A COMPUTERISED OCCUPATIONAL NOISE EXPOSURE ANALYSIS TECHNIQUE (NEAT) FOR DETERMINING RISK OF HEARING IMPAIRMENT AND COST BENEFIT ANALYSIS OF MITIGATION METHODS.

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1.0 INTRODUCTION

The Noise at Work Regulations (NWR) [1] were introduced in January 1990; these place a number of duties on an employer for controlling noise in the workplace. The NWR are governed by 2 action limits 85 and 90 L_{EPd}; the degree of action required is dependent on the magnitude of the personal noise exposure levels, however all employers have a general duty to reduce noise levels to as low as reasonably practicable.

To ensure compliance with the NWR, an employer should develop a coherent noise policy for occupational noise and employee hearing conservation with the following objectives:

i) to minimise the risk to employees of over-exposure to noise in the workplace;
ii) to conform to the applicable legal requirements;
iii) to achieve the above as cost-effectively as possible.

A technique has been developed that will allow these objectives to be met through the evaluation of personnel exposure by analysis of working patterns and noise levels linked in a computerised spreadsheet; this technique also enables identification of the specific noise control measures required and allows cost-benefit analysis of the measures to be carried out.

2.0 PROCEDURE

To meet all the objectives of the noise policy, an employer must first determine which employees (if any) exceed the action limits. The NWR accompanying guidelines outline procedures for assessing noise exposure by dosimetry or by a simple calculation method.

If employee working patterns remain constant, then clearly the daily personal noise exposure level can be determined by measurement of the equivalent continuous noise level at the worker location. However this is rarely a realistic situation. On many sites employees will move around from location to location, job rotations and shift work can all result in considerable variation in daily work patterns.

In these circumstances, determination of employee noise exposure is generally carried out by analysis using personal dosimeters. Whilst dosimeters provide useful information on exposure levels they cannot provide information on noise sources generating the exposure levels and therefore offer little information for cost-effective noise exposure reduction.

An alternative method of determining employee noise exposure is by detailed analysis of the employee work patterns and noise levels; personal exposure levels can then be derived from the combination of these two variables which in turn will establish the associated risk of hearing impairment, to the person and for the site.

COMPUTERISED METHOD FOR NOISE EXPOSURE ANALYSIS

The analysis is carried out in two parts:

i) noise level survey;
ii) audit of personal working patterns.

The survey must establish the noise levels at all working locations due to all working activities. The survey technique is consistent with the requirements outlined in the Noise at Work Regulations.

The audit must establish the long-term average working patterns of all personnel. This includes routine and ad hoc operational and maintenance work. The audit is normally carried out by a combination of interview, observation and analysis of maintenance records and schedules.

3.0 NOISE EXPOSURE ANALYSIS

The exposure analysis combines the noise level and working pattern data. Personnel groups are identified who have the same long-term average working pattern. For each group, the working pattern must be divided to give the time spent carrying out specific activities, at specific locations; for each activity/location it must be possible simply to quantify the noise level.

Each activity/location element gives a corresponding noise exposure element. The sum of the exposure elements is the overall noise exposure of the personnel group. The risk of hearing impairment is then determined from the relationship derived from a study carried out by the HSE, described below.

The analysis procedure is conveniently carried out in spreadsheet form on a computer (a typical example is shown in Figure 1). Once the analysis has been linked into a spreadsheet, it is important to test the sensitivity of the input data; this is carried out to ascertain the margin of error of the exposure levels. Any significant variations should be resolved by rigorous analysis of the input data to increase the confidence of the assessment.

3.1 Risk of Hearing Impairment

A commissioned HSE study was carried out by D. W. Robinson et al.[2] to determine the risk of hearing impairment for otologically normal persons due to long term noise exposure. A significant hearing loss was identified as a 30 dB hearing loss averaged over the frequencies 1,2 and 3 kHz.

The relationship of percentage of population suffering a hearing impairment for increasing long term noise exposure (Figure 1) forms the basis for which employee noise exposure can be assessed and from which noise control options can then be compared.

The summation of the number of personnel in each identified group that are likely to suffer a hearing impairment can be considered as the overall risk to the site; Robinsons findings have shown that this risk can be only be reduced to a limit of 5 % of the population.

COMPUTERISED METHOD FOR NOISE EXPOSURE ANALYSIS

NOISE EXPOSURE ANALYSIS TABLE												
PERSONNEL GROUPS	No.	AREAS	POWER GEN	GAS COMPRESN	PROCESS MOD 01	PROCESS MOD 02	UTILITIES	WRKSHOP	QUIET	TOTAL PE	XRISK	No OF PEOPLE
OPERATIONS:	4	Leq	101.6	93.1	86.8	89.4	90.8	80.6		85.0		
SUPERVISOR		TIME	1.6	1.6	1.6	1.6	1.6	1.5	88.67	0.5	0.16	0
		FE	0.36	0.05	0.01	0.02	0.03	0.00				
		%FE	74.41	10.59	2.49	4.49	6.15	0.33				
		N.FE	1.45	0.21	0.05	0.09	0.12	0.01				
OPERATOR	32	Leq	88.2	80.6	78.7	66.4	71.1	53.0		89.0		
		FE	1.04	0.10	0.12	0.01	0.02	0.00		1.4	6.02	0
		%FE	75.91	13.29	8.51	0.51	1.47	0.03				
		N.FE	33.30	5.84	3.74	0.22	0.65	0.01				
MAINTENANCE	6	Leq	101.6	93.1	86.8	89.4	90.8	80.4		91.0		
SUPERVISOR		TIME	9.3	0.7	0.7	0.2	1.0	0.0	88.03	2.2	1.79	6
		FE	2.12	0.02	0.01	0.00	0.02	0.00				
		%FE	97.68	1.09	0.34	0.16	0.90	0.00				
		N.FE	12.70	0.14	0.03	0.02	0.12	0.00				
MECHANICAL	24	Leq	101.6	93.2	87.3	89.6	89.1	80.0		90.0		
		TIME	27.8	2.2	2.1	0.7	3.1	0.0	64.10	6.4	12.34	24
		FE	6.30	0.07	0.02	0.01	0.04	0.00				
		%FE	97.80	1.14	0.27	0.16	0.62	0.00				
		N.FE	151.26	1.76	0.42	0.25	0.96	0.00				
ELECTRICAL	20	Leq	101.3	88.6	87.2	89.1	90.2	80.0		87.0		
		TIME	3.0	3.6	1.8	1.2	1.0	0.0	89.63	0.7	2.54	0
		FE	0.63	0.04	0.01	0.02	0.02	0.00				
		%FE	88.34	5.32	2.02	2.22	2.30	0.00				
		N.FE	12.60	0.75	0.29	0.32	0.33	0.00				
INSTRUMENTS	10	Leq	102.2	92.9	86.5	89.1	89.2	80.0		94.0		
		TIME	12.4	10.5	2.8	5.1	4.1	0.0	65.11	3.8	4.28	10
		FE	3.29	0.32	0.02	0.07	0.05	0.00				
		%FE	87.67	8.59	0.52	1.75	1.46	0.00				
		N.FE	32.89	3.22	0.20	0.66	0.55	0.00				
No	96	EQA	344.39	11.92	4.73	1.56	2.73	0.02	HAZARD		27.9	40.0

Figure 1: Noise Exposure Analysis Table

4.0 COST-BENEFIT ANALYSIS

The division of the noise exposure calculation into elements is the foundation of the cost-benefit analysis of exposure reduction measures. Those exposure elements which dominate the overall exposure can be readily identified, allowing the risk (of hearing damage) associated with each activity/location to be defined. Noise reduction measures can therefore be targeted on the most significant activity/locations. The degree of noise reduction required is known, as is the benefit, (reduction of risk), resulting from the measure.

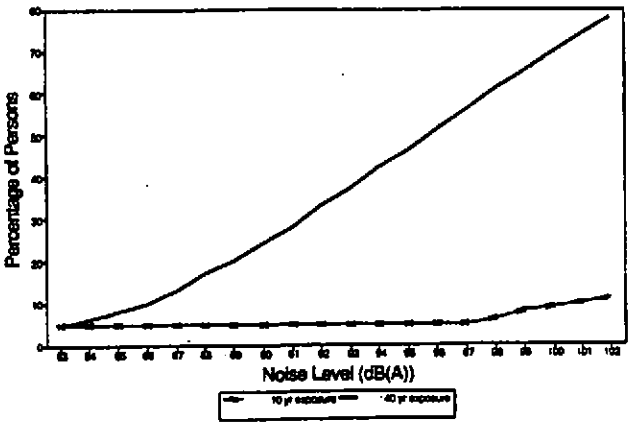

Figure 2: Percentage of Persons Attaining or Exceeding a Mean Hearing Loss of 30 dB

In practice a variety of reduction measures are proposed and evaluated by re-running the exposure analysis spreadsheet. Each measure or combination of measures gives a corresponding reduction in risk to the platform population, this is the benefit for comparison with the cost. Benefit is also used to prioritise the order of implementation of measures.

5.0 CONCLUSIONS

The immediate result of the exposure analysis is a statement of the current personnel exposure levels for comparison with appropriate limits. The future exposure levels with noise reduction incorporated are also known.

The cost-benefit analysis process yields a prioritised list of all reasonably practicable noise reduction measures. This will comprise a set of measures which give a reasonable reduction in risk per unit cost.

6.0 REFERENCES

[1] SI No 1790, 1989, 'The Noise at Work Regulations 1989', October 1989

[2] D. W. ROBINSON, 'Tables for the Estimation of Hearing Impairment Due to Noise for Otologically Normal Persons and for a Typical Unscreened Population as a Function of Age and Duration of Exposure', HSE Contract Research Report No 2.1988 [Updated in 1991]