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AMENDMENT 2
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Mechanical vibration — Laboratory method for evaluating vehicle seat vibration —

Part 1: Basic requirements

AMENDMENT 2

Vibrations mécaniques — Méthode en laboratoire pour l'évaluation des vibrations du siège de véhicule —

Partie 1: Exigences de base

AMENDEMENT 2

Reference number
ISO 10326-1:1992/Amd.2:2011(E)

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

Amendment 2 to ISO 10326-1:1992 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 231, *Mechanical vibration and shock*, in collaboration with Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Mechanical vibration — Laboratory method for evaluating vehicle seat vibration —

Part 1:
Basic requirements

AMENDMENT 2

Page ii, Foreword

Add the following information at the end of the parts list:

The following part is planned:

— Part 3: Specification of dynamic dummies for *z*-axis motion

Page iii, Introduction

Add the following paragraph:

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.

Page 1, Clause 2

Add the following reference:

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*

Page 3, Clause 6

Replace the first paragraph with the following:

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.

Page 4, 7.1.2

After 7.1.2, add the following subclauses.

7.1.3 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;

— 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.

NOTE 8 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.

NOTE 9 Use of a continuous visual indication of ride height position for the test controller or engineer can aid reproducibility by enabling any variations in ride height to be corrected, e.g. resulting from changing damper temperature. Such indications can be electrical or mechanical. It is also necessary for determining the upper end of travel for a suspension with automatic weight adjustment.

NOTE 10 Use of a brief burst of sinusoidal vibration, coupled with visual indication of ride height, can help to reduce the error in setting ride height that can be introduced by friction, particularly in suspensions with low spring rates.

7.1.4 Inclination of backrest

When the inclination of the backrest is adjustable, it shall be set approximately upright, inclined slightly backwards (if possible: 10° ± 5°).

Page 4, 7.2

Replace 7.2 with the following.

7.2 Test persons and posture

Application standards for suspended seats 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 machinery 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.

Whereas existing test standards for suspension seats specify test persons by total clothed weight, measured standing, reproducibility of test results might be improved by specifying sitting weight, measured as below. Some test standards for suspension seats (e.g. ISO 5007, ISO 7096, EN 13490) consistently specify light persons with total mass of 52 kg to 55 kg, and heavy persons with total mass of 98 kg to 103 kg. Specification by sitting weight, based on the approximate assumption that this is 75 % of total weight, would thus become 39 kg to 41 kg for the light person and 74 kg to 77 kg for the heavy person.

In order to check the sitting weight, the test person should sit in an erect upright posture on a hard, flat seat with no backrest on the weighing platform, with feet and legs supported separately, and hands resting on top of the thighs. There should be no contact between the seat and the thighs. For this measurement the upper leg should be approximately horizontal and the lower leg approximately vertical. The value weighed should be that supported by the test person's ischial tuberosities.

NOTE 11 Test persons should be weighed immediately before each continuous series of test runs.

NOTE 12 To meet the required mass of the test persons, added masses may be used. Where this is allowed, and to aid reproducibility, these should be in the form of inert discs (or sheets) placed between the seat cushion and the test person. The added mass should be no more than 5 kg for a light test person, and no more than 8 kg for a heavy test person. 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.

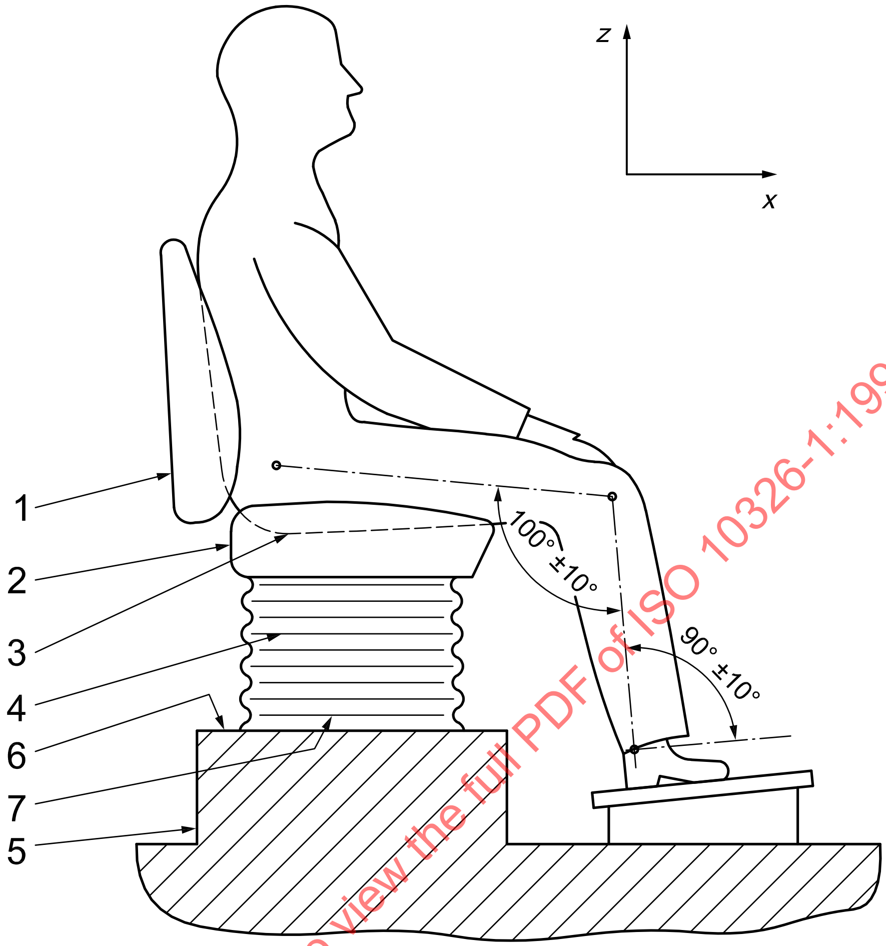
Laboratories are encouraged to gather data to correlate the sitting and standing weights of their test persons.

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. An example of a suitable posture for testing of suspension seats is shown in Figure 3.

In the testing of suspension seats, vibration at the test person's feet can contribute to the acceleration measured on the seat cushion. It is necessary to minimize this consistently. Therefore the height of the feet support should be adjusted so that, when the seat height position is set to the position to be used for the tests (usually mid-ride), there is no pressure between the front of the seat cushion and the thighs of the test person. This may be confirmed subjectively, or by simple means such as sliding a piece of paper between the cushion and the thighs.

NOTE 13 It is usually more convenient to set the foot position after first setting the mid-ride height of the suspension.

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.



Key

1 seat backrest
2 seat pan
3 accelerometer disc on the seat pan (S)
4 seat suspension
5 platform
6 accelerometer on the platform (P)
7 base of the seat

Figure 3 — Suitable posture for testing suspension seats

Page 4, Clause 8

In the second paragraph, replace 8.2 with 8.3.

Page 5, 8.1

After the subclause, add Note 14, Note 15, and a new 8.2. Renumber subsequent subclauses in consequence.

NOTE 14 Annex B shows an example of a simulated input test vibration defined by the power spectral density (PSD).

NOTE 15 Interlaboratory differences might be reduced through sharing input signals generated at one "reference" laboratory. Application standards can include the definition of such reference signals in annexes.

8.2 Tolerances on input vibration

To aid reproducibility in testing suspended seats, application standards should specify tolerances on input vibration in accordance with the following:

a) **r.m.s. values:** A tolerance should be defined for r.m.s. accelerations for the overall test signal (broadband) measured between set frequencies (f_1 and f_2, see Annex B) and for that associated with the dominant spectral peak (f_3 to f_4). Experience with existing test standards has shown that ±5 % of the target r.m.s. values is generally achievable.

b) **amplitude distribution function:** For simulated input test vibrations that are intended to have a Gaussian, or normal, amplitude distribution the following specification has been found to be practicable.

Under the condition that the acceleration on the platform shall be sampled at a minimum of 50 data points per second, and analysed into amplitude cells of not greater than 20 % of the total true r.m.s. acceleration, the probability density function shall be within ±20 % of the ideal Gaussian function between ±200 % of the total true r.m.s. acceleration, and with no data exceeding ±450 % of the total true r.m.s. acceleration.

c) **power spectral density:** Providing that the combination of sample time (duration of single test measurement), T_s, and resolution bandwidth, B_e, is such that

$$2B_eT_s > 140$$

it should be possible to maintain the PSD function within ±10 % of the desired target curve.

NOTE 16 Power spectral density estimates can vary, depending on how they are calculated. For typical input vibration signals, the following parameters have been found to be suitable:

— sampling rate: 200 Hz ($\Delta t = 0{,}005$ s);

— block length: 512 samples ($\Delta f = 0{,}391$ Hz, and therefore $2BT = 140$ for 180 s record),

— window: Hanning, applied in the time domain so that an overlap of 50 % gives the same weight to each time sample.

For calculating the r.m.s. values, as in 8.2 a), the frequencies f_1, f_2, f_3 and f_4 should be chosen to allow simple interpolation of the power spectral density estimates. Alternatively, a re-analysis using a block length of 2 048 samples ($\Delta f \approx 0{,}1$ Hz) might provide sufficiently precise frequency range limits.

Page 5, 8.3.1

Renumber 8.3.1 as 8.4.1 and replace with the following.

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. The total displacement for both the damping test and the determination of the resonance frequency shall be 40 % of the full travel available or 50 mm, whichever is the smaller. All measurements shall be made with an inert mass of 75 kg ± 0,75 kg on the seat, adjusted in accordance with 7.1.3.

NOTE 17 For suspensions fitted with active damping, it is possible that this test is not appropriate. In such cases, the test mass or the input excitation can be reduced. A mass of 60 kg has been found to be appropriate.

Page 5, 9.1.1

After the subclause add the following Note.

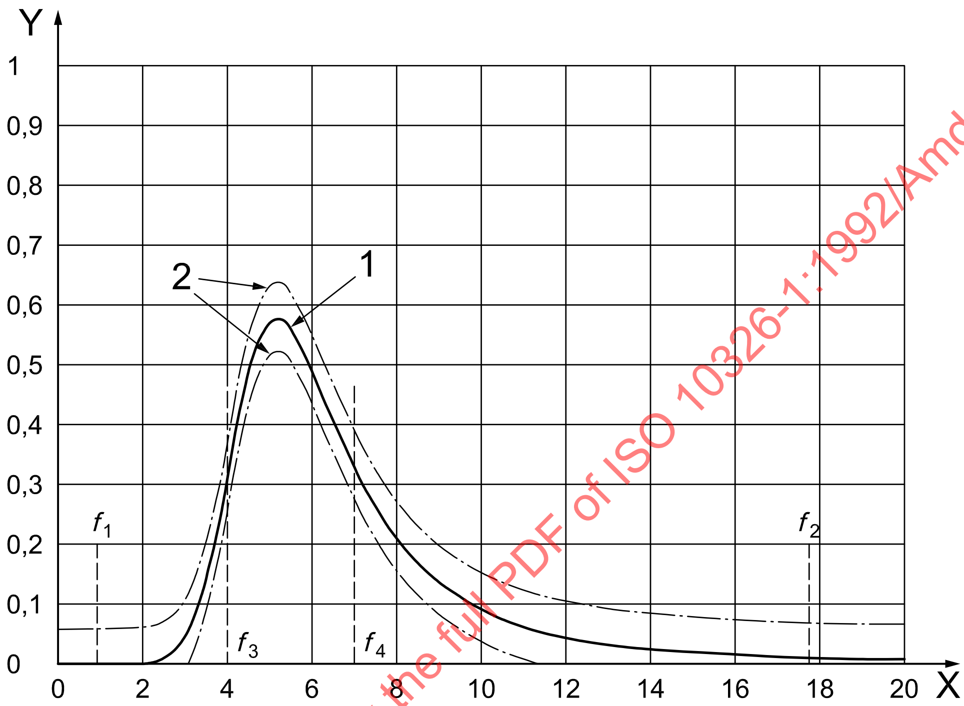
NOTE 18 It has been found that a short period of running to warm-up the seat, up to 10 min, improves the repeatability. It is recommended that a short warm-up should take place immediately before each series of measurements. The seat might be loaded with either a test person or an inert load. A suitable warm-up might be to run and then discard the first reading of each series.

Page 7, after insertion of ISO 10326-1:1992/Amd.1:2007, Annex A

Add Annex B (see next page).

Annex B
(informative)

Example of a simulated input test signal specified by the PSD



Key

Y $G_P^*(f)$ power spectral density, $(\mathrm{m/s^2})^2/\mathrm{Hz}$

X f frequency, Hz

1 reference value

2 allowable limits

Figure B.1 — Example of a simulated input test signal

The power spectral density (PSD) of the simulated input test signal shown in Figure B.1 is given by

$$G_P^*(f) = 1{,}66\ (HP_{24})^2 (LP_{12})^2$$

where

$$HP_{24} = \frac{S^4}{1 + 2{,}613S + 3{,}414S^2 + 2{,}613S^3 + S^4}$$

$$LP_{12} = \frac{1}{1 + 1{,}414S + S^2}$$

in which

$$S = \frac{\mathrm{j}f}{f_\mathrm{c}}$$