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Hand-arm vibration - Guidelines for vibration hazards reduction - Part 2: Management measures at the workplace

Hand-arm vibration - Guidelines for vibration hazards reduction - Part 2: Management measures at the workplace

Hand-Arm-Schwingungen-Leitfaden zur Verringerung der Gefährdung durch Schwingungen - Teil 2: Organisatorische Maßnahmen am Arbeitsplatz

Vibrations main-bras - Guide pour la réduction des risques de vibrations - Partie 2: Mesures de prévention sur le lieu de travail

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CEN

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Foreword

This CEN report has been drawn up by CEN/TC 231 "Mechanical vibration and shock", working group 2 "Hand-arm vibration".

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Introduction

The habitual and prolonged use of machinery which transmit vibration to the hand may cause disorders of the upper limbs.

European legislation requires firms to assess and take measures to prevent or reduce workplace risks to the health and safety of their employees. The basic strategy to be adopted is defined in the legislation and accompanying informative documents under the following broad headings:

- assessment of risks;
- identification of necessary preventative and/or protective measures;
- organisation for the effective implementation of preventative and protective measures;
- implementation of an adequate programme of measures to prevent or reduce risks.

This document is primarily concerned with the second item. Its purpose is to bridge the gap between the existing literature on vibration control and the practical implementation of vibration control measures. It will constitute brief guidance to managers, health and safety officers, engineers, planning and purchasing staff and others on the most important aspects of vibration effect reduction and control.

To reduce the vibration stress for the user it is essential to pay attention not only to the vibration intensity itself but also to the coupling of the machine to the hand-arm system and to the exposure duration. All three parameters can be influenced by technical measures.

Effective protection against vibration will generally require a combination of measures which can be categorised under the following headings:

- engineering measures;
- personal protection;
- management measures.

The application of these measures should take account of: the state of the art regarding technical progress, the availability of practicable vibration reduction and the compatibility of proposed vibration control measures with measures required to reduce or control other workplace hazards.

1 Scope

These guidelines outline practicable measures for the reduction and control of health hazards associated with exposure to hand-arm vibration at work in order to provide practical professional aid to managers and health and safety officers. The document covers four principal aspects, namely:

- identification of main sources of hand-arm vibration within the firm;
- vibration reduction by re-considering task, product, and process and re-design;
- how to select low vibration machinery, anti-vibration system and personal protection;
- management measures for the control of hand-arm vibration exposure.

2 Normative references

This CEN report incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this CEN report only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

CR 1030-1	Hand-arm vibration – Guidelines for vibration hazards reduction – Part 1: Engineering methods by design of machinery
CR (X)*)	Mechanical vibration – Guidelines to health effects of vibration on the human body
prEN 1033	Hand-arm vibration – Laboratory measurement of vibration at the grip surface of hand-guided machinery – General
EN 28662-1	Hand-held portable power tools – Measurement of vibrations at the handle – Part 1: General (ISO 8662-1:1988)
prEN 30819	Mechanical vibration and shock – Hand-arm vibration – Method for the measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand (ISO/DIS 10819:1993)
ISO 5805	Mechanical vibration and shock – Human exposure – Vocabulary

3 Definitions

Except where otherwise stated, technical terms used in this document are as defined in ISO 5805.

*) under preparation

4 Identification of main sources of hand-arm vibration within the firm

In addition to general knowledge about hand-arm vibration, its effects on man and its assessment and control, it is essential that the nature of hazard within the firm be well understood, i. e. that the various sources and their characteristics are known, exposed employees identified and the magnitude of the risks quantified.

In order to do this it will be necessary to know

- legal requirements including "action levels" or exposure limits (see annex A);

- the machinery, processes, tools and tasks in use within the company which are likely to expose employees to vibration.

  NOTE 1: An "action level" represents the conditions under which the situation may become a cause for concern, which will justify specific action, at the least closer examination of the specific situation.

An initial identification of sources of exposure to hand-arm vibration can be made by listing all the vibrating processes, machines and tools used within the firm which require employees to hold or guide a vibrating handle, control, workpiece or other vibrating surface. A list of the more common machines and processes which expose people at work to hand-arm vibration is given in annex B.

Furthermore, it is necessary to know

- the number and location of employees for each of the tasks which expose them to hand-arm vibration;

- representative vibration values for each machine, tool, etc. which create the hazard and the vibration exposure of persons at risk.

The assessment of human exposure to hand-arm vibration requires a knowledge of the vibration values to which people are exposed and of the daily duration of vibration exposure.

Also important is

- the contribution made by each source of vibration to the total vibration burden (TVB) of a person.

TVB represents the contribution of a particular machine, process or tool to the daily vibration exposure of the persons who operate or use it. It is derived by summing their fractional vibration exposures i. e. the ratios of the actual daily vibration exposure associated with each individual's use of the machine or tool to a reference value. The most appropriate reference value might be the first (or lowest) "action level" specified in relevant legislation or guidelines.

The values derived in this way show which tools and processes impose the greatest total vibration burden on the workforce and this could be taken into account when deciding priorities for action.

NOTE 2: It is recognised that the measurement and assessment of vibration may be complex and may require costly equipment; it will generally be necessary to use the service of a competent vibration consultant. Therefore, in some cases it may be practicable to estimate vibration exposures, without making measurements of vibration values, by using vibration data provided by machinery suppliers (EC machinery directive 89/392/EEC makes vibration declaration compulsory for a great variety of industrial machinery) or published in the technical literature and production data concerning the tasks carried out by exposed employees.

The daily exposure (normalized to a standard reference period of 8 hours) associated with the use of a machine can be roughly estimated for each operator from the following equation:

$$a(8) = a_{h,w} \cdot \left(\frac{T}{8}\right)^{\frac{1}{2}}$$

Where $a_{h,w}$ is the frequency weighted r.m.s. acceleration in m/s^2 provided e. g. by machinery suppliers, and T in hours, the exposure required.

5 Vibration reduction by task, product and process re-design

5.1 General

Detailed information should be gathered concerning the usage of the various machines, processes and tools which have been identified as sources of a hand-arm vibration hazard: i. e. what they are used for, how they are used and why they are used.

In considering a particular production function or task, the first step would be to define its purpose or function in broad terms i. e. what is to be achieved or done. At this stage the question as to whether or not the function provided by the process is required at all should be reviewed and to do this it will be necessary to consider all the factors which created the need for the function or task. Some of these factors may, however, be outside the firm's control e. g. customer's requirements, an architect's design or a consultant's recommendation.

The second step is to break the process down into its key elements, processes or stages highlighting those which are the principal contributors to the vibration hazard. (There may, of course be other hazards such as physical strain or noise, which may also need to be dealt with.)

This should then be used for a systematic analysis to determine the most cost-effective combination of protective and preventative measures.

The basic methods for reducing occupational exposure to hard-arm vibration are in order of priority:

a) elimination of hazard by the substitution of alternative non-hazardous processes, machinery or plant, e. g. automated or mechanised processes;

b) reduction of vibration at source by machinery or process modification e. g. the use of low vibration equipment, where a) is not reasonably practicable;

c) reduction of vibration transmission

- in the path between the source of vibration and the handles or other vibrating surfaces gripped by employees' hands,

- from handles and other vibrating surfaces onto the hands gripping them;

d) reduction of exposure duration e. g. work rotation to reduce the time for which employees are actually in contact with tool handles, machine controls, or other vibrating surfaces.

These measures may be practicable at any or all phases of a particular work operation or task. Annex C provides a practical example of how the method works.

5.2 Vibration reduction by work task re-design

The risks to the health of persons who are exposed to hand-arm vibration can be reduced by adapting work tasks to the individual.

Work tasks should be designed so that (see CR (X)):

- the values of hand-arm vibration are as low as practicable;

- the daily period of exposure to hand vibration is as short as possible;

- the working posture is one which imposes the least physical burden on the individual;

- physical loads, particularly (but not only) those on the hand-arm system, are matched to the capabilities of the individual;

- unduly rapid and frequent repetition of finger, hand and/or arm movements are avoided.

In designing the work task, it must be noted that the greater the forces applied by the hand upon vibrating surface, the greater the vibration passing into the user's hand and arm.

Detailed guidance on machinery design is given in CR 1030-1.

5.3 Vibration reduction measures by product re-design

All involved in the process – customers, designers, production engineers and managers – should take into account certain "essential safety requirements" relating to the potential impact of the product on the health and safety of those who are involved.

In respect of hand-arm transmitted vibration product designers should evaluate the effect of alternative designs on the manufacturing process in general and the ergonomic requirements of work tasks.

Where appropriate, the advice of production engineers, production managers, vibration and other specialists should be sought. In particular the aim should be

- to avoid or at least minimise the use of operations and tools which expose workers to hazardous values of vibration;

- to facilitate the use of low vibration tools or processes;

- to facilitate the optimum ergonomic design of work spaces and tasks.

Practical examples are given in annex D.

5.4 Vibration reduction by process re-design

Where employees are exposed to hand-arm vibration a thorough re-appraisal of the production process or task should be carried out and where reasonably practicable, alternative low vibration processes substituted for those which create the hazard.

Often ways of improving the process will be found which not only reduce hazardous vibration (and possibly other hazards) but also improve productivity and quality.

Practical examples of vibration reduction measures by process design are given in annex E.

Some of the more obvious possibilities for vibration reduction by use of an alternative process are as follows:

- the substitution, where practicable, of milling, turning or other machining operations for metal removing processes which used powered hand tools, such as portable grinders and pneumatic chisels;

- the use of arc-air and other flame cutting or gouging methods instead of pneumatic chisels or portable grinders for the rough dressings of castings and similar work;

- the use of smooth hydraulic rather than pneumatic, impulsive, or riveting techniques.

Sometimes the alternative process may not be a complete substitute for processes which expose workers to vibration but nevertheless might reduce substantially the total vibration exposure by reducing the extent to which such processes are used.

Abrasive, mechanical cleaning or mixed mechanical and chemical cleaning, processes, such as shot blasting and rumbling can be substituted for grinding and descaling operations. Where the process involves the removal of rust and paint abrasive or mechanical cleaning will generally be more effective and economic than grinding.

Where elimination or substitution is not reasonably practicable, it may, nevertheless, be possible to re-design the process so as to eliminate many hazardous, manual operations by the greater use of mechanisation and remote control or automation.

NOTE: Care should be taken to ensure that the removal of one hazard does not introduce one that is worse.

6 How to select low vibration machinery, anti-vibration systems and personal protection

6.1 Selection of low vibration machinery

6.1.1 General

When the use of powered hand-held or hand-guided equipment is unavoidable, vibration exposure can be minimised by careful selection of the machinery or tools to be used.

Many manufacturers of hand-held or hand-guided machines thus now market one or more low vibration designs e. g. breakers, grinders, hammers, chipping hammers, sanders, lawn mowers, hedge shears, impact wrenches, chain saws, needle scalers. Annex F gives practical examples of vibration reduction by selection of machinery or equipment.

In practice some difficulty may be experienced in choosing a low vibration machine because of a lack of appropriate test codes and the current inadequacy of available information on machine vibration emissions.

6.1.2 Questions that potential buyers should ask themselves

Before purchasing new machinery or equipment, potential buyers should always ask themselves the following basic questions:

- Is adequate information (vibration declaration) available about the vibration of that machine family and about the lowest vibration achievable?