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Latest Developments in International Standardization of Whole-Body and Hand-Arm Vibration

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Latest developments in international standardization of whole-body and hand-arm vibration are presented. In addition, two German projects are presented that might have impact on international work programs in the next years.

Keywords: standards, whole-body vibration, hand-arm vibration.

1. Introduction

International standards concerning whole-body vibration (WBV) and hand-arm vibration (HAV) are prepared by ISO/TC 108/SC 4 and CEN/TC 231 who are working together under the regulations of the VIENNA AGREEMENT 2001. Currently, there are 83 published standards and amendments in the program of both committees. This paper introduces some aspects of the latest developments in the work of these two committees.

In the first section, two German projects are introduced that affect WBV and HAV, and that are likely to have some impact on international work programs. The next section contains comments on projects for WBV, followed by a section dealing with HAV-projects.

As far as current projects are concerned, the information given here reflects only the momentary state of the discussion, and there is no guarantee that the final standards will actually contain the outlined concepts.

2. DIN projects affecting WBV/HAV with probable impact on ISO and CEN

Two projects of the German Institute for Standardization (DIN) are dealing with the measurement of vibrations from a more general point of view. The first one addresses the question of the uncertainty of measurement. The second is dealing with qualifications of measurement personnel.

As far as the uncertainty of vibration measurements is concerned, a DIN working group is preparing a guide (Technical Report) that summarizes the information available in standards. Starting with the GUM, ENV 13005:1999, ISO/BIPM, the principles of the evaluation of uncertainty are given in the main part of the future guide; annexes are dealing with common situations for WBV, HAV, emission measurements of (hand-held) machinery, and measurements of vibration in the environment (immissions).

Another issue that affects both WBV and HAV is the qualification of the measurement personnel. In this case, the existing standards concerning qualifications of measurement personnel in the field of machinery surveillance are taken as a basis to develop a similar scheme of qualification levels for the personnel of WBV and HAV laboratories.

3. International WBV-projects

In the field of WBV, the measurement standard ISO 2631-1:1997 is currently under revision. Two further projects investigate the measurement of posture together with WBV ISO/TR 10687:2012 and the effect of shock on WBV exposure ISO 2631-5:2004.

3.1. WBV measurement ISO 2631-1

ISO 2631-1:1997 amended in 2010, is concerned with the measurement of WBV and evaluation of the effects of WBV with regard to health, comfort and perception, and motion sickness. Minor technical revisions with regard to health have been incorporated in the amendment of 2010. For example, the defini-

tion of the daily exposure A(8) of the DIRECTIVE 2002/44/EC has been addressed, where the daily exposure A(8) is expressed as the equivalent continuous acceleration over an eight-hour period, calculated as the highest (rms) value. The A(8) cannot be expressed by the VDV.

Currently, the literature concerning health and comfort effects is being reviewed. There are arguments in the literature to simplify and revise the section on comfort. The section on health effects, on the other hand, still reflects in large parts the available knowledge and will most likely not be revised thoroughly. The structure of future revisions will depend on the amount of changes. One possibility is to rewrite ISO 2631-1 with its current structure, another is to take some parts out of ISO 2631-1 and establish them as new parts of ISO 2631.

3.2. Posture and WBV: ISO/TR 10687

The aim of ISO/TR 10687:2012 is to define variables that should be reported whenever posture has to be described within a WBV context. The document lists several body angles which are defined by points on the surface of a subject. The definition is descriptive in the main part of the Technical Report and a mathematical definition is given in an informative annex. A pictorial description of the lateral flexion of lumbar and thoracic spine is given in Fig. 1. Apart from the definition of body angles, the Technical Report requires the user to collect further information regarding musculoskeletal load: whether or not a helmet is worn, whether or not armrests are used, etc.

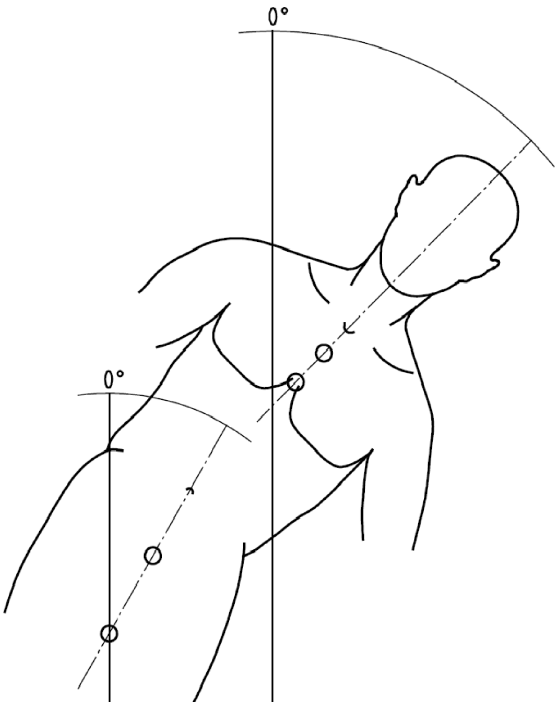

Fig. 1. Lateral flexion of lumbar and thoracic spine.

3.3. Shock ISO 2631-5

The effect of shock in the context of WBV is addressed in ISO 2631-5:2004. The idea of the existing standard is to define a dose based on peaks of a transfer function of an acceleration time series. The transfer function in z-direction is defined by a neuronal network trained at a special set of acceleration time series. In the x- and y-direction, the transfer function is produced by a single-degree-of-freedom lumped parameter model. Due to this different evaluation of the vibrational axes and some other theoretical drawbacks, this standard is currently under revision.

At the moment, two methods are in the discussion which will apply to different excitation regimes: unweighted acceleration time series with peaks above or below 9.81 ms^{-2}. Both methods retain the underlying idea of a dose based on peak values of a transfer function. The method for smaller peaks has already been published as a specification (Technical Report) in Germany: DIN SPEC 45697:2012-06.

4. International HAV-projects

The following three subsections are concerned with standardization projects in the field of HAV. The assessment of coupling forces is presented, followed by the development in emission standards and, finally, the ideas concerning a revision of the frequency weighting for neurological and vascular effects.

4.1. Standards governing coupling forces for hand-arm vibration

ISO 5349-2:2001 requires measurement to be performed directly at the point of transmission to the hand-arm system for precise determining of the vibration stress upon the hand-arm system caused by a hand-held or manually guided machine or control element. Since this is not possible for technical reasons, the vibration is measured on the handle of the machine or the control element.

Where measurement is performed on the handle of the machine, the result of the measurement and the stress upon the hand-arm system are influenced considerably by the coupling of the hand to the machine or control element. Stronger coupling results in a drop in the acceleration values measured at the handle, since more energy is transmitted to the hand-arm system. The stress also increases with rising coupling. Equally, it is necessary for measurement purposes to differentiate between various forces acting upon the hand-arm system.

To address this issue, DIN V 45679, which was published as long ago as 1998, describes not only the frequency weighting, but also a further weighting that is dependent upon the coupling force.

ISO 15230, published in 2007, purposefully addresses the parameters of interaction between the hand and the machine and sets out measurement methods and the requirements applicable to instruments. However, it does not state procedures for evaluating the data.

The German proposal for a supplement containing an evaluation method to be added to ISO 15230 has been rejected. This resulted in development of a CEN Report on the European standardization level, published in 2012 in the form of CEN/TR 16391. Besides dealing with the recommendations made in DIN 45679 concerning evaluation, the report contains guidance on the selection of machines and training of the user for the purpose of reducing the transmitted vibration and thereby the stress caused by it.

The revised version of DIN 45679 published in 2013 contains the provisions in ISO 15230 and the evaluation method to CEN/TR 16391. An English version of the standard is in preparation.

4.2. Standards for measuring hand-arm vibration emissions

Conversion of the measurement method in the ISO 5349-1 basic standard from one to three axes of measurement necessitated revision of the ISO 8662 series of standards governing the measurement of emission values.

Whereas earlier standards governing emissions were developed only with regard to high reproducibility of the measured values and for comparison of machines within a group, the new ISO 28927 series contains more realistic operating conditions for the group of machines concerned for the purpose of risk assessment.

Owing to the standardization work conducted in parallel by CEN and CENELEC, deviations in the provisions concerning the measurement locations for electrically driven machines in IEC 60745-1 required an alternative measurement location to be specified rather than the one measurement location previously defined in the CEN standards (ISO 20643). As a result of these changes, adaptation was also required of the basic standard (ISO 20643). This in turn required new measurement locations for the workplace measurements. An amendment to ISO 5349-2 gives examples of the newly specified alternative measurement locations.

4.3. Standard for a new frequency weighting for hand-arm vibration

In response to a request by France, the preliminary work item (PWI) was discussed at the meeting of WG 3 of ISO/TC 108/SC 4 in September 2008. The results of the enquiry showed that the existing frequency weighting in ISO 5349-1 enjoyed recognition and general use, both in legislative texts and in many standards. The group was therefore unanimous in ruling out a change in this weighting in the immediate future. The group agreed however to define a supplementary frequency weighting which would give better consideration to the neurological and vascular effects. In June 2011, a workshop on the subject was held in conjunction with the Conference on Hand-Arm Vibration in Canada. A draft alternative frequency weighting that had been drawn up by the Canadian head of the project was discussed at the meeting of the WG 3 held in Nancy in September 2012 and is to be completed by the next meeting in September 2013 in the form of ISO 18570. Under discussion is a new supplementary curve with a flat frequency range between the cut-off frequency of 200 Hz and 400 Hz (Brammer, Pitts, 2012).

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