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VIBRATION EXPOSURE IN THE UK FOUNDRY INDUSTRY

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1. INTRODUCTION

In 1985 a HSE survey of hand-transmitted vibration in UK industries by Kyriakides [1] highlighted the foundries as one of those industries likely to have greatest problems with exposure to hand-arm vibration. This survey did not attempt to quantify the extent of these problems. Following the Kyriakides survey the Health and Safety Executive have carried out an investigation into the problems of exposure to hand-transmitted vibration of fettlers and grinders in the UK's foundry industry.

Eight medium to large ferrous foundries in England and Wales provided a range of fettling operations and worker populations for the survey. There were two elements to the investigation. First measurement of typical daily exposure to hand-transmitted vibration and separately an assessment of the prevalence of Hand-Arm Vibration Syndrome (HAVS).

2. EXPOSURE MEASUREMENTS AND HEALTH ASSESSMENTS

Measurements of vibration exposure and assessments of the incidence of HAVS were made at 8 UK foundries. The foundries were located in three geographic regions, and were all involved in the manufacture of steel or iron products. The components being worked ranged from small castings, easily held in one hand, to very large castings of 1 to 2 tons. For the this paper the casting have been placed in four size categories:

- small: castings easily lifted in one hand;
- medium: castings which need to be lifted using two hands;
- large: castings which need to be lifted into position using overhead cranes, but can be moved on the work surface by the tool operator;

very large: castings which could not be moved by a tool operator.

In total, 41 separate tasks were assessed. In making these exposure assessments over 670 separate measurements of vibration magnitude were made. Health assessments were made of 88 fettlers, based on a questionnaire assessment and clinical examination by a nurse or doctor.

3. RESULTS

Most of the tasks being carried out by the fettlers and grinders assessed during this study involved the use of more than one tool. The proportion of time spent using particular tools was obtained using video recordings of the tool operators whilst working normally.

A summary of the task vibration exposures is given in Table 1, the daily vibration exposures are given both in terms of the highest axis vibration and the vector sum. For many tools only a single measurement was made, at a position representing the vibration exposure of both hands (e.g. pedestal grinding and small hand tools); in these cases a single figure is shown for both left and right hands.

Task Exposure Results

Most tasks appear to expose the operator to vibration doses of between 2 and $5ms^{-2}$. Where hammers or chipping hammers are used, the daily vibration exposure is increased significantly. Where hammers are used extensively the vibration exposure of the hand holding the hammer (always the right hand for those taking part in this survey) was increased to as much as $20ms^{-2}$.

For operators carrying out fettling work, but excluding those using hammers and chipping hammers, the range of highest axis daily vibration exposure is from 1.3 to $4.1ms^{-2}$. For operators using chipping hammers vibration exposures ranged from 3.7 to $8.2ms^{-2}$. Where manual hammers were used, the highest daily exposure is $17.3ms^{-2}$.

The most common grinding tool was the 24 inch pedestal grinder. The range of daily vibration exposures for operators using only this type of tool was from 1.5 to $5.1ms^{-2}$. Where wheel dressing was observed it has been included in these daily exposure figures. However, it was noted that the number of times pedestal grinders dressed their wheels varied considerably from one operator (or factory) to another. Some preferred to dress the wheel following every batch of castings, whereas others were not seen to use a dressing tool in one full shift.

Short-term vibration magnitude results

The results from the measurements of short-term average vibration magnitude are summarised in Figure 1 for highest axis vibration magnitudes. Vibration distribution analyses show that most tools produce highest axis vibration magnitudes from 1 to $8ms^{-2}$ (corresponding to vector sum magnitudes from 2 to $10ms^{-2}$).

Medical survey

The incidence of HAVS was shown to be 36% for all workers assessed. Where the duration of exposure is long, after 20 years working in foundries, the incidence rate increases a little to 41%.

For vibration white finger specifically the prevalence was surprisingly low at 25%. When plotted against existing dose-response curves[2] the results for individual workers tended to be well below the 50th percentile.

Musculoskeletal injuries were reported in 35% of cases; a higher incidence than any other HAVS damage. However, in many instances the upper limb symptoms were attributed to the manual handling of castings.

4. CONCLUSIONS

The fettling process produces vibration exposures above (and in many cases well above) the $2.8ms^{-2}$ level recommended in the UK's guidance on hand-arm vibration[3]. While not as high as predicted by existing dose response relationships, the incidence of HAVS in this industry was high at 36%.

The main causes of high daily vibration exposures are the impactive tools, chipping and manual hammers. Those using impactive tools suffered daily vibration exposures up to $17ms^{-2}$, while those using only non-impactive tools were generally below $5ms^{-2}$.

The incidence of musculoskeletal damage was high at 35%, although it is felt that this was associated more with poor manual handling practices than with hand-transmitted vibration. Indicating a need for improved task ergonomics in the foundry industry.

References

[1] Kyriakides K, 'Survey of exposure to hand-arm vibration in Great Britain', Research Paper 26, Health & Safety Executive (1988).

[2] 'Mechanical vibration - Guidelines for the measurement and assessment of human exposure to hand-transmitted vibration', British Standards Institute, ISO 5349 (1986).

[3] 'Hand Arm Vibration', Health and Safety Executive, HSE Books, HS(G) 88 (1995).

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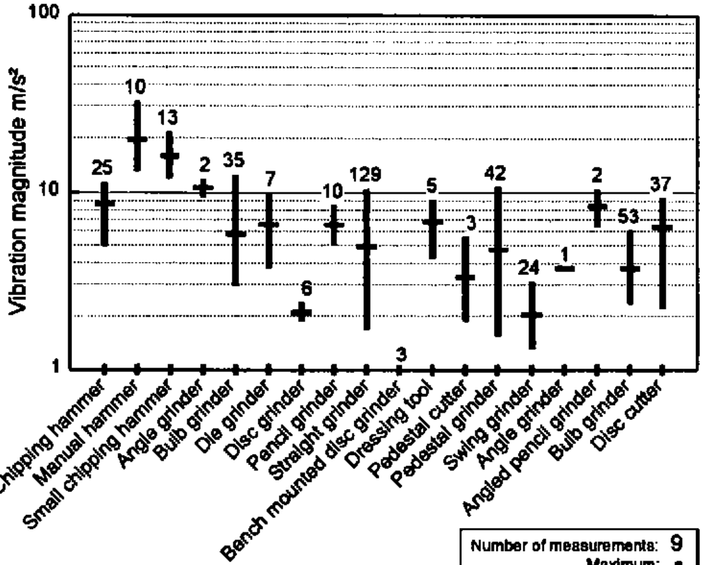
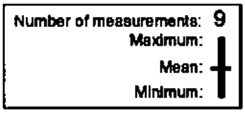
Figure 1 Short-term (highest axis) vibration magnitudes

(a) Both hands, right or rear hand





(b) Both hands, left or forward hand

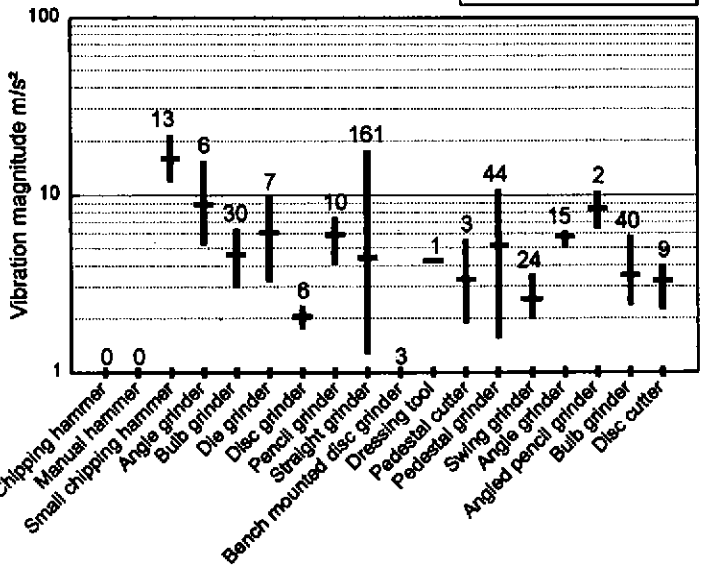


Table 1 Results of task exposure measurements

Tools	Number working on task	Component size	Highest axis (ms^{-2})		Vector sum (ms^{-2})	
			Left	Right	Left	Right
· Angle grinder, 230mm · Bulb grinder · Chipping hammer (with chisel bit and "bumper bit")	7	very large	6.6	8.2	8.6	10.7
· Bench mounted disc grinder	3	small and medium	0.5		0.7	
· Bulb grinder · Straight grinders, 50 & 150mm & dressing tool · Small chipping hammer	2	large	3.6	3.7	4.5	4.7
· Bulb grinder	10	small	1.8	1.8	2.9	2.9
· Bulb grinder	10	small	2.5	2.6	3.2	3.3
· Chipping hammer · Straight grinder	4	very large	5.3	5.8	7.3	8.2
· Die grinder · Straight grinder, 150mm	2	large	1.2	1.5	1.5	1.9
· Die grinder · Straight grinder, 150mm	2	large	2.2	2.1	2.9	2.8
· Die grinder · Straight grinder, 150mm · Hammer	2	large	2.2	17.3	2.9	20.8
· Die grinder · Bulb grinder	10	small	1.3	2.0	1.6	2.6
· Disc cutter · Bulb grinder	4	medium	3.5	4.1	4.2	4.9
· Disc cutter, 40mm · Straight grinder, 25mm	4	small	2.7		3.3	
· Pedestal grinder, 24"	2	large	3.1	2.4	4.1	3.4
· Pedestal grinder, 24" · Hammer	2	medium	1.7	2.4	2.3	3.2
· Pedestal grinder, 24" · Angle grinder, small	2	medium	5.3	4.1	6.5	5.6
· Pedestal grinder, 24"	8	medium	1.9		2.5	
· Pedestal grinder, 24"	4	medium	4.9		5.8	
· Pedestal grinder, 24"	4	medium	5.1		6.2	
· Pedestal grinder, 24" · Hammer	8	medium	1.9	9.7	2.5	10.2
· Pedestal grinder, 24" · Dressing tool	5	medium	2.2		2.9	
· Pedestal grinder, 24" · Hammer	4	medium	4.9	5.1	5.8	6.3
· Pedestal grinder, 24" · Hammer	4	medium	5.1	5.4	6.2	6.7
· Pedestal grinder, 24"	2	medium	1.7		2.3	

Table 1 Results of task exposure measurements

Tools	Number working on task	Component size	Highest axis (ms^{-2}) Left	Highest axis (ms^{-2}) Right	Vector sum (ms^{-2}) Left	Vector sum (ms^{-2}) Right
· Pedestal grinder, 24" · Pedestal grinder, 16"	6	small	4.0		5.1	
· Pedestal grinder, 24" · Hammer · Bulb grinder	4	small	1.8	3.8	2.3	4.8
· Pedestal grinder, 24"	12	small and medium	3.6		4.0	
· Pedestal grinder, 24"	5	small and medium	1.5		2.2	
· Pedestal grinder, 24"	2	small	3.0		3.5	
· Pedestal grinder, 24" · Pedestal cutting wheel	4	small	4.1		6.2	
· Pencil grinder · Chipping hammer	12	small and medium	2.1	4.0	3.1	5.2
· Pencil grinder · Chipping hammer · Straight grinder · Bulb grinder · Angled pencil grinder	4	very large	6.8	5.0	10.1	6.5
· Straight grinder, 150mm · Hammer	4	large	1.7	7.8	2.1	8.4
· Straight grinder · Pencil grinder · Chipping hammer · Pedestal cutting wheel	12	small and medium	3.7	3.5	4.8	4.5
· Straight grinder, 150mm	8	large	2.2	2.4	2.9	3.6
· Straight grinder, 150mm	8	large	1.7	2.0	2.2	2.6
· Straight grinder, 150mm · Hammer	8	large	2.2	5.2	2.9	6.9
· Straight grinder, 150mm · Hammer	8	large	1.7	7.5	2.2	9.7
· Straight grinder, 150mm	4	large	1.7	3.3	2.1	4.2
· Straight grinder, 150mm · Chipping hammer, small	10	medium	6.4	6.4	6.8	6.9
· Straight grinders, 150mm · Die grinder	4	small	1.9	2.1	2.4	2.7
· Straight grinder, 50mm · Disc grinder, small	4	small and medium	1.8	2.4	2.6	3.3
· Swing grinder · Dressing tool	1	large	1.5	1.1	1.7	1.5