Tougher legislation for workplace noise exposure

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In January 2007, the government of Ontario announced changes to the *Occupational Health and Safety Act* (R.R.O. 1990, Regulations 851 and 855), introducing stricter limits for noise exposure in the workplace.

New changes to the *Occupational Health and Safety Act* affect all industrial and oil and gas workplaces in the province and will come into effect on July 1, 2007. The changes are beneficial in that they serve to reduce the risk of noise-induced hearing loss (NIHL) for workers. At the same time, the tougher regulations place additional obligations on industrial employers and on the engineers responsible for the work environment.

Those of us working in plant engineering, facility design, selection/specification of process equipment, or the health and safety field, have a professional obligation to understand the changes to the regulations and know how to comply with them.

In a nutshell, the changes will toughen the regulations in three ways:

- The limit for a worker's daily exposure to noise will be reduced from 90 dBA to 85 dBA, for an eight-hour workday;
- The "exchange rate" will be reduced from 5 dBA to 3 dBA, which means that for every increase in sound level of 3 dBA, the allowable exposure time for the worker is halved; and
- The changes to the regulation make explicit the responsibility to implement engineered noise-control measures where sound levels exceed 85 dBA.

These changes were not a surprise. The Ministry of Labour has been expressing its intent to reduce the daily limit from 90 dBA to 85 dBA for about 20 years. In response, many companies already have internal policies limiting workplace sound levels to 85 dBA or less. But some of the other changes may have been less anticipated and less understood by members of industry in general. The process of introducing the tougher legislation involved consultations in 2005 and 2006 between the ministry and various stakeholders, including industry and labour associations, health and safety organizations, and the Canadian Hearing Society.

Before delving into the benefits and new challenges that follow from the revised regulations, some technical explanation of the two "numerical" changes is worthwhile.

Exposure limit reduction

The human auditory system is sensitive to oscillations in air pressure, which it perceives as sound. The magnitude of the oscillations generally determines the loudness of the sound, and is typically measured logarithmically, in terms of sound pressure level, in units of decibels (dB).

In addition to differences in magnitude, the human ear perceives differences in the frequency or "pitch" of sounds, which corresponds to the number of pressure fluctuations occurring per second, measured in units of Hertz (Hz). A low-frequency sound (in the bass range), such as a tuba, exhibits a relatively small number of oscillations per second, while a high-frequency sound (in the treble range), such as a piccolo, consists of thousands of oscillations per second. The audible frequency range for human hearing extends from about 20 Hz to about 20 kHz.

Most industrial noise contains a multitude of frequencies simultaneously. The human ear varies in its sensitivity to sounds of different frequency. Therefore, sound levels are usually measured using a frequency-weighted filter–referred to as the "A-scale"–which emulates the frequency sensitivity of the human ear. Sounds measured in this way are designated in units of A-weighted decibels (dBA). A dBA sound pressure level is a reasonable single-number representation of the perceived overall loudness of a complex sound that contains multiple different frequencies. The dBA level of a sound also correlates with its potential to cause hearing loss over prolonged exposure.

Perhaps the most significant change to the Ontario regulations is the reduction in the allowable daily exposure limit from 90 dBA to 85 dBA. The significance of this change with respect to the risk of NIHL and to noise control engineering issues will be discussed later. But, in everyday terms, there are two ways to interpret this change. Because of the logarithmic nature of sound, a reduction of 5 dBA represents only a modest change in terms of perceived loudness, but a big change in acoustic energy. As a rule of thumb, a change in sound level less than about 3 dBA is considered imperceptible, while an increase or decrease of 10 dBA sounds like a doubling or halving of perceived loudness. So, a reduction of 5 dBA sounds like a 25 per cent reduction in loudness. However, a 5 dBA reduction translates to a 67 per cent reduction of acoustic energy. So, while a drop from 90 dBA to 85 dBA may not sound like a big change, the ramifications to audiology and noise control can be significant.

Exchange rate reduction

The risk of NIHL varies not only with the magnitude of the sound, but the duration of exposure. In general, a worker

Column 1	Column 2	Column 3	Column 4
Allowable exposure time [h]	5 dBA exchange rate and 90 dBA 8-hour limit	3 dBA exchange rate and 90 dBA 8-hour limit	3 dBA exchange rate and 85 dBA 8-hour limit
8	90	90	85
4	95	93	88
2	100	96	91
1	105	99	94
0.5	110	102	97
0.25	115	105	100

Table I: Allowable exposure time versus TWA sound exposure level

might not be exposed to the same sound level for a full eight-hour shift. Daily exposure often involves sound levels greater than and less than 85 dBA, for varying periods of time, depending upon the location of a worker and the changing sound level in the surroundings. Therefore, the exposure limit is based on a time-weighted average (TWA) value. Generally, this average is not arithmetic, but logarithmic, so that changes in TWA sound level do not translate proportionally to changes in the allowable exposure time. Instead, changes by a fixed *increment* of decibels alter the exposure time by a fixed *ratio*, giving rise to the concept of exchange rate. For instance, an exchange rate of 5 dBA means that for every increase of 5 dBA in a worker's TWA sound exposure, the allowable exposure time is halved. A 3 dBA exchange rate means that for every increase of 3 dBA, the allowable exposure time is halved.

Exchange rate is demonstrated in Table I. The first three columns show a simple comparison between a 5 dBA exchange rate and a 3 dBA exchange rate, starting with the same eight-hour limit of 90 dBA. It is obvious that for increasing sound levels, the 3 dBA exchange rate is more stringent. For example, the 5 dBA exchange rate allows a two-hour exposure to a sound level of 100 dBA (Column 2) within a single work day, whereas the 3 dBA exchange rate allows a two-hour exposure to a sound level of only 96 dBA (Column 3).

It is also evident from Table I that the combination of the 3 dBA exchange rate and the 85 dBA eight-hour exposure limit together (Column 4) is considerably more stringent than the current regulation (Column 2).

Audiological benefits

There are clear ramifications of the two numerical changes to the new regulations–the decrease from 90 dBA to 85 dBA, and the change in exchange rate from 5 dBA to 3 dBA. Both are very reasonable changes and bring the regulations in line with what actually occurs in the human auditory system. The human auditory system appears to be affected by sounds in excess of 85 dBA and the "3 dBA exchange rate" is indeed a good model of how hearing loss progresses over the years. In fact, the provincial Workers' Safety and Insurance Board (WSIB) deems a claim for hearing loss to be acceptable if the worker has been exposed to levels of 85 dBA for at least five years. The change from 90 dBA to 85 dBA will bring the noise regulation in line with the long-standing policy of the WSIB.

The 85 dBA limit should be viewed more as an administrative level for action to be taken, rather than a "target for safety." There is well-controlled laboratory evidence that the effects of permanent NIHL begin as low as 80 dBA, and organizations such as the World Health Organization advocate that noise-control measures be undertaken for exposures above 75 dBA. In the United States, the Environmental Protection Agency states that even for an exposure of 80 dBA, there is still a 5 per cent risk, while the National Institute for Occupational Safety and Health states a 3 per cent risk. A level of 85 dBA, although a reasonable change from the 90 dBA level, is a level where some permanent hearing loss can still occur. Table II shows the predicted permanent threshold hearing losses for long-term exposure for five studies/models at 4000 Hz, for TWA sound exposures of 85 dBA, 90 dBA, and 95 dBA.

With regard to exchange rate, the reduction from 5 dBA to 3 dBA is not only a safer predictor for the worker, but there really is no data or research supporting the older 5 dB exchange rate. The human auditory system (as is the case with most mammals) follows the 3 dB exchange rate, implying support for an "equal energy hypothesis"–we can trade off energy-equivalent TWA exposure level for time. There are numerous research articles demonstrating the validity of the 3 dB exchange rate principle. This known reality will be underscored in the new regulations.

TWA sound exposure	Passchier-Vermeer	Burns & Robinson	Baughn	NIOSH	ISO R-1999
85 dBA	8	6	9	5	6
90 dBA	15	12	14	11	11
95 dBA	23	18	17	20	21

Table II: Decibels of hearing loss associated with varying exposure levels

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Employer onus

In addition to the two numeric changes to the regulation discussed above, there is also a third change, which represents a shift in focus. Currently, paragraph 139 of Regulation 851 stipulates that, where a worker is exposed to a sound level of 90 dBA or greater:

(a) measures shall be taken to reduce the sound level below 90 dBA; and
(b) where such measures are not practical, the exposure durations shall be appropriately limited (as per Column 2 of Table I), or the person shall wear hearing protection.

Although the current wording does favour measures to reduce the sound level, it is vague about what those measures ought to be and about situations that might qualify as "not practical" for implementing noise reduction measures.

Conversely, the revised wording in paragraph 139 of the regulation, effective July 1, 2007, stipulates that, "Every employer shall take all measures reasonably necessary in the circumstances to protect workers from exposure to hazardous sound levels," and "The protective measures shall include the provision and use of engineering controls, work practices, and subject to subsection (7), personal protective equipment."

Subsection (7) states that employers provide such protection to workers, "without requiring them to use and wear personal protective equipment," except where appropriate engineering noise controls are:

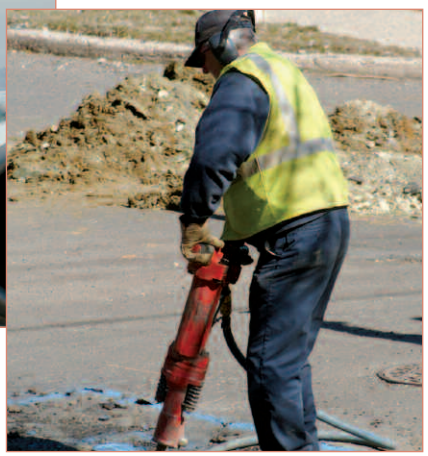
(a) not in existence or not obtainable;
(b) not reasonable or practical to adopt, install or provide because of the duration or frequency of the exposures or because of the nature of the process, operation or work;
(c) rendered ineffective because of a temporary breakdown of such controls; or
(d) ineffective to prevent, control or limit exposure because of an emergency.

So, while it has until now been essentially an employer's option whether to take steps to reduce sound levels in the workplace or to simply make hearing protectors available, the changes to the regulation now make engineering noise controls mandatory except under certain specific and narrow circumstances.

As with any other code or regulation, professional engineers have an obligation to comply with the revised *Occupational Health and Safety Act*, and to make their clients or employers aware of these responsibilities.

When it comes to developing engineered noise-control solutions, the 5 dBA reduction in the noise limit may introduce significant challenges in some industrial workplaces. Because a decrease of 5 dBA necessitates a reduction of 67 per cent in the total acoustic energy released into a given environment, the new regulation will translate into potentially significant additional capital costs for employers.

In this regard, plant and process engineers, and consulting engineers specializing in industrial equipment, system design and health and safety need to keep noise control in mind, more so now than ever before. It has always been true that incorporating noise-control measures into the design of a building or manufacturing process is less expensive and more effective than attempting to remediate a noise problem after things are built or installed. But now with the onus that the regulation places explicitly on the employer to implement appropriate engineered noise-control measures, employers, and the engineers upon whom they rely, are subject to greater risk of liability if proper attention is not paid to noise control during the design and ongoing operation of an industrial workplace.



New *Occupational Health and Safety Act* changes coming in July will reduce the risk of noise-induced hearing loss for workers.

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