Technical Specification

ISO/TS 22270

Mechanical vibration — Practical guidance and requirements for the monitoring and measurement of hand-transmitted vibration on the hand, wrist or forearm

Vibrations mécaniques — Directives pratiques et exigences pour la surveillance et le mesurage des vibrations transmises à la main vibration sur la main, le poignet ou l'avant-bras

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Foreword

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This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock*.

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

The objective of this document is to provide practical guidance and requirements for the monitoring and measurement of hand-transmitted vibration on the hand, wrist, or forearm.

Wearables, MEMS (micro-electro-mechanical systems) transducers, and other technologies are widely available and routinely used for monitoring hand-arm vibration (HAV) exposure in the workplace. These systems and devices are robust, can be inexpensive and substantially smaller than traditional measurement systems on which standards such as ISO 5349-1 [1] and ISO 5349-2 [2] are based.

These evolving technologies provide opportunities for practical in situ monitoring and measurements conducted over long periods of time, which can include the use of multiple machines and work processes. These new types of measurements can be at locations on the hand, wrist or forearm; away from the vibrating surface interface where vibration enters the hand.

Formally, measurements away from the hand-machine interface do not comply with ISO 5349-1 [1]. For this reason, measurements away from the hand-machine interface should not replace ISO 5349-1 [1] measurement when, for example, fulfilling duties under national regulations for either workplace vibration exposures or machinery vibration emissions. Full conformity with ISO 5349-1 [1] is not always required, for example if the purpose is to reduce vibration exposures or for research applications [3]. However, devices using measurement on the body are available and are being used to monitor vibration exposures and augment traditional measurements. If users account for the limitations of the devices, including the additional measurement uncertainties, they can provide data which supplements that given by the ISO 5349-1 [1] methodology, leading to a better understanding of the risks for those exposed to hand arm vibration. The objective of this document is to highlight the potential benefits and limitations of measurement on the hand, wrist or arm and to provide guidance on how to reduce the impact of the limitations on vibration evaluations.

Body-mounted measurement can allow a simpler, lower-cost monitoring of an individual's vibration exposure over long periods, such as a full working day, shift, or even a year or more. This type of long-term monitoring can provide valuable information on vibration exposure patterns and indicators to vibration risks. These data can then inform risk control management procedures and thereby reduce the vibration exposure of individuals.

One objective of body-mounted measurement systems is to reduce or remove the need for specialist technicians to be present during measurement, by allowing simple fitting and removal by operators with basic training and automatic data download. By comparison, traditional measurement, that conforms to ISO 5349-1 [1], should be performed by specialists who should have a detailed understanding of the measurement system and awareness of the possible sources of error.

This document provides guidance to those developing on-body measurement systems and for those using these systems. It discusses the factors that need to be considered, such as: instrumentation characteristics, measurement locations on the hand, wrist, or forearm, and the vibration transfer characteristics from the vibrating surface to the body-mounted sensor.

This document is aimed at manufacturers of systems that measure or monitor vibration on the hand, wrist or arm. This document is also aimed at those performing measurements or monitoring of vibration on the hand, wrist, or arm, including those involved in research.

Mechanical vibration — Practical guidance and requirements for the monitoring and measurement of hand-transmitted vibration on the hand, wrist or forearm

1 Scope

This document provides guidance and requirements on the evaluation of daily exposures to hand-arm vibration in the workplace where measurement or monitoring systems are fitted to the hand, wrist, or arm.

This document provides guidance and to equipment manufacturers on how to provide suitable information to users on the scope and limitations of their equipment. It also provides guidance to users on the practical use and validation of these systems for monitoring or measurement in the workplace.

This document provides information on measurement methods that complement the methods required for ISO 5349-1 [1].

NOTE The methods described in this document are not meant to replace measurements carried out in accordance with ISO 5349-1 [1] when, for example, fulfilling duties under national regulations for either workplace vibration exposures or machinery vibration emissions.

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5349-1, as well as the following apply.

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

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

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

3.1
hand-arm vibration measurement
measurement of vibration magnitude data that is representative of exposure and acquired in accordance with ISO 5349-1, using equipment in conformity with ISO 8041-1 or ISO 8041-2 [4]

3.2
hand-arm vibration on-body monitoring
provision of indicative values for hand-arm vibration exposures based on a combination of exposure time and measurements on the hand, wrist, or forearm, which estimate values that would be given by *hand-arm vibration measurement* (3.1)

3.3
on-body monitor
device used for on-body *monitoring* (3.4) of hand-arm vibration

3.4
monitoring
characterization of vibration exposures using measurements made on the body

3.5
transfer function
mathematical function describing the relationship between vibration magnitude at the point entering the body and the corresponding vibration measured at the on-body location, typically expressed as a ratio of output to input in the frequency domain

3.6
conversion function
mathematical function that converts measurements at an on-body location to estimates of the likely vibration magnitude at a gripping zone location

Note 1 to entry: The *conversion function* (3.6) and the W_h frequency weighting will often be combined into a single function.

3.7
vibration transfer characteristic
general term describing the observed or measured behaviour of vibration transmission from the tool interface to the on-body sensor location, including but not limited to the vibration *transfer function* (3.5)

4 On-body monitoring overview

4.1 General

Evaluation of hand-arm vibration using measurements on the body can provide valuable complementary methods for obtaining hand-arm vibration data.

Hand-arm vibration measurements in accordance with ISO 5349-1 [1] and ISO 5349-2 [2] require measurement on the vibrating surface at the interface between the vibrating surface and the hand. However, these measurements can be complex and require technical knowledge, skill and experience to achieve reliable results. For hand-arm vibration on-body monitoring it is not always necessary for on-body monitors to fulfil all the requirements of ISO 5349-1 [1], for example, if the purpose is to reduce vibration exposures or for research purposes.

Measurements of vibration transmitted to the hand can be made on the hand, wrist, or arm of machine operators. In this document, devices used for on-body measurements are referred to as “on-body monitors”.

On-body monitors estimate the vibration magnitude where the hand is in contact with the vibrating surface by applying a vibration conversion function to the vibration signal at the on-body location.

NOTE Direct measurement at an on-body location (i.e. without applying a conversion function) provides information on the vibration at the location of the sensor(s). For an individual, these measurements can be relevant for physiological or pathological processes occurring at the on-body location. However, this application of on-body measurement is not covered by this document.

It is important to recognize that there are limitations to on-body monitoring. Due to the location of the sensors, the measurements do not comply with existing measurement standards like ISO 5349-1 [1], and the instrumentation cannot fully comply with existing instrumentation standards like ISO 8041-1 [5] and ISO 8041-2 [4], and the terminology for these instruments in ISO/TR 19664 [6]. For these reasons, on-body measurement is referred to as “monitoring”.

4.2 Potential advantages

4.2.1 Compact measurement systems

Small transducers and compact signal processors allow for both the transducer set, and, in some cases, the entire measurement system to be constructed into a compact device. These devices can then be fitted on the hand, wrist, or arm of the machine operator, where they are unobtrusive and monitor vibration exposures of a wearer.

4.2.2 Safety

In some cases, on-body monitors allow the evaluation of hand-arm vibration exposures in situations where traditional measurement according to ISO 5349-1 [1] would be impractical or unsafe (for example where cables risk being caught in rotating machinery, where it is not practical to safely fix transducers to small tools or hand-fed workpieces or in hazardous working environments).

4.2.3 Long-term monitoring

Compact, on-body measurement systems often allow for long-term monitoring, which can provide useful insights into vibration exposure patterns. For example, daily and longer-term measurements of vibration levels over long periods will usually provide:

— a more complete understanding of exposure patterns,

— information on variants/outliers and how they are associated to individual machines, tasks, or operators, and

— indication of changes that are required to maintain low-vibration exposures (for example the need for replacement, maintenance, or training).

4.2.4 Information on exposure patterns

Used with care, measurement away from the gripping point can provide valuable supplementary information, which, for example, can provide information on daily hand-arm vibration exposure patterns for individual workers. Employers can use the information from exposure patterns to improve the targeting of control measures.

4.2.5 Customisable to the individual

On-body measurement systems can be assigned to individuals, with the potential to set customised daily exposure warning levels, limits, or restrictions on machine usage for that individual.

4.2.6 Large data sets

Compact, inexpensive systems that can automatically monitor information on vibration exposure on many people, over many shifts have the capability to create very large data sets. Analysis of large data sets provides an opportunity to look for patterns of exposures that would not otherwise be apparent.

4.2.7 Application to ISO 5349-1 compliant exposure assessments

Exposure time information from monitoring devices can be used in conjunction with data from ISO 5349-1 [1] measurements to give ISO 5349-1 [1] compliant evaluations of the individual's hand-arm vibration exposure.

Total daily vibration exposures can be provided either as real-time cumulative exposure or post-monitoring calculations.

Care shall be taken when comparing on-body exposure time with ISO 5349-1 methods. Due to their precision, exposure time from on-body measurement devices will often give results that are shorter than times determined by other methods and can be much shorter than self-estimates of exposure time.