



# **UNDERSTANDING THE CAUSES AND CONSEQUENCES OF OCCUPATIONAL HEARING LOSS**

Whitepaper



## INTRODUCTION

**Noise Induced Hearing Loss (NIHL)** is the most commonly reported occupational disease<sup>1</sup>. In the EU approximately 52 million people report having hearing loss<sup>2</sup>. Despite being avoidable in most cases, NIHL is expected to become even more widespread in decades to come, with 1.1 billion young people at risk globally<sup>3</sup>.

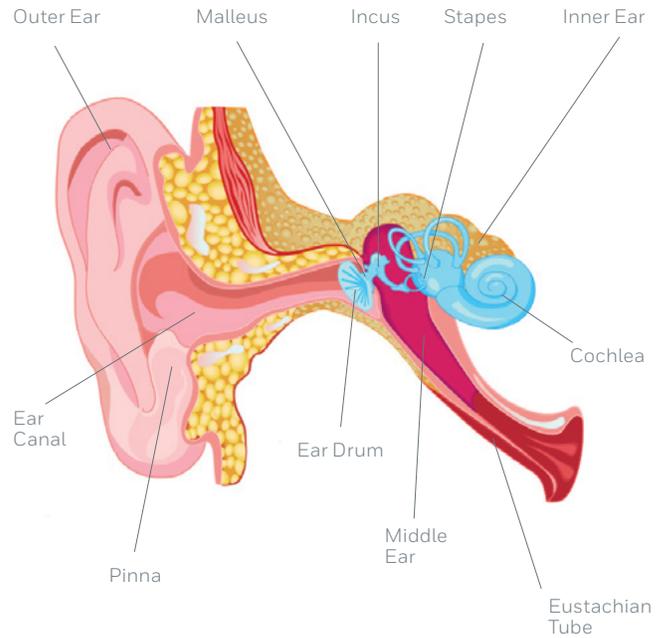
This whitepaper provides insight into the importance of understanding the causes of occupational NIHL and the consequences associated with it – to both individual workers and businesses. It starts by defining noise, reviewing the way in which sound is measured, and gives some examples of the most common industrial applications where NIHL can occur. The paper outlines the health and safety risks associated with not wearing adequate hearing protection or not fitting it correctly and provides an overview of the physical effects as well as the wider and long-term psychological effects, which are often overlooked. The paper also discusses the challenges faced by health and safety professionals and NIHL's impact on business – in the EU, the cost of not treating hearing loss is around 178 billion euros every year<sup>4</sup>.

Often seen as a 'silent' injury, since it is not visible, NIHL results from exposure to noise, which can cause irreversible hearing damage. It is one of the most common health problems in the workplace but can be difficult to detect as the effects build up gradually over time. Throughout all industry, industrial hearing loss remains the occupational disease with the highest number of civil claims accounting for about 75 percent of all occupational disease claims<sup>5</sup>.

One of the main reasons NIHL remains so widespread is a lack of awareness, which can largely be attributed to gaps in legislation combined with inadequate training practices. The whitepaper finishes by reviewing the changes in regulation which mean that noise and hearing loss is now recognised as one of the most severe and irreversible risks in the workplace.

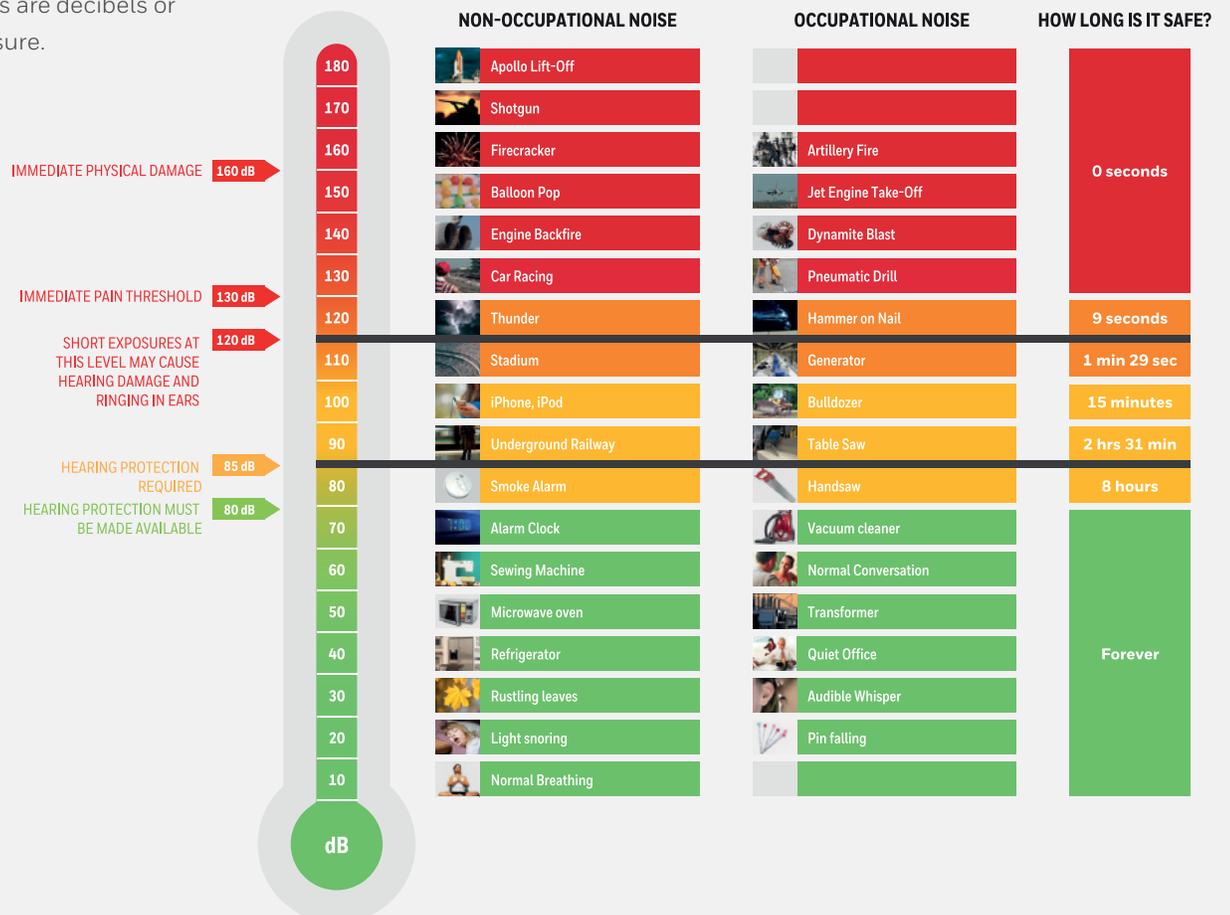
## WHAT IS NOISE?

To put it simply: noise is unwanted sound. As objects vibrate, they create small changes in air pressure, which travels through the air in waves. When these waves reach an ear, they make the eardrum vibrate and these vibrations go through three small bones into the cochlea in the inner ear. There are thousands of tiny hair cells inside the cochlea. It is these hair cells which pick up the vibrations, changing them into electrical signals which are then passed through the auditory nerve to the brain which interprets the signals as sound. Typically, every person is born with approximately 30,000 hair cells in each ear, but over time these cells get damaged, for example by exposure to noise, and subsequently their ability to pick-up and transmit sound is reduced. Once these hair cells are damaged, there is no way of repairing them, and deafness is experienced. The damage done is irreversible, so lost hearing is lost forever.



## HOW IS SOUND MEASURED?

Sound energy travels in waves and is measured in amplitude and frequency. Amplitude measures how forceful the wave is and its units are decibels or dBA of sound pressure.



## CAUSES OF NOISE INDUCED HEARING LOSS (NIHL)

There are two main types of noise and two basic types of NIHL. The first type of noise is general background noise such as that found in a busy workplace, with whirring machines. The second type is impact noise, a one-time intense impulse such as an explosion. Both types of noise overstimulate the delicate hairs in the ear, leading to permanent injury.

Gradually developing NIHL is caused by the first type of noise, whereby permanent cochlea damage occurs from repeated and multiple exposure to loud and excessive sounds over a period of time. However, single exposure to a high-intensity sound pressure level can cause acoustic trauma and potential immediate hearing loss. Sounds of less than 75 decibels are unlikely to cause hearing loss, even after long exposure, whereas sounds that are 85 dBA or above can permanently damage hearing. Furthermore, the more sound pressure there is, the less time it takes to cause damage. For example, a sound at 85 dBA could take up to eight hours to cause permanent damage, whereas a sound at 100 dBA can start damaging hearing after only 15 minutes.

There are many sources of noise in the workplace. Below are some examples and their typical sound levels:

INDUSTRIAL APPLICATION	TYPICAL SOUND LEVEL (dBA)
Glass bottling lines	85 – 100
Product impact on hoppers	90 – 100
Wrapping, cutting wrap, bagging etc	85 – 95
Bowl choppers	> 90
Pneumatic noise and compressed air	85 – 95
Milling operations	85 – 100
Saws / cutting machinery	85 – 107
Blast chillers / freezers	85 – 107
Packaging machinery	85 – 95
Wheeled trolleys/racks	Up to 107 (from wheel bearings)

Hearing loss can also be caused by workers not wearing adequate hearing protection, or wearing ill-fitting protection, and workers not being properly trained in this area. There are many forms of hearing protection including earmuffs, earplugs and moulded earplugs, each providing excellent attenuation for different applications. However, if not fitted correctly, they let noise in, causing damage. For example, even though an earplug may appear to be inserted properly, there may be a hidden leak which can significantly reduce protection levels. Improper sizing and selection, or even a crease in an earplug, may cause an acoustic leak that is not readily visible.

Each hearing protection device has advantages and disadvantages and to get the right protection it's important to understand what each has to offer. Earmuffs for example are good for intermittent use and protection, especially in construction work, but the level of attenuation isn't always as high as that of well fitted foam tips since they fit over the ear, rather than in the ear canal.

## THE EFFECTS OF OCCUPATIONAL HEARING LOSS

We have learnt that the hair cells in the inner ear become damaged, but what about the wider implications for both workers and businesses?

### COST TO WORKERS OF NOT WEARING ADEQUATE PROTECTION

What does the worker physically feel, and what are the perceivable effects? If hearing loss develops slowly, the first symptom of NIHL may be difficulty hearing a conversation against a noisy background. The worker may also experience muffled sounds and tinnitus, and will lose audibility and experience an overall decrease in volume. Hearing will also become distorted and clarity will be lost.

Tinnitus may present itself in a number of ways – it may sound like an intermittent or continuous buzzing, humming or ringing, when there is no external cause for the sound. The sound may be heard in one or both ears, or in the head. Tinnitus is very common and is reported in all age groups, even young children. According to the British Tinnitus Association, about 30 percent of people will experience tinnitus at some point in their lives but the number of people who live with persistent tinnitus is approximately 10 percent<sup>6</sup>.

For those that experience an extreme loud burst of sound, the eardrum may rupture and bones in the middle ear may be damaged. In this case, the worker will suffer an intense pain.

However, the effects are more than just physical. Hearing loss can have long-term psychological effects and a wider effect on a person's overall health and wellbeing. It is these effects that are often overlooked. Not being able to hear properly can have a devastating negative impact on communication and this will have wider adverse effects on social interactions. Being unable to communicate in a way that someone is used to means that person may become withdrawn, and start to feel isolated. This in turn can lead to a reduced self-esteem, shame, fear, anger, stress and depression. Tinnitus may also be a constant presence, leading to loss of concentration and preventing someone from sleeping properly.



## COST TO A BUSINESS OF NOT PROTECTING EMPLOYEES

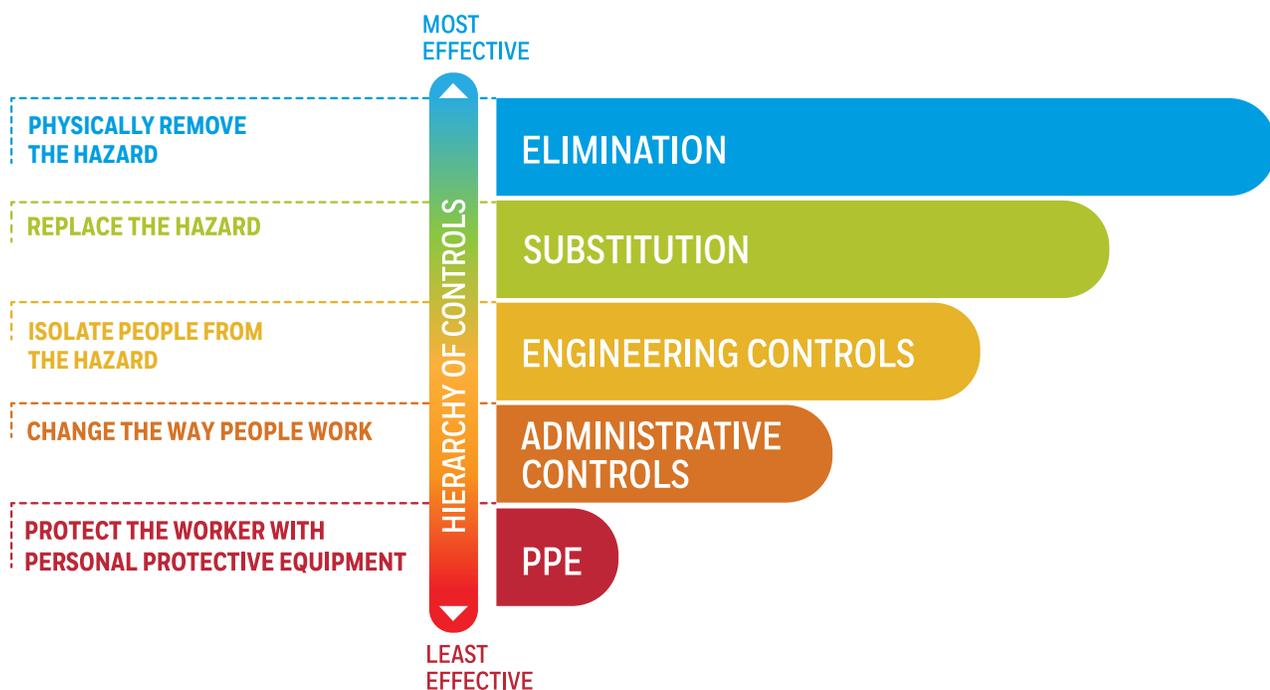
Effects of NIHL are not only felt by individuals, but there are also significant implications for a business. NIHL is becoming ever more prevalent, and the cost of failing to protect workers and following set procedures can hit the bottom line heavily. Incidences of payouts and insurance claims for NIHL are on the rise: in 2017 insurance companies reported that in the previous three years claims had risen by up to 300 percent<sup>7</sup>. One landmark case in 2018 even saw a violin player seek damages worth £750,000 from the Royal Opera House in the UK, after suffering acoustic shock. He suffered a blast from the 18-strong brass section, situated directly behind him, causing the overall volume in the pit to reach at least 137 decibels – about the volume of a jet engine from 30 metres away.

Costs can also be incurred as a result of lost productivity whilst workers are absent through illness. For example, in 2015 long-term sickness absence cost UK businesses £4.17bn a year and this is expected to rise to £4.81bn by 2030<sup>8</sup>. Furthermore, if there is negative media attention surrounding a case, this will ultimately effect the reputation of the company, and you can't put a price on that!

## THE CHALLENGES FOR SAFETY MANAGERS

When it comes to preventing NIHL, there are many considerations for health and safety professionals. What is the best hearing protection and conservation strategy? And how do we know whether it is working or not? Ultimately protection is best achieved by controlling noise at source.

The following five steps can be taken to reduce exposure and risk of NIHL<sup>9</sup>:

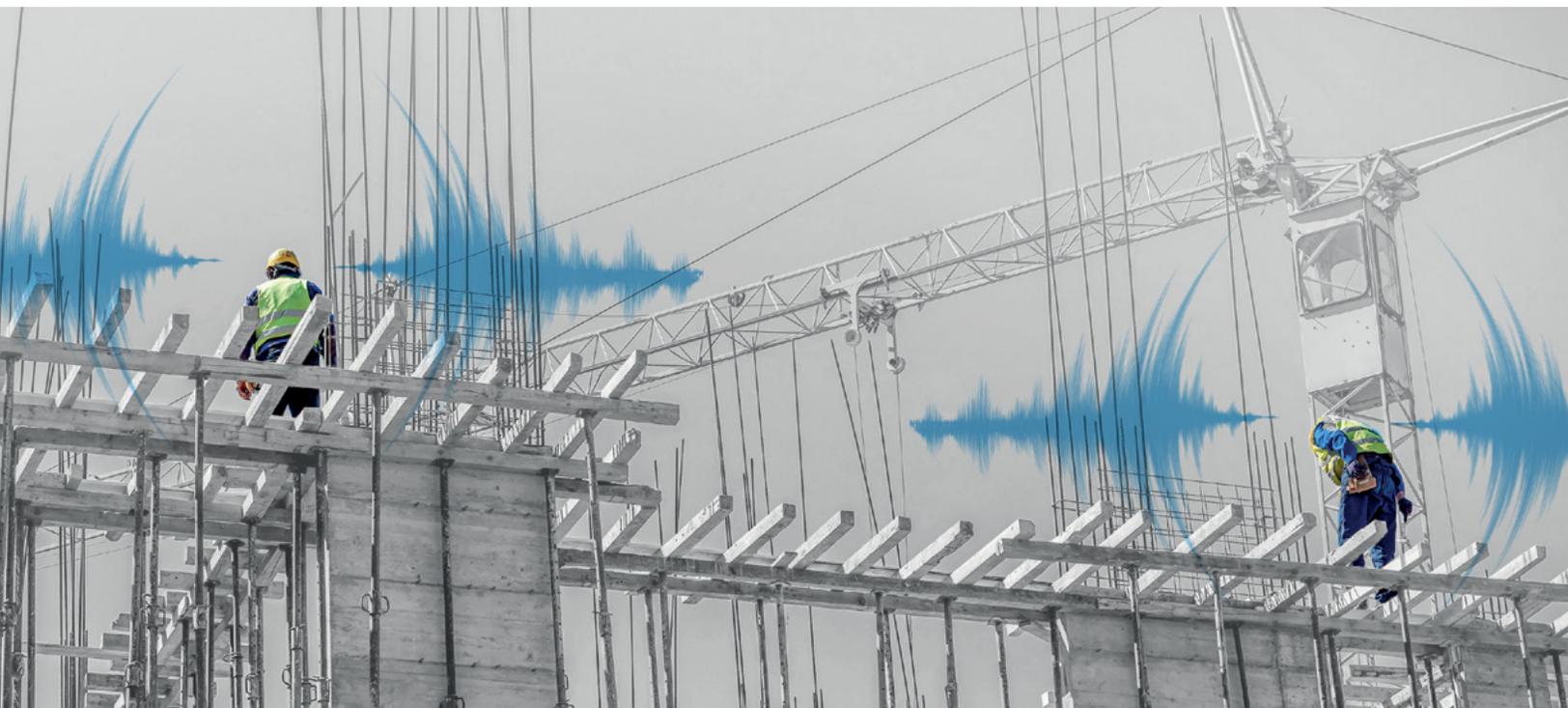


Gaining a reliable picture of actual noise exposure levels and how these evolve over time is no easy task. Technology can certainly play a key role in helping plant and safety managers rise to the challenge, yet, until recently, it has had its limitations. For example, sound level meters can be a useful way of measuring sound pressure levels in a specific location of the plant where noise levels are relatively steady and continuous. However, these devices don't account for any variations in these levels. A sound level meter may indicate that the sound pressure in one section of the factory is relatively low, but step a bit closer to a machine and the actual noise level you are exposed to could be significantly higher. More importantly, a worker's real exposure to noise may be higher than that of a colleague working in the same location using the exact same PPE, simply because they are not wearing it correctly or consistently.

Noise dosimeters on the other hand can be worn by the worker and provide a more accurate picture of noise levels across different locations, enabling safety managers to calculate the average noise levels workers have been exposed to over time. However these devices don't provide information on the PPE's attenuation levels, which is key to knowing the actual noise exposure. Traditionally, the most common way of identifying attenuation levels has been the single number rating (SNR) value. Yet, the SNR is population-based and provides a very rough estimate of the potential attenuation that can be achieved from PPE when used correctly. For example, there can be a significant difference in individual attenuation levels from the same type of earplugs depending on how well the individual has fitted them. Simply relying on the SNR to determine attenuation levels therefore may result in workers not having the protection levels they require.

The Norwegian offshore maintenance operator Beerenberg Group, for example, performed a fit-testing exercise on 288 of its workers in 2013, which revealed that nearly 40 percent of them were not using their PPE correctly. This means that they were receiving insufficient attenuation (less than 16 dB) even though the earplugs used had an SNR between 30–34 dB. Strikingly, when the test was repeated after one-to-one fit-testing training, the percentage of workers with a poor fit dropped to just over five percent<sup>10</sup>. It is clear that training programmes incorporating fit-testing should underpin any hearing conservation effort.

However, fit-testing alone is not enough to ensure complete hearing protection. Its main limitation is that it can only establish if a worker has fitted their hearing protection correctly when the test is performed. In other words, there is no way of knowing if workers will continue wearing it correctly throughout the day and what level of noise they will be exposed to. This is one of the key challenges health and safety professionals have to contend with.



## TECHNOLOGICAL ADVANCES

The good news is that the latest technologies make these challenges far easier to overcome. Some solutions, for example, activate an automatic fit-test during start-up, which tells the worker when they have fitted their hearing protection correctly. They also monitor sound exposure continuously, alerting the user whenever the permissible sound exposure level has been reached. Users can also perform a quick hearing test to monitor their hearing threshold. This will make it possible to detect a NIHL at a much earlier stage than today.

By embedding sensors in PPE to capture data at the point where the individual enters the working environment, the latest connected technology also enables safety and plant managers to track and analyse noise exposure data over time. This allows them to determine exactly how long a worker can stay on task and still be safe and change working patterns accordingly if necessary. Armed with real-time data and intelligence, plant and safety managers can also check whether workers are wearing the right type of protective equipment and have had the correct training.

Supervisors and site health and safety professionals are also often faced with worker objections to using hearing protection. One of the most common concerns of workers is the possibility that hearing protectors may interfere with communication on the job, and so they regularly remove ear defenders to hear each other.

However, new wireless and radio communication technologies are making it easier to combine hearing protection with effective communication. One such example is smart headsets, which incorporate hear-through technology to enable the user to hear sounds at a safe level while being protected from hazardous noise. By using these, workers don't need to remove their hearing protection devices to communicate or hear conversations, alarms and other important sounds in their environment.



## CHANGING REGULATIONS

We have seen that NIHL is a significant and life-changing condition, causing permanent damage, but how is it acknowledged by regulations, and what responsibilities are there on health and safety professionals to ensure they are protecting their employees?

One of the key Directives having an impact on PPE for the last 30 years is Directive 89/686/EEC. However, in April 2018 the directive has been replaced by the PPE Regulation (EU) 2016/425<sup>11</sup>. One of the fundamental changes concerns how some PPE – including hearing protection – is classified. While the regulation maintains the previous EU Directive's three category levels, it now associates PPE with risks rather than pieces of equipment. Under the new regulation hearing protection has been moved from Category II to Category III - the highest risk category - signifying that harmful noise causes irreversible damage to health. Under the new Regulation, responsibility for supplying compliant hearing protection products now also lies with importers and distributors, not only manufacturers and authorised representatives. While the new regulation doesn't change health and safety managers' daily responsibilities, now everyone will be required to take appropriate measures to ensure the PPE meets the latest standards. The new PPE Regulation is mandatory for all EU countries, covering any type of product that falls within its scope.

There is also an introduction of a five-year validity period on EU Type Examination Certificates. This is significant because it means more regular and strict assessments of the quality of PPE. In other words, when a manufacturer comes to renew the certificates for their products, they will be required to ensure that everything they deliver to the market meets the latest industry standard. This move should provide safety managers and other end users who specify hearing protection for the workforce with greater confidence that the products meet the highest levels of quality control.

Users and health and safety managers still have the same obligations as defined in the Directive 2003/10/EC on the "Minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)".

The Control of Noise at Work Regulations 2005, which translated Directive 2003/10/EC into UK law, mandate that employers must provide a worker with hearing protection if their daily or weekly average exposure exceeds 85 decibels<sup>12</sup>.

Employers and workers must still comply to the Action Levels and Exposure Limits, and workers must still take proper care of their own hearing protection and report back to the Supervisor/Manager when replacement is needed. As ever, it is important to ensure that hearing protection devices are purchased from a trusted supplier.

Furthermore, the importance of fit-testing is increasingly being acknowledged by the safety industry and is expected to become a legal requirement in some countries. The US-based Directorate of Standards & Guidance, for example, recognised the importance of ensuring that "PPE must properly fit each employee" at the 2017 International Safety Equipment Association Annual Meeting<sup>13</sup>. A Standard for fit-testing system performance in the USA has been approved by the American National Standards Institute (ANSI) and is expected to be published in 2018. It is anticipated that this will lead to the European Committee for Standardization (CEN) considering a similar standard. Furthermore, standardising bodies in Germany are working on comparing different testing systems to provide a standard for fit-testing. This is promising, as making fit-testing mandatory can go a long way toward tackling NIHL.

## CONCLUSION

It is clear to see that NIHL is a significant risk to both workers and businesses. By gaining greater awareness of this risk, understanding new regulations and implementing more rigorous training and monitoring, employers of workers exposed to noisy environments could better protect their hearing, preventing hearing loss and the associated costs.

Instilling good practice in the workplace is especially important for the next generation considering that millennials are more likely to enter the workplace with pre-existing hearing damage. Nearly half of all teenagers and young adults (12 – 35 year olds) in middle- and high-income countries are exposed to unsafe levels of sound from the use of personal audio devices and some 40 percent of them are exposed to potentially damaging sound levels at clubs, discos and bars<sup>14</sup>. With 1.1 billion young people worldwide estimated to be at risk of hearing loss due to unsafe listening practices, understanding the causes and consequences of NIHL and fully protecting against them will be critical for protecting the hearing of generations to come. Hearing conservation has been considered a low priority in the health and safety community for too long and as the disability isn't visible it hasn't received the recognition it deserves. However, the EU's adoption of the new PPE Regulation is an important step forward because it re-evaluates the importance of hearing protection. While the regulation doesn't appear to provide any specifics around training and how it should be carried out, the fact that hearing protection has moved to Category III should mean that it is taken more seriously by employers.

Hopefully, it will motivate safety managers to access the training support they need to ensure workers are properly equipped to work in noisy environments. Technology will also provide answers to improved hearing protection. By integrating smart, wearable sensors with cutting-edge software and cloud-based services, the latest technology enables both workers and safety managers to measure and monitor noise exposure in real-time. This data can be used to implement proactive safety measures before hearing damage occurs.

## References:

- [1] <https://www.iosh.co.uk/Books-and-resources/Our-OH-toolkit/Noise.aspx>
- [2] [https://www.ehima.com/wp-content/uploads/2017/02/World-Hearing-Day-2017-AEA\\_EFHOH\\_EHIMA-Joined-Press-ReleaseFinal.pdf](https://www.ehima.com/wp-content/uploads/2017/02/World-Hearing-Day-2017-AEA_EFHOH_EHIMA-Joined-Press-ReleaseFinal.pdf)
- [3] <http://www.who.int/mediacentre/factsheets/fs300/en/>
- [4] <http://www.hse.gov.uk/food/noise.htm>
- [5] <https://www.tinnitus.org.uk/all-about-tinnitus>
- [6] <https://www.insurancebusinessmag.com/uk/news/breaking-news/hearing-loss-claims-surge-by-nearly-300-65192.aspx>
- [7] <https://www.unum.co.uk/media/long-term-sickness-absence-costs-uk-businesses-billions>
- [8] <https://www.iosh.co.uk/Books-and-resources/Our-OH-toolkit/Noise/Noise-control-measures.aspx>
- [9] Source: Beerenberg, *Training in the proper use and adjustment of ear plugs*, 27/01/2015
- [10] <https://osha.europa.eu/en/legislation/directives/34>
- [11] <http://www.hse.gov.uk/noise/regulations.htm>
- [12] Directorate of Standards & Guidance Update, *International Safety Equipment Association Annual Meeting*, November 30, 2017
- [13] WHO 2015, *hearing loss due to recreational exposure to loud sounds: a review*

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