# SLOVENSKI STANDARD
# SIST EN 12299:2009

**01-junij-2009**

**Nadomeġļa:**
**SIST ENV 12299:2001**

---

**Železniške naprave - Udobnost vožnje potnikov - Meritve in vrednotenje**

Railway applications - Ride comfort for passengers - Measurement and evaluation

Bahnanwendungen - Fahrkomfort für Fahrgäste - Messung und Auswertung



Applications ferroviaires - Confort de marche des voyageurs - Mesurage et évalutation



**Ta slovenski standard je istoveten z: EN 12299:2009**



---

**ICS:**

| | | |
|---|---|---|
| 13.160 | Vpliv vibracij in udarcev na ljudi | Vibration and shock with respect to human beings |
| 45.060.20 | Železniški vagoni | Trailing stock |

**SIST EN 12299:2009** **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 12299

April 2009

ICS 45.060.20

Supersedes ENV 12299:1999

English Version

# Railway applications - Ride comfort for passengers - Measurement and evaluation

Applications ferroviaires - Confort de marche des voyageurs - Mesurage et évalutation

Bahnanwendungen - Fahrkomfort für Fahrgäste - Messung und Auswertung

This European Standard was approved by CEN on 7 March 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.



CEN members are the national standards bodies of 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.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

**Management Centre: Avenue Marnix 17, B-1000 Brussels**

# Contents

Page

**Figures**

Tables

## Foreword

This document (EN 12299:2009) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, 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 October 2009, and conflicting national standards shall be withdrawn at the latest by October 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes ENV 12299:1999.

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 the United Kingdom.

# 1 Scope

This standard specifies methods for quantifying the effects of vehicle body motions on ride comfort for passengers and vehicle assessment with respect to ride comfort. The effect considered is:

— discomfort, associated with relatively low levels of acceleration and roll velocity.

Other effects, not included in the standard, are associated with higher acceleration levels:

— health risk effect: physical damage and psychological deterioration.

The standard applies to passengers travelling in railway vehicles on railway lines, including main, secondary and suburban lines. This standard could be used as a guide for other railway vehicles, for example locomotives, metros, trams, etc.

The standard applies to passengers in good health.

This standard applies to measurements of motions. It also applies to simulated motions.

# 2 Normative references

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.



EN 14363, *Railway applications — Testing for the acceptance of running characteristics of railway vehicles — Testing of running behaviour and stationary tests*



EN ISO 5353, *Earth-moving machinery, and tractors and machinery for agriculture and forestry - Seat index point (ISO 5353:1995)*

EN ISO 8041, *Human response to vibration - Measuring instrumentation (ISO 8041:2005)*

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

ISO 5348, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

# 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1**
**passengers**
people travelling in a railway vehicle, without specific activities related to the transport

**3.2**
**ride comfort**
complex sensation produced during the application of oscillations and/or inertia forces, via whole-body transmission caused by the railway vehicle body motions

**3.3**
**interfaces**
contact parts between the vehicle body or seat and the passenger with the function of sustaining and guiding the passenger and of transmitting the weight of the same to the vehicle body itself, e.g. floor-feet

**3.4**
**Mean Comfort**
perceived comfort level, continuously adjusted, as evaluated through measurement on a long-time basis (at least some minutes)

**3.5**
**Continuous Comfort**
level of accelerations, ISO frequency weighted continuously evaluated as a set of rms (root mean square) values in vertical, lateral and longitudinal direction over a short time period (typical 5 s)

**3.6**
**Comfort on Curve Transition**
discomfort, due to a perceived curve transition

**3.7**
**Comfort on Discrete Event**
discomfort, due to a perceived transient oscillation

**3.8**
**whole-body transmission**
motion transmitted to the whole body through the interfaces between vehicle body and passenger

**3.9**
**indirect measurement**
measurement of motion environment by different motion quantities, such as acceleration or roll velocity



**3.10**
**direct measurement**
measurement of actual passenger reactions, for example by asking passengers to fill in a questionnaire



**3.11**
**vehicle assessment with respect to ride comfort**
identifying the vehicle's contribution to the ride comfort by relating the measured ride comfort to the condition of the track (geometry, irregularities, turnout, bridges, etc.) and operation condition (speed, cant deficiency, etc.)

**3.12**
**test section**
part of a line used for the comfort test

**3.13**
**test zone**
continuous five-minute period, which is used for Mean Comfort evaluation

**3.14**
**five-second time period**
sampling period, of which 60 forms the test zone

**3.15**
**reference system**
local reference system for a vehicle body is defined through:

Origin: on the floor of the vehicle body, in the central position between the two body-bogie centre pivots (existing or ideally defined)

Axis:

— x-axis: longitudinal

— y-axis: lateral

— z-axis: vertical

Roll motions $(\varphi)$ are defined as rotation around the x-axis.

For human body reference system, right hand system is used with vertical direction defined upwards.

A more detailed definition of the reference system is given in Annex A.

## 4 Symbols, units and abbreviations

Table 1 defines the symbols, units and abbreviations used in this standard.

**Table 1 — Symbols, units and abbreviation**

| General parameters | | | |
|---|---|---|---|
| **Parameter** | **Symbol** | | **Unit** |
| Time | $t$ | | [s] |
| Time period | $T$ | | [s] |
| Integration variable | $\tau$ | | [s] |
| Vehicle speed | $V$ | | [km/h] |
| Frequency | $f$ | | [Hz] |
| Interface, the floor (Plancher in French) | $P$ | | [-] |
| Interface, the seat pan (Assise in French) | $A$ | | [-] |
| Interface, the seat back (Dossier in French) | $D$ | | [-] |
| Frequency weighting curve for vertical direction | $W_b$ | | [-] |
| Frequency weighting curve for longitudinal direction (backrest), | $W_c$ | | [-] |
| Frequency weighting curve for lateral/longitudinal direction, | $W_d$ | | [-] |
| Low-pass filter | $W_p$ | | [-] |
| n-tile | $k$ | | [-] |
| Percentile | $n$ | | [%] |
| Number of samples | $N$ | | [-] |
| Imaginary unit | $i$ | | [-] |
| Root mean square | rms | | [-] |
| **Parameter** | **Longitudinal axis** | **Lateral Axis** | **Vertical Axis** |
| **Translational Accelerations on running gear [m/s$^2$]** | | | |
| Wheel set *i* | – | $\ddot{y}_i$ | – |
| **Translational Accelerations in vehicle body [m/s2]** | | | |
| Leading end of passenger compartment | – | $\ddot{y}^*_{EI}$ | $\ddot{z}^*_{EI}$ |
| Over leading bogie | – | $\ddot{y}^*_{I}$ | $\ddot{z}^*_{I}$ |
| Body centre | $\ddot{x}^*_{M}$ | $\ddot{y}^*_{M}$ | $\ddot{z}^*_{M}$ |

**Table 1** *(continued)*

| Parameter | Longitudinal axis | Lateral Axis | Vertical Axis |
|---|---|---|---|
| Over trailing bogie | – | $\ddot{y}^{*}_{\mathrm{II}}$ | $\ddot{z}^{*}_{\mathrm{II}}$ |
| Trailing end of passenger compartment | – | $\ddot{y}^{*}_{EII}$ | $\ddot{z}^{*}_{\mathrm{EII}}$ |
| Floor, rms | $a_{\mathrm{XP}}$ | $a_{\mathrm{YP}}$ | $a_{\mathrm{ZP}}$ |
| **Translational Weighted accelerations [m/s2]** | | | |
| Seat, weighted $W_c$, $W_b$ | $\ddot{x}^{*}_{\mathrm{D,Wc}}$ | – | $\ddot{z}^{*}_{\mathrm{A,Wb}}$ |
| Vehicle body, weighted $W_d$, $W_b$ | $\ddot{x}^{*}_{\mathrm{P,Wd}}$ | $\ddot{y}^{*}_{\mathrm{P,Wd}}$ | $\ddot{z}^{*}_{\mathrm{P,Wb}}$ |
| Vehicle body, weighted $W_p$ | – | $\ddot{y}^{*}_{\mathrm{P,Wp}}$ | – |
| Seat, weighted $W_c$, $W_d$, $W_b$, rms | $a^{\mathrm{W_c}}_{\mathrm{XD}}$ | $a^{\mathrm{W_d}}_{\mathrm{YA}}$ | $a^{\mathrm{W_b}}_{\mathrm{ZA}}$ |
| Floor, weighted $W_d$, $W_b$, rms | $a^{\mathrm{W_d}}_{\mathrm{XP}}$ | $a^{\mathrm{W_d}}_{\mathrm{YP}}$ | $a^{\mathrm{W_b}}_{\mathrm{ZP}}$ |
| Floor, Weighted $W_d$, $W_b$, rms, 50th percentile | $a^{\mathrm{W_d}}_{\mathrm{XP50}}$ | $a^{\mathrm{W_d}}_{\mathrm{YP50}}$ | $a^{\mathrm{W_b}}_{\mathrm{ZP50}}$ |
| Seat, weighted $W_c$, $W_d$, $W_b$, rms, 95th percentile | $a^{\mathrm{W_c}}_{\mathrm{XD95}}$ | $a^{\mathrm{W_d}}_{\mathrm{YA95}}$ | $a^{\mathrm{W_b}}_{\mathrm{ZA95}}$ |
| Floor, weighted $W_d$, $W_b$, rms, 95th percentile | $a^{\mathrm{W_d}}_{\mathrm{XP95}}$ | $a^{\mathrm{W_d}}_{\mathrm{YP95}}$ | $a^{\mathrm{W_b}}_{\mathrm{ZP95}}$ |
| One-second average | – | $\ddot{y}_{\mathrm{1s}}(t)$ | – |
| Two-second average | – | $\ddot{y}_{\mathrm{2s}}(t)$ | – |
| Peak to peak | – | $\ddot{y}_{\mathrm{pp}}(t)$ | – |
| One-second average, maximum absolute value | – | $\lvert\ddot{y}_{\mathrm{1s}}\rvert_{\mathrm{max}}$ | – |
| Two-second average, absolute value | – | $\lvert\ddot{y}_{\mathrm{2s}}(t)\rvert$ | – |
| **Translational jerk in vehicle body [m/s$^3$]** | | | |
| One-second average | – | $\dddot{y}_{\mathrm{1s}}(t)$ | – |
| One-second average, maximum absolute value | – | $\lvert\dddot{y}_{\mathrm{1s}}\rvert_{\mathrm{max}}$ | – |
| **Angular velocity in vehicle body [rad/s]** | | | |
| Body | $\dot{\varphi}^{*}(t)$ | – | – |
| Weighted $W_p$ | $\dot{\varphi}^{*}_{\mathrm{Wp}}(t)$ | – | – |
| One-second average | $\dot{\varphi}_{\mathrm{1s}}(t)$ | – | – |
| One-second average, maximum absolute value | $\lvert\dot{\varphi}_{\mathrm{1s}}\rvert_{\mathrm{max}}$ | – | – |

**Table 1** *(continued)*

| **Parameter** | **Longitudinal axis** | **Lateral Axis** | **Vertical Axis** |
|---|---|---|---|
| **Comfort indexes [-]** | | | |
| Mean Comfort Standard Method | $N_{MV}$ | | |
| Mean Comfort Standard Method, partial index | $N_{MVx}$ | $N_{MVy}$ | $N_{MVz}$ |
| Mean Comfort Complete Method, seated passenger (in French: VA=voyageur assis) | $N_{VA}$ | | |
| Mean Comfort Complete Method, standing passenger (in French: VD=voyageur debout) | $N_{VD}$ | | |
| Continuous Comfort | $C_{Cx}$ | $C_{Cy}$ | $C_{Cz}$ |
| Comfort on Curve Transitions | $P_{CT}$ | | – |
| Comfort on Discrete Events | – | $P_{DE}$ | – |

| **Constants for Passenger Comfort on curve transitions and discrete events** | | |
|---|---|---|
| **Parameter** | **Symbol** | **Unit** |
| Constant in acceleration component in Curve Transitions | $A$ | [s²/m] |
| Constant in acceleration component in Curve Transitions | $B$ | [s³/m] |
| Constant in acceleration component in Curve Transitions | $C$ | [-] |
| Constant in roll velocity component in Curve Transitions | $D$ | [s/rad] |
| Constant in roll velocity component in Curve Transitions | $E$ | [-] |
| Constant in acceleration component in Discrete Events | $a$ | [s²/m] |
| Constant in acceleration component in Discrete Events | $b$ | [s²/m] |
| Constant in acceleration component in Discrete Events | $e$ | [-] |

| **Transfer functions** | | |
|---|---|---|
| **Parameter** | **Symbol** | **Unit** |
| Corner frequencies, n=1,2,3,4,5,6 | $f_n$ | [Hz] |
| Resonant quality factors, n=1,2,3,4 | $Q_n$ | [-] |
| Gain | $K$ | [-] |
| High pass transfer function | $H_h(f)$ | [-] |
| Low pass transfer function | $H_l(f)$ | [-] |
| Acceleration to velocity transfer function | $H_t(f)$ | [-] |
| Upward gradient transfer function | $H_s(f)$ | [-] |

# 5 General description

## 5.1 General

The comfort of passengers in a railway vehicle is influenced by a number of different factors (temperature, noise, vibration, etc.). This standard considers only that part of the comfort influenced by the vibrations and motions of the vehicle. This is described as ride comfort or as passenger comfort. The standard can also be used for vehicle assessment with respect to ride comfort.

This standard defines as the Standard Method:

a) The Standard Method for Mean Comfort evaluation, taking into account the effects of vibration exposure measured on the floor of the vehicle body.

This standard also defines several methods for special applications:

b) taking into account the short time effects of vibration exposure measured on the floor of the vehicle body as Continuous Comfort for the longitudinal, lateral, and vertical direction;

c) taking into account the vibration exposure measured on the seat or other interfaces on ride comfort as the Complete Method for Mean Comfort evaluation;

d) taking into account the effects of:

   1) discrete events (Comfort on Discrete Events) and

   2) running on curve transitions (Comfort on Curve Transitions) on ride comfort.

e) taking into account the vibration exposure measured on the floor of the vehicle body for the purpose of vehicle assessment with respect to ride comfort.



## 5.2 Passenger exposure to vibrations

Railway transport exposes passengers to vibrations related to the dynamic motions of the vehicle body.

The motions of the vehicle body transmit their effects to the human body through the following interfaces:

a) in the standing position:

   1) floor – feet

b) in the seated position:

   1) headrest – neck

   2) arm rest – arms

   3) seat – hip

   4) backrest – back

   5) floor – feet

The type of transmission is whole-body transmission which acts on the whole body through the interfaces.

## 5.3 Application

Table 2 lists the items included or excluded from this standard:

**Table 2 — Items considered by this standard**

| Item | Included | Excluded |
|---|---|---|
| Effects of vibration exposure | — on ride comfort<br>— on vehicle assessment with respect to ride comfort | — on health<br>— on activities<br>— on motion sickness |
| Vibration transfer | — on whole body through interfaces<br>— through floor interface | — on single body part<br>— on whole surface |
| Test procedure | — definitions<br>— reference system<br>— requirements<br>— measurement and evaluation rules<br>— report guidance | — notes or attributes related to service quality and/or passenger expectation<br>— limiting values |
| Posture and activities of passenger | — standing<br>— seated | — lying<br>— performing specific actions (reading, writing etc.) |
| Type of measurement | — indirect measurement, i.e. measurement of motion environment by different motion quantities | — direct measurements (by asking test subjects)<br>— combined measurements |



## 5.4 Characteristics of railway vehicle motions

The basic typical motion characteristics, referred to the type of measurement and evaluation, are:

a) Different properties, depending on the type of evaluation:

   1) quasi-stationary (Mean Comfort)

   2) non-stationary (Comfort on Curve Transitions and Comfort on Discrete Events).

b) The frequency range of motions expected in rail vehicles includes, in the lateral direction:

   1) up to 15 Hz: due to track characteristics, vehicle body swing-roll and yaw modes at lower frequencies, and suspensions characteristics and vehicle body modes at higher frequencies;

c) The frequency range of motions expected in rail vehicles includes, in the vertical direction:

   1) up to 40 Hz: due to track characteristics, suspensions characteristics, wheel defects, vehicle body modes;

d) Range of frequencies from 0 Hz (quasi-static) to 2 Hz for Comfort on Curve Transitions and for Discrete Events.

## 5.5 Ride comfort

The ride comfort for passengers is the complex sensation, produced on the passenger by the vehicle body motions of the railway vehicle, transmitted to the whole body through the interfaces.