

**Raudteealased rakendused. Reisijate
sõidumugavus. Mõõtmine ja hindamine**

Railway applications - Ride comfort for passengers -
Measurement and evaluation

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

Käesolev Eesti standard EVS-EN 12299:2009 sisaldab Euroopa standardi EN 12299:2009 ingliskeelset teksti.

Standard on kinnitatud Eesti Standardikeskuse 29.05.2009 käskkirjaga ja jõustub sellekohase teate avaldamisel EVS Teatajas.

Euroopa standardimisorganisatsioonide poolt rahvuslikele liikmetele Euroopa standardi teksti kättesaadavaks tegemise kuupäev on 08.04.2009.

Standard on kättesaadav Eesti standardiorganisatsioonist.

This Estonian standard EVS-EN 12299:2009 consists of the English text of the European standard EN 12299:2009.

This standard is ratified with the order of Estonian Centre for Standardisation dated 29.05.2009 and is endorsed with the notification published in the official bulletin of the Estonian national standardisation organisation.

Date of Availability of the European standard text 08.04.2009.

The standard is available from Estonian standardisation organisation.

ICS 45.060.20

Võtmesõnad: measurement, passenger transport, physiological effects, railway equipment, railway rolling stock, vibration severity, vibrations

Standardite reprodutseerimis- ja levitamiseõigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonilisse süsteemi või edastamine ükskõik millises vormis või millisel teel on keelatud ilma Eesti Standardikeskuse poolt antud kirjaliku loata.

Kui Teil on küsimusi standardite autorikaitse kohta, palun võtke ühendust Eesti Standardikeskusega:
Aru 10 Tallinn 10317 Eesti; www.evs.ee; Telefon: 605 5050; E-post: info@evs.ee

English Version

Railway applications - Ride comfort for passengers - Measurement and evaluation

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

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

Foreword.....	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols, units and abbreviations	9
5 General description	12
5.1 General.....	12
5.2 Passenger exposure to vibrations	12
5.3 Application	12
5.4 Characteristics of railway vehicle motions	13
5.5 Ride comfort.....	13
5.6 Direct and indirect measurements.....	14
5.7 Summary table of procedures	14
5.8 Application of comfort indices	15
6 Mean Comfort and Continuous Comfort	15
6.1 General.....	15
6.2 Base of the method.....	16
6.3 Methodology.....	16
6.4 Test conditions	17
6.4.1 General.....	17
6.4.2 Selection of test sections	17
6.4.3 Test speed	17
6.4.4 Wheel-rail contact geometry.....	17
6.4.5 Vehicle condition	17
6.5 Parameters to be measured.....	17
6.5.1 General.....	17
6.5.2 Location of measuring points	17
6.5.3 Filtering	18
6.6 Definition of intermediate quantities	19
6.6.1 Symbols and indices	19
6.6.2 Rms-values of weighted accelerations.....	20
6.6.3 95th and 50th percentiles.....	20
6.7 Definition of comfort indexes	20
6.7.1 Continuous Comfort.....	20
6.7.2 Mean Comfort Standard Method	21
6.7.3 Mean Comfort Complete Method	21
6.8 Test report	21
7 Comfort on Curve Transitions	21
7.1 General.....	21
7.2 Base of the method.....	22
7.3 Methodology.....	22
7.4 Test conditions	22
7.4.1 General.....	22
7.4.2 Selection of test sections	22
7.4.3 Test speed	23
7.4.4 Wheel-rail contact geometry.....	23
7.4.5 Vehicle condition	23
7.5 Parameters to be measured.....	23
7.5.1 General.....	23
7.5.2 Location of measuring points	23
7.5.3 Filtering	23
7.6 Definition of intermediate quantities	23
7.6.1 Symbols and indices	23

7.6.2	Averaging procedure.....	24
7.6.3	Identification of transition periods	24
7.6.4	Intermediate quantities	25
7.7	Definition of comfort index P_{CT}	25
7.8	Test report	25
7.9	Example diagrams	26
8	Comfort on Discrete Events	28
8.1	General.....	28
8.2	Base of the method	28
8.3	Methodology	28
8.4	Test conditions	29
8.4.1	General.....	29
8.4.2	Selection of test sections	29
8.4.3	Test speed	29
8.4.4	Wheel-rail contact geometry	29
8.4.5	Vehicle condition	29
8.5	Parameters to be measured	29
8.5.1	General.....	29
8.5.2	Location of measuring points	29
8.5.3	Filtering.....	29
8.6	Definition of intermediate quantities	30
8.6.1	Symbols and indices	30
8.6.2	Averaging procedure.....	30
8.6.3	Intermediate quantities	30
8.7	Definition of comfort index P_{DE}	31
8.8	Test report	31
8.9	Example diagrams	31
9	Guide for the interpretation of the results (Informative)	31
9.1	General.....	31
9.2	Mean Comfort.....	32
9.3	Continuous Comfort.....	32
9.4	Comfort on Curve Transitions.....	32
9.5	Comfort on Discrete Events	33
Annex A	(normative) Reference system	34
Annex B	(normative) Measurement techniques.....	36
B.1	General.....	36
B.2	Measuring equipment.....	36
B.2.1	General.....	36
B.2.2	Accelerometers and processing amplifiers	36
B.2.3	Recording equipment.....	37
B.2.4	Fixing transducers to the floor.....	37
B.3	Seat measuring devices and their applications	37
Annex C	(normative) Weighting curves	40
C.1	General.....	40
C.2	Filter functions	40
C.2.1	General.....	40
C.2.2	Band-limiting filter	41
C.2.3	Acceleration to velocity transition	41
C.2.4	Upward gradient	41
C.2.5	Overall frequency weighting	41
C.2.6	Reduction of the upper limit of the frequency range in vertical direction.....	42
C.3	Tolerances	42
C.4	Diagrams	44
Annex D	(informative) Presentation of test report.....	47
D.1	General.....	47
D.2	Aim of test	47
D.3	Test performer	47
D.4	References	47

D.5	Test conditions	47
D.5.1	General information.....	47
D.5.2	Vehicle	47
D.5.3	Seat (for Mean Comfort Complete Method)	48
D.5.4	Seat occupant (for Mean Comfort Complete Method)	48
D.5.5	Track	48
D.5.6	Speed profile	48
D.5.7	Test configurations.....	48
D.6	Measurements and processing	48
D.6.1	Measurements.....	48
D.6.2	Processing.....	49
D.7	Report on Mean Comfort and Continuous Comfort	49
D.7.1	General.....	49
D.7.2	Time series	49
D.7.3	Statistical results	49
D.7.4	Comfort evaluation	49
D.7.5	Spectral analyses.....	49
D.7.6	Examples of diagrams.....	50
D.8	Report on comfort in curve transitions	53
D.9	Reporting on Comfort on Discrete Events	53
Annex E	(normative) Vehicle assessment with respect to Mean Comfort Standard Method	55
E.1	General.....	55
E.2	Track geometric quality	55
E.3	Test conditions	55
E.3.1	Selection of test sections and test zones	55
E.3.2	Test speed	56
E.3.3	Wheel-rail contact geometry.....	56
E.3.4	Vehicle condition	56
E.4	Acceptable modifications of the methods for Mean Comfort evaluation	56
E.5	Test report	57
Annex F	(informative) Guideline for the application of direct tests	58
Annex G	(informative) Workflow for numerical integration	59
Annex H	(informative) Determining quantities.....	60
Bibliography		62
Figures		
Figure 1	— Locations of measuring points Passenger coach (Conventional or articulated).....	18
Figure 2	— Location of measuring points Double-Deck vehicle (Conventional or articulated)	18
Figure 3	— Interpretation of the terms, $ \ddot{y}_{1s} _{\max}$ and $ \ddot{y}_{1s} _{\max}$ in the P_{CT} formula	26
Figure 4	— Interpretation of the term $ \dot{\phi}_{1s} _{\max}$ in the P_{CT} formula	27
Figure 5	— Relevant time periods A_i on curve transition.....	27
Figure 6	— Interpretation of $ \ddot{y}_{2s}(t) $ and $\ddot{y}_{pp}(t)$ for calculation of P_{DE}	31
Figure A.1	— Local reference system for a vehicle body.....	34
Figure A.2	— Local reference systems for a person in a seated position.....	35
Figure A.3	— Local reference system for a person in standing position	35
Figure B.1	— Seat pan measuring device (for y- and z-direction).....	37
Figure B.2	— Seat pan measuring device	38
Figure B.3	— Seat back measurement device	39
Figure C.1	— Tolerances for W_b	42

Figure C.2 — Tolerances for W_c	43
Figure C.3 — Tolerances W_d	43
Figure C.4 — Tolerances for W_p	44
Figure C.5 — Magnitude of the alternative frequency weighting W_b for vertical vibration along the z-axis on the floor and seat pan	44
Figure C.6 — Magnitude of the frequency weighting W_c for horizontal vibration along the x-axis, for the seat back	45
Figure C.7 — Magnitude of the frequency weighting W_d for horizontal vibration along the x- or y-axis on the floor, or along the y-axis on the seat pan	45
Figure C.8 — Magnitude of the frequency weighting W_p for lateral acceleration for P_{CT} and P_{DE} , and for roll velocity for P_{CT} evaluation	46
Figure D.1 — Continuous Comfort - Collection of five-minute periods (selected periods marked grey)	50
Figure D.2 — Example of Continuous Comfort and statistical distribution for a five-minute period	51
Figure D.3 — Example of weighted (bold line) and un-weighted (thin line) power spectral density of floor level acceleration in x, y and z directions (Duration: 307,2 s / Sampling rate: 400 Hz / FFT : 2048 points)	52
Figure D.4 — Example of time series for P_{DE} evaluation	54
Tables	
Table 1 — Symbols, units and abbreviation	9
Table 2 — Items considered by this standard	13
Table 3 — Motion quantities and measurement position for estimation of ride comfort	14
Table 4 — Specification of different comfort indices for estimations of ride comfort and Vehicle assessment with respect to ride comfort	15
Table 5 — Guidance to use the different comfort indices for other applications	15
Table 6 — Constants for P_{CT} comfort index	25
Table 7 — Constants for P_{DE} comfort index	31
Table 8 — Scale for the N_{MV} comfort index	32
Table 9 — Preliminary scale for the $C_{cy}(t)$ and $C_{cz}(t)$ comfort indexes	32
Table B.1 — Frequency range for the global transfer function	36
Table C.1 — Weighting curves	40
Table C.2 — Parameters and transfer functions of the frequency weightings	40
Table C.3 — Tolerances on weighting curves	42
Table H.1 — Determining quantities for Mean Comfort	60
Table H.2 — Determining quantities for Comfort in Curve Transitions and Discrete Events	61

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*