TC108

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Evaluation of human exposure to whole-body vibration — Part 1 : General requirements

Estimation de l'exposition des individus à des vibrations globales du corps — Partie 1 : Spécifications générales

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2631/1 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock,* and results from the combination of ISO 2631-1978 with its Amendment 1-1982, changes in content being editorial. The addenda to ISO 2631-1978 which had been published or were in preparation will become subsequent numbered parts of ISO 2631.

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Evaluation of human exposure to whole-body vibration — Part 1 : General requirements

0 Introduction

Vehicles (air, land and water), as well as machinery (for example, in industry and agriculture), expose man to mechanical vibration which can interfere with comfort, working efficiency and, in some circumstances, health and safety. Various methods of rating the severity of exposure and defining limits of exposure based on laboratory or field data have been developed in the past for specific applications. None of these methods can be considered applicable in all situations and consequently none has been universally accepted.

In view of the complex factors determining the human response to vibrations, and in view of the shortage of consistent quantitative data concerning man's perception of vibration and his reactions to it, this International Standard has been prepared first, to facilitate the evaluation and comparison of data gained from continuing research in this field; and, second, to give provisional guidance as to acceptable human exposure to whole body vibration. The limits proposed in this International Standard seem to be a fair compromise between the available data and should satisfy the need for recommendations which are simple and suitable for general application. These limits are defined explicitly in numerical terms to avoid ambiguity and to encourage precise measurement in practice. However, when using these criteria and limits it is important to bear in mind the restrictions placed upon their application.

Because of the wide variety of possible conditions and effects of human exposure to vibrations, and because of the existing shortage of firm data, more detailed guidance is hardly warranted at the present time. Nevertheless, it is hoped that this International Standard not only proves useful in the assessment of existing or predicted vibration environments but also stimulates the reporting and critical evaluation of new findings about the effects of vibration on man.

There are basically three kinds of human exposure to vibration, namely :

a) Vibrations transmitted simultaneously to the whole body surface or substantial parts of it. This occurs when the body is immersed in a vibrating medium. There are circumstances in which this is of practical concern; for example, when high intensity sound in air or water excites vibrations of the body.

b) Vibrations transmitted to the body as a whole through the supporting surface, namely, the feet of a standing man, the buttocks of a seated man or the supporting area of a reclining man. This kind of vibration is usual in vehicles, in vibrating buildings and in the vicinity of working machinery.

c) Vibrations applied to particular parts of the body such as the head or limbs; for example, by vibrating handles, pedals or head-rests, or by the wide variety of powered tools and appliances held in the hand.

It is also possible to recognize the condition in which an indirect vibration nuisance is caused by the vibration of external objects in the visual field (for example, an instrument panel).

This International Standard, however, applies chiefly to the common condition (b) above; and, in particular, where the vibration is applied through the principal supporting surface to the body of a standing or seated man. In the case of vibrations applied directly to a reclining or recumbent man, insufficient data are available to make a firm recommendation; this is particularly true of vibration transmitted directly to the head, when tolerability is generally reduced. Tolerance may also be reduced when conditions (b) and (c) exist together. Provisionally, however, the limits for the standing or seated man may also be used for the reclining or recumbent man. It shall be appreciated that some circumstances will arise in which the rigorous application of these limits would be inappropriate.

This International Standard comprises the following parts :

Part 1 : General requirements.

Part 2 : Evaluation of human exposure to vibration and shock in buildings (1 to 80 Hz).[1)]

Part 3 : Evaluation of exposure to whole-body z-axis vertical vibration in the frequency range 0,1 to 0,63 Hz.

Part 4 : Evaluation of crew exposure to vibration on board sea-going ships (1 to 80 Hz).[1)]

1) At present at the stage of draft.

1 Scope and field of application

This part of ISO 2631 defines and gives numerical values for limits of exposure for vibrations transmitted from solid surfaces to the human body in the frequency range 1 to 80 Hz. It may be applied, within the specified frequency range, to periodic vibrations and to random or non-periodic vibrations with a distributed frequency spectrum. Provisionally, it may also be applied to continuous shock-type excitation in so far as the energy in question is contained within the 1 to 80 Hz band.

These limits (defined in detail in clause 4) are given for use according to the three generally recognizable criteria of preserving comfort, working efficiency, and safety or health. The limits set according to these criteria are named respectively in this part of ISO 2631 the "reduced comfort boundary", "fatigue-decreased proficiency boundary" and the "exposure limit". For example, where the primary concern is to maintain the working efficiency of a vehicle driver or a machine operator working in vibration, the "fatigue-decreased proficiency boundary" would be used as the guiding limit in laying down vibration specifications or in carrying out vibration control measures, while, in the design of passenger accommodations, the "reduced comfort boundary" should be considered.

According to the criteria mentioned, these limits are specified in terms of vibration frequency, acceleration magnitude, exposure time and the direction of vibration relative to the torso. This direction is defined according to the recognized anatomical axes of the human body (see clause 3).

This part of ISO 2631 is applicable only to situations involving people in normal health : that is, persons who are considered fit to carry out normal living routines, including travel, and to undergo the stress of a typical working day or shift.

No information given in this part of ISO 2631 shall be extrapolated to frequencies outside the range 1 to 80 Hz (see notes below).

It has been well established that differences in response to vibration occur both between and within individuals. These differences affect the level and shape of the curves and the relative effects of simple and complex motions. The guidance given in this part of ISO 2631 is based on the average response of subjects in a variety of situations. Thus two motions, which are assessed as equally severe by the recommended evaluation procedure may have different effects. Individuals, and groups of individuals, will sometimes disagree on which of two motions is worse and variables such as posture and subject activities can have large effects.

NOTES

1 The limits specified in this part of ISO 2631 are based upon data available from both practical experience and laboratory experimentation in the field of human response to mechanical vibration. To date, useful observations have been made mainly in the frequency range between about 1 and 100 Hz. The frequency range, its subdivisions and the corner frequencies defined in this part of ISO 2631 have been selected in accordance with ISO 266 and with national standards in several countries.

2 Vibrations in the frequency range below about 1 Hz are a special problem, associated with symptoms such as kinetosis (motion sickness) which are of a character different from the effects of higher frequency vibrations. The appearance of such symptoms depends on complicated individual factors not simply related to the intensity, frequency or duration of the provocative motion. Mechanical vibrations applied to the feet or buttocks above the frequency range considered in this part of ISO 2631 increasingly produce sensations and effects which are highly dependent upon local factors such as the precise direction, site and area of application of the vibration to the body and the presence of damping materials (for example, clothing or footwear) which may control the vibratory response of the skin and superficial layers of the body. For these reasons, therefore, it is not possible on the basis of present data to formulate generally valid recommendations for frequencies outside the 1 to 80 Hz band.

In some applications, constant sensitivity to accelerations has been tentatively assumed for the frequency range 0,63 to 1 Hz.

2 References

ISO 266, *Acoustics — Preferred frequencies for measurements.*

IEC Publication 184, *Methods for specifying the characteristics of electro-mechanical transducers for shock and vibration measurements.*

IEC Publication 222, *Methods for specifying the characteristics of auxiliary equipment for shock and vibration measurement.*

IEC Publication 225, *Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations.*

3 Characterization of vibration exposure

3.1 Direction of vibration

3.1.1 Rectilinear vibrations transmitted to man should be measured in the appropriate directions of an orthogonal coordinate system having its origin at the location of the heart (see figure 1).

NOTE — The terminology commonly used in biodynamics relates the coordinate system to the human skeleton in a normal anatomical position. Accelerations (motion) in the foot-(or buttocks-)to-head (or longitudinal) axis are designated $\pm a_z$; accelerations in the fore-and-aft (anteroposterior or chest-to-back) axis, $\pm a_x$; and in the lateral (right-to-left side) axis, $\pm a_y$. These axes are illustrated in figure 1.

3.1.2 Angular (or rotational) vibrations about a centre of rotation are frequently an important part of a vibration environment. For example, in tractors going over rough terrain, or in aircraft flying through turbulence, the pitching or rolling motions of the seat may be more disturbing than the rectilinear vibration up and down. However, little information on the effects of angular (or rotational) vibration is yet available. In practice, the centre of vibratory rotation can often be assumed to lie far enough from the point of application of vibration to the body for the resulting motion to be represented by translatory vibrations alone. Nevertheless, whenever practicable, rotational vibrations in roll, pitch and yaw (as related to the anatomical axes) should be measured and reported, in order to increase our knowledge of the human response to such excitation.

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