Effects of Workplace Noise Exposure

Noise exposure at work results in hearing loss which impacts affected individuals' quality of life significantly. Overexposure to high noise levels day after day, regardless of the source, will lead to Noise Induced Hearing Loss (NIHL) and this is an irreversible injury. The loss of hearing does not recover if the noise exposure is stopped, and tinnitus, a loud continuous 'ringing' or 'hissing' sound perceived by the brain of a person with hearing loss may result. Although it is sometimes considered to be a problem primarily found in manufacturing industries, many other occupational environments have potential for creating hearing loss. These include mining, oil and gas production, transportation, construction, and even some service industries where noise is present as a normal function of the work being performed.

Occupational Noise Exposure and Hearing Loss

Hearing loss resulting from overexposure to noise in the workplace is one of the most prevalent occupational injuries in the US today. According to CDC/NIOSH:

Four million workers go to work each day in damaging noise. Ten million people in the U.S. have a noise-related hearing loss. Twenty-two million workers are exposed to potentially damaging noise each year.

In 2008, approximately 2 million U.S. workers were exposed to noise levels at work that put them at risk of hearing loss.

In 2007, approximately 23,000 cases were reported of occupational hearing loss that was great enough to cause hearing impairment. Reported cases of hearing loss accounted for 14% of occupational illness in 2007.

In 2007, approximately 82% of the cases involving occupational hearing loss were reported among workers in the manufacturing sector.

OSHA, Noise Exposure and Hearing Loss

CFR 1910.95 1910 (Occupational Safety and Health Standards, Subpart: G, Occupational Health and Environmental Control, Standard Number: 1910.95 Occupational noise exposure) mandates that protection against the effects of noise exposure shall be provided when the sound levels exceed 90dB (A weighted, Slow response) for an 8 hour time of exposure.

As of 2004, hearing loss must be recorded in a separate column in the OSHA 300 log. According to DOL/OSHA, as stated in standard 1904.10 Recording criteria for cases involving occupational hearing loss: "If an employee's hearing test (audiogram) reveals that the employee has experienced a work-related Standard Threshold Shift (STS) in hearing in one or both ears, and the employee's total hearing level is 25 decibels (dB) or more above audiometric zero (averaged at 2000, 3000, and 4000 Hz) in the same ear(s) as the STS, you must record the case on the OSHA 300 Log." (from section 1904.10(b))

Engineering and Administrative Controls or PPE?

In 1910.95(b)(1), OSHA states (in part): When employees are subjected to sound

levels exceeding those listed, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the limits, personal protective equipment shall be provided and used to reduce sound levels within the levels shown.

Hearing Conservation Programs
In 1910.95(c)(1) OSHA states: The employer shall administer a continuing, effective hearing conservation program, as described in paragraphs (c) through (o) of this section, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale (slow response) or, equivalently, a dose of fifty percent

Exposure Assessment
Exposure assessment of employees working in noisy areas is necessary to ensure that harmful noise levels are not exceeded without proper countermeasures being taken. As a simple rule of thumb, if you need to raise your voice to carry on a conversation with someone, then it is likely that the noise level is around 85 dB so a sound level meter or dosimeter should be used the determine the actual decibel level. A simple instrument to check continuous noise levels in a fixed location is the **CEL-240**. Other simple sound level meters such as the **CEL-244** can be used where noise levels have lots of variation or impulses as they will ‘integrate’ (i.e. average together) these sound pressure level fluctuations making a correct and accurate measurement more feasible. NOTE: ANY instrument used for OSHA regulatory compliance or compliance with EU directives, i.e. instruments used to demonstrate that the exposure levels are at, above or below recommended threshold limit values (TLV’s), permissible exposure limits (PEL) or daily action and exposure limit values (DEAV, DELV) must be capable of meeting the applicable ANSI and IEC standards for measurement accuracy.

Regulations exist in almost all countries which set limits on the amount of noise allowed in the workplace. These limits are usually expressed as an average decibel level measured with an 'A' weighted filter and ‘slow response’ detector derived from a representative sample taken over a majority of the work shift, with an additional limit on any single impulsive (or ‘peak’) noise level that occurred. For consistency, an average of the sound level readings over the measurement period is expressed as if it were present for a standard 8 hour work shift. This is called the time weighted average level, or TWA. A limit for the single highest instantaneous peak level that can be tolerated is also specified in many regulations. Peak noise levels are measured as ‘Z-weighted’, ‘unweighted’ or ‘linear’ levels as opposed to the ‘A’ weighting used for continuous noise measurement, although some standards allow the ‘C’ weighted scale to be used. The **CEL-244** or **CEL-246** are basic integrating sound level meters to use for obtaining Lavg (average) or TWA results.

Noise Dosimeter or Sound Level Meter?

In the US, Time Weighted Average is presented as a decibel value expected for 8 hours such as 90 dBA which can then be compared to the limits shown in the OSHA table G-1. But that same noise exposure can also be expressed as a 'dose' – for this example, where 100% of the allowable noise dose is equivalent to a continuous noise level average of 90 dB(A) for 8 hours. For European directives, the limit is called the "daily personal exposure level" and is expressed as LEP,d. This is somewhat similar in concept to the OSHA noise limit although they are not measured or calculated in exactly the same way. Casella CEL instruments are capable of measuring multiple noise parameters simultaneously so you are always assured of obtaining the proper results. Differences include the Criterion Level (i.e. what is the value of time-weighted average decibel level that equates to 100% dose for an 8 hour equivalent exposure?) and the Exchange Rate (what increase in average decibel level would require a 'halving' of the exposure time? (usually 3 or 5dB)). Also in the US, a 'threshold level' is specified that excludes noise levels below the threshold level value when calculating the TWA or % dose. Measurements are usually made with 90 and 80 dB threshold values to compute multiple TWA and exposure results that are used for determining effectiveness of engineering controls, compliance with permissible exposure limits and/or inclusion of the exposed worker in a Hearing Conservation Program (HCP). An HCP is required when noise exposure for an 8 hour period is above the "action level" of 85 dB(A). In any compliant HCP, additional responsibilities fall upon the employer to provide annual hearing tests (audiograms), training and hearing protection devices to protect against occupational noise induced hearing loss (ONIHL).

The TWA or Noise Dose can be obtained from measurements using either a traditional integrating sound level meter or personal noise dosimeter. The sound level meter is a hand held instrument, such as the **CEL-620**, used to gather the different noise levels produced by different machines or work processes. A personal noise dosimeter, such as the **CEL-350**, is a small, lightweight instrument worn on the worker, to accurately monitor their exposure throughout the day, regardless of their location or work being performed. It samples all the noise to which the worker is exposed by means of a small microphone mounted on the shoulder in the 'hearing zone'. Multiple measurements using noise dosimeters can be made, allowing more than one worker to be monitored without having to download the results after each measurement. Intrinsically safe **CEL-350** noise dosimeters are available for use in hazardous areas as defined by NFPA and other safety codes for operating safely in explosive or flammable environments.

When measurement results are obtained using an IEC and ANSI standards

compliant sound level meter or noise dosimeter, a Safety Engineer, Certified Safety Professional (CSP) or Industrial Hygienist (IH) can easily review the noise exposure levels and compare them against regulatory compliance limits or stricter internal limits based on corporate policy. Instruments that "log" the noise levels throughout the measurement are extremely useful for determining the source and possible reasons for excessive noise exposure. Storage of continuous readings in the instrument's memory allows the noise measurements to be transferred to a personal computer for further analysis and permanent archiving. The **CEL-350** Dose badge and the **CEL-632** logging sound level meter are logging instruments.

Hearing protection

When noise measurements show that the levels are too high then steps must be taken to reduce noise exposure. Ideally this should be done through engineering controls to reduce or eliminate the excessive noise levels from machines or manufacturing processes. As an alternative solution it may be necessary to provide personal hearing protection devices to workers. These are usually in the form of muffs that fit over the ear or plugs which fit inside the ear canal. Noise measurements can be very helpful to aid you in choosing the correct hearing protectors. Either octave band measurements using a sound level meter with octave band analysis or a simpler method called ‘C-A’ (C weighted value minus the A weighted value) can help in selecting a hearing protection device (HPD) that is adequately protective. The **CEL-620B**, **CEL-630B** or **CEL-632B** sound level meters are ideal for measuring the frequency content of industrial noises to specify the correct hearing protectors for workers. The simpler **CEL-240**series meters have both the A and C frequency weightings as an alternative.