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THE EEC MACHINE SAFETY DIRECTIVE AND ITS IMPLICATIONS IN THE FIELD OF HAND-ARM VIBRATION

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EEC DIRECTIVE

In July 1989 the EEC published a Council directive (89/392/EEC) on the safety of machines. It covers many health hazards including noise and vibration. In regard to vibration it states,

"Machinery must be so designed and constructed that risks resulting from vibrations produced by machinery are reduced to the lowest level, taking account of technical progress and availability of means of reducing vibration, in particular at source".

and in the case of hand held or hand guided machinery,

"The instructions must give the following information concerning vibrations transmitted by hand held and hand guided machinery:

- the weighted root mean square acceleration value to which arms are subjected if it exceeds $2.5ms^{-2}$ as determined by the appropriate test code. Where the acceleration does not exceed $2.5ms^{-2}$ this must be mentioned.

If there is no applicable test code, the manufacturer must indicate the measurement methods and conditions under which measurements were made".

This directive will have the force of law within the member states and so the associated measurement test codes are that much more important. Tools will have to have measured vibration values in the notice of instruction and also in the sales literature.

The whole directive focusses on the protection of workers using machinery and so the action taken concerning vibration must be related to reduction of the risk to damage resulting from the vibration exposure. The figure $2.5ms^{-2}$ must be considered within this context.

The preparation of the appropriate test codes is the task of CEN the European Standards committee. The measurement procedures have to be realistic so that the values give some indication of the risk to vibration damage as a result of using the tool. Also the vibration values have to be reliable ie. the results are sufficiently accurate that one can have confidence in the measurements and reproducible ie. different test stations will be able to obtain the same results. The directive requires that these values be stated in the notice of instruction and in the sales literature. Therefore these figures will have considerable commercial significance.

Unfortunately for many tools the search for reliability and reproducibility demands very precisely defined measurement conditions which set up an artificial environment far removed from that found in normal use. The task of setting up a measurement procedure which is

both realistic and reliable is very difficult.

CURRENT STANDARDS

There are a number of standards in the field of hand arm vibration either published or in preparation.

ISO 5349 "Guidelines for the measurement and assessment of human exposure to Hand-Transmitted Vibration". This document is concerned with risk and gives general guidance for the measurement of vibration exposure in terms of a four hour energy equivalent value. This document is not tool specific and cannot address the problem of reliable reproducible measurements. The document cannot therefore be used as the basis for comparing vibration values with the directive value of $2.5ms^{-2}$. The British Standard BS 6842 "Guide to Measurement and Evaluation of human exposure to vibration transmitted to the hand" is very similar to ISO 5349. It recommends an eight hour energy equivalent vibration exposure value. Both standards give guidance on the estimation of risk of damage from the exposure. Again the British Standard is not tool specific and cannot be used directly in the implementation of the EEC directive.

In 1986 ISO published ISO 7505 "Forestry machinery - chainsaws - measurement of hand-transmitted vibration". This document describes a detailed measurement methodology for chainsaws. The location and direction of the transducer axis are described together with a detailed working procedure during which measurements are made. The working procedure includes idling, cutting and racing each of which relate to the use of the saw in normal working. It is recommended that the vector sum of the three vibration directions be evaluated and reported for both the front and rear handles. This is a type test procedure and can be used to compare one tool with another and of course the values can be compared with the directive figure of $2.5ms^{-2}$. The accuracy of these measuremens are unlikely to be better than ±15% (ie. $2\sigma_{n-1}/\bar{x}$) for both idling and cutting. The question of accuracy will have to be addressed when using results obtained from test codes in conjunction with the directive.

The vector value cannot be used in conjunction with either ISO 5349 or BS 8642 in order to assess risk because both of these standards use single axis (the dominant axis) for the assessment. Nevertheless the test code can be used to obtain such single axis measurements.

ISO TC118 SC3 has set up a working group to produce test codes for vibration measurements on a number of pneumatic tools. It has been agreed that the power source for the tool (pneumatic, hydraulic or electric) is less significant than the other parameters, which the tools have in common, in setting up measurement methodologies. Therefore the working group invited experts from the other tool manufacturers to participate and hence the codes are intended to cover all portable hand tools. The working group has produced ISO 8662.1 "Hand-held portable power tools - Measurement of vibrations at the handle. Part 1: General" which was published as a standard in 1988. This document gives general guidance for the setting up of measurement methodologies. In particular it looks at the working procedure which is necessary to reduce the variability of the measurements.

ISO 8622.2 - "Chipping hammers and rivetting hammers" is currently a draft proposal for a

standard. A lot of work was done on investigating the working procedure for the measurement of chipping hammers. A special rig was designed which held a piece of steel so that a thin chip could be cut in a controlled manner. This method was tested in a Round Robin where a tool was circulated amongst several laboratories and the results compared. This proved less than satisfactory as the results showed differences of more than 50% between the test stations. The reasons for these differences were thought to be the way different operators were able to perform the cutting process. In order to improve the reproducibility it was thought that a different energy absorber should be used. This was chosen to be a tube filled with hardened steel balls. The tool is fitted with a tamper which rests on the balls and during operation a vertical down force is applied and the tool works on top of absorber. This is illustrated in Figure 1.

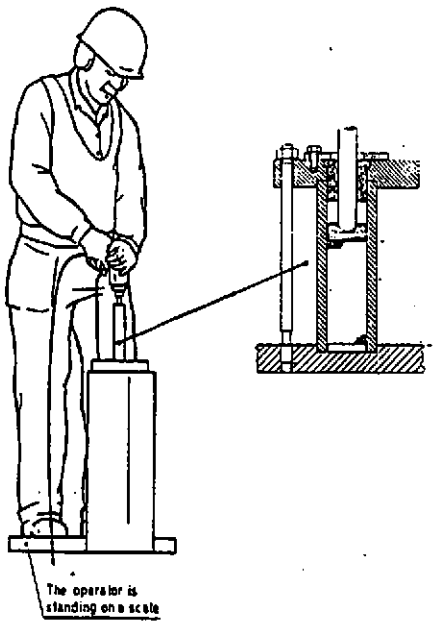

Fig Chipping or riveting hammer. Working position of operator

The operation of the chipping hammer during the vibration measurement is artificial and not how the tool would be used in industry. It provides for a type test measurement the result of which can be compared with the directive value of $2.5ms^{-2}$. The measurement obtained is typical of that obtained when used in industry. The question remains - can the measurement be used to determine the vibration exposure in order to estimate the degree of risk?

ISO 8662.3 "Rock drills and rotary hammers". This document provides a measurement methodology for those tools which provide both rotation and a hammer action. For light tools (weight less than 15kg) the working procedure is to drill a concrete block. For heavier machines a steel ball absorber is used. The reasons for the artificial device are for reproducibility and also for economy.

ISO 8662.5 "Pavement breakers and hammers for construction work" provides a working procedure using the steel ball absorber and ISO 8662.6 "Impact drills" uses a concrete block.

ISO 8662.4 "Portable grinding machines". This document results from a lot of work done in Pneurop - the European Committee of Manufacturers of Compressors Vacuum Pumps and Pneumatic Tools. The vibration committee produced a test code for grinding machines in 1983. In this code the machine with a mounted grinding wheel was used to grind a piece of steel in a controlled manner. During a round robin test it was found that when the test stations were allowed to choose their own wheel,the ratio of the highest to the lowest

weighted level was about a factor of two. It was soon realised that the major factor in these differences was the out of balance in the mounted grinding wheels.

The effect of this unbalance was studied by various people. The conclusions that can be drawn from these studies are

1. There is a wide variation in the out of balance in a batch of nominally the same wheels even in when manufactured to within ISO recommended tolerances.

2. There is a strong correlation between the weighted level during grinding and the weighted level measured when running free.

It has been decided that a type test procedure cannot give sufficient reproducibility if it uses grinding with standard wheels as a working procedure. The proposed standard has therefore recommended a procedure where the machine is hand held, free running with an artificial wheel of specified out of balance.

The vibration level measured will be largely affected by the choice of unbalance recommended for the artificial wheel. This choice was made using the criterion that for each wheel size the out of balance was near the average of that found for a batch of such wheels. Also it was thought advantageous to try to maintain a constant centripetal force resulting from the rotating static unbalance in each size of wheel. Happily it has been possible to set unbalances satisfying both criteria.

CONCLUSION

The EEC machine directive will have considerable impact on manufacturers and users of hand held tools. It poses a difficult problem for those developing test codes. How can a methodology provide reliable reproducible measurements at the same time as giving realistic values for vibration exposure? This problem is highlighted in the case of portable grinding machines. The vibration level will depend on the grinding wheel being used - this is not in the control of the manufacturer. The test code will give a value which is entirely dependent on the specified out of balance which is determined by the appropriate CEN committee. So what is the meaning of this measured value in relationship with $2.5ms^{-2}$?

A lot of work is yet to be done before the machine directive can be implemented successfully in the area of hand arm vibration. A lot of work remains to be done before the results obtained are interpreted correctly.

REFERENCES

EEC Council Directive 89/392/EEC

ISO 5349 1986 "Guidelines for the measurement and assessment of human exposure to hand-transmitted vibration".

ISO 8662.1 1988 "Hand-held portable tools - measurement of vibration at the handles Part 1: General".

ISO 8662.2 "Chipping hammers and rivetting hammers".

ISO 8662.3 "Rock drills and rotary hammers".

ISO 8662.4 "Portable grinding machines".

ISO 8662.5 "Pavement breakers and hammers for the construction industry".

ISO 8662.6 "Impact drills".

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