The estimation of noise exposure when using hearing protectors

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Abstract

Occupational health professionals are aware that noise exposure estimates for employees must be made not taking into account any hearing protection that may be worn. So how can exposure estimates be made for individuals or groups when they wear hearing protectors in noise? It is a lot easier than first imagined based on a few solid practical principles.

Keywords: hearing protectors, noise exposure estimates.

National Standards for exposure to occupational noise[1] recommend not only the criteria for hazardous noise but also clearly specify that when estimating noise exposure the effect of wearing hearing protectors (HP) must not be taken into account. This requirement has typically been accepted into all state and territory regulations in Australia[2] and New Zealand[3]. For exposure assessment purposes this is as it should be. However, in order to run an effective occupational noise management program, it may be necessary to estimate the probable exposure of individuals who may not necessarily wear their HP for the entire duration of their exposure.

That individuals do not necessarily wear their HP for the duration of their hazardous noise exposure is well supported by many research studies. In a recent Australian survey[4] in response to the question: *"How often did you wear your personal hearing protectors while working in loud noise* (within the last two weeks)*?"*: 34% responded *Always*; 20% *Most of the time*; 15% *Sometimes*; and 31% *Never*. A second study in the Australian construction industry found that individuals *"wear their HP between 50% and 70% of the time when they are in noisy environments"*.[5] Earlier studies enquired about HP use but were not so specific in detail such as wear-time, only remarking that *"65% of the workers observed did not use hearing protection at all"* while *"35% . . . used ear protection for some tasks"* [6] and there was *"little training in the correct use of. plugs and muffs"* and that there was *"an impression that wearing personal hearing protection is a sign of weakness"*[7].

As discussed by Robens[8] in his report into safety and health at work in the UK *"the most important single reason for accidents at work is apathy"* and the above HP wear time figures seem to indicate that this is possibly still the case. The rational for this comment was suggested by Robens as *"serious accidents at work are rare events in the*

experience of individuals" while *"even rarer is personal awareness of the more subtle hazards of insidious diseases which manifest themselves long after periods of exposure in an unhealthy working environment".* This was reflected in the finding that on a scale of 1 to 10, where 1 represents "not a hazard at my workplace" and 10 "an extremely serious hazard", that noise exposure rated 6.6. Concern was concentrated around more immediate physical injuries such as falls, falling objects and back and muscle strain[5].

Given the obvious practical difficulty of having the entire workforce diligently wear their HP for the duration of their workplace noise exposure, there is a way to simply estimate noise exposure for inconsistent HP use. This utilises the effective protection – wear-time curve familiar to those users of AS/NZS 1269.3: 2005[9] and interpreted below in *Figure 1*.

Figure 1: Effective equivalent reduction of noise exposure, $L_{Aeq,8h}$, against total cumulative wear-time over an eight-hour work period for three sets of hearing protectors capable of supplying 10 dB, 20 dB and 30 dB attenuation (see text for appropriate interpretation of the graphs)
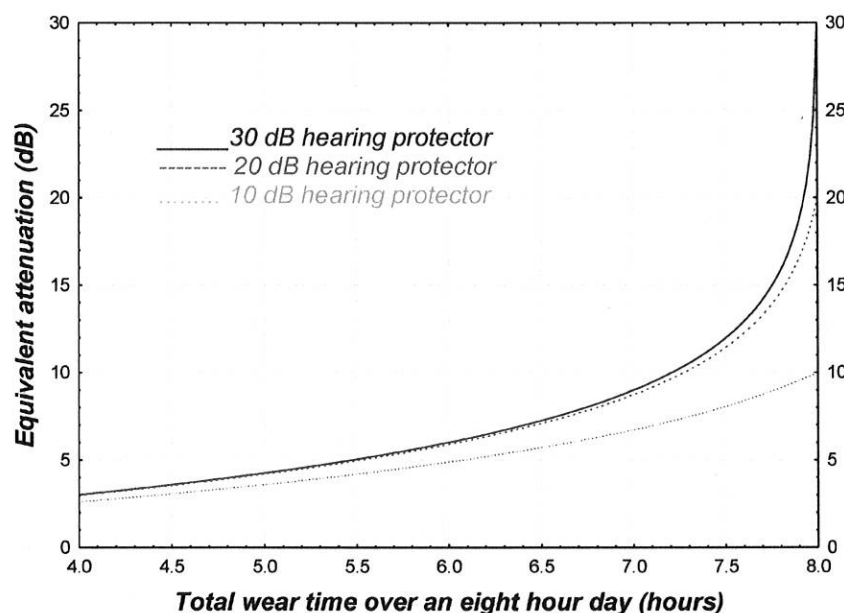
The graph in *Figure 1* shows that if a hearing protector with an attenuation of 20 dB is worn for a cumulative total of seven hours the effective reduction in exposure will be reduced to around 8 dB as compared to the expected reduction of 20 dB if worn for the whole eight-hour exposure. If the same hearing protector was worn for a total of only four hours the effective reduction would be even less at around 3 dB. The same protector worn for 7.5 hours would yield a reduction of about 12 dB.

This loss of attenuation of 8 dB to an effective 12 dB for 7.5 hours of wear-time represents a significant decrease compared to the expected 20 dB and is of concern as it implies a serious decrease in performance. If the hypothetical user was exposed to an

$L_{Aeq,8h}$ of, say, 100 dB then the effective exposure is actually around 88 dB compared to the planned 80 dB. This exposure is greater than that required by the regulations. Just think how easy it is in a busy workplace to accumulate 30 minutes of non-wear time over a period of eight hours. HPs are removed to: scratch your head; speak to a work colleague; speak to the foreman; receive new work instructions; take pressure off the side of the head; and numerous other reasons. Simple.

Thus wear-time is important when considering a hearing protector program particularly in the light of the figures quoted previously for typical HP usage of between 50% and 70%. This argument could be countered by suggesting that the use of HPs with higher attenuation could be used to maximise attenuation when worn and minimise the overall loss caused by decreased wear-time. As can be seen from a comparison of the three graphs presented in *Figure 1* for HPs capable of supplying 10 dB, 20 dB and 30 dB attenuation when wear-time is less than around six hours, or 75%, there is very little to be gained through overprotection by using HPs with higher attenuation. Only a maximum of an extra 2 dB can be achieved.

The argument for increasing the attenuation of HP can be taken to the extreme by considering a hypothetical HP capable of supplying an almost total reduction of external noise of 100 dB. The results of this exercise are represented in *Figure 2* where a fourth "100 dB hearing protector" graph has been added for our hypothetical HP.

Figure 2: This is the same graph as Figure 1 with an added 100 dB hearing protector and emphasising the time range of 7.90 to 8.00 hours
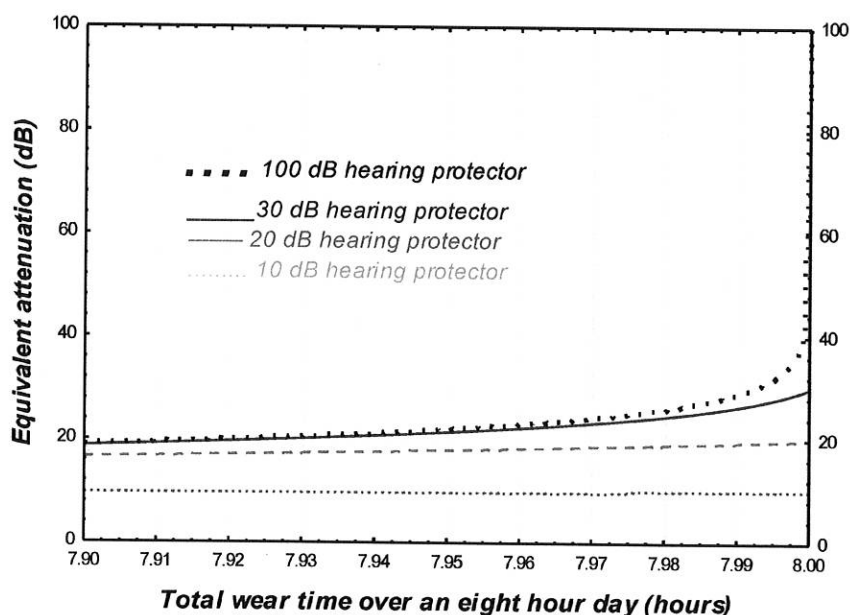
It must be noted that the portion of the graph only shows the last 0.1 hour, or six minutes of exposure from 7.90 hrs to 8.00 hrs. Clearly there is little to be gained by

using this HP when compared to increasing the total overall wear-time of the 30 dB or even the 20 dB device.

One of the outcomes of looking at the extreme HP graph is that it emphasises the definite physical limit that exists when attempting to control noise exposure using HPs only. From this, realistic estimates can be made of the attenuation individuals receive when using hearing protectors and hence their overall noise exposure. *Table 1* summarises these approximate maximum attenuation estimates.

Table 1: Approximate maximum attenuation achievable when wearing 30 dB hearing protectors for a given portion of the total exposure time

Cumulative wear-time		Approximate maximum attenuation wearing a 100 dB hearing protector
Approximate percentage (%)	*Hours per eight-hour day (h:m:s)*	*(dB)*
50	4	3
75	6	6
90	7	10
95	7:30	16
99	7:54	20
99.9	7:59:56	30

The implication of these figures is that an estimate can be made of the likely exposure of individuals who work in a noisy situation but who do wear HP for a portion of their exposure time. For example, using the construction workers cited above who indicated they wore HP between 50% to 70% of the time they work in noisy environments, a reasonable estimate would be that they could expect to receive from 3 dB to an absolute maximum of 6 dB of reduction in their $L_{Aeq,8h}$. Construction workers can be exposed to a wide variety of noises from processes, plant and machinery but if for convenience an exposure level, $L_{Aeq,8h}$, of 95 dB is the assumed exposure then if the reduction is at most 6 dB, workers are still exposed to 89 dB, 4 dB above the regulation figure of 85 dB. Either a better compliance rate is required or other methods of reducing the noise need to be more fully considered.

This simple method to estimate noise exposure when using hearing protectors is very useful for the OHS practitioner. The emphasis is made that the use of hearing protectors as the first line of defence against hazardous noise exposure is mistaken unless compliance rates are extremely close to the 100% mark — any less will end with poor results. More importantly, this tool exposes that reliance on hearing protectors alone will not necessarily succeed and solutions from top of the hierarchy of risk management, such as elimination or the use of alternate, quieter processes, may be better propositions. Unless it can be shown that full compliance with hearing protector wear-times does occur in the workplace, those responsible for such programs may not be able to demonstrate that they can defend their action under the applicable code of practice for noise management and protection of hearing at work.[10].

References

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