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**Hand-transmitted vibration —
Part 3 : General requirements for
measurement and evaluation**

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from The Japan Society of Mechanical Engineers (JSME) /Japanese Standards Association (JSA), with a draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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JIS B 7761 consists of the following 3 parts under the general title "*Hand-transmitted vibration*" ;

Part 1: Measuring instrumentation

Part 2: Practical guidance for measurement at the workplace

Part 3: General requirements for measurement and evaluation.

Hand-transmitted vibration — Part 3 : General requirements for measurement and evaluation

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of ISO 5349-1 published in 2001 without modifying the technical contents.

The portions given dotted underlines are the matters not stated in the original International Standard.

1 Scope

This part of JIS B 7761 specifies general requirements for measuring and reporting hand-transmitted vibration exposure in three orthogonal axes. It defines a frequency weighting and band-limiting filters to allow uniform comparison of measurements. The values obtained can be used to predict adverse effects of hand-transmitted vibration over the frequency range covered by the octave bands from 8 Hz to 1 000 Hz.

This part of JIS B 7761 is applicable to periodic and to random or non-periodic vibration. Provisionally, this part of JIS B 7761 is also applicable to repeated shock type excitation (impact).

This part of JIS B 7761 provides guidance for the evaluation of hand-transmitted vibration exposure, specified in terms of a frequency-weighted vibration acceleration and daily exposure time. It does not define limits of safe vibration exposure.

NOTE 1 The time dependency for human response to repeated shocks is not fully known. Application of this part of JIS B 7761 for such vibration is to be made with caution.

NOTE 2 Annex C is concerned with the approximate relative importance of various characteristics of the vibration exposure which are believed to produce health effects.

NOTE 3 The International Standard corresponding to this part of JIS B 7761 is as follows.

ISO 5349-1 : 2001 *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 1 : General requirements* (IDT)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and JIS are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of **JIS B 7761**. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0153 *Glossary of terms used in mechanical vibration and shock*

NOTE : Corresponding International Standard : **ISO 2041** *Vibration and shock — Vocabulary* (MOD)

JIS B 7761-1 *Hand-transmitted vibration — Part 1 : Measuring instrumentation*

NOTE : Corresponding International Standard : **ISO 8041** *Human response to vibration — Measuring instrumentation* (MOD)

JIS B 7761-2 *Hand-transmitted vibration — Part 2 : Practical guidance for measurement at the workplace*

NOTE : Corresponding International Standard : **ISO 5349-2** *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 2 : Practical guidance for measurement at the workplace* (IDT)

JIS C 1514 *Electroacoustics — Octave-band and fractional-octave-band filters*

NOTE : Corresponding International Standard : **IEC 61260** *Electroacoustics — Octave-band and fractional-octave-band filters* (IDT)

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this part of **JIS B 7761**, the terms and definitions given in **JIS B 0153** apply.

NOTE : For the convenience of users of this part of **JIS B 7761**, a glossary of terms relating to medical conditions is given in Annex B.

3.2 Symbols

In this part of **JIS B 7761**, the following symbols are used.

$a_{hw}(t)$: instantaneous single-axis acceleration value of the frequency-weighted hand-transmitted vibration at time t , in metres per second squared (m/s^2) ;

a_{hw} : root-mean-square (r.m.s.) single-axis acceleration value of the frequency-weighted hand-transmitted vibration, in metres per second squared (m/s^2) ;

a_{hwx} , a_{hwy} , a_{hwz} : values of a_{hw} , in metres per second squared (m/s^2), for the axes denoted x , y and z respectively ;

a_{hv} : vibration total value of frequency-weighted r.m.s. acceleration (some-

times known as the vector sum or the frequency-weighted acceleration sum); it is the root-sum-of-squares of the a_{hw} values for the three measured axes of vibration, in metres per second squared (m/s^2) ;

$a_{hv (eq,8h)}$: daily vibration exposure (8-h energy-equivalent vibration total value), in metres per second squared (m/s^2) ;

$A (8)$: a convenient alternative term for the daily vibration exposure $a_{hv (eq,8h)}$;

D_y : group mean total (lifetime) exposure duration, in years ;

T : total daily duration of exposure to the vibration a_{hv} ;

T_0 : reference duration of 8 h (28 800 s) ;

W_h : frequency-weighting characteristic for hand-transmitted vibration.

4 Characterization of hand-transmitted vibration

4.1 General considerations

The method specified in this part of **JIS B 7761** takes account of the following factors which are known to influence the effects of human exposure to hand-transmitted vibration in working conditions :

- a) the frequency spectrum of vibration ;
- b) the magnitude of vibration ;
- c) the duration of exposure per working day ;
- d) the cumulative exposure to date.

Other factors which may influence the effects of vibration exposure, but for which standardized methods for reporting do not yet exist, are listed in Annex D.

4.2 Measuring equipment for hand-transmitted vibration

4.2.1 General

Measurement of hand-transmitted vibration shall be undertaken using instrumentation conforming to the requirements of **JIS B 7761-1**. This equipment shall be checked for correct operation before and after use. The calibration shall be traceable to a recognized standard maintained by an accredited laboratory.

4.2.2 Vibration transducers

The vibration transducer may be an accelerometer which may be designed to make general vibration measurements (for non-percussive tools) or may be specifically designed for large peak accelerations such as those produced by percussive tools.

The vibration transducers shall be able to withstand the range of vibration magnitudes and shall have stable characteristics. The dimensions of the transducers shall be such that they do not interfere with the operation of the machine and such that the location of the point of measurement can be identified.

JIS B 7761-2 contains further guidance on the selection of transducers.

4.2.3 Location and orientation of transducers

The vibration transmitted to the hand shall be measured and reported for three directions of an orthogonal coordinate system such as defined in figure 1.

For practical vibration measurements, the orientation of the coordinate system may be defined with reference to an appropriate basicentric coordinate system (see figure 1) originating, for example, in a vibrating appliance, workpiece, handle or control device gripped by the hand (see **JIS B 7761-2** for further information).

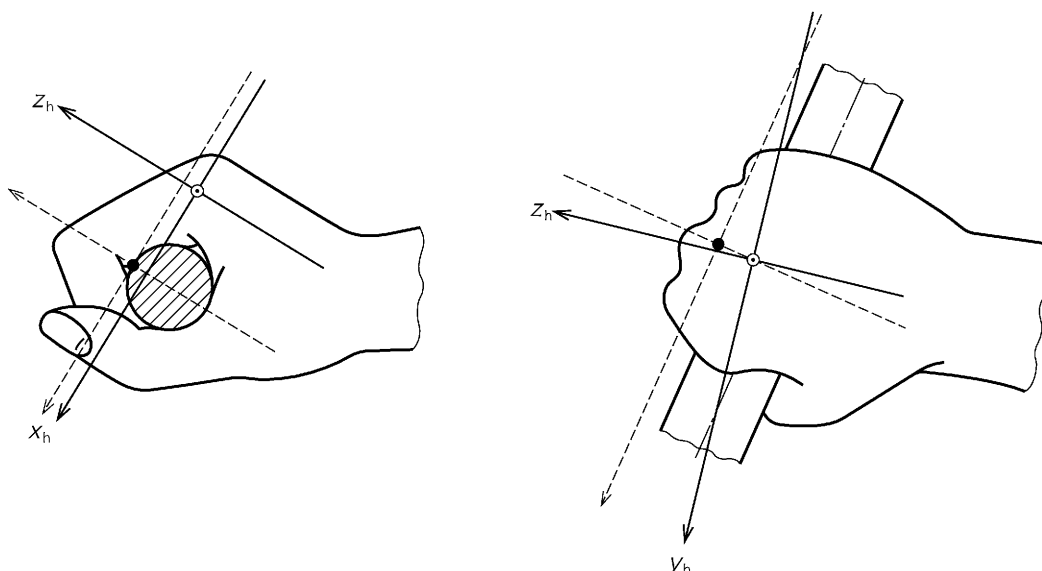
The vibration in the three directions should preferably be measured simultaneously. Measurements made sequentially along each of the three axes are acceptable, provided the operating conditions are similar for all three measurements. The measurements shall be made on the vibrating surface as close as possible to the centre of the gripping zone of the machine, tool or workpiece. The location of the transducers shall be reported.

NOTE : The vibration magnitude can vary considerably with position on the vibrating surface.

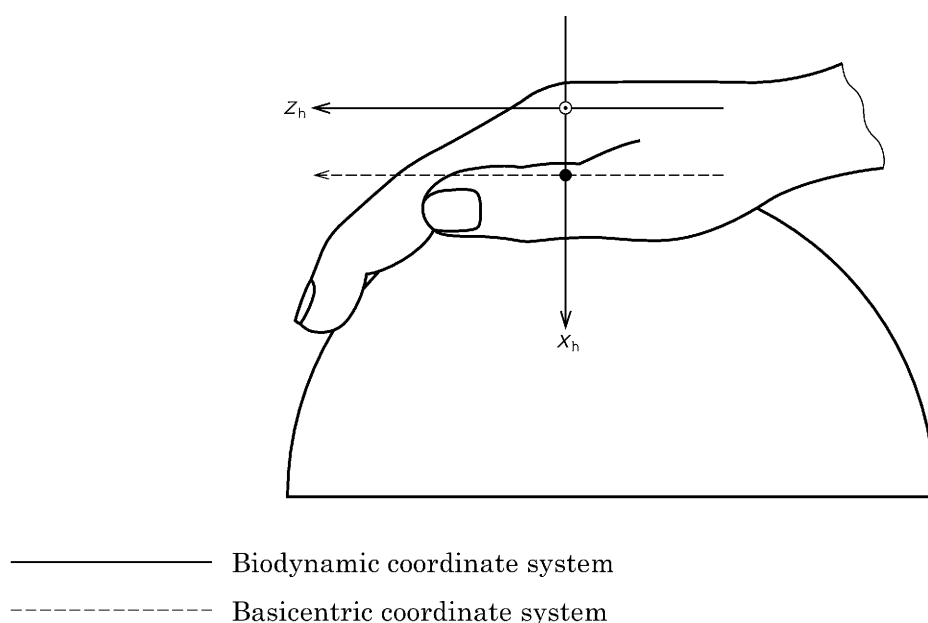
Further guidance on transducer positioning is given in **JIS B 7761-2**.

4.2.4 Mounting of transducers

The transducers should be mounted rigidly. Further information on accelerometer mounting is given in **JIS B 7761-2** and **ISO 5348** (see Bibliography). Practical guidance on mounting transducers in difficult situations (such as on resilient surfaces or where the vibration is impulsive), and on the use of hand-held adaptors, is also given in **JIS B 7761-2**.



a) "Handgrip" position (In this position, the hand adopts a standardized grip on a cylindrical bar)



b) "Flat palm" position (In this position, the hand presses down onto a sphere)

NOTE : The origin of the biodynamic coordinate system is the head of the third metacarpal (distal extremity). The z_h -axis (i.e. hand axis) is defined as the longitudinal axis of the third metacarpal bone and is oriented positively towards the distal end of the finger. The x_h -axis passes through the origin, is perpendicular to the z_h -axis, and is positive in the forwards direction when the hand is in the normal anatomical position (palm facing forwards). The y_h -axis is perpendicular to the other two axes and is positive in the direction towards the fifth finger (thumb). In practice, the basicentric coordinate system is used: the system is generally rotated in the $y - z$ plane so that the y_h -axis is parallel to the handle axis.

Figure 1 Coordinate systems for the hand

4.3 Coupling of the hand to the vibration source

Although characterization of the vibration exposure currently uses the acceleration of the surface in contact with the hand as the primary quantity, it is reasonable to assume that the biological effects depend to a large extent on the coupling of the hand to the vibration source. It should also be noted that the coupling can affect considerably the vibration magnitudes measured.

The vibration measurements shall be made with forces which are representative of the coupling of the hand to the vibrating power tool, handle or workpiece in typical operation of the tool or process.

Forces between the hand and gripping zone should be measured and reported.¹⁾ It is also recommended that a description of the operator's posture be reported for individual conditions and/or operating procedures (see Annexes D and F).

Note ¹⁾ An International Standard on the measurement of gripping and pushing

forces is in course of preparation.

4.4 Quantity to be measured

The primary quantity used to describe the magnitude of the vibration shall be the root-mean-square (r.m.s.) frequency-weighted acceleration expressed in metres per second squared (m/s²).

The measurement of frequency-weighted acceleration requires the application of a frequency weighting and band-limiting filters. The frequency weighting W_h reflects the assumed importance of different frequencies in causing injury to the hand. The characteristics of the W_h frequency weighting and methods for band-limiting are given in Annex A.

The r.m.s. value shall be measured using a linear integration method. The integration time shall be chosen such that a representative sample of the vibration signal is used (see JIS B 7761-2).

For additional purposes (research, prevention, technical reduction of vibration) it is strongly recommended that frequency spectra be obtained (see Annex F for further information).

4.5 Multi-axis vibration

It is known that on most power tools the vibration entering the hand contains contributions from all three measurement directions. It is assumed that vibration in each of the three directions is equally detrimental. Measurements should therefore be made for all three directions. The frequency-weighted r.m.s. acceleration values for the x -, y - and z -axes, a_{hwx} , a_{hwy} and a_{hwz} , shall be reported separately (see Annex F).

The evaluation of vibration exposure (see clause 5), however, is based on a quantity that combines all three axes. This is the vibration total value, a_{hv} , and is defined as the root-sum-of-squares of the three component values:

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2} \dots\dots\dots(1)$$

In some cases it may not be possible to make vibration measurements in three axes. If measurements are made only in one or two axes, the axis of greatest vibration shall be included (where this can be identified). The vibration total value shall be estimated using the measured values available and a carefully considered multiplying factor. The vibration magnitude in the axis of greatest vibration requires a multiplying factor in the range 1.0 to 1.7 to give the vibration total value (for further advice, see JIS B 7761-2). Where a multiplying factor is used to estimate the vibration total value, the multiplying factor and a justification for the choice of value shall be reported, together with the component value (s) measured.

5 Characterization of hand-transmitted vibration exposure

5.1 General

Vibration exposure is dependent on the magnitude of the vibration and on the duration of the exposure. In order to apply the guidance on health effects given in Annex C, the vibration magnitude is represented by the vibration total value a_{hv} .

5.2 Daily exposure duration

Daily exposure duration is the total time for which the hand(s) is (are) exposed to vibration during the working day. The vibration exposure time may be shorter than the time for which the person is working with the power tools or workpieces. It is important to base estimates of total daily exposure duration on appropriate representative samples for the various operating conditions and durations and their intermittency (see JIS B 7761-2 for further guidance).

5.3 Daily vibration exposure

Daily vibration exposure is derived from the magnitude of the vibration (vibration total value) and the daily exposure duration.

In order to facilitate comparisons between daily exposures of different durations, the daily vibration exposure shall be expressed in terms of the 8-h energy-equivalent frequency-weighted vibration total value, $a_{\text{hv (eq,8h)}}$, as shown in equation (2). For convenience, $a_{\text{hv (eq,8h)}}$ is denoted $A(8)$:

$$A(8) = a_{\text{hv}} \sqrt{\frac{T}{T_0}} \dots\dots\dots (2)$$

where, T : the total daily duration of exposure to the vibration a_{hv} ;
 T_0 : the reference duration of 8 h (28 800 s).

If the work is such that the total daily vibration exposure consists of several operations with different vibration magnitudes, then the daily vibration exposure, $A(8)$, shall be obtained using equation (3) :

$$A(8) = \sqrt{\frac{1}{T_0} \sum_{i=1}^n a_{\text{hvi}}^2 T_i} \dots\dots\dots (3)$$

where, a_{hvi} : the vibration total value for the i th operation ;
 n : the number of individual vibration exposures ;
 T_i : the duration of the i th operation.

The individual contributions to $A(8)$ shall be reported separately.

Example : If the vibration total values for exposure times of 1 h, 3 h and 0.5 h (within the same working day) are 2 m/s², 3.5 m/s² and 10 m/s² respectively, then :

$$A(8) = \sqrt{\frac{1}{8\text{h}} \left[(2\text{ m/s}^2)^2 \times 1\text{h} + (3.5\text{ m/s}^2)^2 \times 3\text{h} + (10\text{ m/s}^2)^2 \times 0.5\text{h} \right]} = 3.4\text{ m/s}^2$$

NOTE : The result of the calculation in the above example is quoted to two significant figures. This does not imply an equivalent accuracy of measurement but arises from the computation. In normal measuring situations it would require great care to obtain an accuracy better than