INTERNATIONAL STANDARD

ISO 10326-1

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Mechanical vibration — Laboratory method for evaluating vehicle seat vibration —

Part 1:
Basic requirements

Vibrations mécaniques — Méthode en laboratoire pour l'évaluation des vibrations du siège de véhicule —
Partie 1: Exigences de base

Reference number
ISO 10326-1:1992(E)

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.

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.

International Standard ISO 10326-1 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Sub-Committee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

ISO 10326 consists of the following parts, under the general title *Mechanical vibration — Laboratory method for evaluating vehicle seat vibration*:

— *Part 1: Basic requirements*

— *Part 2: Application to railway vehicles*

Annex A of this part of ISO 10326 is for information only.

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Introduction

Drivers, staff and passengers of vehicles (land, air or water) and mobile off-road machinery are exposed to mechanical vibration which interferes with their comfort, working efficiency and, in some circumstances, safety and health. The following basic requirements have therefore been developed for the laboratory testing of vibration transmission through a vehicle seat to the occupant.

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Mechanical vibration — Laboratory method for evaluating vehicle seat vibration —

Part 1:
Basic requirements

1 Scope

This part of ISO 10326 specifies basic requirements for the laboratory testing of vibration transmission through a vehicle seat to the occupant. These methods for measurement and analysis make it possible to compare test results from different laboratories.

It specifies the test method, the instrumentation requirements, the measuring assessment method and the way to report the test result.

This part of ISO 10326 applies to specific laboratory seat tests which evaluate vibration transmission to the occupants of any type of seat used in vehicles and mobile off-road machinery.

Application standards for specific vehicles should refer to this part of ISO 10326 when defining the test input vibration that is typical for the vibration characteristics of the type or class of vehicle or machinery in which the seat is to be fitted.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10326. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10326 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2631-1:1985, *Evaluation of human exposure to whole-body vibration — Part 1: General requirements.*

ISO 5347-0:1987, *Methods for the calibration of vibration and shock pick-ups — Part 0: Basic concepts.*

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

3 General

The measurement and assessment methods given in this part of ISO 10326 comply with the present practice standardized in ISO 2631-1. The measuring equipment and the frequency weightings shall be in accordance with ISO 8041.

The primary test for the vibration characteristics of the seat involves measurements under conditions which simulate the range of actual uses of a vehicle or machine. For some applications, a secondary test is used to ensure that the seat responds acceptably to occasional severe shocks or transient vibration. Given the present state of knowledge, a test to evaluate the damping of the seat suspension is proposed for this purpose. The seat to be tested shall be mounted on a horizontal platform of a vibration simulator, which shall have movements in the vertical and/or one of the horizontal directions, as specified in application standards.

NOTE 1 In order to make tests in both horizontal directions, x and y, the seat may be turned 90° on the platform.

4 Instrumentation

4.1 Acceleration transducers

The measuring systems selected for the evaluation of vibration at the seat mounting base or platform of the vibration simulator and that selected for the evaluation of vibration transmitted to the seat occupant, or to an inert mass when used, shall have similar characteristics.

The characteristics of the vibration measuring system, accelerometers, signal conditioning and data acquisition equipment, including recording devices, shall be specified in the relevant application standard, especially the dynamic range, sensitivity, accuracy, linearity and overload capacity.

4.2 Transducer mounting

One accelerometer shall be located on the platform (P) at the place of the vibration transmission to the seat. The other accelerometer(s) shall be located at the interface between the human body and the seat, at either the seat pan (S) and/or the backrest (B) (see figure 1).

Dimensions in millimetres

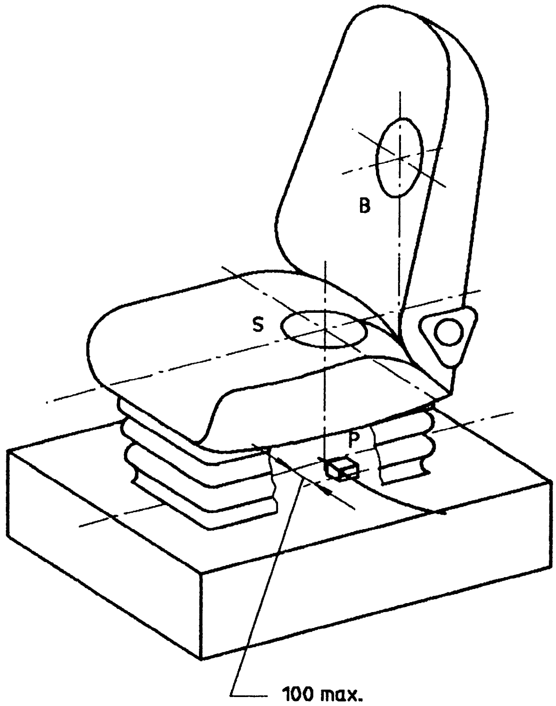

Figure 1 — Location of the accelerometers on the platform (P), on the seat pan (S) and on the backrest (B)

4.2.1 Transducer mounting on the platform

The accelerometer on the platform shall be located within a circle with a diameter of 200 mm centred directly below the seat accelerometer. The measuring directions shall be aligned parallel to the movement of the platform.

4.2.2 Transducer mounting on the seat pan and/or backrest

The accelerometers on the seat pan shall be attached in the centre of a mounting disc with a total diameter of 250 mm ± 50 mm. The disc shall be as thin as possible (see figure 2). The height shall not be more than 12 mm. This semi-rigid mounting disc of approximately 80 to 90 durometer units (A-scale) moulded rubber or plastics material shall have a centre cavity in which to place the accelerometers. The accelerometers shall be attached to a thin metal disc with a thickness of 1,5 mm ± 0,2 mm and a diameter of 75 mm ± 5 mm.

The mounting disc shall be placed on the surface of the seat pan and taped to the cushion in such a way that the accelerometers are located midway between the ischial tuberosities of the seat occupant with a tolerance to be defined in the relevant application standards. Alternative positioning of the disc may be recommended for certain applications. Any variation from the position here defined shall be specified in application standards.

When tests are performed without a person sitting on the seat, e.g. during damping tests, the disc shall be placed in the same position as if a person were seated in the seat.

If measurements are made on the backrest, the accelerometers shall be (horizontally) located in the vertical longitudinal plane through the centre-line of the seat. The relevant application standards shall specify the vertical position of the accelerometers. The measurement axes shall be aligned parallel to the basicentric coordinate system.

NOTES

2 Besides the semi-rigid mounting disc recommended for soft or highly countoured cushions, a rigid disc with a generally flat surface or an individual-form design may be used. Such discs may be, for instance, required for testing rail vehicle passenger seats. The transducer mounting should be made of low-mass materials, so that the resonant frequency of the mounting is at least four times the highest frequency specified for the test.

3 For practical reasons, it is usually not possible to align perfectly the accelerometers in the disc with the axes of motion of the platform. In a tolerance range within 15° of the appropriate axes, the accelerometers may be considered as aligned parallel to the axes of interest. For deviations greater than 15°, acceleration should be measured along two axes and the acceleration vector sum along the axis of interest should be calculated.

Dimensions in millimetres

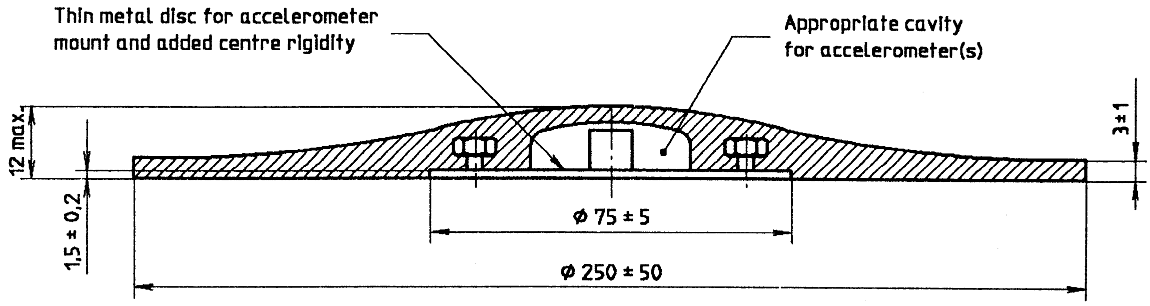

Figure 2 — A semi-rigid mounting disc

4.3 Frequency weighting

Frequency weighting shall be in accordance with ISO 8041.

4.4 Calibration

The instrumentation shall be calibrated in accordance with ISO 5347-0 and, depending on the type of measuring system used, to the relevant part of ISO 5347[1)].

It is recommended to check the whole measuring chain following the specifications given in ISO 8041.

Calibration shall be made before and after each test series.

Where necessary, the output from each accelerometer amplifier shall be zeroed after mounting the accelerometers in the test position.

5 Vibration equipment

5.1 Physical characteristics

The minimum equipment required is a vibrator capable of driving the platform in the vertical and/or horizontal directions. The dynamic response of the exciter shall be capable of exciting the seat with the seated test person and additional equipment, in accordance with the specified test input vibration.

Attributes of performance to be specified include frequency range and displacement capability in each of the required directions.

Application standards shall specify the lowest acceptable resonance frequency of the platform, the acceptable cross-axis motion of the platform and the frequency range for which this applies.

Application standards shall specify requirements for test stand dimensions and equipment to ensure that these are adequate for each particular application.

NOTE 4 It has been observed that the use of certain equipment (e.g. a steering wheel, pedals, etc.) may lower the repeatability of the results.

5.2 Control system

The frequency response characteristics of the vibration test system shall be compensated for to ensure that the power spectral density (PSD) and the probability density function (PDF) of the acceleration amplitudes of the vibration at the seat mounting base comply with the requirements of the specified test input vibration.

6 Safety requirements

Safety requirements with regard to tests in which people are exposed to mechanical vibration and repeated shock will be the subject of a future International Standard.

Specific safety requirements shall be considered when the relevant application standard is being developed.

7 Test conditions

7.1 Test seat

7.1.1 General

The seat to be tested shall be representative of actual or intended production models with regard to design, construction, mechanical and geometrical characteristics, and any other factors which may affect the vibration test results.

1) Parts 1 to 20 are to be published.

NOTE 5 The performance may vary between seats of the same type. Therefore, it is recommended to test more than one seat.

7.1.2 Run-in periods for suspension seats

Suspension seats require a run-in period prior to exposure to vibration in order to free the moving parts of the suspension. This period shall be long enough for the seat performance to stabilize.

Any required air, hydraulic or electric power shall be supplied to the seat at the pressure and flow rate, or voltage, recommended by the seat manufacturer and shall be connected to the seat in the manner recommended by the seat manufacturer. The test seat shall be loaded with an inert mass of 75 kg ± 1 % placed on the seat cushion, and the seat shall be adjusted according to the manufacturer's instructions for a nominal value of 100 kg operator mass.

NOTE 6 A suitable inert mass consists of lead shot. The lead shot can be contained within thin cushions which are sewn so as to form a quilt. About ten such cushions are sufficient to obtain a 75 kg mass.

During the run-in period, the test seat shall be excited by a sinusoidal input vibration at approximately the natural frequency of the suspension. The amplitude of the applied sinusoidal vibration shall be 75 % of the full amplitude of the seat suspension.

The damper may over-heat during the run-in period. Therefore, use an automatic shut-down and monitor the temperature of the damper.

If additional vibration tests in the horizontal direction are planned, the run-in procedure shall be followed under the same conditions separately for each direction.

NOTE 7 Deviations from this run-in method for the seat suspension may be specified in relevant application standards for individual seat tests.

7.2 Test persons

Application standards shall specify the masses of two test persons to be used for the test. These masses will normally be based on the 5th and the 95th percentile masses of the population of vehicle or machinary users for which the seat is intended. The tolerance shall be low, preferably $^{0}_{-5}$ % of the required mass for the low-mass test person. For the heavy test person, a greater tolerance is permissible, up to $^{+5}_{0}$ % of the required mass.

NOTE 8 To meet the required mass of the test persons, added masses may be used. The use of added masses and other optional possibilities (such as carrying out the test with only one test person) should be dealt with in application standards.

The application standards shall also define a posture appropriate to the application. This could include some relationship between seat height and longitudinal footrest position, absence or presence of a steering wheel (and its position), and some guidance as to how the correct posture can be assured, e.g. by measurement of certain limb or joint angles.

The test persons shall be trained in preliminary tests until they have become accustomed to maintaining a normal, inactive behaviour and posture with respect to the seat throughout the test.

7.3 Other possibilities

In order to avoid the exposure of human beings to testing, it may in future application standards be possible to recommend other solutions.

8 Test input vibration

The application standards shall specify one or more dynamic tests, designed to ensure that a seat is suitable for the intended purpose. As a minimum, there shall be a test using an input representative of severe but not abnormal use, in the course of which the vibration transmitted to the interface between the seat and the operator is measured, as the basic performance parameter of the seat.

In order to specify the transmission characteristics of seats with regard to different input frequencies (e.g. for tuning the vibration response of seats on different types of vehicle, such as foam seats in passenger cars), an alternative method is recommended in 8.2 for the determination of the transfer function for the relevant frequency range with a sinusoidal vibration input.

For seats with suspension systems used in off-road machinery, there should be a test of the effectiveness of the suspension damper in controlling occasional large-amplitude vibrations or shocks. This can take the form of a sinusoidal test to determine the maximum response of the seat at a frequency close to its resonant frequency when carrying a simple load equivalent to an average operator (e.g. the inert mass as specified in 7.1.2).

NOTE 9 In some case, a further or alternative test may be needed to ensure that, under conditions of excessive suspension travel, the suspension end stops are so constructed as to keep the resulting shock acceleration at an acceptable level. Application standards should specify this additional test if needed.

8.1 Simulated input vibration test

The simulated input test vibration shall be specified in accordance with the vehicle or machinery groups defined either by the acceleration power spectral density function or by the time history of an actual and representative signal.

When the input vibration is defined by PSD, the relevant application standard should give the equation describing the PSD and its tolerance. The equation for the PSD may be in the form of filter equations, which should be those of a low-pass filter and a high-pass filter (the pair constituting a band-pass filter), both of the Butterworth type. The cut-off frequencies and the slopes of the filters shall be clearly defined.

When the input vibration is defined by a time history, the application standard shall specify the number of measured (calculated) points, frequency and amplitude spacing and the sampling rate.

A tolerance on this level shall also be specified when the input vibration is defined by a time history.

The probability density function of the random vibration at the mounting base of the seat during the test may be required in application standards.

For both types of input vibration, the required root mean square (r.m.s.) acceleration on the platform, a_{wP}, shall be specified in application standards.

8.2 Transfer function with sinusoidal vibration input

The vibration transfer function test shall be carried out with two persons, as specified in 7.2. Input vibration magnitude and phase versus frequency, frequency spacing, transient time and duration of vibration input per frequency step shall be specified in application standards.

8.3 Damping test

8.3.1 Suspension seats

Application standards shall specify the characteristics of either a sinusoidal vibration or a random vibration to be used to assess the damping of suspension seats. The sine-wave test shall be conducted at the resonance frequency of the seat suspension. This resonance frequency shall be determined by exciting the seat in the frequency range from 0,5 to 2,0 times the expected resonance frequency. This displacement amplitude for both the damping test and the determination of the resonance frequency shall be (75 ± 5) % of the full travel available. All measurements shall be made with an inert mass of 75 kg ± 1 % on the seat, adjusted in accordance with 7.1.2.

8.3.2 Other seats

Application standards may specify damping tests for non-suspension seats in a manner similar to that described above, with appropriate modifications.

9 Test procedure

Mount the seat to be tested on the platform of the vibration simulator, in accordance with the specified test seat arrangement. Check the safety requirements and calibrate the instruments. Prior to the damping test and simulated input vibration test, carry out the run-in procedure on the test seat (see 7.1.2).

9.1 Simulated input vibration test

9.1.1 Position a test person in the seat. Operate the vibration simulator to produce the appropriate test input vibration.

The test input vibration, during each test run, shall be continuous to provide an analysing time sufficient to be specified in application standards.

Repeat the test to obtain three consecutive test runs in which the frequency-weighted r.m.s. acceleration values, a_w, measured at the seat are within ± 5 % of their arithmetic mean. Record this arithmetic mean as the fequency-weighted r.m.s. acceleration at the seat, a_{wS}.

For the tests described above, the vibration at the platform during each test shall be within the PSD tolerances mentioned in 8.1. The arithmetic mean of the three test values measured at the platform shall be recorded as the frequency-weighted r.m.s. acceleration values at the platform, a_{wP}.

9.1.2 If the purpose of the simulated input vibration test of the relevant application standard is to obtain the seat effective amplitude transmissibility factor (SEAT) of the seat, calculate the ratio of the recorded values as follows:

$$\mathrm{SEAT} = \frac{a_{wS}}{a_{wP}}$$

where a_{wS} and a_{wP} are as defined in 9.1.1.