What are we still doing wrong in assessing occupational noise exposure?

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Abstract: While the measurement of sound has improved over the last 20 years, four improvements are suggested. These are: (1) make the minimum measurement envelope independent of type, (2) better measure infrasound and ultrasound, (3) account for the effect of intermittent noise exposure, (4) provide a means for lifetime noise dosimetry.

INTRODUCTION

Sound level meters and dosimeters have improved greatly over the last 20 years, instruments can be expected assess the energy of impulsive noise correctly, have sufficient dynamic range, provide a time history of the noise exposure, and provide histograms of peak and sound level values. These improvements allow a better understanding of the types and sources of noise that might cause noise induced hearing loss. In spite of what may be said at this session, I believe that the current instruments are sufficiently accurate. Of more concern are some conceptual errors being made. Specifically we have errors designed into our standards, we don’t worry about supra low and high frequency sounds, we ignore the concept of “effective quiet”, and we don’t measure for long enough time. The four improvements in our noise measurement strategy to resolve this issue are as follow:

IMPROVEMENTS NEEDED

Improve our standards. Our standards need to be reworked such that the type designation only relates to the accuracy, not to the performance envelope. The fact that a type 2 instrument can be made to measure nothing above 8 kHz while a type 1 must measure up to 12.5 kHz. It is left up to the instrument manufacturer to decide how to interpret the minus infinity response that is allowable for frequencies above these 8 kHz and 12.5 kHz values. Thus the difference between a measurement made with a type 1 and type 2 instruments (ANSI S1.4-1983) (1) could be as large as 10, 20 or even 70 dB. Which measure better assesses the effect of noise on hearing? My vote is for the type 2 instrument with a sharp cutoff at the high frequencies, as I know of no evidence that A-weighting is the correct response past 8 kHz. But of more importance is that the world accepts a uniform method of measurement. Likewise the pulse range requirements (IEC 804) need to be the same for all instruments. The minimum range that is needed to assess the hazard of noise to hearing is from 80 dB to 140 dB although 75 dB to 140 dB is the preferred range. This means that the pulse range for any instrument needs to be at least 63 dB and better yet, 68 dB.

Check for infrasound and ultrasound. For the assessment of the hazards of infrasound or ultrasound, there needs to be a simple method for indicating when detailed measurements are needed. For instance, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) for ultrasound are ceiling values of 105 dB for Third-octave Bands of 10, 12.5, 16, and 20 kHz (3). While in most occupational settings, ultrasound is not a problem, how does one really know? Like wise for infrasound. The TLV in process of being proposed is a ceiling limit of 145 dB for any non-impulsive sound for any one-third octave band from 1 Hz to 100 Hz. Should a simple meter be developed to perform this function or should a one-third octave band analyzer become a necessity for any measurement with respect to preventing noise induced hearing loss? There are standardized weightings for both ultrasound and infrasound, but neither is correct for noise induced hearing loss.

Correct for intermittent noise exposures. Ward established the fact that temporary threshold shifts (TTS) in hearing would recover in a normal fashion only if the noise exposure during the recovery period was at a sufficiently low level. This level was called “effective quiet”. Ward and Turner have shown that for the same acoustical energy (3-dB trading relation), noises interrupted with periods of quiet less than 75 dB are less damaging to the cochlea (4). The resultant correction factor proposed can be as much as 7 decibels. To me this represents a measurement error just as important as those discussed by other presenters at this session. But of more importance, focussing on intermittency would put emphasis on the background

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noise levels. It is possible that a 7 dB drop in background noise could be as beneficial as a 5 dB drop in a major noise source. Likewise, one of the goals of assessing the performance of hearing protectors would be to use some type of intermittency correction. A hearing protector that reduced the background to less than 75 dB should result in a less damaging noise exposure. The consideration of effective quiet is why the measurement range ought to be from 75 dB to 140 dB.

**Long term noise dose measurements** One of the problems with making noise measurements is that they are always for a finite amount of time. Even if a person wore a dosimeter for a month, which has been done (5), this time period just begins to sample a person's life exposure. What I'd like to see is a method that would sample noise over a person's lifetime. This method would capture both occupational and non-occupational noise exposures. Thus, the influence of each could be sorted out. Rare, but potentially very damaging over exposures, could be identified. Is this dreaming? I think not. In 1980, the US air Force almost took delivery on ten dosimeters the size of a wristwatch. Only the fact an integrated circuit manufacturer stopped making a key part prevented this from occurring. Ten dosimeters were delivered, but they were four times larger than what was at first envisioned. While used in a couple of studies (6,7), a week was the practical limit for these units. Had they indeed been able to replace a wristwatch, I would have certainly tried to use them for a year on ten individuals. The technology is certainly now available to do want was attempted almost 20 years ago. But the wrist is not the optimum place to wear a dosimeter. So how can we make it feasible for a person to wear a dosimeter for long periods of time? It is going to be difficult to convince individuals to wear anything extra just to measure a noise exposure. Thus I see the noise dosimeter being piggybacked on some other instrumentation package. An obvious one is a hearing aid. However the numbers of users is limited and our goal should be to limit the number further by preventing noise induced hearing loss. In the future I envision long time monitoring of general health parameters. This is where I'd like to see a supra miniature dosimeter be ready to be added to this type of package.

**SUMMARY**

This paper has listed a number of problem areas with respect to the overall assessment of the effect of noise on hearing. There are other problem areas such as the lack simple method for measuring impulse noise above 140 dB, microphone placement, and etc. The point I want to make is that while it is nice to worry about errors of a decibel or two, there is the potential for much greater errors that require attention.

**REFERENCES**