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Mehanske vibracije - Smernice za ocenjevanje izpostavljenosti vibracijam preko rok z uporabo podatkov o stroju, vključno s podatki proizvajalca

Mechanical vibration - Guideline for the assessment of exposure to hand-transmitted vibration using available information including that provided by manufacturers of machinery

Mechanische Schwingungen - Anleitung zur Beurteilung der Belastung durch Hand-Arm-Schwingungen aus Angaben zu den benutzten Maschinen einschließlich Angaben von den Maschinenherstellern

Vibrations mécaniques - Guide pour l'évaluation de l'exposition aux vibrations transmises à la main à partir de l'information disponible, y compris l'information fournie par les fabricants de machines

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (CEN/TR 15350:2020) has been prepared by Technical Committee CEN/TC 231 “Mechanical vibration and shock”, the secretariat of which is held by DIN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TR 15350:2013.

The main changes are as follows:

— Document brought in line with CEN/TR 1030-2:2016 by removing content already covered there;

— Annex B updated by explaining the procedure for identifying vibration risks that need to be controlled;

— Annex C now based on harmonized standards published after 2007 (e.g. EN 60745, EN 62841, EN ISO 28927, EN ISO 22867), providing more realistic results, without the need of multiplying factors, formely used for correcting the risk of underevaluating vibration exposure;

— new Annex D included, providing the estimation of exposure duration with examples of indicative exposure durations according to the quality of operators.

Introduction

This document provides information on how to estimate the exposure time (exposure duration) and how to assess the vibration exposure from hand-held power tools and hand-guided machines. The methods described use existing vibration emission values declared for the machine of interest or information coming from other sources.

Daily vibration exposure depends on both the average vibration magnitude at the vibrating surface in contact with the hand and the total user time for which an employee is in contact with that vibration.

EN ISO 5349-1 notes that vibration is affected by many factors, such as force, posture, inserted tools etc. It is therefore important to recognize that vibration exposure values are estimates of true exposures and therefore estimates of true risk from hand-arm vibration. To make good exposure assessments it is important to have an appreciation of the limitations of different vibration information sources (sources such as collated information on types of machine, manufacturer's declared emission values, or workplace). However, it is also important to recognize when your estimate of exposure is sufficiently precise for your application.

It is important that the vibration values used in the exposure assessment are representative of those in the specific use of the machinery. Workplace measurements, however, are required if suitable data are not available to represent the vibration under the specific working conditions or if the calculation results do not help to decide whether or not the vibration exposure limit value or exposure action value is likely to be exceeded or if appropriate information from health surveillance shows needs of precaution.

1 Scope

This document gives guidelines for estimating and documenting the daily vibration exposure due to the use of hand-held power tools and hand-guided machines, in relation to the requirements of the European Physical Agents Directive (vibration) 2002/44/EC. This document is addressed to competent services for the assessment of vibration exposure at the workplace and to national authorities and industrial organizations.

The methods in this document are based on the requirements and guidance given in EN ISO 5349-1 and EN ISO 5349-2 but instead of measuring the vibration magnitudes at the specific workplaces, the methods in this document use existing vibration values from other sources of information including those provided by the manufacturers of the machinery in relation to the requirements of the Machinery Directive 2006/42/EC.

This document gives guidance on how to estimate the exposure time and the daily vibration exposure $A(8)$ as defined in EN ISO 5349-1. It also offers a simple method for estimating the daily vibration exposure by means of a table which indicates the vibration exposure as a function of the equivalent vibration total value and the associated exposure time. Both methods can be used even in cases of multiple exposures on the same day.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 5349-1, *Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 1: General requirements (ISO 5349-1)*

EN ISO 5349-2:2001, *Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 2: Practical guidance for measurement at the workplace (ISO 5349-2)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 5349-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
user time
user time of the work involving the use of the machinery, i.e. including the interruptions required by the work and the break periods directly related to the use

Note 1 to entry: This is more likely to be reported by the operator than the exposure time (see 3.2).

3.2
exposure time
T
total duration the hand is in direct contact with the vibrating surface (handle, work piece, etc.)

EXAMPLE The user time for mounting wheels on five automobiles is estimated by the operator at 1 h per day; but the exposure time is just 5 cars x 4 lug nuts x 4 wheels x 2 loosening/tightening actions x 4 s which yields T = 0,18 h. The exposure proportion is only 18 %.

Note 1 to entry: The exposure time is often confused with the user time when estimating the daily exposure time T.

3.3
equivalent vibration total value
$a_{\mathrm{hv,eq}}$
time-averaged sum of the vibration total values of the various machinery operating modes, $a_{\mathrm{hv}i}$, during their associated exposure times T_i

$$a_{\mathrm{hv,eq}} = \sqrt{\frac{1}{T}\sum_{i=1}^{m} a_{\mathrm{hv}\,i}^{2}\,T_i} \qquad (1)$$

Note 1 to entry: For the vibration total value a_{hv}, see EN ISO 5349-1. The total exposure time T for a machine is the sum of all m individual exposure times T_i within the entire work cycle considered (an example is given in Annex F). If there is one operating mode only, then $a_{\mathrm{hv,eq}} = a_{\mathrm{hv}}$.

3.4
partial vibration exposure points
P_E
index describing the vibration exposure from a single machine or work task during the associated exposure time

$$P_E = \left(\frac{a_{hv,eq}}{2{,}5\ \mathrm{m/s^2}} \right)^2 \frac{T}{8\ \mathrm{h}} \times 100 \tag{2}$$

with the equivalent vibration total value $a_{hv,eq}$ and the associated exposure time T

Note 1 to entry: Vibration exposure points are a simple alternative to the $A(8)$ value for describing a person's partial or total daily vibration exposure. The relationship is:

$$A(8) = \frac{2{,}5\ \mathrm{m/s^2}}{10} \sqrt{P_E} \tag{3}$$

3.5
total vibration exposure points
$P_{E\,tot}$
sum of the partial vibration exposure points P_E within one day

$$P_{E\,tot} = \sum_{i=1}^{n} P_{E\,i} \tag{4}$$

with n being the number of partial vibration exposures considered

Note 1 to entry: A score of 100 points for the total vibration exposure in a day is equal to the exposure action value of $A(8) = 2{,}5\ \mathrm{m/s^2}$ and a score of 400 points is equal to the exposure limit value of $A(8) = 5\ \mathrm{m/s^2}$ (see Annex E).

4 Estimation of the vibration exposure

4.1 General

The daily vibration exposure depends on two key elements:

a) average magnitude of vibration at the surface in contact with the hand and

b) total daily time for which an employee is in contact with that vibration.

The daily vibration exposure is determined from vibration magnitude and exposure time values obtained using the procedures in Clauses 4 and 5. The principle of the procedure for the estimation of the daily vibration exposure based on existing vibration values is outlined in Annex B. Estimation and assessment can be performed either using $A(8)$ values or more easily using vibration exposure points P_E, see Annex E.

4.2 Using the daily vibration exposure $A(8)$

The daily vibration exposure $A(8)$ can be calculated by using the equivalent vibration total value $a_{hv,eq}$ and the daily exposure time T for the specific machine and work task as follows:

$$A(8) = a_{hv,eq}\sqrt{\frac{T}{T_0}} \tag{5}$$

where T_0 = 8 h.

If the work of the day consists of usage of n machines with the individual equivalent vibration total value $a_{hv,eq\,i}$ and exposure time T_i for the i-th machine, calculate the partial vibration exposure for each machine, $A_i(8)$, according to Formula (5) and combine the $A_i(8)$ values as follows:

$$A(8) = \sqrt{\sum_{i=1}^{n} A_i^2(8)} \tag{6}$$

This procedure is described in EN ISO 5349-1 and further guidance is given in EN ISO 5349-2. Examples of the use of this procedure are shown in Annex F.

NOTE When a machine is used under several different working conditions with known vibration values, it can be regarded as several machines each with its own vibration magnitude and exposure time.

The daily vibration exposure is assessed by comparison with the exposure action value of $A(8)$ = 2,5 m/s^2 and the exposure limit value of $A(8)$ = 5 m/s^2 in order to establish the necessary action by the employer (see the Physical Agents Directive 2002/44/EC and Table E.1). The daily exposure values have a high level of uncertainty. If the estimated value is close to the exposure action value or the exposure limit value it is better to assume that the value is likely to be exceeded and employers should take necessary actions.

5 Estimation of the vibration magnitude

5.1 Sources of information

Vibration magnitudes may be measured at the workplace by the employer, or on his behalf. However, this can be expensive and difficult and it is not always necessary. There are other sources of information on vibration magnitudes, which are often sufficient to roughly estimate the daily vibration exposure of workers and help to decide whether the exposure action value or the exposure limit value is likely to be exceeded.

Declared vibration emission values may be available (and shall be available for hand-held power tools) from manufacturers or suppliers of machinery. Some employers are making vibration measurement data available to others in the same industry (often through trade associations); sharing information in this way can be cost effective for companies using similar machinery for similar work. Other sources of vibration data include specialist vibration consultants, employers' organizations (trade associations) and government bodies. Data can also be found in various technical or scientific publications and on the internet. If data from one of these sources are used, the quality and accuracy of the data should be checked, e.g. by comparing data from two or more sources; comparing data from several sources is generally recommended. It should be tried to find a value (or range of values) which represents the likely vibration magnitude for the particular machine and operating conditions.

If sufficient magnitude data are not available from other sources, then workplace measurements might become necessary.

5.2 Manufacturer's declared vibration emission values

5.2.1 General

An important source of information is the manufacturer or supplier of the machinery. Annex A lists the information employers can expect from manufacturers and suppliers to help them identify and manage vibration risks.

An estimation of the vibration total value can be obtained in the manufacturer's information. This estimated value should be used only where the information in Annex C shows it is likely to be representative of the specific use of the machinery. Where this is not possible, measurement of the vibration, in accordance with EN ISO 5349-1, will be required for the specific use of the machine.

The principle of the procedure for the estimation of the daily vibration exposure based on existing vibration values is outlined in Annex B. This method can be used only if all of the following conditions are met:

a) declared vibration emission values(s) for the machine, and the test code used, are given, e.g. by the manufacturer;

b) machine and equipment, like inserted tools, are in good condition and are maintained in accordance with manufacturer's recommendations;

c) machine and equipment, like inserted tools, are used according to manufacturer's recommendations.

5.2.2 Vibration test codes

The vibration values given by manufacturers in their instruction handbooks or other publications (declared vibration emission values) are determined under standardized measuring and operating conditions which are defined in the appropriate vibration test code for the family of machines. Following EN ISO 20643, the vibration test codes developed should use three axes and give values representative of the upper quartile of vibration total values produced by the machines in their intended use.

If the declared vibration emission value is not representative of the vibration likely in the intended use of the machine, machine manufacturers and suppliers should provide additional information which may include more appropriate information on likely vibration magnitudes in practical use (see Annex A).

5.2.3 Interpreting manufacturers' declared vibration emission values

If the machine manufacturer or supplier is unable to confirm that the declared vibration emission value (and uncertainty *K*) represents the vibration in the intended use, and does not provide additional information, then the employer may need to seek information from other sources or make measurements at the workplace in order to assess the exposure of his employees (see 5.1 and 5.3).

Manufacturers will usually not publish vibration emission values if they are below 2,5 m/s^2 but in this case they shall state that it is less than 2,5 m/s^2. In this case the value of 2,5 m/s^2 shall be used for estimating exposures. In this case the value of 2,5 m/s^2 shall be used for estimating exposures, see C.1.

If the declared emission vibration value is not determined by using a harmonized test code the employer shall ensure that the way he is using the machine is in accordance with the operating conditions described by the manufacturer. More information about the influence of machine operating and measurement conditions can be found in EN ISO 20643.

NOTE Information about possibly influencing factors, like the influence of anti-vibration systems and resilient grips inserted tools can be found in CEN/TR 1030-2.

5.3 When vibration measurements are appropriate

There may be situations in which the vibration exposures cannot adequately be estimated. It may then be necessary to make measurements at the workplace.

EXAMPLE 1 A vibrating machine is used for an unusual purpose, of which the manufacturer has limited previous experience and so cannot provide vibration information.

EXAMPLE 2 It may not be clear, from the limited information available, whether the exposure action value or the exposure limit value is likely to be exceeded.

EXAMPLE 3 Employer may wish to check the effectiveness of actions taken to control vibration exposure.

Further information and practical guidance on exposure evaluation and vibration measurement at the workplace is given in EN ISO 5349-2.

6 Estimation of the daily exposure time

The daily exposure time for each relevant machine or process should be determined. This should generally be done directly by observing the work (see EN ISO 5349-2:2001, 5.5). Alternatively, this can be done with reduced accuracy by multiplying the user time (e.g. that estimated by the operator) by an appropriate exposure proportion.

It should be recognized that for most machines the vibration exposure time is shorter than the user time.

In some special cases it may be possible to estimate the daily exposure time using generic exposure times obtained from time studies.

Exposure time is often estimated subjectively. Table 1 lists the various methods for determining the exposure time according to their quality.

Estimation of the exposure time should be accompanied by a plausibility check, for example by means of the following procedure:

1) Division of the entire working time per day into periods with and without use of the tool.

2) Estimation of the duration of use of the tool in the case concerned.

3) Plausibility check with reference to the material or energy consumption.

4) Plausibility check with guideline values for the typical application case (see Annex D).

Table 1 — Methods for determining the exposure time according to their quality

Method	Remarks
Time studies (video recordings, stopwatch)	This method is resource-intensive, and consideration may have to be given to the inaccuracy if short random samples are used.
Measurement of the tool usage time with a sensor system fitted to the machine or equipment or worn by the operator	This method and the measurement equipment are described in CEN ISO/TR 19664 and in EN ISO 5349-2:2001, Annex E.
Estimation of the duration of tool use and plausibility check against empirically observed exposure times	In almost all cases, the duration of use of a tool is higher than the actual duration of exposure. Consequently, subjective estimation frequently leads to the duration of exposure being overestimated, and must therefore be accompanied by a plausibility check.
Estimation of the duration of exposure and performance of a plausibility check with typical mean durations of exposure	Daily exposure times determined by manufacturers are stated in Annex D according to the type of tool and drive. Personal exposure times may however deviate strongly from these values in specific cases.

7 Consideration of variabilities and uncertainties

There are many reasons to make a poor estimation of the vibration exposure because of the variabilities of the conditions of the use of machines and uncertainties of measurements.

The vibration magnitude for a particular machine can be highly variable. For example, operators, different operating conditions and different inserted tools all influence the actual magnitude. The magnitude also often varies over time. It is usually difficult or impossible to obtain a precise value or narrow value range, so an indication of the average value is all that can be expected. For exposure estimation, it is usually necessary to take into account the fact that values are obtained within a range of uncertainty (see CEN/TR 1030-2:2016, Annex H). In case of doubt the employer will have to check the plausibility of his estimation by other means such as databases or the “Non-binding guide to good practice for implementing Directive 2002/44/EC (Vibrations at work)”, Part I “Guide to good practice on hand-arm vibration”, which is addressed to the European Member States.

NOTE 1 The uncertainty of the declared vibration emission value from the manufacturer is given as a *K* value estimated in accordance with EN 12096. The uncertainty of the vibration value in real use is normally much greater.

NOTE 2 The manufacturer's declared vibration emission values are determined using new or almost new machines. Irregular or poor maintenance of machines can lead to substantial changes in the vibration emissions, depending on the type of machine in question.