Proceedings of the Institute of Acoustics

OCCUPATIONAL EXPOSURE TO HAND-ARM VIBRATION

By A W Bednall

SUMMARY

The Health & Safety Executive (HSE) is the executive arm of the Health & Safety Commission. Its chief concern is occupational health and safety in Great Britain and the enforcement of relevant legislation. The Inspectors who have the primary task of monitoring health and safety in industry, are supported by the organisation's doctors, technologists and scientists who have the task of providing a good medical, scientific and technological basis for effective action.

Adverse health effects caused or exacerbated by exposure to hand-arm vibration at work - collectively described as the hand-arm vibration syndrome (HAVS) - are amongst the many workplace health problems with which the organisation in general, and its specialist medical, scientific and technological divisions in particular, are concerned.

Ten years ago there were large gaps in our scientific and medical knowledge concerning HAVS and the essential technology for the measurement and assessment of vibration exposure was only just beginning to emerge. Since then much progress has been made, not only in our understanding of HAVS but also in the development of instrumentation and appropriate standards for the measurement and assessment of exposure. There are thus, to-day, no fundamental reasons why those whose workers are exposed to hand-arm vibration cannot assess the problem and implement a programme of effective action to reduce the hazard.

This paper gives an indication of the size of the problem in Great Britain and outlines work carried out by HSE on various aspects of HAVS. The progress made is briefly reviewed and some areas where further work would be most useful at the present time are indicated. Above all this paper emphasises the need for effective action now.

THE HAND-ARM VIBRATION PROBLEM

1. Although there is still no generally accepted, detailed, model of the way in which vibration acts on and damages the hand-arm system, nevertheless civil courts have (since 1946) accepted that a causal relationship exists between exposure to vibration and the disease vibration white finger (VWF). Furthermore, since April 1985 VWF has been recognised in Great Britain as an

industrial disease for which claimants who satisfy certain, stringent, criteria may receive compensation.

2. A recent HSE survey suggests that despite the traumatic changes in British industry -which have substantially reduced the numbers of persons exposed to hand-arm vibration in our traditional, heavy industries, approximately 500,000 people exposed to hand-arm vibration at work. Of these approximately 150,000 are exposed for relatively long periods. These figures may understate the case since they represent only that portion of the British workforce which is employed in manufacturing industry; the public utilities; agriculture and forestry and the construction industry.[1]

A FRAMEWORK FOR ACTION

3. The broad requirements of the Health and Safety at Work etc Act 1974 provide a framework for action to tackle the hazard. The framework is insufficient in itself and must be clad with policies, plans, standards, information, resources and above all, carefully considered, effective actions in order to achieve a better working environment and ensure that in accepting a job workers do not also, unwittingly, accept a handicap.

4. Many of the tools and processes causing the problem also create a noise problem and a similar, systematic approach should be adopted. The problem should be assessed and the workers and processes involved identified. Ways of eliminating or reducing vibration exposure should be evaluated before drawing up and implementing a programme of action. To be successful in the long term such programmes require the allocation of adequate resources and the informed involvement not only of managers but also of the workers at risk.

5. Many firms have, without any "official" prompting, already got to grips with the problem and taken effective action. Measures to control vibration exposure in some forestry work, taken in the 1970s has had a considerable, beneficial, effect on workers who use chain saws. Regrettably, many firms have failed to take action or even to recognise the problem and in such cases the law must be enforced. However, certain requirements have to be met before effective enforcement action can be taken.

6. Enforcing the law does not necessarily mean the prosecution of firms or the issuing of improvement notices. The HSE has always relied more on persuasion and good advice to enforce health and safety law than on the means popularly supposed to be enforcement ie. prosecution. But the would-be enforcer must be sure of his ground for, in the last resort, he may be required to justify his actions, under cross examination, in a court of law.

Strong medical support is needed to confirm the nature and seriousness of the disease; the connection with exposure to vibration at work; and the risk to workers so exposed. Good, factual scientific evidence is required of the vibration exposure of the workers at risk and last but not least, convincing expert evidence concerning the sources of vibration exposure and any technical measures that can be taken to reduce it.

7. For many years the implementation and enforcement of effective preventative measures has been inhibited by the inadequacy of the scientific and medical basis for action and since at least 1976 HSE has been undertaking research with a view to remedying this situation.

HSE RESEARCH

8. Research has been carried out both intra- and extra-murally and a key element in this programme was the work carried out by Mike Griffin of the Institute of Sound and Vibration Research (ISVR) at Southampton University which was published as HSE Research Report No. 9 [2]. Griffin pointed to the need for further research to provide a better understanding of the hand-arm vibration syndrome (HAVS); to improve the diagnosis of VWF; and to improve the measurement and assessment of vibration exposure. Since 1980 when this paper was published extra-mural research has been carried out on a range of topics including objective tests for the determination of VWF in individuals[3]; the protective value of gloves[4]; the vibration of pedestal grinders and the design of low vibration chipping hammers.

9. Intra-mural research has been carried out by the noise and vibration section of HSE's Research Laboratories and Services Division (RLSD) based at Buxton. This work has been principally concerned with the development of equipment and methods for the measurement and assessment of hand-arm vibration. The results form the basis of our technical input to the relevant standards but are chiefly aimed at providing HSE's "in house" noise and vibration consultants with high quality equipment and reliable application techniques.

10. RLSD scientists are currently completing a project on chain saw vibration which was initiated with the aim of assessing the extent to which the vibration levels increase with normal, well maintained use and at the same time evaluating the standard test procedure specified in BS 6916: 1988 (ISO 7505). Chain Saws Pt. 8. Method of measurement hand transmitted vibration. Papers on this work were recently presented to the UK Informal Working Group on Human Response to Vibration.

11. The lack of an adequate, simple and portable vibration meter has not prevented us from trying to resolve problems which HSE's Employment Medical Advisors (EMAs) and Factory Inspectors have identified and the work carried

out in this area by RLSD's scientists has provided additional "sharp end" input to the research programme. Our EMAs also carry out research from time to time and one - Dr R A Randell - has recently completed a survey of VWF amongst shoe pounders in the footwear industry which will be published in the British Medical Journal.

12. Since 1980 when Griffin's paper was published some progress has been made towards the acquisition of an adequate basis - of scientific knowledge and supporting technology - for effective preventative action to be taken by those whose activities create the hazard ie. product, process and machine designers; production and mechanical engineers; managers and employers.

13. The broad relationship between cause and effect has been officially recognised with the acceptance of VWF as an industrial disease for which compensation may be paid. NB. In 1987 successful claims exceeded 1060 (a success rate of 79%) with approximately 20% being assessed as being above Stage 3 on the Taylor Pelmear scale for VWF.

Civil courts have recognised the association between VWF and exposure to vibration at work for about 40 years. Although civil actions have always been something of a lottery, many hundreds (if not thousands) of successful claims have been made - most of which have been settled out of court. Many more are pending in the steel forging, gas and motor industries and elsewhere. Because of the scale of the problem, and the high cost of awards where a loss of earnings has been involved, (up to £85,000) some insurance companies have negotiated special compensation schemes with trades unions.

14. Compensation may be a just and reasonable measure but it is much more important to take effective measures to reduce exposure and prevent the handicap.

CURRENT HSE ACTIVITY

15. HSE's efforts on vibration have been initially concentrated on hand-arm vibration. This includes assessing the available information and identifying where further research is needed.

16. There are a number of, as yet, unresolved issues which need tackling. For example: better information on vibration exposure in the workplace is required. Research is due to start in 1990 which should provide good data on vibration exposure, the prevalence of VWF and the practicability of vibration reduction, in two important sectors of industry. The results will

be used, in conjunction with information obtained from the "Survey of exposure to hand-arm vibration in Great Britain", to establish priorities for action. When this work has been completed, the usefulness of extending the survey to other industries will be considered.

STANDARDS FOR THE MEASUREMENT AND ASSESSMENT OF EXPOSURE

HSE's specialists are also involved in the work of relevant British and international standards committees - particularly that of CEN.

17. Since 1980, standards for the measurement and assessment of occupational exposure to hand-arm vibration have been, internationally agreed (ISO 5349:1986 Guidelines for the measurement and assessment of hand transmitted vibration) and developments in the field of instrumentation and in instrumentation standards (ISO 8041: Human Response to Vibration: Measuring Instruments; ISO 5348:1987 Mechanical vibration and shock - Mechanical mounting of accelerometers) mean that simple, relatively low cost equipment, suitable for every day use by specialist inspectors and others, is or shortly will be available. Care will of course be needed in using the equipment and detailed guidance is needed on methods of measurement for difficult applications such as those involving high, impulsive, vibration levels or the evaluation of the vibration exposure of people who use pedestal grinders and similar machines. In this latter case, the workpieces vary widely in shape and size, the exposure time per item may be very small and the position of the operative's hands with respect to any fixed accelerator mounting position may vary more or less continuously throughout the operation being carried out. How is this best taken into account?

18. Measurement standards for particular machines, particularly powered portable tools, such as chain saws, hammer drills, chipping hammers etc have been or are being developed. For example ISO 8662 Measurement of vibration in handheld power tools. Much more research and development work is needed to ensure that not only are test results accurate and consistent but also that the measured accelerations are reasonably representative of the values likely to occur in normal use. We need to know more about the relationship between measurements carried out under standard test conditions (as in chain saw testing) and the vibration experienced in use.

19. The pace of development of vibration measurement standards and of machine design standards incorporating vibration requirements, is being forced by the European Communities 1992 initiative and by the "Machinery Safety" Directive in particular. This Directive was published in the official journal of the European Communities in 1989 (L183 Vol. 32, 29 June 1989) and lays down broad "essential safety requirements" which must be met before new machines "for use at work" can be sold within the common market. Harmonised standards developed by the European Committee for Standardisation

(CEN) will provide detailed guidance to manufacturers on what they might do and will be the basis for judging whether or not they have satisfied their legal obligations in respect of the effect of their machines etc on the health and safety of workers.

20. In respect of vibration machines must be designed and constructed so as to reduce the risks caused by the vibrations they produce to the lowest level that is reasonably practicable and the Directive emphasises "at source reduction". Industry need good measurement standards and criteria to judge the results by.

21. The requirements of the Directive have stimulated standards work within and outside the Community and a number of ISO test standards may, with modification be accepted as CEN standards but much remains to be done. It is essential that all who are likely to be affected by this Directive - designers and manufacturers of machines, employers and employees - are aware of its implications and make sure that their points of view are taken into account in the drafting of these standards.

INFORMATION AND GUIDANCE

22. Advice and guidance forms an important part of HSE's work. Guidance on vibration white finger and the action which should be taken to deal with the hazards created by exposure to hand-arm vibration at work. This will be followed by further guidance notes covering the measurement, assessment and reduction of vibration exposure.

These publications will supplement that which is already available in the technical press and in documents issued by bodies such as the Engineering Employers Federation. A particularly useful booklet is one entitled "Vibration at Work" - recently published by the "International Social Security Association" (ISSA) following an international symposium on the topic in Vienna in 1989.

23. Employers and employees need more than guidance: they need information about the vibration which the machines they buy and use produce, about the risk it creates and about any measures that they might take to reduce the risk. The effect of the EC "Machinery Safety" Directive will be not only to reinforce the existing requirements of our own Health & Safety at Work etc Act with regard to the duty of designers, manufacturers, suppliers etc to ensure that their machines are (with respect to vibration as well as other potential hazards) as safe as it is reasonably practicable to make them but will also increase the pressure for better information.

24. The Directive states that information regarding vibration must be given in sales brochures as well as in instruction manuals. Machines must carry warnings of residual risks. In the case of hand-held or hand guided machinery, information on the weighted rms acceleration to which the arms (of users) are subjected must be given if it exceeds 2.5m/s2. when determined by an appropriate test code.

25. In Scandanavia, Japan, France, Germany and elsewhere, research and development work on tools and processes has identified or led to the production of low vibration alternatives to some of the traditional tools and methods which create the problem. Changes in working practices (including increased mechanisation and automation) necessitated by the need to improve productivity and the decay of traditional heavy industries, have also had a significant effect on the total problem. However, much still needs to be done. Much information on methods of reducing vibration exposure must exist both within and outside the industries which create the problem. Possibly, because the problem is not recognised, available solutions aren't applied. This information needs to be collated, evaluated and then made readily available to those seeking solutions. Professionals working in relevant areas have a considerable part to play and perhaps the professional institutions could provide a lead in this work.

SOME UNRESOLVED ISSUES

26. One of the issues where international standardisation is clearly needed is agreement on a standard procedure for the diagnosis of VWF (and other vibration induced diseases of the hand-arm system) in individuals -has to be resolved. There has long been a need for a procedure which would rationalise and unify the recording of relevant medical data and supplement the subjective assessment with a minimum number of simple objective tests.

Many experts have expressed opinions on this and what is needed is a consensus view on an acceptable procedure. This need not necessarily be the most precise and reliable procedure. What is required is the best practicable approach which will allow the problem of disease prevention to be tackled effectively - now!

27. There are a number of other aspects of the VWF problem where more research, information and international discussion is desirable.

- a means of identifying the early signs of damage in individuals would be valuable - are there any which are sufficiently reliable?
- are the various prophylactic measures suggested by several eastern block countries worthwhile-practicable?
- is there now a good consensus on the effect of cessation of vibration exposure on the progression/regression of VWF;

28. Although there is an agreed international standard for the measurement of vibration exposure there are still some doubts about the frequency weighting used. Are we giving too much emphasis to low frequencies? It is important to know the correct weighting not only to improve the assessment of hazard but also in order to effect preventative measures. For example: the current weighting suggests that the use of anti-vibration gloves is unlikely to be of much value in reducing vibration transmission to the hands of the wearer but, if high frequency is more important than the current weighting suggests, the opposite may be the case[5].

29. In addition to the need, mentioned above, for research design and development work into ways of reducing machine vibration and the vibration exposure of workers work is also needed to develop a good standard test for the evaluation of anti-vibration gloves and handles. Work on this topic is now beginning in CEN Technical Committee 162 and UK manufacturers and users should become involved in this.

30. Should we be measuring the flow of vibration into the hand? Remember that what is important is preventative action and the sooner the better. If simple, less ideal measurements will enable us to achieve this objective then why complicate matters?

IN CONCLUSION: MAN IS NOT A MACHINE

31. Engineers required to consider a mobile, self acting, programmable machine featuring an interactive control system and integrated software, capable of lifting and manipulating a wide range of objects and widely used, would be concerned to ensure its operational integrity. Dynamic analysis, response calculations, prototype and other forms of testing would be used and design modifications made or limitations placed on the environments in which it might be used.

Unfortunately, all too often, insufficient attention is given to one of the most common "machines" of this type ....MAN!

32. Man is, however, not a machine but a complex bio-dynamic system which is frequently coupled into machines and processes which subject him or her - often - to noise, vibration and thermal loadings without any account being taken of his or her likely response.

The simpler forms of mal-function may be considered - physical damage due to interaction with machines; damage by fire or explosion; lack of maintenance and occasionally software failure but the more subtle and complex, longer term problems are often not thought about at all. If they are the assumption is made (without any evidence) that the problem is trivial.

33. The hand-arm vibration syndrome (HAVS) is one of these "longer term problems" noise induced deafness is another. Both can be and should be effectively dealt with by those whose activities create the noise and vibration hazards. The scientific knowledge and technological means required to reduce the risk now, by and large, exist. What is, in many cases lacking is the will to take effective action and the appreciation that man is not, after all, simply a machine. Where the will is lacking, we have the law to provide a stimulus.

34. We have only a few years left before the 21st century commences. Effective action is needed NOW if we are to ensure that the industries of the next century - in providing a better standard of living for us all - do not exact a toll from the health of the workers they employ. The motto should be "a better future for all".

REFERENCES

[1] Kyriakides K. Survey of exposure to hand-arm vibration in Great Britain. HSE Research Paper No. 26 1988 ISBN. 07176 03156.

[2] Griffin M J. Vibration Injuries of the hand and arm: their occurrence and the evolution of standards and limits. HSE Research Paper No. 9 1980.

[3] Hayward R A., M J Griffin. The Application of Vibractile Thresholds to the Diagnosis of Vibration Induced White Finger. Human Factors Res. Unit ISVR. Southampton 1987. To be published in the HSE Research Paper Series.

[4] Macfarlane C R. Vibration Attenuating Properties of Gloves. ISVR Paper presented at UK. Informal Group Meeting on Human Response to Vibration. Swansea 11-12 Sept. 1980.

[5] Bednall A W. Anti-vibration Gloves. HSE Tech. Div. SIR No. 13 1988.

NOTE: The views expressed in this paper are solely those of the author and do not represent in any way the official views of the Health & Safety Executive or any government department.