SLOVENSKI STANDARD
SIST EN 13490:2002+A1:2009

01-februar-2009

Mehanske vibracije - Industrijska tovorna vozila - Laboratorijsko vrednotenje in specifikacije vibracij voznikovega sedeža

Mechanical vibration - Industrial trucks - Laboratory evaluation and specification of operator seat vibration

Mechanische Schwingungen - Flurförderzeuge - Laborverfahren zur Bewertung sowie Spezifikation der Schwingungen des Maschinenführersitzes

Vibrations mécaniques - Chariots industriels - Évaluation en laboratoire et spécification des vibrations transmises à l'opérateur par le siège

Ta slovenski standard je istoveten z: **EN 13490:2001+A1:2008**

ICS:

13.160	Vpliv vibracij in udarcev na ljudi	Vibration and shock with respect to human beings
53.060	Industrijski tovornjaki	Industrial trucks

SIST EN 13490:2002+A1:2009 **en,fr,de**

EUROPEAN STANDARD

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Mechanical vibration - Industrial trucks - Laboratory evaluation and specification of operator seat vibration

Vibrations mécaniques - Chariots industriels - Evaluation en laboratoire et spécification des vibrations transmises à l'opérateur par le siège

Mechanische Schwingungen - Flurförderzeuge - Laborverfahren zur Bewertung sowie Spezifikation der Schwingungen des Maschinenführersitzes

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (EN 13490:2001+A1:2008) has been prepared by Technical Committee CEN/TC 231 "Mechanical vibration and shock", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2008-10-05.

This document supersedes EN 13490:2001.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] 〈A1〉.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

[A1] For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. 〈A1〉

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

The operators of industrial trucks are often exposed to a low-frequency vibration environment mainly caused by the movement of the vehicles over uneven ground. 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. The performance criteria provided in this European Standard have been set in accordance with what is attainable using what is at present the best design practice. They do not necessarily ensure the complete protection of the operator against effects of vibration and shock. They may be revised in the light of future developments and improvements in suspension design.

Performance criteria obtained in accordance with this European Standard may be useful to manufacturers of industrial trucks when selecting seats for possible use in their products. However, to satisfy fully the requirements of the [A1⟩ EU ⟨A1] Machinery Directive it is important for suppliers of mobile machinery to demonstrate that the seat supplied reduces the vibration in the specified machine to the lowest level that can be reasonably achieved.

The test inputs included in this European Standard are based on a very large number of measurements taken in situ on industrial trucks while they were used under severe but typical operating conditions. The test method is based on EN 30326-1, which is a general method applicable to seats for different types of vehicles.

1 Scope

1.1 This European Standard is applicable to operator seats used on industrial trucks as defined in ISO 5053:1987 irrespective of power supply, type of equipment, lifting mechanism and tyres. It also applies to seats for other trucks not covered by ISO 5053:1987, e.g. variable-reach trucks and lowlift order picking trucks.

1.2 This European Standard specifies, in accordance with EN 30326-1, a laboratory method for measuring and evaluating the effectiveness of the seat suspension in reducing the vertical wholebody vibration transmitted to the operator of industrial trucks at frequencies between 1 Hz and 20 Hz.

1.3 This European Standard defines the input spectral classes required for the following industrial trucks. Each class defines a group of machines having similar vibration characteristics:

— Platform trucks, trucks rider-controlled, etc. with wheel mean diameter below 200 mm and highload non-rubber solid tyres (category 1)[1)]

— Reach trucks, articulated trucks, etc. with wheel mean diameter below 450 mm and high-load non-rubber solid tyres or cylindrical/conical base rubber solid tyres (category 2)[1)]

— Straddle trucks, trucks with wheel mean diameter below 645 mm and rubber solid or pneumatic tyres (category 3)[1)]

— Straddle trucks, trucks with wheel mean diameter between 645 mm and 900 mm and rubber solid or pneumatic tyres (category 4a)[1)]

— Straddle trucks, trucks with wheel mean diameter between 900 mm and 1 200 mm and rubber solid or pneumatic tyres (category 4b)[1)]

— Trucks with wheel mean diameter between 1 200 mm and 2 000 mm and rubber solid or pneumatic tyres (category 5)[1)]

— All-terrain trucks (category 6)[1)]

1.4 This European Standard specifies performance criteria to be achieved by seats intended for each of the above-mentioned groups of machines.

1.5 The tests and criteria defined in this European Standard are intended for operator seats used in industrial trucks of conventional design.

NOTE Other tests may be appropriate for machines with design features that result in significantly different vibration characteristics.

1.6 This European Standard is only concerned with the vertical component of whole-body vibration. Vibration which reaches the operator other than through his seat, for example that sensed by his feet on the platform or control pedals or by his hands on the steering-wheel, is not covered.

2 Normative references

[A1] The following referenced documents are indispensable for the application 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. [A1]

[A1] *deleted text* [A1]

EN 30326-1:1994, *Mechanical vibration — Laboratory method for evaluating vehicle seat vibration – Part 1: Basic requirements (ISO 10326-1:1992)*

[A1] EN ISO 8041, *Human response to vibration — Measuring instrumentation (ISO 8041:2005)* [A1]

EN 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 13090-1:1998)*

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

ISO 5053:1987, *Powered industrial trucks — Terminology*

ISO 5805:1997, *Mechanical vibration and shock — Human exposure — Vocabulary*

[A1] *deleted text* [A1]

3 Terms and definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in ISO 5805:1997 and the following apply.

3.1.1
whole-body vibration
vibration transmitted to the body as a whole through the buttocks of a seated operator

1) See [A1] EN 13059 [A1].

3.1.2
input spectral class
machines having similar ride vibration characteristics at the seat attachment point, grouped by virtue of various mechanical characteristics

3.1.3
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 (for example, for adjusting the seat position)

3.1.4
frequency analysis
process of arriving at a quantitative description of a vibration amplitude as a function of frequency

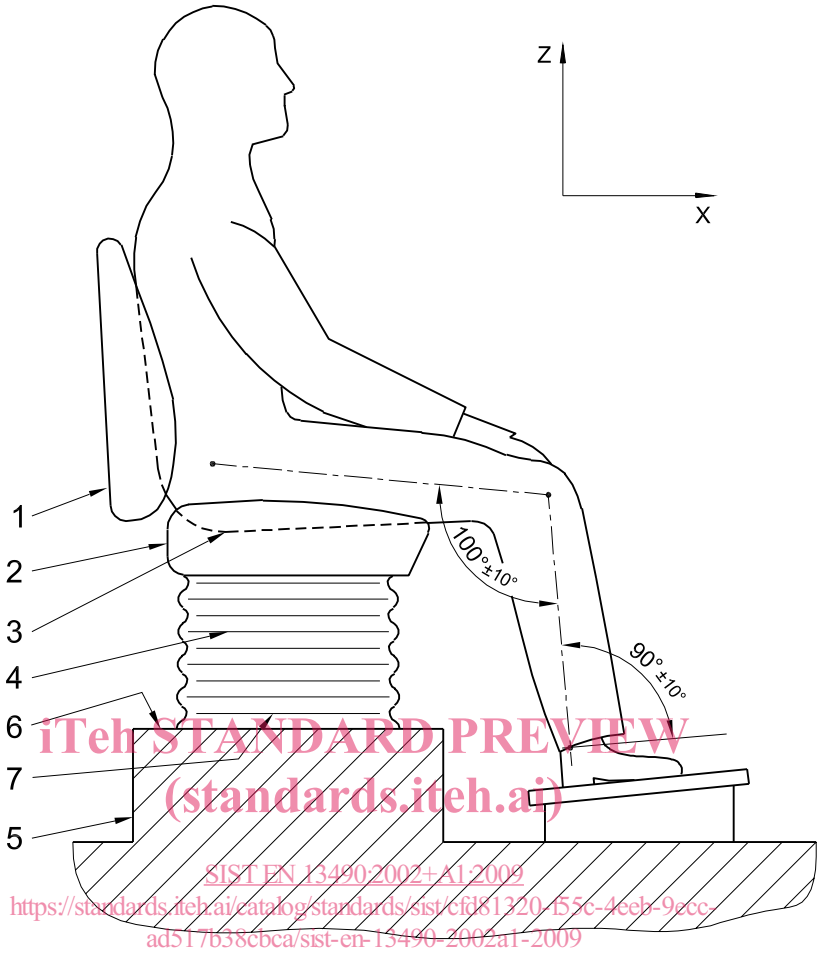
3.1.5
measuring period
time duration in which vibration data for analysis is obtained

3.2 Symbols and abbreviations

For the purposes of this European Standard, the following symbols and abbreviations apply:

$a_P(f_r)$	unweighted r.m.s. value of the measured vertical acceleration at the platform at the resonance frequency
a^*_{P12}, a^*_{P34}	unweighted r.m.s. value of the target vertical acceleration at the platform under the seat (see Figure 1) between frequencies f_1 and f_2, or f_3 and f_4
a_{P12}, a_{P34}	unweighted r.m.s. value of the measured vertical acceleration at the platform between frequencies f_1 and f_2, or f_3 and f_4
$a_S(f_r)$	unweighted r.m.s. value of the measured vertical acceleration at the seat disc at the resonance frequency
a^*_{wP12}, a^*_{wP34}	weighted r.m.s. value of the target vertical acceleration at the platform between frequencies f_1 and f_2, or f_3 and f_4
a_{wP12}	weighted r.m.s. value of the measured vertical acceleration at the platform between frequencies f_1 and f_2
a_{wS12}	weighted r.m.s. value of the measured vertical acceleration at the seat disc (see Figure 1) between frequencies f_1 and f_2
B_e	resolution bandwidth, Hz
EM	Earth-moving Machinery
f	frequency, Hz
f_r	frequency at resonance
$G_P(f)$	measured PSD of the vertical vibration at the platform (seat base)
$G^*_P(f)$	target PSD of the vertical vibration at the platform (seat base)
$G^*_{PL}(f)$	lower limit for the measured PSD of the vertical vibration at the platform (seat base)

$G^*_{PU}(f)$	upper limit for the measured PSD of the vertical vibration at the platform (seat base)
$H(f_r)$	transmissibility at resonance
HP	high-pass filter
IT	Industrial Truck
LP	Low-pass filter
PSD	Power spectral density expressed as acceleration squared per unit bandwidth, $(m/s^2)^2/Hz$
r.m.s.	root mean square
SEAT	Seat Effective Amplitude Transmissibility factor
T_s	sampling time, s.



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

Provision shall be made for adjustment of the angles of the knees, the ankles and the backrest (if possible) (see 5.2).

Figure 1 — Posture of the test person

4 General

4.1 The laboratory simulated machine vertical vibration, specified as input spectral class, is based on representative measured data from machines in severe but typical working conditions. The input spectral class is a representative envelope for the machines within the class, therefore the laboratory test is more severe than the typical vibration environment of any specific machine.

4.2 Two criteria are used for the evaluation of seat:

a) the Seat Effective Amplitude Transmissibility (SEAT) factor according to EN 30326-1:1994, 9.1, but with frequency weighting according to ISO 2631-1,

b) the maximum transmission ratio in the damping test according to EN 30326-1:1994, 9.2.

4.3 The measuring equipment shall be in accordance with ▌A1⟩ EN ISO 8041 ⟨A1▐ and EN 30326-1:1994, Clauses 4 and 5. The frequency weighting shall include the effects of the band limiting filters, and be in accordance with ISO 2631-1 (see ▌A1⟩ EN ISO 8041 ⟨A1▐).

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

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

5 Test conditions and test procedure

The test conditions and test procedure shall be in accordance with EN 30326-1:1994, Clauses 7 and 8.

5.1 Simulation of vibration

See EN 30326-1:1994, Clause 5.

A platform, the dimensions of which correspond approximately to those of the operator's platform of an industrial truck, shall be mounted on a vibrator which is capable of generating vibration along the vertical axis (see Figure 1).

5.2 Test seat

The operator seat for the test shall be representative of series-produced models, with regard to construction, static and vibration characteristics and other features which may affect the vibration test results. Before the test, the suspension seats shall be run-in under conditions stipulated by the manufacturer. If the manufacturer does not state such conditions, then the seat shall be run-in for 5 000 cycles, with measurements at 1 000-cycle intervals.

For this purpose, the seat shall be loaded with an inert mass of 75 kg and adjusted to the mass in accordance with the manufacturer's instructions. The seat and suspension shall be mounted on the platform of a vibrator, and a sinusoidal input vibration shall be applied to the platform at approximately the suspension natural frequency. This input vibration shall have a peak-to-peak displacement sufficient to cause movement of the seat suspension over approximately 75 % of its stroke. A platform peak-to-peak displacement of approximately 40 % of the seat suspension stroke is likely to achieve this. Care should be taken to ensure against overheating of the suspension damper during the running-in, for which forced cooling is acceptable.

The seat shall be considered to have been run-in if the value for the vertical transmissibility remains within a tolerance of ± 5 % when three successive measurements are performed under the condition described above. The time interval between two measurements shall be half an hour, or 1 000 cycles (whichever is less), with the seat being constantly run-in.

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

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

With seats where the suspension stroke available is **affected** by the adjustment of the seat height or by test person weight, testing shall be performed in the lowest position which provides the full working suspension stroke as specified by the seat manufacturer.

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

5.3 Test person and posture

The simulated input vibration test shall be performed with two persons. 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.

Each person shall adopt a natural upright position on the seat and maintain this position throughout the test (see Figure 1).

Differences in the posture of the test person can cause a 10 % difference between test results. For this reason, recommended angles of knees and ankles have been specified in Figure 1.

5.4 Input vibration

5.4.1 Simulated input vibration test to evaluate the SEAT factor

This European Standard specifies the input vibration in four input spectral classes (IT 1 through IT 4) for industrial trucks for the purpose of determining the SEAT factor.

In accordance with EN 30326-1:1994, 9.1.2, the SEAT factor is defined as

$$\mathrm{SEAT}=\frac{a_{wS12}}{a_{wP12}} \qquad (1)$$

The simulated input vibration used to determine the SEAT factor is defined in accordance with EN 30326-1:1994, 8.1, but the frequency weighting shall be in accordance with ISO 2631-1. The test input for each class is defined by a power spectral density, $G^*_P(f)$, of the vertical (z axis) acceleration of the vibrating platform, and by the unweighted r.m.s. vertical accelerations on that platform (a^*_{P12}, a^*_{P34}).

The vibration characteristics for each input spectral class IT 1 through IT 4 are shown in Figures 2 through 5. Equations for the acceleration power spectral density curves of Figures 2 to 5 are included in Table 2. The curves defined by these equations are the target values to be produced at the base of the seat for the simulated input vibration test of 5.5.2.

The input vibration shall be determined (calculated) without components at frequencies outside the frequency range defined by f_1 and f_2.

Table 3 further defines the test input values for the actual test input PSD at the base of the seat.