SIST

SLOVENSKI STANDARD
SIST-TP CEN/TR 15172-2:2006

01-julij-2006

Tresenje celotnega telesa – Smernice za zmanjšanje tveganja zaradi vibracij – 2. del: Organizacijski ukrepi na delovnem mestu

Whole-body vibration - Guidelines for vibration hazards reduction - Part 2: Management measures at the workplace

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

Vibrations globales du corps - Guide pour la réduction des risques de vibrations - Partie 2: Mesures de prévention sur le lieu de travail

Ta slovenski standard je istoveten z: CEN/TR 15172-2:2005

ICS:

13.160	Vpliv vibracij in udarcev na ljudi	Vibration and shock with respect to human beings

SIST-TP CEN/TR 15172-2:2006 en

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 15172-2

November 2005

ICS 13.160; 17.160

English Version

Whole-body vibration - Guidelines for vibration hazards reduction - Part 2: Management measures at the workplace

Vibrations globales du corps - Guide pour la réduction des risques de vibrations - Partie 2: Mesures de prévention sur le lieu de travail

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

This Technical Report was approved by CEN on 25 July 2005. It has been drawn up by the Technical Committee CEN/TC 231.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. CEN/TR 15172-2:2005: E

Contents

Page

Foreword

This Technical Report (CEN/TR 15172-2:2005) has been prepared by Technical Committee CEN/TC 231 “Mechanical vibration and shock”, the secretariat of which is held by DIN.

CEN/TR 15172 consists of the following parts:

CEN/TR 15172-1, *Whole-body vibration — Guidelines for vibration hazards reduction — Part 1: Engineering methods by design of machinery*

CEN/TR 15172-2, *Whole-body vibration — Guidelines for vibration hazards reduction — Part 2: Management measures at the workplace*

Introduction

The EU Directive 2002/44/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration) requires those responsible for workplaces to introduce measures protecting workers from the risks arising from vibration insofar as these affect the health and safety of workers.

This Technical Report reviews measures of value in the efforts of workplace management to protect workers from adverse health effects of whole-body vibration and shock. It is recognised that workplaces are very different and that for a specific workplace only some of the measures are applicable.

Guidelines on engineering methods directed to designers and manufacturers of machinery transmitting vibration to the human body are given in CEN/TR 15172-1.

1 Scope

This Technical Report outlines practicable measures for the reduction and control of exposure to whole-body vibration at workplaces in order to provide a practical professional aid to workplace managers and health and safety officers. It covers identification and reduction of health risks from exposure to hazardous machinery vibration at the particular workplace, corresponding to Articles 4, 5 and 6 in the EU Directive 2002/44/EC, including

— identification of main sources of whole-body vibration at the workplace,

— formulation of a strategy for minimising and control of vibration exposure and

— implementation of the strategy.

NOTE Although the term vibration covers continuous vibration and transient vibration (shocks), in this Technical Report shocks are referred to in special cases where they require special attention.

This Technical Report is not concerned with hand-arm vibration which is covered by CR 1030-2.

2 Normative references

The following referenced documents are indispensable for the application of this Technical Report. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 14253:2003, *Mechanical vibration — Measurement and calculation of occupational exposure to whole-body vibration with reference to health — Practical guidance*

ISO 2631-1:1997, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*

ISO 2631-5, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 5: Method for evaluation of vibration containing multiple shocks*

3 Abbreviations

In this Technical Report the following abbreviations are used:

r.m.s. acceleration root-mean-square acceleration and

VDV fourth power vibration dose value, both of which are defined in ISO 2631-1.

S_{ed} daily equivalent static compression dose, which is defined in ISO 2531-5.

EAV daily exposure action value and

ELV daily exposure limit value, which both are defined in EU Directive 2002/44/EC.

4 Determination and assessment of health risks

4.1 General

General knowledge about whole-body vibration, its effects on man and its assessment and control, is important as a basis for the determination of health risks at the workplace.

It is necessary to know

— the main sources of whole-body vibration at the workplace,

— the relationships between whole-body vibration exposure and health risk and

— legal requirements including exposure action and limit values.

4.2 Identification of main sources of whole-body vibration at the workplace

The major sources of excessive vibration and shock are usually mobile machinery travelling over rough surfaces and working with machine tools (loading, drilling, soil compaction, road milling, etc.). A list of the more common machinery and processes that expose operators to whole-body vibration is given in Annex A.

Furthermore, it is necessary to know representative vibration values for each machine and process that create the hazard and the corresponding patterns of vibration exposure in order that the exposure of operators can be estimated.

Of special importance is to search for the following information about the machinery used:

— What are the whole-body vibration exposure values for typical operations of the machine?

— Which operational conditions can be expected to cause whole-body vibration exposures above the exposure action value and/or above the exposure limit value?

— Which modifications of the machine could cause changes of the declared values?

— Which seats and tools can be considered as suited for the machine, i.e. without worsening the declared values?

— Which effect will an incorrect adjustment of the seat have on the whole-body vibration exposure?

If an operation handbook does not provide this information, the manufacturer should be asked to provide additional information.

A thorough knowledge of how the machines are used in practical work is essential. This requires studies at work sites and collection of information from operators of the machines.

4.3 Relationships between whole-body vibration exposure and health risk

Disorder of the spine and related structures is the main health problem which may be caused by whole-body vibration. General information on health risks from exposure to whole-body vibration can be found in the literature.

ISO 2631-1 and ISO 2631-5 provide guidance on health risks from whole-body vibration as well as limits at which a health risk can be expected. Postures with bending and or twisting of the spine can significantly increase the health risk at these exposures. Since the strength of the matured spine decreases with age, the risk of injury due to a particular exposure can essentially increase with age.

There are indications of an exponential rise of the risk with an increasing intensity. Therefore, the integrated values (e.g. r.m.s. values) will severely underestimate the health risk if daily exposures contain segments with a high magnitude or transients with high peak acceleration (shocks, bumps). The more sophisticated procedures described in ISO 2631-5 will be required for an adequate evaluation in such cases. For the same reason, averaging of r.m.s. values for different days can lead to an underestimation of the health risk. This is the case if days with significantly different daily exposure values are averaged.

EN 14253 describes how to measure and calculate the daily vibration exposure in various situations. Annex A of EN 14253:2003 includes calculation of daily exposure for the cases where the daily work consists of long uninterrupted operations and for the cases where the daily work consists of operations or work cycles with different vibration magnitudes over short periods.

NOTE Research is continuously going on in various places and it is important for the management to follow the development and be aware of revisions of the applicable standards.

4.4 Legal requirements

The EU Directive 2002/44/EC includes requirements on vibration exposure values that shall not be exceeded (limit values) and exposure values above which actions for reduction of the vibration shall be taken (exposure action values).

The vibration exposures should be determined for a workday that is representative for the most pronounced vibration conditions. Averaging over workdays should not be made.

It should be noted that the limit values given by the EU Directive 2002/44/EC are not "safe" values. According to ISO 2631-1:1997, Annex B, a significant health risk can be expected at levels below the limit values of the EU Directive 2002/44/EC. Although exposures below the action value do not generally generate significant health risks, there are cases where exposures below the action value can cause health problems. This is, for example, the case when the exposure contains shocks or at unfavourable postures.

Guidance on strategies for assessment of a workplace is given in Annex B.

4.5 Use of declared values

The Machinery Directive 98/37/EC requires a declaration of the vibration emission value at operator’s position in case this value is above 0,5 m/s^2. According to EN 1032, the declared value is representative of the 75-percentile of vibration values experienced in typical intended use of the machinery in the mode of operation causing the highest vibration. It also states that the emission values should not be used for assessment of the health risk. However, the declared emission values can be useful in comparison of machinery and in selection of a machine for a certain task. If declared emission values are used, together with exposure duration, in order to get a rough and conservative estimate of the daily exposure that can be expected, it should be kept in mind that the declared value may be temporarily exceeded.

5 Formulation of provisions aimed at avoiding and reducing vibration exposure

In case the daily vibration exposure for an individual operator can exceed the action value of the EU Directive 2002/44/EC, a strategy for reduction and control of the vibration exposure should be formulated and implemented. If the exposure action value is not exceeded but risk is demonstrated to exist (e.g. because of exposure to high level of shocks), the strategy should include control of this risk. Elements of a strategy for the control of vibration and shock exposure may include one or more of the following activities:

— work task re-design, especially with regard to the main contributor to the vibration exposure;

— machinery or process modification, e.g. use of low-vibration machinery;

— modification of means for reduction of vibration transmission from source to operator, e.g. selection of machine with cab suspension, appropriate seats, etc.;

— limitation of individual exposure durations, especially with regard to the main contributor to the vibration exposure (including job rotation);

— control of that the tyre inflation pressure is maintained according to the manufacturer's manual;

— selection of manufacturer's options for wheels and tyres appropriate for the conditions of use;

— maintenance of road surface.

Annex C provides a practical example of application of the various methods.

6 Minimising vibration exposure

6.1 Vibration reduction by task and process re-design

Detailed information should be gathered concerning the usage of the various machines, processes and tools that have been identified as sources of whole-body vibration hazard.

In considering a particular process or task, the first step would be to define its purpose in broad terms, i.e. what is to be achieved or done. The second step is to split up the process into its key elements, highlighting those stages that are the principal contributors to the vibration exposure. Actions for limitation of the vibration exposure may be concentrated to these contributors.

Work tasks should be designed so that

— whole-body vibration exposures are as low as practicable,

— the daily period of exposure to excessive vibration is as short as possible,

— the exposure to severe shocks is avoided and

— the working posture is one which imposes the least adverse health effects of the vibration.

In many cases, travelling over rough ground is the main contributor to the vibration exposure. This exposure may be managed by the following activities:

— Minimising the travelling distance by organisation of the work, including (if applicable) travelling to and from breaks. This is also positive for the work efficiency.

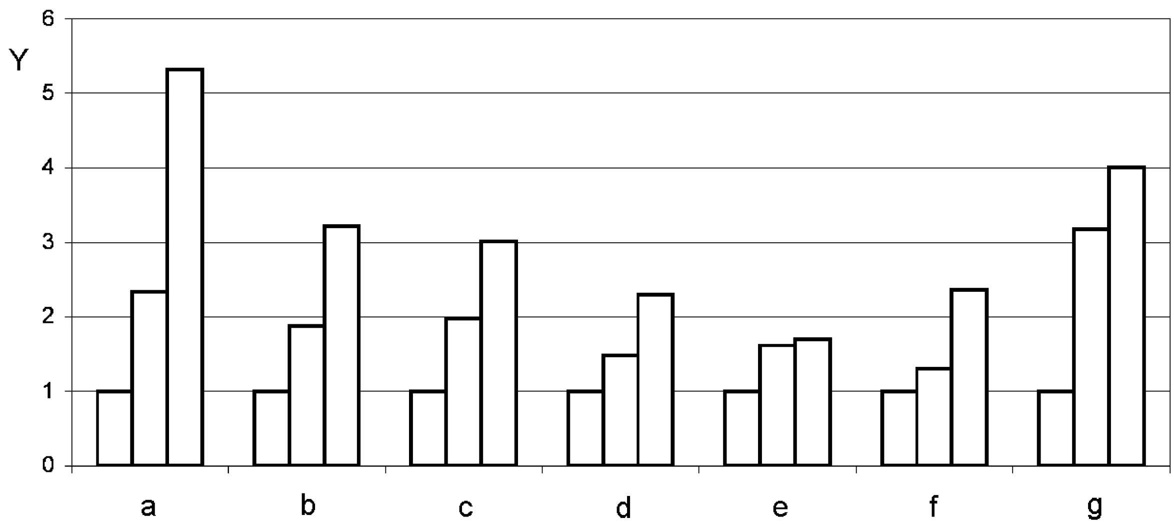
— Limitation of the travelling speed. Travelling speed has a very pronounced effect on the vibration value as shown by the examples in Figure 1. Effective management of the work and information of the operator on the health risks are prerequisites for getting speed limitation rules followed in practice.

— Maintenance of the ground surface by removing obstacles, filling potholes, levelling of transport roads, etc.

— Information to the operator of the health importance of correct adjustment of the seat and seat back (in case this is adjustable) and of the driving posture.

For some machines, other operations than travelling can involve excessive vibration and shocks. An example is tree harvesting, where the main effect of vibration exposure can be from shocks originating from felling operation and movement of the stem in the harvesting head as delimbing occurs.

To reduce the risks the work should be organised in such a way that unnecessary climbing out from the cabin in slippery conditions is reduced to a minimum. The management of the workplace should make sure that sufficient support for feet and hands is provided and that footwear is provided with adequate anti-slipping device (at least under heals). The operators should be trained for safe manners in choosing the place and position of the machinery for climbing out.



Key

Y ratio between vibration values

a hauler (dumper with an articulated frame for steering)

b heavy wheel loader

c light wheel loader

d soil compactor

e agricultural transporter

f agricultural tractor

g small dumper

NOTE Figure 1 shows the ratio between the vibration values at the lowest speed, twice the lowest speed and three times the lowest speed, and the vibration value at the lowest speed. The measurements were made in the z-direction in the seat cushion, underneath the driver, at travelling over more or less rough surfaces. Similar measurements on industrial trucks show that a doubling of speed increases the vibration value by a factor of two.

Figure 1 — Influence of driving speed on vibration value

6.2 Vibration reduction by selection of machinery, tools and seats

6.2.1 General

The management of a workplace should be careful in selection of machinery and working equipment and give enough priority to freedom of excessive vibration and possibilities to operate the machine and working equipment without attaining an undesirable posture.

6.2.2 Selection of machinery

The supplier should be asked to provide well-founded information on vibration emission and also an assessment of exposure values during intended use of the machine.

In practice, some difficulty may be experienced in choosing low-vibration machine because of a lack of appropriate test codes and the current inadequacy of available information on machine vibration emissions. The declared vibration value provided in accordance with the requirements of the Machinery Directive 98/37/EC is useful for comparison of machines from different manufacturers.

Proper training and experience of use of the machinery are important factors for controlling vibration exposure and avoid inappropriate postures. It is also important that the maintenance of the machinery is clear and easy.

More detailed guidance for selecting mobile machinery is provided in Annex D.

Annex E provides a list of the most important questions with regard to whole-body vibration that potential buyers of machinery should ask suppliers.

6.2.3 Selection of working equipment or tools for the machine

When selecting working equipment or tools for the machine, soft movements of the working equipment and its coupling to the machine should be aimed at. A check should be made to investigate to which extent the tool influences the vibration level at the operator's position.

One important factor is to provide the right tool for the job. The machinery producer/manufacturer/supplier should be asked for guidance on what tools to use and how to operate the tools in order to minimising the vibration without loosing in efficiency. Also the tool maintenance instructions are important.

Machines that have suspensions of booms or buckets should have these suspensions in operation when travelling.

A check should be made so that the control levers of the working equipment or tools are placed so that the operator will maintain an upright posture and avoid unnecessary twisting of the body when using the equipment or tools.

6.2.4 Selection of seats

The machine supplier should give detailed information on appropriate seat selection. It is important that there is no conflict between the resonance frequencies of the tyre-machine system, chassis suspension system or cab suspension system on one side and of the seat suspension system on the other side. It is further important that there is enough room for the seat suspension to avoid topping and bottoming of the suspension system. In order to avoid dangerous shocks when driving across an unexpected, severe obstacle, it is also important that there is a protection from very hard topping and bottoming (reasonably soft end stops).

The manufacturer/supplier should be asked for proper mounting instructions. It is important to check and assure that the seat mounting surface is rigid enough to avoid resonance problems. This is important also in lateral directions where the vibration can be amplified and become dominant in certain mobile machinery with current seats.

In selection of seats, it is also important that the seat suspension is easy to adjust according to the operator's weight and body size. Height, forward-backward and backrest adjustments are especially important. The seat cushions should be ergonomically well designed with width and height according to the needs of the operator.

The seat supplier should be asked to provide information on the life of the resilient materials included in the seat suspension. This is especially important if the resilient material is organic (e.g. elastomers).

For more detailed guidance on selection of seats, see Annex F.

6.2.5 Selection of type of tyres

Tyres are usually selected according to their rolling resistance, grip, stability, cost, resistance to collision damage, acceptability to the driver, etc.

Most all-terrain vehicles are fitted with pneumatic tyres because they filter out the small ground surface irregularities. An exception to this are off-road machines fitted with caterpillar tracks and industrial trucks which are often mounted on solid tyres for stability reasons and for puncture resistance. These tyres should only be used on perfectly smooth ground.

Other parameters, such as damping and stiffness, have to be taken into account in order to absorb obstacle impact. However, even large tyres cannot absorb vibration energy as well as a shock absorber. Therefore, vibration builds up even on relatively smooth surfaces. Tyres are normally much stiffer than a suspension system. Excessively soft tyres may induce low-frequency motions, including pitching. In general, changes in tyre pressure do not result in a simple increase or decrease in vibration, but rather have an effect which is dependent on other vehicle characteristics, such as load and dimension.

Figure 2 compares r.m.s. acceleration values measured for an unloaded 1,5 t counterbalance truck fitted with solid or pneumatic tyres and running over an obstacle at different speeds. Acceleration variations resulted from phase interference between the free vibration of the counterbalance truck after the front tyres had run over the obstacle and the impact of the rear tyres when hitting the obstacle. In some cases, it may be judicious to select solid tyres with a carefully selected internal filling, which would offer optimised damping of the vibration induced by impact with an obstacle. However, research is required to develop a suitable design.

6.2.6 Widening track width or use of dual wheels

Measurements of vibration in agricultural tractors show that widening track width or use of dual wheels reduces transverse vibration (in the y-direction) significantly. An example of the effects on the frequency-weighted r.m.s. acceleration value in the seat of an agricultural tractor when using dual wheels is shown in Figure 3.