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HAND-TRANSMITTED VIBRATION EXPOSURE IN SHIPBUILDING AND SHIP REPAIR

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1. INTRODUCTION

This paper summarises the results of a survey of hand-transmitted vibration in shipbuilding and ship repair. Measurements of hand-transmitted vibration exposure were made at six shipyards in the UK between October 1993 and December 1994. The aims of the project were to investigate the range of daily vibration exposures of shipyard workers who use powered hand tools and to identify the tools in use which contribute most significantly to the risk of exposure to hand-transmitted vibration in the industry.

2. SHIPYARDS SURVEYED

Measurements were made in three ship repair yards and three shipbuilding yards. The main work in the repair yards involving powered hand tools was removal of paint, scale and corrosion from metal surfaces, preparation of surfaces for welding and backgouging of welded joints. This type of work invariably involved the use of scaling or chipping hammers. The main work in the shipbuilding yards tended to involve buffing and finishing of welds, edges and others scars on the metal plates. Various types of grinders and sanders were most commonly used for this work.

3. ASSESSMENT OF EXPOSURE

Measurements were made on 79 individual tools of various types. Estimates of daily vibration exposure were made for a total of 33 operators. Exposure time estimates were made with the help of a

questionnaire devised specifically for the purpose. The estimation of daily exposure time is often difficult in the case of the shipbuilding and ship repair industry, since the exposure patterns vary greatly from job to job and week to week.

4. RESULTS

Acceleration magnitudes on tools in use in shipyards
Figure 1 summarises the highest axis frequency weighted acceleration magnitudes for the tools encountered during the survey. In order to simplify this figure, the 79 tools on which measurements were made have been grouped into 16 categories. Categories 1-3 are the impulsive tools and categories 4-16 are the non-impulsive tools.

Daily exposures of shipyard workers
Figures 2a and 2b show the distribution of daily vibration exposures of the shipyard workers. Figure 2a gives the exposures in terms of the highest axis data and Figure 2b gives the exposures in terms of the vector sum data. The Figures also indicate whether or not impulsive tools, are part of the exposure pattern contributing to the daily exposure of the individual.

5. DISCUSSION

HSE Guidance on Hand-transmitted Vibration
HSE's recent guidance note on hand-transmitted vibration, HS(G)88 [1], recommends programmes of preventive measures and health surveillance where a worker's daily exposure regularly exceeds an action level of $2.8ms^{-2}$. This figure is based on highest axis data. Considering the results of the survey in terms of the highest axis data, of the 33 operators surveyed, 25 (76%) are estimated to have exposures in excess of $2.8ms^{-2}$.

The overall range of highest axis daily vibration exposures is 1.4 to $30ms^{-2}$, the highest vibration exposures being for those operators who use impulsive tools. For those who do not use impulsive tools, the highest axis daily vibration exposure only ranges up to $5.9ms^{-2}$.

Proposed EC Directive on Physical Agents
The proposed EC Directive on Physical Agents [2] defines a series of vibration exposure levels at which various actions are required. Table 1 below summarises the exposures and required actions.

Table 1. Exposures and actions of proposed EC Directive on Physical Agents

Daily Exposure Level (A8)*, except where indicated	Required Action
1ms^{-2} Threshold level	• Risks to be reduced to lowest achievable level • Information to be given to those exposed on risks
2.5ms^{-2} Action level	• Vibration exposure assessments • Information to be given to those exposed on protection and control measures • Workers entitled to health surveillance • Employers to establish programme of control measures • Workers representatives to receive results of exposure assessments and the programme of control measures
5ms^{-2} Exposure limit	• Systematic health surveillance required • Exposure must be reduced by controlling exposure time
10ms^{-2} (short term level)	• "Increased efforts" to be made to reduce vibration
20ms^{-2} (short term level)	• Equipment to be marked • Activities to be declared to the "authority responsible"

Comparing the data from this survey with the action levels in Table 1 shows that:

- 32 of the 33 operators (97%) have a daily exposure above 2.5ms^{-2}.
- 19 of the 33 operators (58%) have a daily exposure above 5ms^{-2}.
- 19 tools (28%) are above the 10ms^{-2} short term level.
- 5 tools (7%), all from the hammers/scalers category, are above the 20ms^{-2} short term level.

Variation between yards

As can be seen in Figures 2a and 2b, all of the yards have at least one operator whose daily exposure is estimated to be above either 2.8ms^{-2} (highest axis) or 5ms^{-2} (vector sum). Yard 5, a shipbuilding yard, has the lowest exposure patterns overall with only one of the six workers surveyed exceeding the exposure limit of 5ms^{-2}. The highest daily vibration exposures are almost invariably caused by use of impulsive tools. Only 1 operator out of all the 33 operators surveyed has a daily

exposure estimated at below 2.5ms^{-2} based on vector sum data. This operator is from Yard 4, which is a shipbuilding yard.

The highest exposure figures of all the Yards are found at Yard 6. The reason for the high exposure levels in this yard is the combination of both high vibration magnitudes and long daily exposure times. At the time of the measurement visit, a large number of casual labourers had been brought in to carry out specific tasks. The exposure figures therefore only apply for the period of the work being done, which would probably be a matter of weeks. At other times the same labourer may not be submitted to any hand-transmitted vibration at all.

6. CONCLUSIONS

High daily vibration exposures can occur as a result of using impulsive tools such as scaling and chipping hammers. These types of tools may produce frequency weighted acceleration magnitudes in excess of 20ms^{-2}. Tools which produce accelerations of this magnitude can only be used for a few minutes before an operator's daily vibration exposure exceeds the acceptable limits as indicated in current guidance on hand-transmitted vibration. Tools such as angle grinders and sanders can be used for 2 - 3 hours before the operator's daily vibration exposure is likely to exceed the same limits.

Based on the results of this survey, the consequences of the proposed Physical Agents Directive for the shipbuilding and repair industry would be as follows:

- Almost all activities involving powered hand tools would require assessment.
- Approximately half of the tasks would require some control over exposure time to keep daily exposure below 5ms^{-2}.
- Scaling and chipping hammers, scabblers and large needle guns would require labelling and declaring to the authority responsible.

To reduce vibration exposure, users and purchasers must have information to allow them to identify low vibration tools. Further investigation of the data from this survey is needed to determine whether parameters such as operating speed, power source, bit type have influenced the vibration magnitude for each tool category.

References

[1] Health and Safety Executive. "Hand-Arm Vibration". Health and Safety series booklet HS(G)88. 1994.

[2] European Commission. "Proposal for a directive on the protection of workers from exposure to physical agents". Official Journal of the European Communities, Vol 37, No.C 230 pp3-29, 1994.

Figure 1 - Summary of highest axis vibration magnitudes

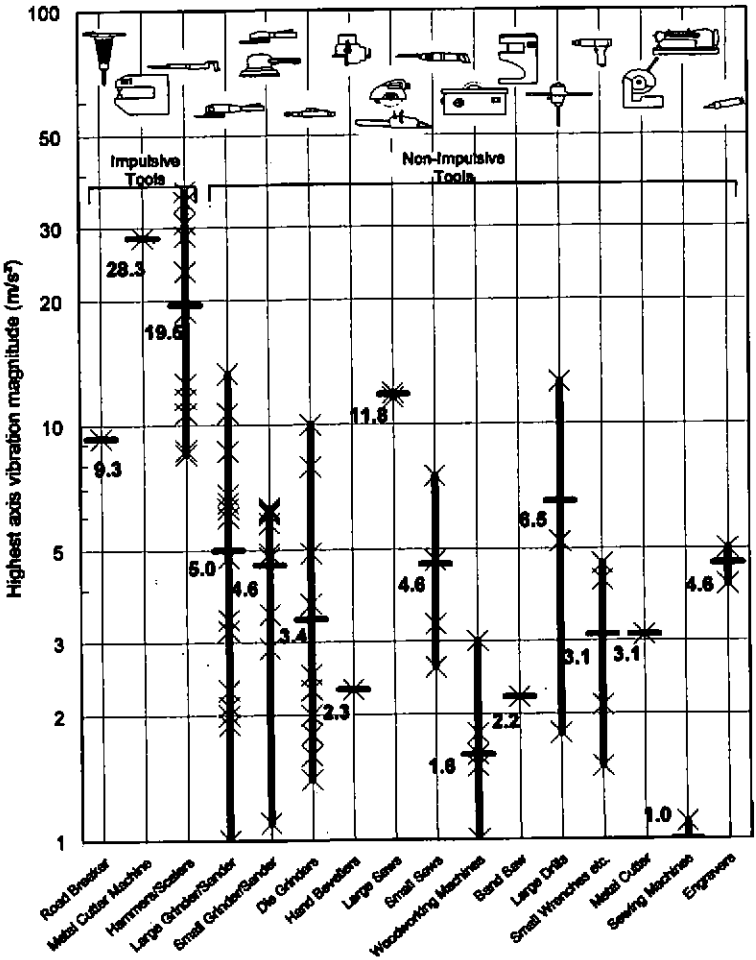

Figure 2a - Distribution of Daily Vibration Exposures
Based on highest axis data

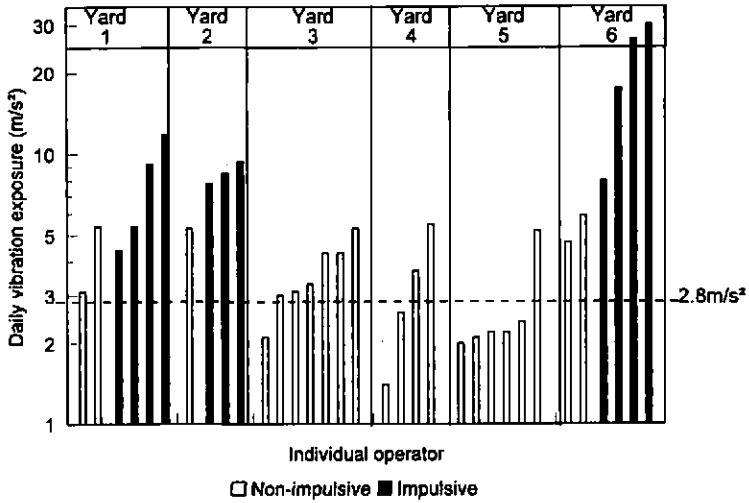

Figure 2b - Distribution of Daily Vibration Exposures
Based on vector sum data