INTERNATIONAL STANDARD

ISO 5008

Second edition
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Agricultural wheeled tractors and field machinery — Measurement of whole-body vibration of the operator

Tracteurs et matériels agricoles à roues — Mesurage des vibrations globales du corps du conducteur

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5008 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 2, *Common tests*.

This second edition cancels and replaces the first edition (ISO 5008:1979), which has been technically revised.

Annexes A and B of this International Standard are for information only.

Introduction

The purpose of this International Standard is to define the specification of instruments, measurement procedures, measurement site characteristics and frequency weighting that will allow the whole body vibration of agricultural wheeled tractors and field machinery to be made and reported with acceptable precision.

The vibration is evaluated in accordance with currently accepted standards including means of weighting the vibration levels at different frequencies to take account of the frequency sensitivity of the human operator to whole body vibration.

Agricultural wheeled tractors and field machinery — Measurement of whole-body vibration of the operator

1 Scope

1.1 This International Standard specifies methods for measuring and reporting the whole body vibration to which the operator of an agricultural wheeled tractor or other field machine is exposed when operating on a standard test track.

1.2 The operating conditions of the machine and the ordinates of the artificial test tracks are also included.

1.3. This International Standard applies when measurements are made on the artificial test tracks defined herein.

1.4. Measurements made under field conditions are covered in annex A.

1.5. This International Standard does not include assessment of vibration reaching the operator other than through his/her seat or foot platform (e.g., vibration that is sensed by the feet through the controls or by the hands through the steering wheel is not considered).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2041:1990, *Vibration and shock — Vocabulary*

ISO 2631-1:1997, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*

ISO 5007:[1)], *Agricultural wheeled tractors — Operator's seat — Laboratory measurement of transmitted vibration*

ISO 5348:1998, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

ISO 8041:1990, *Human response to vibration — Measuring instrumentation*

ISO 10326-1:1992, *Mechanical vibration — Laboratory method for evaluating vehicle seat vibration — Part 1: Basic requirements*

ISO 13090-1:1998, *Mechanical vibration and shock — Guidance on safety aspects of tests and experiments with people — Part 1: Exposure to whole-body mechanical vibration and repeated shock*

1) To be published. (Revision of ISO 5007:1990)

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 2041 and the following apply.

3.1
whole-body vibration
vibration transmitted to the body as a whole through the buttocks of a seated operator

3.2
operator seat
that portion of the machine provided for the purpose of supporting the buttocks and back of the seated operator, including any suspension system and other mechanisms provided (e.g., for adjusting the seat position)

3.3
frequency analysis
process of arriving at a quantitative description of vibration amplitude as a function of frequency

3.4
measuring period
time duration in which vibration data for analysis is obtained

4 Symbols

$a_{wi}(t)$	frequency weighted acceleration in the direction i (i = x, y or z)
a_{wx}	rms value of the frequency weighted acceleration in the x direction
a_{wy}	rms value of the frequency weighted acceleration in the y direction
a_{wz}	rms value of the frequency weighted acceleration in the z direction
B_e	resolution bandwidth of the frequency analysis, in hertz
D	distance from start, in metres (see clause 11)
L	ordinate of left-hand strip, in millimetres (see clause 11)
rms	root-mean-square
R	ordinate of right-hand strip, in millimetres (see clause 11)
T_s	sampling time, in seconds

5 Vibration measurements

5.1 Location of the measurements

The vibration shall be measured along three mutually perpendicular axes, defined as follows:

x-direction: back to chest

y-direction: right side to left side

z-direction: foot (or buttocks) to head

The vibration shall be determined as close as possible to the point or area through which the vibration is transmitted to the body.

a) In the case where the operator is normally sitting, transducers mounted in a semirigid disc shall be placed on the surface of the seat such that the transducers are located midway between the ischial tuberosities of the seated person. It is acceptable if the centre of the disc is located slightly in front (up to 5 cm) of the ischial turberosities or the vertical projection of the Seat Index Point (SIP).

b) In the case where the operator is normally standing, the transducers shall be located on the platform midway between the arches of the feet.

5.2 Magnitude of vibration

The quantity used to describe the magnitude of vibration shall be the frequency-weighted acceleration in meters per second squared (m/s^2), expressed as a root-mean-square (rms) value.

The frequency weightings to be used are defined in 6.3.

The rms value a_{wi} used in this International Standard is defined as the rms value of the frequency weighted acceleration signal $a_{wi}(t)$ [i = x,y or z]:

$$a_{wi} = \left[\frac{1}{T} \int_0^T a_{wi}^2(t)\,\mathrm{d}t \right]^{1/2}$$

For tests on a standard track, the integration time shall be the time required to traverse the track.

6 Instrumentation

6.1 General

Measuring equipment may comprise:

a) transducers (usually accelerometers);

b) conditioning amplifiers and filters;

c) telemetry set;

d) recorders (digital or analog);

e) meters.

The dynamic range, sensitivity, accuracy, linearity and overload capacity of the vibration measuring system shall be in accordance with ISO 8041:1990 for type 1 instruments.

6.2 Transducers

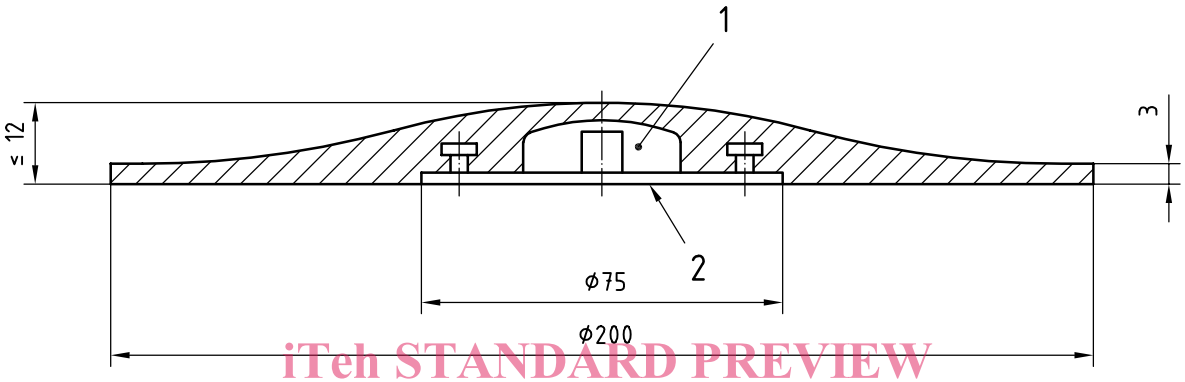
Accelerometers shall normally be used for measurement of vibration. The mounting of accelerometers shall be in accordance with ISO 5348 and the transducer manufacturer's instructions. Transducers oriented in different directions at a single measurement location shall be as close together as possible. Care should be taken to ensure, as far as is practical, that neither the mass of the measuring device and its fixture, nor any local resonances, significantly affect the measured value.

The transducers used for the measurement in the seat shall be mounted in a semirigid disc (see Figure 1). The disc shall be 12 mm or less in thickness and be made of approximately 80-90 Shore-A molded rubber or plastic material.

NOTE For practical reasons it is usually not possible to perfectly align the accelerometers in the disc with the directions of the basicentric coordinate system. In a tolerance range to within ± 15° of the appropriate directions, the accelerometers may be considered as aligned parallel to these directions.

The transducers used for the measurement at the feet of a standing operator shall be rigidly fixed (e.g. by screwing or glueing) on to the working platform. If the working platform is covered by a resilient material, the transducers may be mounted in the middle of a rigid metal plate (about 30 cm × 40 cm) with the operator standing on the plate.

Dimensions in millimetres



Key

1 Cavity appropriate for accelerometers

2 Thin metal disc for accelerometer mount and added centre rigidity

Figure 1 — Design for semirigid disc for seat accelerometers
(see ISO 10326-1)

6.3 Frequency weighting

The frequency weightings to be used shall correspond to frequency weightings W_d (for the x and y directions) and W_k (for the z direction) in accordance with ISO 2631-1:1997 for whole body vibration.

6.4 Calibration

The whole measurement chain shall be checked both before and after a sequence of measurements by using a calibration source that produces a known acceleration at a known frequency.

NOTE It is also important to regularly check that the whole chain is also calibrated at other frequencies throughout the frequency range of interest.

In addition to regular preventive calibration (e.g. every two years), calibration is also necessary after rough handling of any important part of the measurement chain. The results of the calibration check shall be recorded.

7 Safety recommendations

Safety precautions shall be in accordance with ISO 13090-1.

8 Operator

If the tractor fits one of the 3 tractor classes that are defined in ISO 5007 and is equipped with a seat for which the SEAT factor has been established for that class, the test can be made with one operator weighing 75 kg ± 5 kg.

If the tractor does not fit one of the 3 tractor classes that are defined in ISO 5007 and/or the SEAT factor for the seat has not been established, the test shall be made with both a light and a heavy operator. The light person shall have a total mass of 52 kg to 55 kg, of which not more than 5 kg may be carried in a belt around the waist. The heavy person shall have a total mass of 98 kg to 103 kg, of which not more than 8 kg may be carried in a belt around the waist.

9 Operator seat

9.1 General

The operator seat for the test shall be representative of series-produced models, with regard to construction, static and vibration characteristics and other features that may affect the vibration test result.

Any compliant end-stops or devices normally fitted to production versions of the seat to be tested to minimize the effect of suspension over-travel shall be in place for the tests.

9.2 Run-in

Before the test, the suspension seats shall be run-in for a minimum of 1 h of operation under typical working conditions.

9.3 Seat adjustment

The seat shall be adjusted to the weight of the test person in accordance with the manufacturer's instructions.

For seats with adjustable damping, the damper shall be set according to the manufacturer’s instructions.

For seats with fore-aft and/or lateral isolation, such isolation shall be working.

The other seat adjustments shall be made to suit the operator.

10 Condition of tractor

The tractor may be with or without a safety frame or cab, however, a ROPS structure and the use of a seat belt are highly recommended. For normal measurements, the tractor shall be in working order with full fuel tank and radiator, but without optional front and rear weights, tyre ballast, mounted implements and equipment and any specialized components. The tyres used in the test shall be the standard size for the tractor, as specified by the manufacturer. The depth of the tread shall be not less than 65 % of the depth of a new tread. The tyre walls shall not be damaged and the tyre pressures shall be the arithmetic mean of the ranges recommended by the manufacturer. The tyres shall be warmed up by traversing the test course at least × 2 immediately prior to the start of the test runs. Tyre pressures shall be measured before and after a set of test runs and shall be within ± 5 % of each other. The track width adjustment shall be that which is usual for normal field work with the tractor on which the seat is fitted.

When measurements are made under conditions different from those specified above, all differences shall be reported.