COMMENTS ON "*VALIDATION OF THE CSAZ107.56 STANDARD METHOD FOR THE MEASUREMENT OF NOISE EXPOSURE FROM HEADSETS*" BY G. NESPOLI, A. BEHAR & F. RUSSO, VOL. 41, NO. 3 (2013)

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The authors present a study aimed at validating the method described in CAN/CSA Z107.56-13 to estimate the sound exposure arising from the use of communication headsets in the workplace. The data was reported in a different way than specified in the Standard, which led to inappropriate comparisons that inhibit proper interpretation of the study.

The estimation method in Clause 7.3.4 of CAN/CSA Z107.56-13 is based on the principle that, in a practical situation, the user will likely adjust the volume of the audio channel of the headset, and thereby the listening signal-to-noise ratio (SNR), so as to ensure proper reception of speech given the masking effect of the background noise. The Standard specifies an A-weighted effective listening SNR of 15 dB to be used to estimate the sound exposure of a worker wearing headsets, given the A-weighted external background noise (L_N) and noise reduction of the headset (*NR*). Assuming that the audio signal is always present when the headset is fitted, consistent with the study by Nespoli et al. (2013), the sound level is calculated as:

$$L_{headset} = 10\log\left(10^{(L_N - NR)/10} + 10^{(L_N - NR + SNR)/10}\right) \qquad 1)$$

The first term is the exposure to the background noise attenuated by the headset shell, and the second term is the exposure to the audio channel.

In their paper, Nespoli et al. (2013) are using an artificial ear method, specified in Clause 7.3.3.3 of the Standard, to test the estimation method with a group of laboratory subjects for different background noises and headsets. According to the paper, "*the parameter investigated … was the noise exposure increase in the headset due to the speech signal*". The noise exposure increase was calculated as the difference in sound level between (1) the combined speech signal plus residual noise through the headset measured with the device fitted on the artificial ear, and (2) the background noise in the artificial ear without the device fitted. In other words, and as best as can be inferred from the paper, the data reported by the authors is the increase in exposure as a result of wearing a headset in background noise with respect to the open-ear exposure in the same background noise. Thus, the data reported correspond to $L_{headset} - L_N$ in equation (1).

The "exposure increase" metric used by Nespoli et al. (2013) can be useful to draw certain conclusions about the impact of introducing communication headsets in an environment where workers are otherwise working in open ears (e.g. in demonstrating that headsets with higher sound attenuation reduce overall exposure). However, as is clearly apparent from equation (1), $L_{headset} - L_N$ is far different from and does not equate to the "effective listening SNR" specified in the Standard, and this invalidates any direct comparison between the two metrics (e.g. in declaring the exposure increase to be very different than the 15 dB specified in the Standard).

The difference between the two metrics, exposure increase $L_{headset} - L_N$ and effective listening SNR, is easily illustrated using the data reported by Nespoli et al. (2013). They measured an A-weighted noise reduction of about 23 dB in construction noise with their high attenuation headset. Assuming a construction noise of 80 dBA, the estimated sound level from equation (1), with a SNR of 15 dB, is $L_{headset}$ = 72.1 dBA, which corresponds to an estimated exposure increase $L_{headset} - L_N$ of -7.9 dB. Using the noise reduction in construction noise measured for their low attenuation headset, *NR* = 6 dB, the estimated exposure increase $L_{headset} - L_N$ becomes +9.1 dB. In other words, the same SNR of 15 dB leads to different estimated exposure increases depending on the noise reduction of the headsets. It is therefore not surprising that the authors found their exposure increase data to be "*drastically different from the 15 dBA stipulated in the Standard*" and stated "*it also seems that the 15 dB value is too high*". The two metrics cannot be compared in the way presented by the authors. To provide insight into the method proposed in the Standard, Nespoli et al. (2013) had to compare their "measured" exposure increase to the "estimated" increase $L_{headset} - L_N$ arising from equation (1), and not to the SNR of 15 dB per se.

There are further complications in making a direct comparison as described above for the current data set as a result of certain methodological choices made by the authors. Firstly, the authors report $L_{headset}$ and L_N data measured in the artificial ear, whereas these parameters are sound field equivalent levels in the Standard. Thus, their measurements must be transformed back to the sound field using third-octave band procedures prescribed in the Standard. This step is needed because the transformation between artificial ear and sound field equivalent levels is frequency-dependent, and typically will be different for $L_{headset}$ (speech dominated) and L_N (noise). Secondly, an accurate estimate of the sound attenuation of the headsets is needed to calculate the expected exposure increase using equation (1). The authors used the artificial ear to measure attenuation, but such a test fixture is not qualified for attenuation measurements. The primary difficulty lies in the lack of sufficient sound isolation in artificial ears, particularly at low frequencies, which can lead to an underestimation of attenuation. Thirdly, the authors used background noise levels as low as 60 dBA and, when combined to the high attenuation headset, the question arises as to whether the subjects were adjusting the headset volume based on the masking effect of the residual noise, as assumed in the Standard, or on some other audibility criterion more related to speech listening in quiet. It also seems odd that the authors could not produce distortion free background noise levels above 70 dBA using an array of five loudspeakers.

Finally, a laboratory study cannot be construed as validating a method, as implied by the title of the paper, which was calibrated on the basis of field data. The 15 dB number specified in the Standard was based on a meta-analysis of field studies comprising a total of 55 measurement cases covering intra-aural, supra-aural and circumaural communication headsets with real workers in a range of civil and military noise environments (Giguère et al., 2012). The reported mean A-weighted listening SNR was 13.7 dB with a standard deviation of 5.9 dB, indicating that in 68% of cases the listening SNR in the field ranged from 7.8 to 19.6 dB. The field data, based on measurements with real workers, include all associated aural and non-aural tasks required by the job and provide the highest level of face validity. Laboratory data, with test subjects at rest focusing on the experiment, can easily underestimate the headset signal level used in the field. Hodgetts et al. (2007), for example, reported a 3 dB increase in the preferred volume levels in noise when users of portable music devices are exercising as opposed to being at rest.

In summary, Nespoli et al. (2013) report laboratory data on the effect of different background noises on the exposure increase arising from the use of communication headsets with respect to the open-ear exposure in the same background noises. This metric is far different from the effective listening SNR parameter specified in CAN/CSA Z107.56-13. A comparison with the Standard requires a complete re-analysis of the data and consideration of the difference between laboratory and field validation.

ACKNOWLEDGEMENTS

The author wishes to thank Hilmi R. Dajani (University of Ottawa) and Stephen E. Keith (Health Canada) for their valuable comments.

REFERENCES

CAN/CSA Z107.56-13. “Measurement of Noise Exposure,” Canadian Standard CAN/CSA Z107.56-13, Canadian Standards Association, Mississauga.

Giguère, C. , Behar, A., Dajani, H.R., Kelsall, T., and Keith, S.E. (2012). “Direct and indirect methods for the measurement of occupational sound exposure form communication headsets,” Noise Control Engr. J., 60(6), 630-644.

Nespoli, G.N., Behar, A., and Russo, F. (2013). “Validation of the CSAZ107.56 Standard Method for the Measurement of Noise Exposure from Headsets,” Canadian Acoustics, 41(3), 31-36.

Hodgetts, W.E., Rieger, J.M., and Szarko, R.A. (2007). “The effects of listening environment and earphone style on preferred listening levels of normal hearing adults using an MP3 player”, Ear Hear., 28(3), 290–297.