SLOVENSKI STANDARD
SIST ISO 5008:1995

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Kmetijski kolesni traktorji in poljski stroji - Merjenje vibracij celotnega telesa voznika

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

Tracteurs et matériels agricoles à roues -- Mesurage des vibrations transmises globalement au conducteur

Ta slovenski standard je istoveten z: **ISO 5008:1979**

ICS:

13.160	Vpliv vibracij in udarcev na ljudi	Vibration and shock with respect to human beings
65.060.01	Kmetijski stroji in oprema na splošno	Agricultural machines and equipment in general

SIST ISO 5008:1995 **en**

International Standard 5008

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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 transmises globalement au conducteur

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

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.

International Standard ISO 5008 was developed by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, and was circulated to the member bodies in November 1976.

It has been approved by the member bodies of the following countries :

Australia	Hungary	Romania
Austria	India	South Africa, Rep. of
Brazil	Iran	Spain
Bulgaria	Italy	Sweden
Canada	Korea, Dem. P. Rep. of	Switzerland
Chile	Korea, Rep. of	Turkey
Czechoslovakia	Mexico	United Kingdom
Denmark	New Zealand	Yugoslavia
Finland	Poland	
Germany, F. R.	Portugal	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Belgium
France
USSR

Printed in Switzerland

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

0 INTRODUCTION

The specification of instruments, measurement site characteristics and frequency analysis of weighting allows the measurements to be made and reported with an acceptable precision.

The vibration is evaluated in accordance with ISO 2631. The procedure includes means of weighting the vibration level at different frequencies to take account of agreed approximations to the frequency sensitivity of the human operator.

1 SCOPE AND FIELD OF APPLICATION

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.

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

This International Standard applies when measurements are made under field conditions or where artificial surfaces are used for the comparison of different models of particular machines.

It is recognized that there may be designs of tractor for which this International Standard is not appropriate, for example stilt-tractors, tricycle tractors, hillside tractors or vineyard tractors etc.

NOTE — The standard does not include assessment of vibration reaching the operator other than through his seat or foot platform; for example, that sensed by the feet through the controls or by the hands through the steering wheel is not considered. ISO/TR 5007 specifies measurement of transmitted vibration and seat dimensions for operator's seats for agricultural tractors.

2 REFERENCES

ISO 2041, *Vibration and shock — Vocabulary.*

ISO 2631, *Guide for the evaluation of human exposure to whole-body vibration.*

ISO/TR 5007, *Agricultural wheeled tractors — Operator seat — Measurement of transmitted vibration and seat dimensions.*

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

3 DEFINITION

For the purposes of this International Standard, the following definition shall supplement those of ISO 2041 :

3.1 weighted vibration : The measured vibration acceleration modified by the frequency-weighting defined below.

4 VIBRATION MEASUREMENT AXES

The vibration shall be measured along three mutually perpendicular axes passing through a point on the interface between the operator and his seat. These axes are vertical, longitudinal and lateral (a_z, a_x and a_y) with respect to the tractor.

These axes correspond in their orientation with the similar axes (a_z, a_x, and a_y) for the operator, when the operator is at his work-place, and are defined in detail in ISO 2631.

5 INSTRUMENTS

5.1 Vibration transducers and amplifiers

The vibration shall be sensed by acceleration transducers (accelerometers) attached to the rigid part of a disc of 250 ± 50 mm diameter of which the centre part shall be rigid up to a diameter of 75 mm (a typical arrangement is shown in figure 1). The transducer should preferably be protected by a rigid cover. The disc, which may be covered with a 20 mm thick resilient material, shall be placed between the operator and the centre of his seat. Where the operator is standing, the transducers shall be rigidly attached to the foot platform as near as possible to his feet.

The transducers together with their associated amplifiers shall be sensitive to vibration levels of 0,05 m/s^2 and shall be capable of measuring vibrations of 5 m/s^2 r.m.s. with a crest factor (ratio of peak to r.m.s. value) as great as 3 without distortion and with an accuracy of ± 0,05 m/s^2. Frequency response shall not vary in the range 1 to 80 Hz by more than 5 %.

5.2 Recording equipment

The electrical signals generated by the transducers may be recorded for later analysis on magnetic tape or other recording equipment.

The recording equipment shall have a replay accuracy of better than ± 3,5 % over the frequency range 1 to 80 Hz including any change of tape speed made during replay for the purpose of analysis.

5.3 Frequency weighting

Frequency weighting shall be achieved in either of two ways :

— by analysis of the acceleration into 1/3 octave band levels, weighting the levels in individual bands and re-combination;

— or by direct use of electrical filters in a frequency-weighting "ride meter".

5.3.1 *Frequency analysis method*

5.3.1.1 Analyse each vibration tape recording into 1/3 octave component accelerations over the frequency range 1,0 to 80 Hz, the 1/3 octave centre frequencies being in compliance with IEC Publication 225, which shall however, be extrapolated for the lower frequencies.

5.3.1.2 Average the root mean square (r.m.s.) value of each component (b_f) over the duration specified for the measurement.

5.3.1.3 Multiply the 1/3 octave values by the weighing factors (w_f) listed in table 1, and calculate a weighted acceleration (B_w) value for each recording as the square root of the sum of the squares of the weighted 1/3 values :

$$B_w = \sqrt{\sum_{f=1,0}^{80} w_f^2 \, b_f^2}$$

TABLE 1 — **Weighting factors relative to the frequency range of maximum acceleration sensitivity (see ISO 2631)**

Frequency (centre frequency of 1/3 octave band) Hz	Weighting factor for vertical vibrations (figure 2)	Weighting factor for horizontal vibrations (figure 3)
1,0	0,50 = − 6 dB	1,00 = 0 dB
1,25	0,56 = − 5 dB	1,00 = 0 dB
1,6	0,63 = − 4 dB	1,00 = 0 dB
2,0	0,71 = − 3 dB	1,00 = 0 dB
2,5	0,80 = − 2 dB	0,80 = − 2 dB
3,15	0,90 = − 1 dB	0,63 = − 4 dB
4,00	1,00 = 0 dB	0,5 = − 6 dB
5,00	1,00 = 0 dB	0,4 = − 8 dB
6,3	1,00 = 0 dB	0,315 = − 10 dB
8,00	1,00 = 0 dB	0,25 = − 12 dB
10,00	0,80 = − 2 dB	0,2 = − 14 dB
12,5	0,63 = − 4 dB	0,16 = − 16 dB
16,0	0,50 = − 6 dB	0,125 = − 18 dB
20,0	0,40 = − 8 dB	0,1 = − 20 dB
25,0	0,315 = − 10 dB	0,08 = − 22 dB
31,5	0,25 = − 12 dB	0,063 = − 24 dB
40,0	0,20 = − 14 dB	0,05 = − 26 dB
50,0	0,16 = − 16 dB	0,04 = − 28 dB
63,0	0,125 = − 18 dB	0,031 5 = − 30 dB
80,0	0,10 = − 20 dB	0,025 = − 32 dB

5.3.2 *Frequency-weighting "ride meter"*

The "ride meter", if employed for direct indication of the weighted vibration, shall consist of an electronic weighting network incorporated between the transducer and a time integration stage. The weighting network shall have an insertion loss according to the curve in figure 2, for vertical vibration, or figure 3, for horizontal vibration. The loss shall not deviate from the curve by more than 0,5 dB from 2 to 4 Hz for vertical measurement or ± 1 dB at 6,3 Hz vertical measurement and 1,25 Hz horizontal measurement. For any other frequency, vertical or horizontal, ± 2 dB shall apply. The integration stage shall be capable of indicating the integral (I) of the square of weighted vibration acceleration (b_w^2) for the time period of the test run (T), or its square root (I'), i.e.

$$I = \int_{t=0}^{T} b_w^2 \, dT$$

$$\text{or } I' = \sqrt{\int_{t=0}^{T} b_w^2 \, dT}$$

or directly the r.m.s. value of the weighted vibration acceleration (A_{weff}) :

$$A_{weff} = \sqrt{\frac{I}{T}} = \frac{\sqrt{I}}{\sqrt{T}}$$

The overall accuracy of the so determined r.m.s value of the weighted vibration acceleration shall be within ± 5 %.

5.4 Calibration

The entire measurement and analysis equipment shall be regularly calibrated, where possible in accordance with existing standards or recommendations.

6 MEASUREMENT SITE AND OPERATING CONDITIONS

The measurement site and operating conditions shall be those appropriate for the machine under test. The type of soil and condition of surface shall be recorded, and, where possible, the ground profile or its power spectrum shall also be recorded. The speed, load and any other relevant operating condition of the machine shall be kept constant throughout the measurement period and shall be measured to an accuracy of ± 5 %. The measuring period shall be as long as is required to obtain vibration measurements representative of the machine and operating conditions and shall be specified for each machine.

NOTE — It is recommended that the mass of the operator should also be reported where this is likely to affect the vibration levels. To facilitate comparison of test results, the mass of the operator should, preferably, be 55 kg or 98 kg.

7 REPORTED VIBRATION LEVELS

The weighted vibration level in each of the three directions shall be reported separately, to the nearest 0,1 m/s^2. If the 1/3 octave analysis method has been employed, the weighted accelerations in each 1/3 octave band may be presented graphically.

8 AGRICULTURAL WHEELED TRACTORS : TEST TRACK METHOD

8.1 Condition of tractor

The tractor may be with or without a safety frame or cab. For normal measurements the tractor shall be in working order with full 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 means of the ranges recommended by the manufacturer. The track wheel setting shall be that which is usual for normal field work.

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

8.2 Artificial test tracks

Vibration measurements shall be made when the tractor is driven over one or both of the following :

a) a 100 m smoother track;

b) a 35 m rougher track.

Each track shall consist of two parallel strips suitably spaced for the wheel track of the tractor. The surface of each strip shall be either cast in smoothly surfaced concrete or formed of pieces of wood or concrete sited firmly in a base framework. The surface of each track strip shall be defined by the ordinates of elevation, with respect to a level base, listed in tables 2 and 3. For the smoother track (see table 3), the elevation shall be defined at intervals of 160 mm along each strip; for the rougher track (see table 2), the elevation shall be defined at intervals of 80 mm.

The strips shall be firmly sited on level ground and at each point along their length shall have negligible variation across their width, which shall be sufficient for the tractor wheels to be fully supported. Where the strips are constructed of pieces of wood or concrete, these shall be 60 to 80 mm thick. They shall be spaced at 160 mm intervals for the smoother track and at 80 mm intervals for the rougher track, but if it is more convenient, 80 mm intervals may be used for the smoother track.

Recommended driving speeds for these tracks are :

a) for the smoother track, 12 km/h;

b) for the rougher track, 5 km/h.

The speeds used shall be reported with an accuracy of ± 5 % of the measured value.

8.3 Tractor vibration

The r.m.s. values of weighted vibration along the three axes throughout the test runs shall be determined and reported together with details of the tractor design, its operating speed, the masses of the operators and the instrumentation employed.

Each measurement shall be carried out at least twice. The results will normally be expected to differ by not more than ± 5 % from the arithmetic mean. Larger discrepancies shall be resolved by further repeat measurements.

9 SPECIMEN REPORT FORM

A specimen report is included in the annex to show the way in which the result should be reported.

Dimensions in millimetres

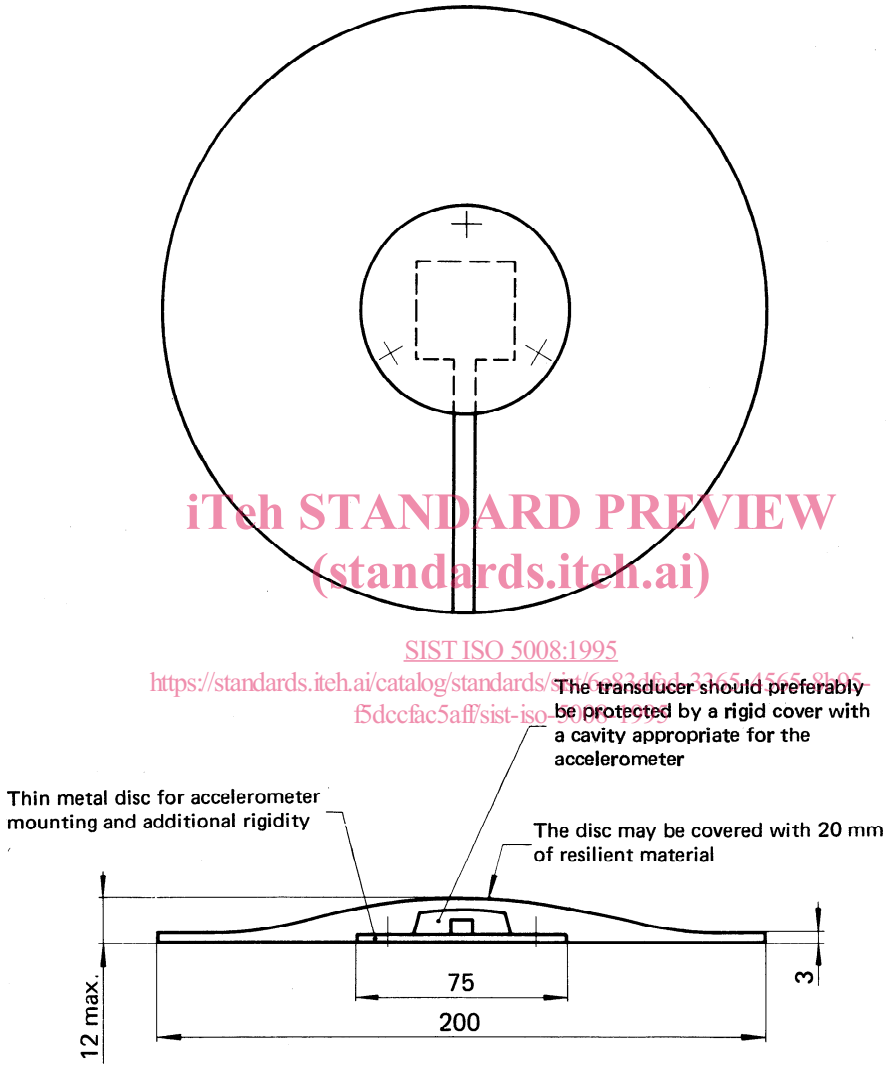

FIGURE 1 — **Suggested design for a semi-rigid disc for accelerometer mounting**

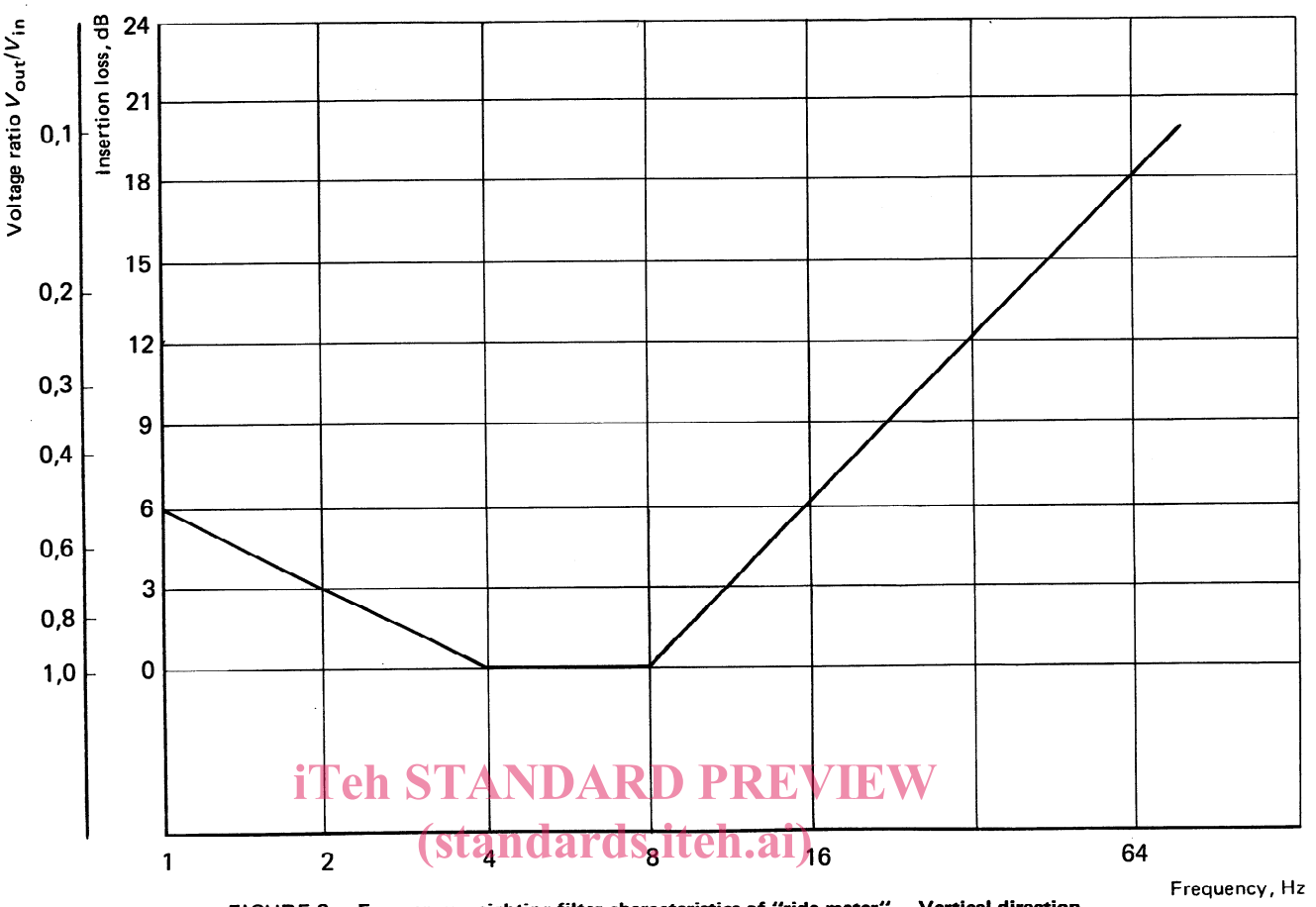

FIGURE 2 – **Frequency-weighting filter characteristics of "ride meter" – Vertical direction**

FIGURE 3 – **Frequency-weighting filter characteristics of "ride meter" – Horizontal direction**