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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
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock*.

This second edition cancels and replaces the first edition (ISO 10326-1:1992), which has been technically revised. It also incorporates the amendments ISO 10326-1:1992/Amd 1:2007 and ISO 10326-1:1992/Amd 2:2011.

A list of all parts in the ISO 10326 series can be found on the ISO website.

This corrected version of ISO 10326-1:2016 incorporates the following correction.

A.3.5 The corrupted symbol À was replaced with the correct symbol π in six instances.

Introduction

Drivers, staff and passengers of vehicles (land, air or water) and mobile machinery are exposed to mechanical vibration which interferes with their comfort, working efficiency and, in some circumstances, safety and health. Such vehicles and mobile machines are often fitted with seats that are designed and made in accordance with current state-of-the-art with regard to their capacity to control or reduce transmitted whole-body vibration.

To assist in the development of such seats, specific test codes have been, or are being, produced to evaluate the performance of seats. The following basic requirements have therefore been developed to give guidance for the specification of laboratory testing of vibration transmission through a vehicle seat to the occupant and for the evaluation of the ability of a seat to control the shock arising from over-travel of the suspension.

The seat constitutes the last stage of suspension before the driver. To be efficient at attenuating the vibration, the suspension seat should be chosen according to the dynamic characteristics of the vehicle. Any performance criteria provided should be set in accordance with what is attainable using best design practice. Such criteria do not necessarily ensure the complete protection of the operator against risks associated with exposure to vibration and shock which are generally believed to be risk of spinal injury.

Mechanical vibration — Laboratory method for evaluating vehicle seat vibration —

Part 1: Basic requirements

1 Scope

This document 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 for equivalent seats.

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

This document 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 refer to this document 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.

NOTE Examples of application standards are given in the bibliography.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 5347 (all parts), *Methods for the calibration of vibration and shock pick-ups*

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

ISO 13090-1, *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*

ISO 16063 (all parts), *Methods for the calibration of vibration and shock transducers*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 General

The measurement and assessment methods given in this document 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 applications where occasional severe shocks or transient vibration can be expected (and in particular for seats whose suspension travel is short, such as those intended for use on industrial trucks or off-road vehicles), in addition to the damping test, a secondary test is required to ensure that the seat responds acceptably. Machinery-specific standards shall give guidance on the need for this secondary test which comprises a method for assessing the accelerations associated with impact with the suspension end-stops when over-travel occurs. The test is described in Annex A.

5 Instrumentation

5.1 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.

5.2 Transducer mounting

5.2.1 General

One accelerometer for each required test direction 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

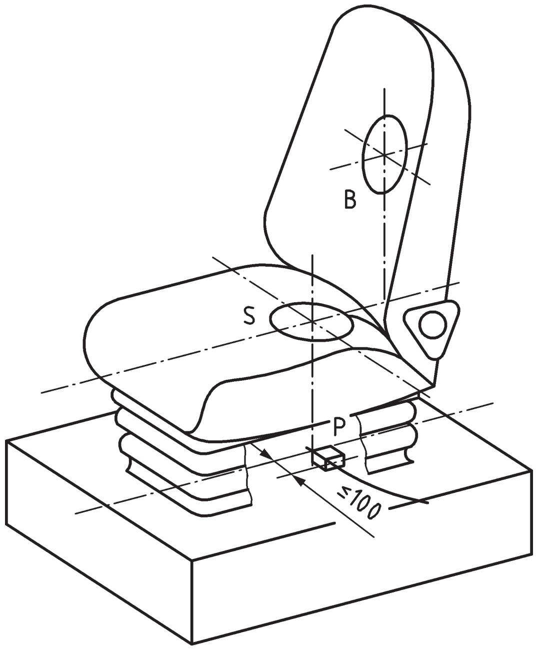


Figure 1 — Location of the accelerometers on the platform (P), on the seat pan (S) and on the backrest (B)

5.2.2 Transducer mounting on the platform

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

5.2.3 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 durometer 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.

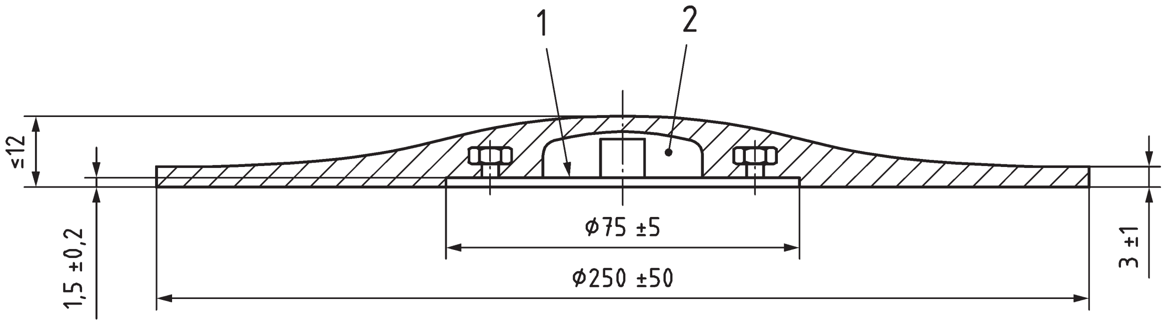
When tests are performed without a person sitting on the seat, e.g. during damping tests, the disc shall be placed in the same position as if a person were seated in the seat.

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.

Besides the semi-rigid mounting disc recommended for soft or highly contoured 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.

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



Key

1 thin metal disc for accelerometer mount and added centre rigidity

2 appropriate cavity for accelerometer(s)

Figure 2 — Semi-rigid mounting disc

5.3 Frequency weighting

Frequency weighting shall be in accordance with ISO 8041.

5.4 Calibration

The instrumentation shall be calibrated in accordance with ISO 16063-1 and, depending on the type of measuring system used, to the relevant part of ISO 5347 or ISO 16063.

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.

6 Vibration equipment

6.1 Physical characteristics

The minimum equipment required is a vibrator capable of driving the platform in the vertical and/or horizontal directions. Application standards may define situations where it is appropriate to turn the seat by 90° on the platform to account for excitations in *x*- and *y*-axis (as opposed to a combined axes excitation). 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.

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

6.2 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.

7 Safety requirements

The guidance on safety requirements with regard to tests in which people are exposed to mechanical vibration and repeated shock as given in ISO 13090-1 shall be followed.

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

8 Test conditions

8.1 Test seat

8.1.1 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.

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

8.1.2 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 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 10 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 overheat during the run-in period. Therefore, use an automatic shutdown 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.

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

8.1.3 Measurement of suspension travel and adjustment to weight of test person

Differences in the setting of ride height when testing suspended seats can have significant effects on test results. Therefore, the test standard should include guidance on how the height should be adjusted, such as

— with seats where the suspension stroke available is *affected* by the adjustment of the seat height or by the test person weight, including where the height adjustment is integrated into the suspension travel, testing shall be performed in the lowest position that provides the full working suspension stroke as specified by the seat manufacturer, and

— with seats where the suspension stroke available is *unaffected* by the adjustment of the seat height or by test person weight, testing shall be performed with the seat adjusted to the centre of stroke.

Determination of the ride position requires location of the upper and the lower ends of travel for the suspension, as follows.

a) For suspensions with manual weight adjustment, the following procedure is recommended.

The upper end of travel should be determined with no load on the seat, and with the suspension weight adjustment set approximately to suit the heavy test person (e.g. 100 kg).

The lower end of travel, including compression of the lower bump stop, should be determined with a load of 1 500 N, and with the suspension weight adjustment set approximately to suit the light test person (e.g. 55 kg).

b) For suspensions with automatic weight adjustment, which usually are air suspensions, the following procedure is recommended.

To determine the upper end of travel, a dynamic test is needed. Starting with a heavy (e.g. 100 kg) test person sitting on the seat, the height should be adjusted to mid-ride (in cases where the height adjustment is integrated into the suspension travel, adjust to the upmost mid-ride position). The test person rises from the seat very quickly, so that the suspension is compressed into the upper end-stop. The highest position measured gives the upper end of travel. In this context, mid-ride means the mid-point of the working stroke.

To determine the lower end of travel, first exhaust the suspension completely so that the suspension is just resting on the lower end-stop. If necessary, add weight to the seat to bring the suspension into contact with the end-stop. Then, compress the suspension further with a force of 1 000 N (or load with a mass of 100 kg). This lowest position gives the lower end of travel.

For a suspension that cannot be measured in this way, an alternative method that has the same basic objectives should be devised.

The following information should be included in the report:

— full working stroke (as given by the manufacturer);

— measured working stroke (suspension without integral height adjustment) or full measured suspension travel (suspension with integral height adjustment);

— position used during the vibration test (distance above lower end of travel);

— available height adjustment (suspension with integral height adjustment) being the full measured suspension travel less the working stroke as specified by the manufacturer.

