 3** And then lastly, it also turns out that wearing a mask can affect how you produce speech. Wearers continually raise their voices to be heard.³⁰

To help improve communications, consider using respiratory protection with speaking diaphragms or hearing protection devices that can help enhance communications.



Consider Audibility when Selecting Hearing Protectors

To go beyond the basics requires us to think a little differently about selecting hearing protection. In construction, acoustical environments are often dynamic and task based. The noise may be intermittent, fluctuate during the day or the source of noise may shift location. There may be periods of relative quiet, or a need to be aware of moving equipment, warning signals and alarms.

As a result, selecting hearing protection is more complicated than simply knowing the time weighted average or how loud the noise is. Besides the required regulatory elements based on assessment of the noise exposure and the attenuation capabilities or the NRR of the hearing protector, there are many other factors to consider. Focusing on only the required elements limits the opportunity to go beyond regulatory compliance and implement best practices.

In addition to the regulatory requirements, consider the following additional criteria for a more holistic approach to selecting hearing protection.

- **Fit and Comfort:** Each worker is a unique individual with unique ear anatomy, has differing ideas of comfort and may possess a different skill level for inserting earplugs.
- **Application:** Construction tasks may vary each day, and the working conditions and environment may be different (such as temperature, humidity, elements, etc.).
- **Compatibility with other PPE:** Construction tasks may often require the use of additional PPE such as hard hats, safety glasses, and respirators. Consider the compatibility with other PPE the workers are required to wear.
- **Hearing Ability:** Some construction workers may have pre-existing hearing impairment.
- **Audibility:** And finally, what about the worker's need for audibility and communication while they do their job duties?

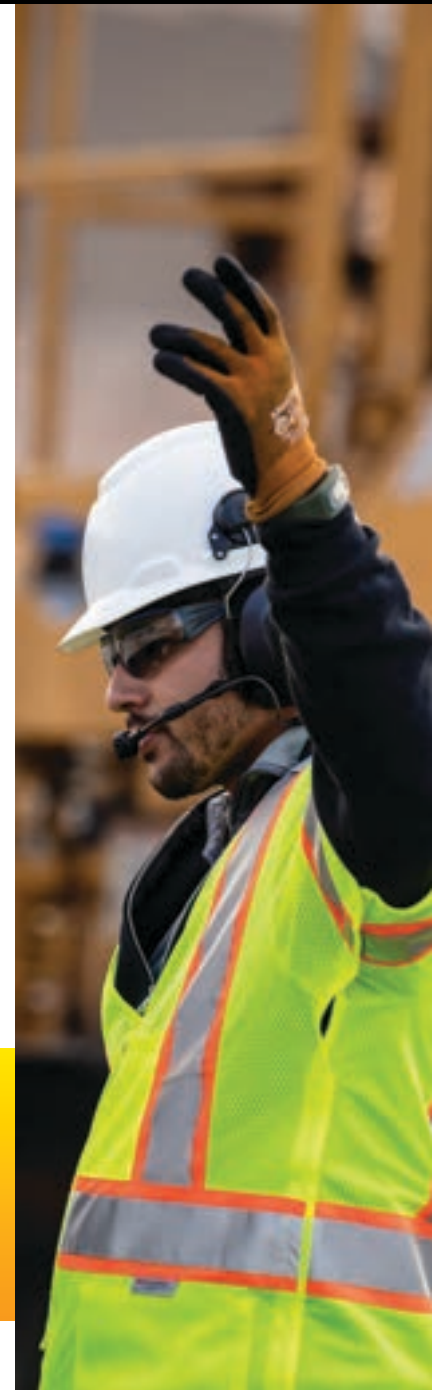
Audibility in Construction

In construction work, our auditory demands are significant. The ability to have auditory situational awareness may impact safety. The ability to communicate face-to-face and over radio may impact productivity and work efficiency. It may impact the quality of a person's work life. According to ANSI/ASA 3.71-2019, auditory situational awareness describes how people use auditory information and their other senses, to develop an understanding of their environment. Components of situational awareness include sound detection, distance estimation, sound localization, and ability to understand speech communication.

On a busy construction site, estimating the distance to moving equipment is crucial. For example, you can't determine the location of a sound before you detect it. Sound detection is critical. The other components of awareness may rely on additional systems or senses. When we hear a sound or noise, we naturally turn our head to look for the source of the noise.

The level of importance with each criterion varies with task, dynamic listening situation and industry. Not all factors are equivalent in all situations. As a hearing conservation program manager, are you evaluating the audibility and communication needs of your workers? Have you ever wondered if a worker's hearing protection device compliance is related to their audibility and communication needs? Consider an audibility risk assessment to help incorporate these additional criteria in your program.

The ability to have auditory situational awareness may impact safety





Audibility Risk Assessment

You may be inclined to review your hearing conservation or hearing loss prevention program from a risk assessment point of view. Consider these questions when you are reviewing your overall hearing conservation program:

- What is a “typical” hazardous noise exposure?
- What do workers need and want to hear while working?
- Are workers OK with reduced hearing due to hearing protection use?
- What is the impact of hearing protection on a hearing-impaired worker?
- What effects are your hearing protector selections having on safety? Productivity? Efficiency?

Observe Worker Communication

Look for people wearing hearing protection and using two-way radios:

- What happens if they can’t hear each other?
- Could improved communication help enhance productivity?

Look for the physical hazards: fork trucks, moving equipment, etc.

- What degree of auditory awareness is necessary to maintain safety?
- Could improved communication help reduce the potential for injuries?

After you identify the high-risk tasks, evaluate your noise, your worker’s hearing abilities and hearing protector attenuation by conducting hearing protector fit testing. Evaluate whether the HPD solution “works” for the worker!

Once this process is complete, incorporate audibility and communication in your Hearing Conservation Program. Apply the expanded HPD selection criteria.

Additional Considerations for Incorporating Auditory Situational Awareness and Communication in your Hearing Conservation Program



Identify Higher Risk Tasks

Warning signals/machinery need to be heard

Collision with a moving vehicle is possible

Communication is critical



Evaluate

Ambient noise frequency spectrum

Speech/warning signals frequency spectrum

Hearing protection attenuation

Workers' audiograms

Electronic communications



Incorporate in Hearing Conservation Program

Hearing Ability

Hearing Requirements

Fit

Engineering Controls

Take a proactive approach to hearing protection by considering every possible scenario related to noise and communication. When you ask important questions before construction work begins, you can better understand the possible hazards that may arise. As a result, it will be easier to choose the PPE that best suits your team's specific needs.

Productivity: Case Study Swedish Excavation and Pipe Installation Project

A [2015 study](#) of a Swedish company completing excavation and pipe installation activities demonstrated significant downtime reductions. The study showed that workers continued face-to-face, radio and cell phone communications without needing to leave noisy areas. Workers also reported that they could better hear warning sounds and equipment.³¹



Personal Protective Equipment Considerations

Advanced hearing protection and communication solutions, such as [PELTOR Protection & Communication Solutions](#), are among the most innovative ways to assist construction workers who work in very dynamic noise environments. The hearing protection attribute of these electronic or active devices is the same as their passive hearing protector counterparts, but this family of advanced products allows for additional capabilities to assist workers with audibility and communication on the job. Consider two categories of advanced HPDs: protective hearing solutions and protective communication solutions.

Protective Hearing Solutions

Protective hearing solution devices allow sounds to pass through when it is quiet, but also help provide hearing protection when it is loud with environmental listening technology—also called level-dependent technology. Environmental listening microphones can be found in both in-ear and over-the-ear products.

This category of products may help workers hear communications when they are exposed to intermittent, unpredictable or low to moderate levels of noise. Or when there are periods of quiet

or periods of quiet interrupted by impulsive noise. Environmental listening technology can assist workers who move between loud and quiet areas and assists if the workers need a heightened awareness of their surrounding due to moving vehicles, equipment or alarms. It is important to note that when you turn the electronics off, the device functions as a passive hearing protector. When the electronics are turned on, the worker can adjust the level of sound and even amplify the sound coming in through the environmental microphones. Just as amplification can help normal hearing workers with auditory needs, it may also benefit workers with pre-existing hearing impairments. However, these products are not considered hearing aids.

All [environmental listening safety products](#) should have circuitry, or an external sound limiter built into the device. PELTOR products use compression to limit the sound level through these environmental microphones down to around 82 dBA or lower in a continuous noise environment. Compression takes the auditory signal that the mic has picked up; keeps the signal but reproduces it and limits it lower than 82 dBA. Other manufacturers may use peak clipping where any signal above 82 dBA is clipped, which may result in a distorted sound output compared to a compressed signal. In the case of protective hearing products, a worker's protected exposure depends on the combination of the environmental listening

electronic circuit limiter and the amount of passive attenuation provided by the hearing protector.

Simply, how does environmental listening technology work? In quiet environments, sounds pass through. In loud environments, sounds coming in through the environmental microphones are compressed and reproduced down below 82 dBA or lower. Therefore, the protection becomes “level-dependent.” The protection against the noise coming in through the environmental microphones automatically adjusts as the noise level changes.

Protective hearing solutions give workers the ability to have face-to-face communication in low noise. Consequently, workers may be less tempted to remove their hearing protectors to hear and this may encourage workers to wear their hearing protection correctly and consistently.

Here are some resources to learn more about hearing protection options for the hearing-impaired worker:

- [US Federal OSHA safety and health information bulletin on Hearing Conservation for the Hearing-Impaired Worker](#)
- [Speech recognition in noise under hearing protection: A computational study of the combined effects of hearing loss and hearing protector attenuation.](#)

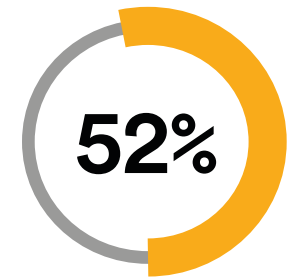


Personal Protective Equipment Considerations

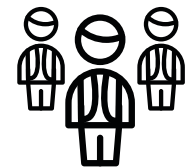
Protective Communication Solutions

Protective communication solutions are advanced HPDs that feature integrated two-way radios and/or wireless technology, along with noise-canceling speech microphones, and enable workers to communicate in high noise environments. In conjunction with the voice-operated transmission, workers can communicate hands-free so they can remain productive while communicating.

These advanced HPDs are smart hearing protectors that can not only help protect workers' hearing but may also improve the workers' ability to communicate in noise and/or hear the important sounds needed to do their job safely and productively. Ultimately, if workers are provided hearing protectors with an amount of noise reduction appropriate for their environment while also helping them communicate with their colleagues, they may be even more motivated to wear their HPDs continually and consistently. This factor may help to reduce the incidence of NIHL in the construction industry.



52% of construction workers with noise exposure do not wear hearing protection³²



25% of young construction workers 21 and under in British Columbia, Canada report not wearing hearing protection³³



3M hearing solutions are backed by science and incorporate innovative technologies. Explore 3M solutions in action in [this video](#).

Protective Hearing Devices

Environmental Listening (Level-Dependent) Technology

The noise reduction provided by level-dependent hearing protectors varies with the level of the noise. This type of protector provides more noise reduction at high noise levels and is particularly effective for:

- Intermittent or variable noise conditions: Helps make it easier for workers to maintain situational awareness without having to remove their hearing protectors.
- Impulse noises: Very short, loud sounds such as the blast of an arc flash or the bang of a pneumatic nail gun. To learn more about hearing protection for impulse noise, read [3M Technical Data Bulletin #234](#).

Level-dependent HPDs may be non-electronic (passive) or electronic (active). Electronic level-dependent HPDs feature environmental microphones to pick up low-level sounds. The wearer can adjust the volume of the incoming sounds for their preferred listening level.



[3M™ PELTOR™ Electronic Earplug, EEP-100](#)

Helps protect workers' hearing and can help promote auditory situational awareness and communications in challenging environments. External microphones help you hear communication and environmental sounds. Intuitive one-button operation powers earpiece on/off and selects volume level. The small and lightweight design helps improve the overall comfort and user experience and makes it compatible with most head borne PPE, such as helmets and face shields.

Protective Communication Devices

Protective communication solutions are advanced HPDs that feature integrated two-way radios and/or wireless technology, along with noise-canceling speech microphones, and enable workers to communicate in high noise environments. Using the voice-operated transmission, workers can communicate hands-free so they can remain productive while communicating.



[3M™ PELTOR™ LiteCom Plus Headset](#)

The 3M™ PELTOR™ LiteCom Plus Headset is a hearing protector with an integrated analog two-way radio and a noise-cancelling speech microphone to deliver a wireless, hands-free protective communication solution. The LiteCom Plus headset also includes the environmental listening technology that assists workers to hear environmental sounds in low noise and helps provide protection when it's loud.

Designed for use in equipment maintenance, crane operations, construction and many other applications in noisy environments, the LiteCom Plus Headset helps your workgroup communicate while helping provide hearing protection when workers are exposed to hazardous noise. Three buttons on earcup designed for simple and intuitive operation. The noise-cancelling microphone can be activated by pressing the Push-to-Talk button on the earcup or by using voice operated transmission (VOX). As you speak into the microphone, the channel is opened in milliseconds, allowing for near instantaneous, clear communication in noisy environments.

Choose the Appropriate Hearing Protection Solution

Selecting the appropriate hearing protection solutions depends entirely on your unique circumstances. The work site environment and your team's operational needs should factor into the decision. Every situation is different, so consider the factors below to help in your decision.



References

1. International Labour Organization, "Occupational safety and health", 2021. [Online]. Available: <https://www.ilo.org/moscow/areas-of-work/occupational-safety-and-health/lang-en/index.htm>. [Accessed 22 November, 2021].
2. 3M, "Science of Safety", 2021. [Online]. Available: https://www.3m.com/3M/en_US/worker-health-safety-us/safety-resources-training-news/science-of-safety/. [Accessed 22 November, 2021].
3. Kerns E, Masterson EA, Themann CL, Calvert GM. (2018). Cardiovascular conditions, hearing difficulty and occupational noise exposure within U.S. industries and occupations. *American Journal of Industrial Medicine*, 61, 477-491.
4. Neitzel R, Stover B, & Seixas N. 2011. Longitudinal assessment of noise exposure in a cohort of construction workers (Table 1). *Annals of Occupational Hygiene*, 55(8):906-916.
5. Elizabeth A. Masterson, PhD1; P. Timothy Bushnell, PhD2; Christa L. Themann, MA3; Thais C. Morata, PhD, "Hearing Impairment Among Noise-Exposed Workers — United States, 2003–2012", April 2016. [Online]. Available: https://www.cdc.gov/mmwr/volumes/65/wr/mm6515a2.htm?s_cid=mm6515a2_e. [Accessed 10 November, 2021].
6. AIHA, "Focus Four for Health", 2020. [Online]. Available: https://aiha-assets.sfo2.digitaloceanspaces.com/AIHA/resources/FocusFour-forHealth_GuidanceDocument.pdf. [Accessed 10 November, 2021].
7. OSHA 3498-12N, "Protecting Yourself from Noise in Construction", 2011. [Online]. Available: <https://www.osha.gov/sites/default/files/publications/3498noise-in-construction-pocket-guide.pdf>. [Accessed 22 November, 2021].
8. Health and Safety Executive, "Health risks from welding", 2021. [Online]. Available: <https://www.hse.gov.uk/welding/health-risks-welding.htm>. [Accessed 14 December, 2021].
9. Work Safe BC, "How loud is it? – Construction", November 2019. [Online]. Available: <https://www.worksafebc.com/en/resources/health-safety/hazard-alerts/how-loud-is-it-construction?lang=en>. [Accessed 17 January, 2022].
10. Elliott H. Berger, E-A-RLOG, "Hearing Protector Performance: How They Work – and What Goes Wrong in the Real World", 1996. [Online]. Available: <https://multimedia.3m.com/mws/media/6006330/e-a-r-log-5-protection-performance.pdf>. [Accessed 13 January, 2022].
11. 3M, "Life Can Be Loud", 2010. [Online]. Available: <https://multimedia.3m.com/mws/media/8832040/life-can-be-loud-know-your-hearing-protection.pdf?fn=Life%20Can%20Be%20Loud%207070017.pdf>. [Accessed 10 November, 2021].
12. Masterson EA, Bushnell PT, Themann CL, & Morata TC. (2016). Hearing impairment among noise-exposed workers — United States, 2003–2012. *Morbidity and Mortality Weekly Report*, 65(15), 389-394.
13. Masterson EA, Themann CL, Luckhaupt SE, Li J. & Calvert GM. (2016). Hearing difficulty and tinnitus among U.S. workers and non-workers in 2007. *American Journal of Industrial Medicine*, 59, 290-300.
14. Laborers' Health and Safety Fund of North America, "Controlling Noise on Construction Sites", 2021. [Online]. Available: <https://www.lhsfna.org/LHSFNA/assets/File/bpguide%202014.pdf>. [Accessed 10 November, 2021].
15. Nelson D [2011]. Adaptation of NASA buy-quiet process roadmap for construction firms. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 212-2011-M-38379, 2011 Apr; :1-21.
16. Centers for Disease Control and Prevention, "Reducing Noise Exposure: Personal Protective Equipment", February 2018. [Online]. Available: <https://www.cdc.gov/niosh/topics/noise/reducenoiseexposure/adminppe.html>. [Accessed 10 November, 2021].
17. Canadian Standards Association. Z94.2-14 Hearing Protection Devices Performance, Selection, Care and Use. 2014 (reaffirmed 2019).
18. ANSI/ASA, "S12.71-2018. Performance Criteria For Systems That Estimate The Attenuation Of Passive Hearing Protectors For Individual Users", 2018. [Online]. Available: <https://webstore.ansi.org/standards/asa/ansiasas12712018>. [Accessed 10 November, 2021].
19. Martinez, Luis Felipe, "Can you hear me now? Occupational hearing loss 2004– 2010", 2012. [Online]. Available: <https://www.bls.gov/opub/mlr/2012/07/art4full.pdf>. [Accessed 10 November, 2021].
20. 3M, "Hearing Protection Fit Testing: What, Why and How", August 2018. [Online]. Available: <https://multimedia.3m.com/mws/media/15784680/hearing-protection-fit-testing-what-why-how-technical-bulletin.pdf>. [Accessed 10 November, 2021].
21. Neitzel R., Rabinowitz P.M., Cantley L., Galusha D., and Slayer S., "A Mixed-Methods Assessment of Hearing Conservation Program Effectiveness", *NHCA Spectrum*, Vol. 34, No. 3, December 2017.
22. Murphy W.J., Themann C.L., Murata T.K. Field-Testing NIOSH HPD Well-Fit: Off-Shore Oil Rig Inspectors in Louisiana and Texas. U.S. National Institute for Occupational Safety and Health (NIOSH); Washington, DC, USA: 2015. EPHB Report 360-11a, DHHS-CDC-NIOSH.
23. Macedo, Gorman, Berger. Australian Institute of Occ. Hygienists, 34th Annual Conference & Expo, December 2016.
24. Elliott H. Berger, E-A-RLOG, "The Naked Truth about NRRs", 2000. [Online]. Available: <https://multimedia.3m.com/mws/media/6006340/e-a-r-log-20-truth-about-nrr.pdf?fn=E-A-Rlog20%20truth%20about%20NRR.pdf>. [Accessed 10 November, 2021].
25. OSHA, "Hearing Conservation for the Hearing-Impaired Worker", December 2005. [Online]. Available: <https://www.osha.gov/sites/default/files/publications/shib122705.pdf>. [Accessed 23 March, 2022].
26. U.S. Bureau of Labor Statistics, "Fatal Occupational Injuries Involving Cranes", November 2017. [Online]. Available: https://www.bls.gov/iif/oshwc/cfoi/cranes_fact_sheet.htm. [Accessed 10 November, 2021].
27. ASME/ANSI B30.5-2018 Section 5.3-3 Signals
28. Andrew J. Palmiero, Daniel Symons, Judge W. Morgan III & Ronald E. Shaffer (2016) Speech intelligibility assessment of protective facemasks and air-purifying respirators, *Journal of Occupational and Environmental Hygiene*, 13:12, 960-968, DOI: 10.1080/15459624.2016.1200723.
29. American Speech-Language-Hearing Association (2020). ASHA to CDC: Recognize Need for Clear Face Masks, Flexible Communication Methods to Protect Those With Hearing and Other Communication Disorders.
30. Goldin A, Weinstein BE, Shiman N. (2020). How do medical masks degrade speech perception? *Hearing Review*, 27(5):8-9.
31. 3M PELTOR Communications Solutions, University Case Study on worker productivity made by Victoria Joanf and Ajdin Sadikovic. Lund University Faculty of Engineering (LTH) in Sweden.
32. Centers for Disease Control and Prevention, "Study Finds Over Half of Noise-Exposed Workers Do Not Use Hearing Protection When Exposed to Noise on the Job", October 2021. [Online]. Available: <https://www.cdc.gov/niosh/updates/upd-10-07-21.html>. [Accessed 22 November, 2021].
33. Work Safe BC, "New data shows young construction workers less likely to wear hearing protection", February 2017. [Online]. Available: <https://www.worksafebc.com/en/about-us/news-events/news-releases/2017/February/young-construction-workers-hearing-protection>. Accessed 17 January, 2022].

Hearing and PELTOR

▲ WARNING

These hearing protectors help reduce exposure to hazardous noise and other loud sounds. Misuse or failure to wear hearing protectors at all times that you are exposed to noise may result in hearing loss or injury. For correct use, consult supervisor and User Instructions, or call 3M PSD Technical Service in the USA at 1-800-665-2942. In Canada, call 1-800-267-4414. 3M PSD products are for occupational use only.

▲ WARNING

U.S. EPA specifies the NRR as the measure of hearing protector noise reduction. However, 3M makes no warranties as to the suitability of the NRR for this purpose. 3M strongly recommends personal fit testing of hearing protectors. Research suggests that users may receive less noise reduction than indicated by the attenuation label value(s) on the packaging due to variation in fit, fitting skill, and motivation of the user. Refer to applicable regulations or guidance on how to adjust attenuation label values. It is recommended that the NRR be reduced by 50% to better estimate typical protection.



Personal Safety Division
3M Center, Building 235
St. Paul, MN 55144-1000

3M Canada
P.O. Box 5757
London, Ontario N6A 4T1

For more information:

In U.S.:
Technical Assistance 1-800-243-4630
Customer Service 1-800-328-1667
[3M.com/workersafety](https://www.3M.com/workersafety)

In Canada:
Technical Assistance 1-800-267-4414
Customer Service 1-800-410-6880
[3M.ca/ppesafety](https://www.3M.ca/ppesafety)

Always consult the User Instructions for any personal protective equipment you are using and follow local laws and regulations.

3M PSD products are occupational use only. Not for consumer use or sale.

3M, E-A-R, E-A-Rfit, E-A-R Classic, E-A-Rsoft, E-A-Rsoft Grippers, E-A-Rsoft Yellow Neons, E-A-R UltraFit, E-A-R Caboflex and PELTOR are trademarks of 3M. Used under license by 3M subsidiaries and affiliates.
3M 2022. All rights reserved.