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# HEARING HANDICAP PREVENTION: A BASIS FOR LEGISLATION

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## INTRODUCTION

Hearing protection legislation should be based on a number of technical considerations including the relationship between noise exposure and hearing handicap risk, the precision of monitoring audiometry and the reliability of hearing protectors. There is wide variation in the published estimates of the first and the second has not, apparently, been taken into account at all in some proposals for legislation.

Legislation should, of course, take other practical and economic implications into account as well, but this paper is concerned only with those technical considerations noted above. It is based on a detailed critique of these technical aspects of the proposed EEC Directive on Protection of Workers from Noise published by the Confederation of British Industry and the Engineering Employers' Federation in 1983 (1).

## DISCUSSION

### Hearing Handicap Criteria

The purpose of hearing protection legislation is generally taken as being to reduce to the practicable minimum the risk of hearing handicap in relation to understanding speech. Handicap is "impairment that limits or prevents the fulfilment of a role that is normal for the individual" (2) (see also ISO/DIS 1999 para 3.7)

It is convenient to set a numerical criterion of handicap in terms of average hearing threshold level (AHTL) over the relevant range of frequencies, which can be measured by audiometry. Two methods have been used to determine this criterion, or threshold, of handicap:

(i) Measure word recognition ability by laboratory test and relate this to AHTL. This can be done objectively, but the decision as to what level of word recognition ability represents actual handicap is a matter of subjective judgement. Several different values of AHTL have been selected as representing handicap (1) including:

(a) 15 dB AHTL at 1,2,3 kHz
(b) 30 dB AHTL at 1,2,3 kHz
(c) 25 dB AHTL at 0·5,1,2 kHz

(ii) Ask a representative sample of the population whether they have any difficulty in understanding speech, and relate their replies to their AHTL's.

Both methods have been used and there are objections to either. The results should, in any case, be interpreted in the light of the experimental details. The findings of (i) laboratory studies and (ii) self assessment, for a typical population of a developed country, are compared in Table 1.

Table 1. Proportion of population with hearing handicap.

| Average age y | Handicap Criterion | | | |
|---|---|---|---|---|
| | (a) 15 dB 1,2,3 kHz | (b) 30 dB 1,2,3 kHz | (c) 25 dB ·5,1,2 kHz | Self-assessed |
| 20 | 15 % | 2 % | 1 % | 1 % |
| 40 | 28 % | 6 % | 3 % | 3 % |
| 60 | 50 % | 23 % | 14 % | 6 % |
| 70 | 75 % | 45 % | 32 % | 13 % |

The derivation and validity of each criterion is discussed in (1). It appears that (c) matches self-assessment most closely but many authorities consider that it underestimates handicap to some extent, (b) is a realistic, possibly conservative, criterion of handicap, appropriate for use in connection with occupational noise control since it includes some latitude for further presbyacusis in old age, and (a) is unrealistic as a general criterion of handicap.

Hearing Handicap Risk

There are several data bases from which hearing handicap risk can be estimated. The most recent and authoritative international consensus data base is that provided by ISO/DIS 1999 (1982)* with ISO/DIS 7029.2 (1980)

Table 2 gives hearing loss and risk data derived from the ISO/DIS documents for a screened male population age 60 y with 40 y exposure to occupational noise at the levels stated.

* There are several errors in ISO/DIS 1999 as printed which have been corrected for the calculations made here.

Table 2. Handicap threshold 30 dB AHTL at 1,2,3 kHz

| Noise exposure Leq dB(A) - | 80 | 85 | 90 | 95 |
|---|---|---|---|---|
| Proportion of people reaching or exceeding handicap threshold - total | 10 % | 13 % | 21 % | 37 % |
| - noise | 0 % | 3 % | 11 % | 27 % |
| Hearing loss at threshold level due to age | 30dB | 27dB | 22dB | 16dB |
| due to noise | 0dB | 3dB | 8dB | 14dB |

In an unscreened (typical) population, both noise risk % and noise loss dB figures are slightly lower.

## Audiometry

The accuracy and reproducibility of monitoring audiometry is well established (1). It is probably rather less good in practice than is indicated in ISO/DIS 6189.2. With typical good practice, the minimum change in measured HTL at 1,2,3 or 4 kHz required for 95% confidence that a real change has taken place is approximately 15 dB.

Table 3. Period to reach audiometrically significant noise-induced hearing loss at stated level of noise exposure ( - indicates >40 y)

| Noise exposure Leq dB(A) - | 80 | 85 | 90 | 95 |
|---|---|---|---|---|
| 1,2,3 kHz (2 of the 3 freq's)- 50% of pop'n. | - | - | - | 25 y |
| - 10% | - | - | - | 4 y |
| 4 kHz - 50% | - | - | 40 y | 5 y |
| - 10% | - | - | 10 y | 3 y |

Table 3 shows that audiometry is not generally useful for routine detection of NIHL unless noise exposure exceeds 90 dB(A) Leq over a period of many years. The data relates to men with no previous noise exposure. The rate of increase in NIHL reduces with the total period of exposure. With 90 dB(A) Leq, after the first 5 y exposure, only 10% of the population would show a further significant increment and that would take up to 35 y more.

## Hearing Protectors

There are problems in testing the performance of hearing protectors and applying the test data in practice (3). It is recognised also that the protection achieved as worn at work may be less than as worn in the laboratory. If the method of selection described in (1) and (3) is employed, and a further deduction of 3 dB "as worn" is made, no more than 15% of the population would be expected to reach audiometrically significant NIHL in a full working lifetime of 40 y work in 95 dB(A) Leq or higher unprotected noise level.

CONCLUSIONS

1. For purposes of hearing protection legislation, the numerical criterion of hearing handicap threshold can reasonably be taken as 30 dB AHTL at 1,2,3 kHz.

2. At 90 dB(A) Leq, the incremental number of men expected to reach handicap threshold in a working lifetime of 40 y is 11%, and one-quarter of their total hearing loss would be due to noise exposure.

   At 85 dB(A) Leq, the corresponding figures are 3% and one-tenth.

   These figures apply to a screened population, for an unscreened population they would be slightly lower.

3. Routine audiometry is likely to be useful in detection of noise-induced hearing loss only where there is significant risk of exposure to over 90 dB(A) Leq for a period of many years.

   When properly selected hearing protectors are used this will not be the case unless the unprotected exposure level is over 95 dB(A) Leq.

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