Health and Safety Executive **Information Document**
HSE 246/31

REDUCING RISK OF HAND-ARM VIBRATION INJURY FROM HAND-HELD POWER TOOLS

INTRODUCTION

1 This document contains internal guidance which has been made available to the public. The guidance is considered good practice (rather than compulsory) but you may find it useful in deciding what you need to do to comply with the law. However, the guidance may not be applicable in all circumstances and any queries should be directed to the appropriate enforcing authority.

2 HSE leaflet INDG 338 *Power Tools. How to reduce vibration health risks. Guide for employers*, provides basic guidance to assist users of hand-held power tools to take account of vibration emission data in the selection of suitable hand-held power tools. INDG 338 should be read first for an introduction to this subject. This information document is intended to provide additional technical guidance on this issue.

HEALTH RISKS AND HAND-ARM VIBRATION (HAV)

3 There are several diseases caused by regular exposure to HAV and use of hand-held power tools is associated with these. Further details are given in INDG 338 and HS(G)88 *Hand-arm vibration*.

SELECTION OF HAND-HELD POWER TOOLS

4 The Provision and Use of Work Equipment Regulations 1998 (PUWER 98) regulation 4 places duties on employers and requires that hand-held power tools be:

(1) suitable for the purpose for and working conditions in which they are to be used;

(2) used only for purposes for which they are suited; and

(3) used only under conditions for which they are suitable.

5 Regulation 5 requires that work equipment is maintained in an efficient state, in efficient working order and in good repair (efficient relates to how it might affect health and safety).

6 In considering suitability of hand-held power tools, account should be taken of the health risks from HAV. To do this, users will need to obtain information on vibration emission from the tools they are considering.

SOURCES OF VIBRATION DATA

7 The supplier (including manufacture, importer and tool hire firm) of powered hand-held or hand-guided tools should provide information about vibration risk (see paras 12 -18).

8 Many users of hand-held power tools have already measured vibration for particular tasks and the results may be available through a relevant trade association. When considering a specific task, try to find data which is derived from as similar a task as possible as this will provide a better guide to the range in levels likely to be found in practice when the task is performed in the workplace.

9 Data from suppliers and some workplace data is available on the Internet. An EU-supported website is http://umetech.niwl.se/English/.

10 Users should only need to arrange for hand-arm vibration emissions to be measured when adequate data does not exist elsewhere. For example, when data from the supplier etc is unlikely to represent the expected risk and available data suggests that vibration emissions vary very widely by task. Advice on measurement procedures is given in HS(G)88 and EN ISO 5349-2 (awaiting publication in 2001). Users who have to make measurements can minimise overall cost and effort by co-operation with others involved in similar activities. Trade associations might assist by managing a database for the benefit of all members.

11 Data collected from as many sources as possible will establish reasonable estimates for likely ranges of vibration emissions for a variety of tasks.

INFORMATION FROM SUPPLIERS

12 Suppliers have duties under The Supply of Machinery (Safety) Regulations 1992 (as amended). Their first duty is to eliminate risks by design or by protection measures so that it is possible to use machinery without risks to health or safety. New tools must be manufactured taking into account the 'state of the art' and, in designing and constructing tools, manufacturers must consider normal and abnormal use.

13 Where limitations in technology prevent elimination of a risk by design or by protection measures and a residual risk remains, suppliers etc must warn the purchaser of the residual risk and provide information on training and other requirements that might be appropriate to control of the risk. A suggested format for this information is given at the appendix. Further explanation is given in paragraphs 19-32.

Standards for determination of vibration emissions

14 Suppliers usually report vibration emission data according to harmonised European standards produced in CEN or adopted from ISO. Examples are listed at paragraph 37.

15 Where standards specific to a type of tool do not exist, suppliers will use a general standard method (EN 1033) to determine vibration but it is unlikely that all suppliers will choose identical operating conditions for the measurements. In such cases, care is needed to compare the data from different suppliers, particularly if they have made measurements for different tasks. Manufacturers are obliged to report the test procedures they have adopted.

16 Some of the early standards have significant shortfalls. For example:

- vibration not measured at the handle/grip point producing the highest emission (needle scaler and chipping hammer standards);
- specified direction of measurement is not the axis of highest magnitude (needle scaler, chipping and grinder standards);
- specified or simulated task generates magnitudes below those likely to be found in normal use (grinder standards).

17 Test codes are reviewed every 5 years and future versions will provide a more accurate guide to likely vibration emissions during 'intended use'.

18 Vibration emission testing of electrical tools has generally developed independently of tests for tools using other power sources, eg pneumatic powered tools. Comparison of vibration emission test data for electric and tools using other power sources should be made with caution.

Use of information from suppliers to determine risk

19 Suppliers must report the vibration emission from hand-held power tools if it exceeds a threshold of 2.5m/s^2. If it does not exceed 2.5 m/s^2, this must be stated.

20 Suppliers should report two values: *a* and *K*. The value *a* is the measured level and *K* is the uncertainty. The uncertainty allows for error in measurement or variation in production and can be more than 40% of the measured emission *a* and is often several m/s^2. The supplier guarantees that the level determined from a reproduction of the vibration test used to determine the emission will produce a measured level with a value less than *a + K.*

21 The emission level provided by the supplier will often be sufficient to alert the user to the need to control the vibration risk. Combining a dominant axis emission level with the duration that the tool is likely to be operated during the day will give a figure for comparison with HSE's recommended action level of 2.8m/s^2 A(8) and

hence an indication of the level of management required to adequately control vibration risk.

22 If the emission level provided by the supplier is below the threshold of 2.5 m/s^2 but the likely level in the workplace is much higher, the emission level data has failed to inform of a residual vibration risk likely to require management. In such cases suppliers are obliged to make the likelihood of a vibration risk evident. This may be done by pictograms; reporting the results of alternative tests; or by giving a written report (see the appendix). Similarly, if the supplier reports a level above the threshold of 2.5 m/s^2 but unrepresentative of the emission level likely to be found during 'intended use', the supplier should provide further information to the user.

23 The 8-hour time weighted average vibration exposure is given by:

$$A(8) = a \times \sqrt{\frac{t_{used}}{8}} \qquad (1)$$

Where *a* is the value (in m/s^2) reported by the supplier (or, in some cases, measured in the workplace) and t_{used} is the time for which the tool is used during the day (in hours).

24 If several tools are used in the day it will be necessary to sum the contributions of each tool to the daily vibration exposure. The total exposure for the day is then:

$$A(8) = \sqrt{A_1(8)^2 + A_2(8)^2 + A_3(8)^2 + \ldots}$$

where $A_1(8)$, etc are the 8-hour time weighted averages calculated for each tool according to equation (1). The procedure, including a nomogram, is presented in more detail in HS(G)88 pages 42-43. Alternatively a 'calculator' is included in HSE's CD-ROM (see paragraph 35).

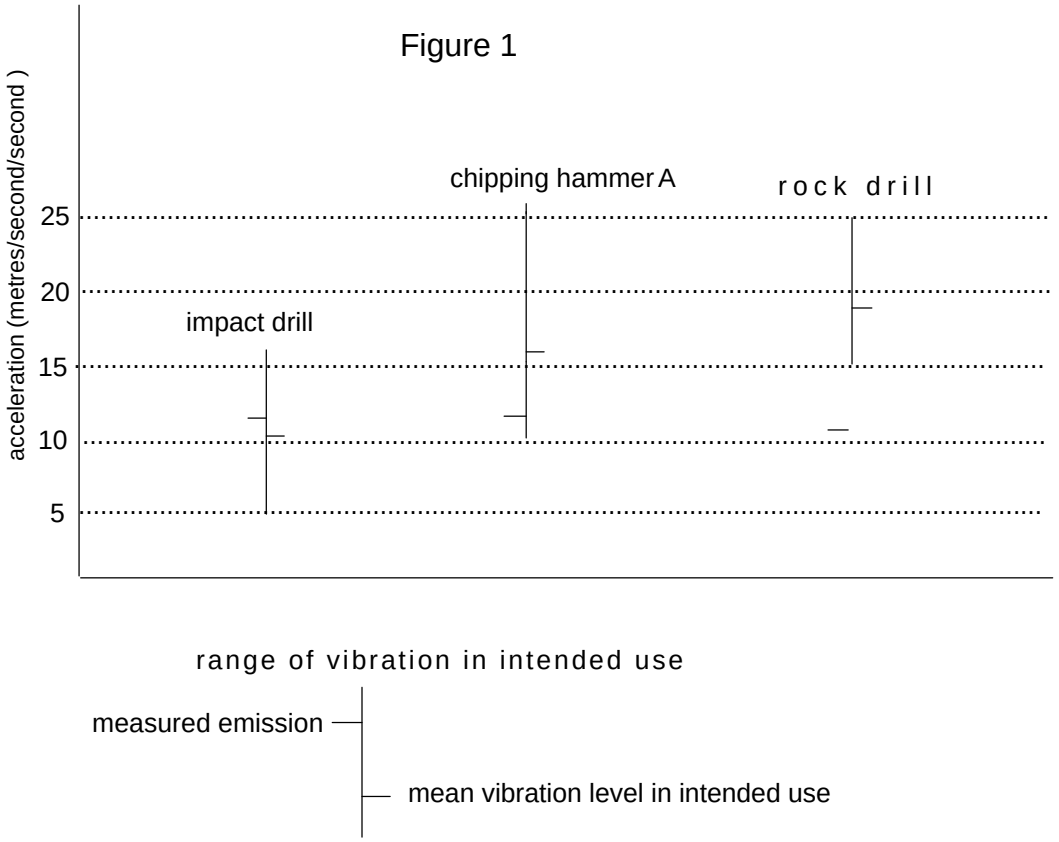
Note: Most data currently provided with hand-held power tools is reported for the dominant axis and exposures should be estimated as above for comparison with HSE's recommended action level of 2.8 m/s^2 A(8) which is also dominant axis. Future data will increasingly be for the sum of three axes of vibration - often referred to as 'root-sum-of-squares', 'rss', or 'vector sum'. The rss equivalent of HSE's action level is approximately 4 m/s^2 A(8). HSE's action level is expected to be superseded by implementation of a proposed new European Directive on vibration which is likely to include an rss exposure action level and limit value (draft values at February 2001 are 2.5 and 5 m/s^2 A(8) respectively).

AVOIDING HIGH VIBRATION HAND-HELD POWER TOOLS

25 Vibration emissions of hand-held power tools vary greatly from user to user and task to task often by factors of 2 or 3:1 between worst and best circumstances. Figure 1 shows typical vibration emission data for 3 tools. Each tool has a range of levels which will be found during 'intended' use. This is shown by the vertical line. The average (mean) of these use levels is shown by the mark to the right of the

vertical line. The measured emission value supplied with the tool is shown by the mark to the left of the vertical line.

Figure 1



26 For the impact drill the levels found in 'intended' use varied between 5 and 17 m/s^2 with a mean value of just over 10 m/s^2. This was represented well by the supplied level from the standard test for the tool which gave a value of about 12 m/s^2.

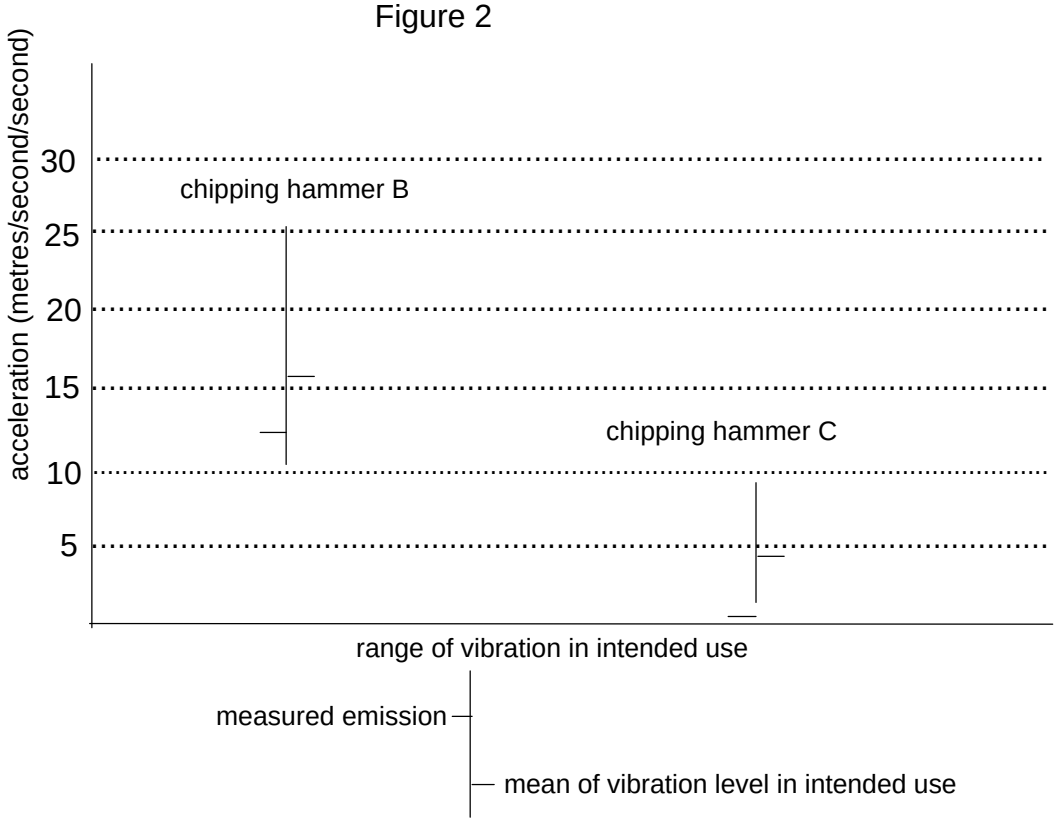
27 For the chipping hammer the levels found during 'intended' use varied between 10 and 26 m/s^2 with a mean of about 16 m/s^2. The standard test for the tool produces a value that lies at the low end of the range of levels measured during 'intended' use but nevertheless gives a clear indication that vibration emission magnitudes are high and will require management.

28 For the rock drill the level during 'intended' use was found to vary between 15 and 25 m/s^2 with a mean of about 18 m/s^2. The standard test produced a level of about 12 m/s^2 which is below the range of levels measured during 'intended use'.

29 Despite the large variations found for each of the tools during 'intended' use and the failure of some of the standard tests to produce values within the range of levels found during 'intended' use, each of the tests produces a vibration emission level of a high magnitude sufficient to warn of the likely presence of a vibration risk that will require management. (The similarity of the levels found according to the standard tests for each of these tools is pure coincidence.)

30 The vibration data provided by suppliers can also help to identify high or low vibration tools. Figure 2 shows data for two chipping hammers. Both hammers have a large range in their vibration emission depending on task, etc but it is clear both from the 'intended' use data and the supplier's data that one of the hammers is a generally lower vibration tool than the other.

Figure 2



31 Comparisons based on suppliers' vibration data are usually most reliable when there is no overlap in the range of uncertainty of the measured emission levels, *a* to *a+K* for each of the tools. The uncertainty can be more than 40% of the measured emission *a* and is often several m/s^2. If an uncertainty *K* is not quoted it is reasonable to assume it is 40%. If it is necessary to make close comparisons there will probably be a need to conduct measurements for the tasks in question.

32 Many of the first generation of vibration emission test codes produce levels below the threshold of $2.5m/s^2$ for reporting to users even though there is a vibration hazard that requires management (see also paragraphs 16-18 and 22). For example, the standard test data for chipping hammer C in Figure 2 suggests that the emission is about 2 m/s^2, ie below the threshold for reporting actual vibration levels, while the 'intended' use data clearly shows that the tool can generate hazardous levels of vibration.

TRAINING

33 Some hand-held power tools may require training of the operator to ensure that low vibration exposures are achieved and sustained. It may also be necessary to train others such as those who will undertake maintenance of tools. Suppliers have a duty to alert users to particular training that is required. This might include:

- training in new operator skills for tools with vibration reduction features;
- notification of applications of the tool that produce unusually high vibration emissions;
- information about particular methods of using the tool to be adopted or avoided that greatly affect the emitted vibration; and
- training in maintenance requirements to avoid unnecessary exposure.

Users have duties under PUWER 98 to ensure all those using work equipment have adequate health and safety information and instructions and have received adequate training.

ANTI-VIBRATION GLOVES

34 At present, anti-vibration gloves generally provide negligible attenuation of vibration. Tool suppliers should not recommend anti-vibration gloves as a means of attenuating the vibration from hand-held power tools unless models of anti-vibration gloves have been demonstrated to provide protection in accordance with the requirements of the Personal Protective Equipment at Work Regulations 1992. However, gloves may help prevent vibration injury by keeping hands warm and dry.

REFERENCES AND BIBLIOGRAPHY

35 Guidance published by HSE includes:

HS(G)88 *Hand-arm vibration*

INDG126(rev1) *Health risks from hand-arm vibration. Advice for employees and the self-employed*

INDG175(rev1) *Health risks from hand-arm vibration. Advice for employers*

INDG 338 *Power Tools. Reduce vibration health risks. Guide for employers*

CD-ROM The successful management of hand-arm vibration.

36 Standards for evaluating exposure:

BS EN ISO 5349-1 (publication expected during 2001) Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 1: General guidelines.

BS EN ISO 5349-2 (publication expected during 2001) Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 2: Practical guidance for measurement in the workplace.

37 Test codes for determination of hand-arm vibration emissions from hand-held power tools:

BS EN 1033:1996 Hand-arm vibration - Laboratory measurement of vibration at the grip surface of hand-guided machinery - General (in revision - may absorb EN 28662-1).

BS EN 12096:1997 Mechanical vibration - Declaration and verification of vibration emission values.

BS EN 28662-1:1993 Hand-held portable power tools - Measurement of vibrations at the handle - Part 1: General (under review - may be absorbed into EN 1033)

BS EN 28662-2:1995 Hand-held portable power tools - Measurement of vibrations at the handle - Part 2: Chipping hammers and riveting hammers

BS EN ISO 8662-4:1995 Hand-held portable power tools - Measurement of vibrations at the handle - Part 4: Grinding machines.

BS EN 28662-5:1995 Hand-held portable power tools - Measurement of vibrations at the handle - Part 5: Pavement breakers and hammers for construction work.

BS EN ISO 8662-14:1997 Hand-held portable power tools - Measurement of vibrations at the handle - Part 14: Stone working tools and needle scalers.

BS EN 50144-1:1999 Safety of hand-held electric motor operated tools. Part 1: General requirements.

BS EN 50144-2-3 Safety of hand-held electric motor operated tools. Particular requirements for grinders, disc type sanders and polishers. (Awaiting publication)

BS EN 50144-2-6:2001 Safety of hand-held electric motor operated tools. Particular requirements for hammers.

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APPENDIX
(paras 13 and 22)

SPECIMEN OF AN APPROACH WHICH MIGHT BE ADOPTED BY SUPPLIERS TO THE PROVISION OF INFORMATION TO HELP PROTECT AGAINST RESIDUAL RISKS FROM HAND-ARM VIBRATION

Risk of hand-arm vibration injury

Chipping hammer make ABC, type 990, model 12-UH, 0,6 MPa when operated in accordance with these instructions and tested in accordance with EN 28662-2:1994 results in the following vibration emission declared in accordance with EN12096:1996

Measured vibration emission value	a -	8.0 m/s^2
Uncertainty	K -	2.3 m/s^2

These values are suitable for comparison with the emission levels of other tools that have been subjected to the same test.

Note: This data represents the vibration in the z-axis on the main handle. The z-axis is not always the highest axis on the main handle when the tool is in normal use and much higher vibration levels occur at the hand position on the main body of the tool.

This tool may cause hand-arm vibration syndrome if its use is inadequately managed.

The vibration emission from chipping hammers varies greatly with task and operator grip and feed force. We believe that normal intended use of the tool will usually produce vibration emissions at the hand position on the body of the tool that vary between 12 and 16 m/s^2 depending on the details of the task but emissions outside this range may occur for some applications. A figure of 14m/s^2 is probably a useful average emission value, say, for estimating the likely average exposures (and hence risk in accordance with EN 5349-1) of tool users performing a wide range of tasks within the intended use of the tool.

We point out that application of the tool to a sole specialist task may produce a different average emission and in such cases we recommend a specific evaluation of the vibration emission but we would expect the average to fall between 12 and 16m/s^2.

Recommended measures to reduce risk of hand-arm vibration syndrome

The tool should not be used by an individual regularly for more than 20 minutes (hands-on power-on) in any one day, and never more than 40 minutes. This duration of use should be reduced if the individual is exposed to hand-arm vibration from other sources. The vibration emission is closely linked to the operating pressure in the air supply. You should ensure that the pressure is set in accordance

with our recommendations to assure optimum efficiency with minimised vibration exposure.

The transmission of vibration to the user is reduced by inclusion of components **A** and **B** (an exploded diagram might be used to identify components A and B). The condition of these components should be checked and they should be replaced every **n** months during routine maintenance and earlier if they show signs of wear or age. We recommend a programme of health surveillance to detect early symptoms of injury so that management procedures can be modified to help prevent significant handicap.

Personal protective equipment

We are not aware of any PPE that provides protection against vibration injury by attenuating the vibration emissions of this tool. We recommend sufficient supply of clothing (including gloves) to enable the operator to remain warm and dry and maintain good blood circulation in fingers, etc.