

Proceedings of The Institute of Acoustics

EAR PROTECTION - THE HSE VIEW

G R Custard

Health & Safety Executive, Technology Division, Merseyside.

INTRODUCTION

Personal ear protection is important and is here to stay.

That may appear as a surprising statement bearing in mind the advice given in the Code of Practice [1] and the EC Directive [2]. Do they not tell us that ear protection should be seen as an interim measure and not as a substitute for effective noise control?

Certainly ear protection does have a short term role in minimising the risk of deafness while engineering methods of reducing the hazard are sought and perfected. But it also has a long term role: in many industrial situations it is doubtful if we will ever find satisfactory methods of eliminating the noise hazard. Regrettably, even the short term benefits of ear protection are often neglected by industry and by those who give professional advice. Whilst it is appreciated that ear protectors have limitations (which will be discussed shortly), a great many workpeople will be relying on them as their only defence against deafness.

There is much ground to make up in this field. For example, two years ago HM Factory Inspectorate carried out a limited survey of almost 500 factories to check compliance with the current Code of Practice [3]. It was found that of persons exposed to more than 90 dB(A) Leq(8), an average of only about 40% were wearing ear protection. As shown in Figure 1, in about half the premises visited, usage amongst those who should have been wearing protection was 25% or less. Furthermore, the vast majority of firms who made protection available did not back up its use with adequate training, instruction and supervision.

LEGISLATION

Faced with a need both to clarify legal obligations and to implement a European Directive, the Health and Safety Commission is about to publish proposals for new Noise Regulations. These should be introduced by the end of 1989. Whilst it is not my intention to predict what will emerge, the likely proposals for ear protection can be deduced from what has already been published in the Directive.

Proceedings of The Institute of Acoustics

EAR PROTECTION - THE HSE VIEW

The broad principles for ear protection are as follows:

- 1 Make protection available when noise reaches a daily exposure level of 85 dB(A).
- 2 Protect the workforce immediately when noise reaches a daily exposure level of 90 dB(A), or a peak of 140 dB. Ear protectors must be worn.
- 3 Ensure that the protection is effective and suitable for the purpose and that employees know how to use it properly.
- 4 Do not rely on ear protectors forever, but introduce a programme for reducing the hazard wherever it is feasible to do so.

The protectors are considered effective if they can reasonably be expected to reduce the daily average levels at the wearer's ears to below 90 dB(A). Whilst it is appreciated that this is not necessarily a safe level for all people, it can be demonstrated that this is compatible with the "action level" of 90 dB(A) for noise reduction by engineering means [4]. Also, the aim should be to provide the wearer with just enough sound attenuation to reduce the noise to an acceptable level, without leading to sensations of excessive isolation or great difficulties in hearing warning sounds or verbal communications.

STANDARDS

Through the Code of Practice, HSE has encouraged the concept of Assumed Protection for assessing the likely performance of ear protectors in a given noise environment. Thus HSE would seek to encourage manufacturers and suppliers to give test data in accordance with BS 5108 [5], especially since this method has now been adopted by ISO 4869 [6]. This test method may have weaknesses, but it is the best method that is presently available that takes some account of how the product performs amongst people. It is awkward for the user to have to compare noise hazard and assumed protection in eight octave bands, but there is presently no generally acceptable alternative. Proposed Single Number Ratings [7] have so far erred to over-simplification and rely on C-A weightings that are not available on most industrial meters.

EAR PROTECTION - THE HSE VIEW

BS 6344 [8] is a standard dealing with the physical properties of ear protectors and also the information that should be provided on their physical and acoustical performance. HSE has participated in the BSI committee work to publish Parts which deal with the different classes of protector. The drafting and support for standards such as these is seen as important because they represent technical agreements between users and manufacturers as to what can reasonably be achieved and provided.

Part 1 of BS6344 deals with ear muffs; it has already been published and is due for revision. Part 2 deals with ear plugs and is about to be issued. Part 3, on helmet-mounted muffs, is shortly to be published as a draft for public comment.

In the standard for plugs, HSE has sought to introduce the concept of plug sizing in order to encourage users to become more aware of the need to fit properly sized plugs to achieve adequate protection. Whilst the method of sizing may be judged as crude compared with the complex shapes of ear canals, it represents a reasonable compromise between the ideal and the currently achievable.

RESEARCH

Three research projects on ear protection have been funded by HSE, and these will be discussed in turn.

Wearability of muffs

This was a brief project undertaken by the Institute for Consumer Ergonomics, Loughborough University, to look at physical parameters, such as force, pressure and weight, which might affect wearer acceptability. Much of the project involved the use of ear muffs which had been modified to allow the weight and force across the cups to be systematically varied. These were then used in laboratory based trials for subjects engaged in light manual work.

Within the limitations of this study, it was confirmed that muff comfort was dominated by headband force and associated seal pressure; no measurable effect due to weight was found within the normal range of market muffs. In order to ensure a high level of muff wearability and acceptable comfort levels, upper limits of 3000 Pa and 9 N were recommended for pressure and force, respectively. [9]

EAR PROTECTION - THE HSE VIEW

Dual protection

Some excessive noise situations are encountered where even the best muffs or plugs cannot achieve an assumed protected level of 90 dB(A) Leq(8). Examples are the use of pneumatic chipping hammers in confined spaces, such as boilermaking, ship caulking and hard rock drilling underground. Others are close to large electric furnaces, or where cast concrete sections are compacted by vibration. It is likely that individual protectors will fail to protect the wearer when the noise exceeds about 115 dB(A), especially if there is a predomination of sounds at 500 Hz and below.

In such extreme circumstances, the wearer needs muffs and plugs together, but there is little information on how such combinations perform in practice. Therefore HSE sponsored ISVR, Southampton University, to undertake a series of tests of combinations in accordance with BS 5108.

Our present understanding of the results is that the test data for individual protectors do not lead to a reliable prediction of their performance when they are worn in combination. Good ear plugs worn with low performance muffs do not necessarily give better performance when used with high performance muffs. Figure 2 shows the range of assumed protection afforded when EAR plugs were tested with several muffs; the effect of bone conduction is clearly evident at frequencies exceeding 1 kHz.

It is concluded therefore that our present understanding of the physical parameters affecting the performance of dual protection is inadequate. It is recommended that in extreme noise hazards, the selection of dual protection should be based on test data obtained for the proposed combination and not on adaptation of single protector values.[10]

Real ear protection

Work reported in the U.S.A. [11] has shown that the attenuation of protectors when measured "as worn" in industry can be considerably less than the laboratory-based figures of test. An important factor leading to this difference is likely to be the degree of selectivity of subjects and results allowed under the terms of the American Standard. Such differences may not be so large if similar comparisons were made with BS 5108 data, but this has yet to be demonstrated. Other factors affecting "real ear" performance are likely to be:

EAR PROTECTION - THE HSE VIEW

- (a) improper size or poorness of fit;
- (b) disruption of muff seal by long hair, glasses, etc.;
- (c) protector damage or ageing.

In order to investigate this matter further, HSE has sponsored a joint project with the Universities of Salford and Southampton (ISVR).

It is intended to use a mobile test facility to give wearers a BS 5108 test with their protectors as worn on site. This will allow a direct comparison to be made between "real ear" values and published data obtained according to the same British Standard. ISVR has already carried out a pilot exercise to demonstrate the viability of confining the test sound field to a small booth, instead of the usual anechoic room with tetrahedral speaker array.

THE FUTURE

HSE sees a future for ear protection. This may become more secure in some industry sectors if protectors are perfected which combine good comfort, adequate attenuation and a flatter frequency response to lessen the distortion of the wearer's perceived environment. A new breed of these protectors is just beginning to emerge. Protectors which also attempt to improve speech perception by introducing "non-linear" techniques present a challenge to those of us concerned with ensuring that there are adequate standards for specifying performance: BS 5108 was not designed to cope with non-linear effects.

Another subject on which HSE is maintaining a watching brief is masking effects of noise and audibility of warning sounds. Work arising from Patterson's treatment of the subject [12] may have implications for ear protection selection.

All acousticians will appreciate that ear protectors can only be effective if they are worn for all of the exposure period. This human factor, together with doubts as to their "real ear" attenuation, make it highly desirable to reduce noise by engineering means wherever it is feasible to do so. Inspectors of Health and Safety, backed up by new Noise Regulations, will be seeking to ensure that industry progressively reduces its noise hazard. Meanwhile, however, a great many workpeople will have to rely on their personal protection; employers and employees will have important obligations to fulfill to ensure that it is effective.

Proceedings of The Institute of Acoustics

EAR PROTECTION - THE HSE VIEW

REFERENCES

[1] "Code of Practice for Reducing the Exposure of Employed Persons to Noise." Health & Safety Executive. 1972 HMSO.

[2] "Council Directive of 12 May 1986 on the Protection of Workers from the Risks Related to Exposure to Noise at Work." Official Journal of the European Communities no. L 137/28 (24.5.86).

[3] CUSTARD G.R. "Noise Hazard Awareness: A British Factory Inspectorate Survey." Internoise 86, Cambridge U.S.A.

[4] CUSTARD G.R. "Hearing Protection Versus Engineering Controls - Are They Comparable?" Internoise 85, Munich.

[5] BS 5108:1983 "Method for Measurement of Sound Attenuation of Hearing Protectors."

[6] ISO 4869-1981 "Acoustics - Measurement of Sound Attenuation of Hearing Protectors."

[7] SUTTON G.J., ROBINSON D.W. "An Appraisal of Methods for Estimating Effectiveness of Hearing Protectors". Journal of Sound and Vibration July 1981. Vol. 77 no. 1.

WAUGH R. "Simplified Hearing Protector Ratings - an International Comparison." Journal of Sound and Vibration March 1984. Vol. 93 no. 2.

CLUFF G.L. "A Comparison of Rating Procedures for Hearing Protectors." Sound & Vibration (U.S.A.). October 1982. Vol. 16 no. 10.

[8] BS 6344:1983 "Industrial Hearing Protectors".
Part 1 Specification for Ear Muffs.
Part 2 " " " Ear Plugs.
Part 3 " " " Helmet Mounted Muffs.

[9] HARRIS C.M.T., WILLIAMS M., WHEATLEY D.W., ISTANCE H.O. "An Investigation of the Effects of Force, Weight and Other Physical Characteristics of Ear Muffs on User Acceptability" Report by Institute of Consumer Ergonomics, Loughborough, for the Health and Safety Executive.

ACTON W.I., LEE G.L., SMITH D.J. "Effect of Head Band Forces and Pressure on Comfort of Ear Muffs. Ann. Occup. Hyg. December 1976.

Proceedings of The Institute of Acoustics

EAR PROTECTION - THE HSE VIEW

[10] RAWLINSON R.D., WHEELER P.D., CUSTARD G.R. "The Acoustical Attenuation of Some Combinations of Earplugs and Earmuffs." For publication in Annals of Occupational Hygiene.

BERGER E.H. "Laboratory Attenuation of Earmuffs and Earplugs Both Singly and in Combination." Am. Ind. Hyg. Assn. J. 44(5) 321-329.

[11] LEMPERT B.L., EDWARDS B.L. "Field Investigations of Noise Reduction Afforded by Insert-type Hearing Protectors." American Industrial Hygiene Association Journal. December 1983. Vol. 44 no. 12.

CHUNG D.Y., HARDIE R., GANNON R.P. "The Performance of Circumaural Hearing Protectors by Dosimetry." Journal of Occupational Medicine. September 1983. Vol. 25 no. 9.

BERGER E.H. "Hearing Protector Performance - How They Work and What Goes Wrong in the Real World." Noise & Vibration Control Worldwide. March 1982.

[12] PATTERSON R.D. "Guidelines for Auditory Warning Systems on Civil Aircraft." Civil Aviation Authority. Paper 82017.

WILKINS P.A., MARTIN A.M. "The Role of Acoustical Characteristics in the perception of Warning Sounds and the Effects of Wearing Hearing Protection." J. Sound & Vibration Vol. 100 no. 2.

ABEL S.M. "Noise Induced Hearing Loss and Hearing Protective Devices." Can. Acoust. Vol. 15 no. 1.

EAR PROTECTION - THE HSE VIEW

Fig. 1 % USE OF EAR PROTECTION

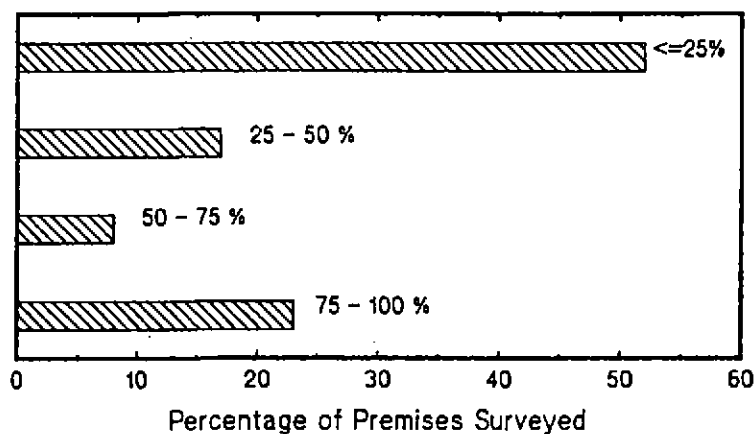


Fig. 2 RANGE OF AP FOR MUFFS + E.A.R.

