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Human response to vibration — Measuring instrumentation —

Part 2: Personal vibration exposure meters

Réponse des individus aux vibrations — Appareillage de mesure —

Partie 2: Instruments de mesure de l'exposition des personnes aux vibrations

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 231, *Mechanical vibration and shock,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 8041 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 8041-1 specifies instruments for measuring human exposure to vibration. These instruments are used for temporary, short time measurements or controlled measurements.

This document specifies personal vibration exposure meters (abbreviated to PVEM) for measuring human exposure to vibration over long time periods, e.g. a whole working shift.

It is not necessary for PVEM to fulfil all of the specifications given in ISO 8041-1. On the other hand, it is necessary for them to fulfil other requirements which allow non-controlled measurements or stand-alone measurements over longer time periods. In combination with alarm functions, PVEM can make it possible to alert the user before vibration exposure reaches certain values (action value, limit value). For this reason, it is necessary to distinguish PVEM from the instrumentation specified in ISO 8041-1.

Whilst some potential applications and artefacts are covered in the informative annexes, this standard is an instrument standard and does not cover all potential applications of the PVEM. The reader should refer to measurement standards and guidance for further information.

Annex A describes the treatment of transient acceleration artefacts, Annexes B and C describe possible extension features with additional information for the measurement procedure.

Human response to vibration — Measuring instrumentation —

Part 2: Personal vibration exposure meters

1 Scope

This document specifies minimum requirements for personal vibration exposure meters (PVEM).

This document is applicable to instruments designed for measurements of whole-body vibration in the context of industrial hygiene applications (according to ISO 2631-1, ISO 2631-2 and ISO 2631-4) and/or hand-arm vibration (according to ISO 5349-1) together with the associated exposure times.

This document provides specified design goals and permitted tolerances that define the minimum performance capabilities and functional requirements of instruments designed to measure personal daily vibration exposure.

This document does not apply to instruments designed to measure or log exposure times without also performing vibration measurement. Instrumentation of this type is described in ISO/TR 19664.

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.

ISO 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

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

ISO 2631-2, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 2: Vibration in buildings (1 Hz to 80 Hz)*

ISO 2631-4, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems*

ISO 5347 (all parts), *Methods for the calibration of vibration and shock pick-ups*

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

ISO 5805, *Mechanical vibration and shock — Human exposure — Vocabulary*

ISO 8041-1:2017, *Human response to vibration — Measuring instrumentation — Part 1: General purpose vibration meters*

ISO 10326-1, *Mechanical vibration — Laboratory method for evaluating vehicle seat vibration — Part 1: Basic requirements*

ISO 15230-1, *Mechanical vibration and shock — Coupling forces at the man-machine interface for hand-transmitted vibration*

ISO 16063 (all parts), *Methods for the calibration of vibration and shock transducers*

ISO 16063-21, *Methods for the calibration of vibration and shock transducers — Part 21: Vibration calibration by comparison to a reference transducer*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity standard for industrial environments*

CISPR 22:2008, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041, ISO 2631-1, ISO 5349-1, ISO 5805, ISO 8041-1 and the following apply.

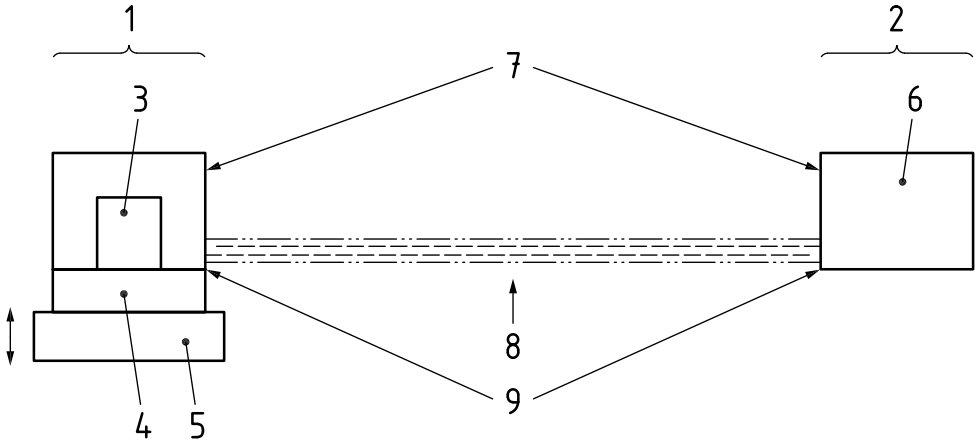
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

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

3.1
personal vibration exposure meter
PVEM
instrument designed to measure and log personal vibration exposures by detecting occurrences of exposure and measuring associated human vibration together with the exposure time

Note 1 to entry: The principal components of a personal vibration exposure meter are shown in Figure 1.



Key

1 part A
2 part B
3 transducer
4 coupling
5 vibrating surface
6 display and control
7 logging, signal processing
8 fixed or temporary wired or wireless interface
9 operator detection system (ODS)

Figure 1 — Principal components of a PVEM

3.2
permanent measurement system
system which is permanently incorporated into or fitted onto a machine

Note 1 to entry: A permanent measurement system is not designed to be routinely transferred to other vibrating machinery.

3.3
non-permanent measurement system
system which is designed to be used on several machines or other vibrating objects

Note 1 to entry: A non-permanent measurement system is capable of routinely being transferred from one vibrating object or machine to another.

3.4
user
person authorized to operate a *PVEM* (3.1)

3.5
operator
worker
person who performs a work task at a workplace

3.6
logging
storing measured acceleration values at regular time intervals

3.7
logging step
time interval between the start of two consecutive *logging* (3.6) periods

3.8
measurement period
duration of all measurements, representing the *worker's* (3.5) exposure time

Note 1 to entry: The measurement period usually comprises many *logging steps* (3.7).

3.9
transient acceleration artefact
event or effect that can alter the computation of *workers'* (3.5) daily exposure to vibration

Note 1 to entry: For a *PVEM* (3.1), it is essential to log sufficient information to identify transient acceleration artefacts for the purpose to treat them in real time or in the post-processing.

4 Reference environmental conditions

Reference environmental conditions for specifying the performance of a personal vibration exposure meter are the following:

— air temperature: 23 °C;

— relative humidity: 50 %.

5 Performance specifications

5.1 General characteristics

5.1.1 Common characteristics

A personal vibration exposure meter (PVEM) is a vibration measurement system meeting the relevant requirements of ISO 8041-1 with the additional capability to monitor personal exposures up to a full working day.

Since personal vibration exposure meters are instruments capable of measuring and computing daily vibration exposures they are simple to use and implement (internal complexity hidden from the user) and automatic (i.e. they do not require manual post-processing or computations), while displaying accurate and reliable results. Hence, as compared to general-purpose vibration meters, PVEM shall run algorithms that replace as much as possible any required manual signal post-processing.

Particularly, one design goal is to identify measurement events or periods that might need to be rejected and that could be automatically discarded from the vibration exposure computation using artefact rejection algorithms. Those automatic artefacts rejection algorithms are an additional feature of PVEM as compared to general-purpose vibration meters. In operation PVEMs are typically left unattended.

5.19 to 5.24 give additional recommendations and specifications for PVEM.

The PVEM may consist of separate parts (see parts A and B in Figure 1). Part B of the PVEM provides the means to present the results of measurements. The presentation of results may be in any suitable form, e.g. continuous "live" display or upload of measured values to a dedicated displaying unit or a computer at the end of the measurement period. Part B is an inherent part of the PVEM and compulsory for a pattern evaluation and periodic verification of the PVEM. However it needs not to be used with part A for the period of exposure measurement.

In addition to the relevant requirements of ISO 8041-1, a PVEM shall

— derive vibration exposure by measuring vibration magnitudes and directly related exposure times,

— measure vibration in three directions (x, y, z) simultaneously,

— provide capability for measurement over the period of a working day (at least 12 h) without intervention by the user,

— include a real-time clock,

— continuously log vibration data versus time over the full measurement period at suitable programmable intervals which are no greater than 1 s,

NOTE Suitable logging steps can be as defined in ISO 2631-4 or selected by the user. The manufacturer can provide a choice of logging periods according to the measurement type.

— store logged vibration exposure data in a non-volatile memory, such that the data are not compromised if the power supply is interrupted (e.g. if the battery is low or being replaced),

— output information on logged vibration magnitudes, corresponding real time, and overall daily vibration exposure and daily exposure time, and

— provide information that will assist the user to exclude transient acceleration artefacts from exposure measurements (see Annex A).

The facility for reading measurement data from the instrument may be a direct display on the instrument or a remote display, or both.

Where the PVEM provides alarms for exposure exceedances, then the manufacturer shall provide information on the conditions for the alarm trigger points and on any capability to adjust the exposure trigger levels.

The reference vibration signal values and reference frequencies are given in Table 1.

Not all of the frequency weightings given in Table 1 need to be implemented in a PVEM, and further frequency weightings (see ISO/TR 18570) may also be implemented. The manufacturer shall state which frequency weightings are implemented.

Table 1 — Reference vibration values and frequencies

Application	Frequency weighting	Nominal frequency range	Reference		Weighting factor at reference frequency	Weighted acceleration at reference frequency and RMS acceleration value
			Frequency	RMS acceleration value		
		Hz		m/s^2		m/s^2
Hand-transmitted	W_h	8 to 1 000	500 rad/s (79,58 Hz)	10	0,202 0	2,020
Whole-body	W_b	0,5 to 80	100 rad/s (15,915 Hz)	1	0,812 6	0,812 6
	W_c				0,514 5	0,514 5
	W_d				0,126 1	0,126 1
	W_e				0,062 87	0,062 87
	W_j				1,019	1,019
	W_k				0,771 8	0,771 8
	W_m	1 to 80			0,336 2	0,336 2
Low-frequency whole-body	W_f	0,1 to 0,5	2,5 rad/s (0,397 9 Hz)	0,1	0,388 8	0,038 88

5.1.2 Special characteristics for whole-body vibration measurement

For instruments designed for whole-body vibration, the PVEM shall

— measure vibration at the interface between the machine and the operator's body (in accordance with ISO 2631-1),

— be capable of responding to vibration peak values up to 50 m/s^2,

NOTE In special applications vibration peak values up to 200 m/s^2 have been observed.

— measure exposure characteristics based on A(8) exposures,

— optionally, measure exposure characteristics based on vibration dose value (VDV),

— optionally, measure exposure characteristics based on maximum transient vibration value (MTVV),

— optionally, measure exposure characteristics based on motion sickness dose value (MSDV),

— allow all part A components (see Figure 1) to be fitted unobtrusively to either the machine seat or the machine operator,

— (for non-permanent and optionally for permanent measurement systems) incorporate the part A component of the instrument into a seat pad meeting the requirements of ISO 10326-1, and

— (for permanent measurement systems not using a seat pad) incorporate the part A component of the PVEM into a seat structure in a way that does not adversely impact the seat suspension system or comfort of the driver but provides measurements equivalent to that required by ISO 2631-1 for health effects.

The directions of the three orthogonal axes shall be marked on the transducer.

5.1.3 Special characteristics for hand-arm vibration measurement

For instruments designed for hand-arm vibration, the PVEM shall

— measure vibration at the interface between the machine and the operator's hand (in accordance with ISO 5349-1). The directions of the three orthogonal axes shall be marked on the transducer.

— define the range of application of the PVEM based on the maximum peak vibration capability of the instrument. In any case, as a minimum, the transducer shall be capable of responding to peak accelerations up to 2 000 m/s^2.

  NOTE Higher peak acceleration capability is needed for measurements on impactive machines (e.g. up to 30 000 m/s^2).

— allow all part A components (see Figure 1) to be fitted unobtrusively to either the machine operator or the vibrating machine (see ISO 5349-2).

The part A component of the instrument shall conform to the requirements of ISO 5349-1 and take account of the guidance given in ISO 5349-2. The part A component of the instrument may be incorporated into or fitted to a machine or power tool. If the part A component is incorporated into the device an operator identification system can be necessary.

If the PVEM is designed to provide evaluation of coupling forces, it shall conform to the applicable requirements of ISO 15230-1.

5.2 Display

Displaying of the vibration magnitude and other results measured by the PVEM should be provided by part B of the instrument at least for testing purpose (see Figure 1).

