



BSI Standards Publication

Railway applications — Track — Railbound construction and maintenance machines

Part 1: Technical requirements for running

National foreword

This British Standard is the UK implementation of EN 14033-1:2017. It supersedes BS EN 14033-1:2011, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RAE/2, Railway Applications - Track.

A list of organizations represented on this committee can be obtained on request to its secretary.

The UK committee draws users' attention to the distinction between normative and informative elements, as defined in Clause 3 of the CEN/CENELEC Internal Regulations, Part 3.

Normative: Requirements conveying criteria to be fulfilled if compliance with the document is to be claimed and from which no deviation is permitted.

Informative: Information intended to assist the understanding or use of the document. Informative annexes do not contain requirements, except as optional requirements, and are not mandatory. For example, a test method may contain requirements, but there is no need to comply with these requirements to claim compliance with the standard.

The UK committee draws users' attentions to Annex C, which is erroneously shown as 'Normative'. The committee suggests that Annex C is informative because it is referred to in subclause 20.3.1 c) as an example, therefore making it not mandatory.

The UK committee draws users' attentions to Annex B, Table B.1, line 12, where the minimum energised overhead contact line height is shown as 4190 mm. It should be noted that this height is for machine design purposes only; the actual minimum wire height in some locations is lower than this, but special operational rules cover these areas.

The UK committee would also like to highlight that subclause 11.2 of BS EN 14033-1:2017 makes reference to Figure A.11 in EN 50238-1:2003. Unfortunately, BS EN 50238-1:2003 has an error in numbering and the correct figure, which should be used as a reference, is titled Figure A.22, Sensitive zone of wheel detector, in BS EN 50238-1:2003.

When speeds in km/h require unit conversion for use in the UK, users are advised to use equivalent values rounded to the nearest whole number. The use of absolute values for converted units should be avoided in these cases. Please refer to the table below for agreed conversion figures:

INS, RST and ENE speed conversions	
km/h	mph
5	3
10	5
20	10
30	20
80	50

INS, RST and ENE speed conversions	
km/h	mph
160	100
190	120

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Amendments/corrigenda issued since publication

Date	Text affected
31 October 2017	Missing text added to National foreword
30 April 2018	Further information added to National foreword

English Version

Railway applications - Track - Railbound construction and maintenance machines - Part 1: Technical requirements for running

Applications ferroviaires - Voie - Machines de construction et de maintenance empruntant exclusivement les voies ferrées - Partie 1 : Prescriptions techniques pour la circulation

Bahnanwendungen - Oberbau - Schienengebundene Bau- und Instandhaltungsmaschinen - Teil 1: Technische Anforderungen an das Fahren

This European Standard was approved by CEN on 2 October 2016.

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Contents

Page

European foreword.....	7
Introduction	10
1 Scope	11
2 Normative references	11
3 Terms and definitions	15
4 Machine categorization.....	16
4.1 General rules.....	16
4.2 Demountable modules	16
5 Rolling stock gauge.....	17
5.1 General rules.....	17
5.2 Stowing of moveable machine parts in running positions	17
5.2.1 Component locks	17
5.2.2 Exemption from locking	17
5.2.3 Secondary support.....	17
5.2.4 Indication of locked state	18
5.2.5 Running.....	18
6 Frame.....	18
6.1 Design of the machine frame and attachments	18
6.2 Lifting and jacking points.....	18
6.3 Hook for stowage on boats and for towing	19
7 Bogie and running gear.....	20
7.1 General.....	20
7.2 Structural design	21
7.2.1 Structural design of the bogie frame.....	21
7.2.2 Other components	21
7.3 Wheel diameter	21
7.4 Static axle loading	22
7.5 Wheel profile	22
7.6 Shape and dimensions of the axles and wheelsets.....	22
7.7 Machine mass measurement.....	24
7.7.1 Axle arrangement and axle loads	24
7.7.2 Operational mass of the machine.....	25
7.7.3 Maximum mass of the machine without payload	26
7.7.4 Maximum mass of the machine with payload.....	26
7.7.5 Weighing method	26
7.8 Design for longitudinal compressive forces.....	27
7.9 Lifeguards	27
7.10 Obstacle deflector	28
8 Running safety.....	28
8.1 Running tests	28
8.2 Running safety on track twists	29
8.3 Running simulation	29
9 Brakes.....	29

9.1	Mandatory braking equipment	29
9.2	Characteristics	31
9.2.1	Performance	31
9.2.2	Brake testing	31
9.2.3	Mechanical characteristics of the brake	32
9.2.4	Automatic compressed air brake	33
9.2.5	Direct brake	34
9.2.6	Brake functions to keep a machine stationary	35
9.2.7	Dynamic brake	36
9.2.8	Emergency brake	36
9.2.9	Brake distributor controls	37
9.2.10	Other brake systems	37
9.3	Air reservoirs	37
9.4	Compressed air production of self-propelled machines	38
9.5	Brake hose connections	38
9.6	Special braking equipment	38
10	Buffing and draw gear	39
10.1	General	39
10.2	Conventional connection between machines/vehicles	39
10.2.1	Couplings	39
10.2.2	Buffers	39
10.2.3	Interaction of buffers and screw couplings	39
10.3	Connection between machines/vehicles	40
10.4	Interaction forces between the machine and coupled vehicles	41
10.5	Space to be kept free at the end of the machine	41
10.6	Shunters' handrail	42
10.7	Shunters' step	42
11	Operation of track circuits, axle-counters, treadles for level crossings, hot box detectors and unreleased brake detectors	42
11.1	Operation of track circuits	42
11.2	Operation of axle-counters and treadles for level crossings	42
11.3	Operation of hot axle box and unreleased brake detectors	43
11.4	On board hot box detection	43
11.5	Operation of other signalling systems	43
12	Running safety equipment	43
12.1	Indication equipment	43
12.2	Data recorder	43
13	Warning equipment and lights	43
13.1	Warning horns	43
13.1.1	Audibility	43
13.1.2	Warning horn sound pressure level	44
13.1.3	Protection	44
13.2	Headlights	44
13.3	Lamp brackets and marker lights	44
13.3.1	Lamp brackets	44
13.3.2	Arrangement of marker lights	46
13.3.3	Additional devices	47
13.3.4	Light switching arrangements	47
14	Drivers cabs and driving positions	47
14.1	General	47
14.2	Access to cab	47

14.2.1	General.....	47
14.2.2	Steps, handrails, platforms and railings.....	48
14.2.3	Doors.....	48
14.3	Interior of cab.....	48
14.3.1	Driver's position.....	48
14.3.2	Additional seats.....	48
14.3.3	Layout of driver's cab(s).....	49
14.3.4	Windscreens and forward facing windows.....	49
14.3.5	Other glazing.....	49
14.3.6	Cab side windows.....	49
14.4	Heating, cooling and ventilation.....	50
14.5	Internal lighting.....	50
14.6	Area of visibility.....	50
14.7	Driver's desks.....	51
14.8	Controls and indicators.....	51
14.9	Driver's and assistant's seats.....	52
14.10	Equipment and controls.....	52
14.10.1	Minimum equipment necessary for the driving of the machine.....	52
14.10.2	Equipment necessary for the monitoring of the machine.....	53
14.10.3	Arrangement of instruments for the driver's assistant.....	53
14.10.4	Miscellaneous accessories.....	53
14.11	Driver's vigilance device.....	53
15	Safety design features.....	54
15.1	Electrical protection measures.....	54
15.2	Mechanical protection measures.....	55
15.3	Fire protection.....	55
15.3.1	Material requirements.....	55
15.3.2	Specific measures for flammable liquids.....	55
15.3.3	Portable fire extinguishers.....	55
15.3.4	Fire detection and suppression systems.....	55
15.3.5	Driver's cab emergency exit.....	55
15.3.6	Floors.....	55
15.4	Personnel protection.....	55
15.5	Electromagnetic compatibility.....	56
16	Environmental conditions.....	56
16.1	General.....	56
16.2	Carriage and storage of fuel and oil.....	56
16.3	Tanks and equipment.....	56
16.3.1	Fuel tanks and pipework.....	56
16.3.2	Hydraulic oil circuit.....	57
16.4	Power equipment.....	57
17	Aerodynamic effects.....	57
17.1	Cross wind.....	57
17.2	Slipstream effect of machines with maximum speed greater than 160 km/h.....	57
17.3	Head pressure pulse.....	58
18	Design for recovery purposes.....	58
19	Machine marking.....	59
19.1	Lettering on the machine.....	59
19.2	Machine identification number.....	59
19.3	Details of the railway infrastructure where the machine is allowed to run.....	59

20	User information.....	59
20.1	General	59
20.2	Data for inclusion in National Vehicle Register	60
20.3	Instruction Handbook.....	63
20.3.1	Technical documentation	63
20.3.2	Technical documentation for operators	65
20.4	Maintenance instructions.....	67
20.4.1	Maintenance schedule	67
20.4.2	Maintenance manual	67
Annex A (normative)	Application of technical requirements to machines categories	69
Annex B (normative)	Special national conditions	74
Annex C (normative)	Machine diagram with gauge and critical points.....	86
Annex D (normative)	Free space at the end of the machine	87
Annex E (informative)	Steps, handrails and door handles	89
Annex F (informative)	Identification plate.....	90
Annex G (normative)	Marking	91
Annex H (normative)	On board safety equipment.....	93
Annex I (informative)	Structure of European Standards for track construction and maintenance machines.....	101
Annex J (informative)	Clause by clause comparison with Commission Regulation (EU) No 1302/2014 (Loc&Pas TSI).....	103
Annex ZA (informative)	Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC	107
Bibliography		112

Tables

Table 1 — Machine categories by maximum running speed	16
Table 2 — Static axle loading.....	22
Table 3 — Wheelset dimension	23
Table 4 — Distance between wheelsets.....	25
Table 5 — Compulsory braking equipment	30
Table 6 — Minimum compressed air production for the number of braked wheelsets.....	38
Table 7 — Limit criteria for slipstream effects on passengers on platform and on workers trackside	58
Table A.1 — Application of technical requirements to machines categories	70
Table B.1 — Special national conditions	79
Table G.1 — Marking	91
Table H.1 — On board safety equipment.....	93
Table I.1 — Structure of European standards for track construction and maintenance machines	102

Table J.1 — Clause by clause comparison with Commission Regulation (EU) No 1302/1014 (Loc&Pas TSI)	103
Table ZA.1 — Correspondence between this European Standard, the Commission Regulation (EU) No 1302/2014 of 18 November 2014 concerning a technical specification for interoperability relating to the ‘rolling stock — locomotives and passenger rolling stock’ subsystem of the rail system in the European Union published in the Official Journal L356/228 on 12/12/2014 and Directive 2008/57/EC	108
Table ZA.2 — Correspondence between this European Standard, the Commission Decision 2012/88/EU of 25 January 2012 on the technical specification for interoperability relating to the control-command and signalling subsystems of the trans-European rail system published in the Official Journal L 51/1 on 23/2/2012 and Directive 2008/57/EC.....	109
Table ZA.3 — Correspondence between this European Standard, Commission Regulation (EU) No 1304/2014 of 26 November 2014 on the technical specification for interoperability relating to the subsystem ‘rolling stock — noise’ amending Decision 2008/232/EC and repealing Decision 2011/229/EU - published in the Official Journal L356/421 on 12/12/2014 and Directive 2008/57/EC	110
Table ZA.4 — Correspondence between this European Standard, the Commission Decision (EU) No 2011/314/EU of 12 May 2011 concerning the technical specification for interoperability relating to the ‘operation and traffic management’ subsystem of the trans-European conventional rail system - published in the Official Journal L 144/1 on 31/5/2011 and Directive 2008/57/EC	111
 Figures	
Figure 1 — Stowage and towing hook.....	20
Figure 2 — Wheelset dimensions	24
Figure 3 — Distance between buffer and drawhook	40
Figure 4 — Tail signal lamp brackets.....	45
Figure 5 — Tail signal lamps, required space – envelope.....	46
Figure 6 — Control directions.....	51
Figure C.1 — Machine diagram with gauge and critical points.....	86
Figure D.1 — Free space at the end of the machine	87
Figure D.2 — ISO 7010-W019 "Warning; Crushing"	88
Figure E.1 — Steps, handrails and door handles.....	89
Figure F.1 — Identification plate	90
Figure I.1 —Flowchart of European standards for track construction and maintenance machines	101

European foreword

This document (EN 14033-1:2017) 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 November 2017, and conflicting national standards shall be withdrawn at the latest by November 2017.

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 EN 14033-1:2011.

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 EU Directive 2008/57/EC.

For relationship with EU Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document.

This series of standards EN 14033, *Railway applications — Track — Railbound construction and maintenance machines*, consists of the following parts:

- *Part 1: Technical requirements for running;*
- *Part 2: Technical requirements for travelling and working;*
- *Part 3: General safety requirements.*

Amended clauses compared to EN 14033-1:2011:

General	All references updated to latest issue
3.3	Inspection vehicles recognized as an additional type of railbound machine
3.8 to 3.10	Different modes of machine defined
4.2	New section on demountable modules added
5.1	Requirement for reference profile to be marked
5.2.5	Additional requirements for prevention of operation of locks in running mode
6.1	Clarification added concerning machine attachments and when fatigue calculations are required
6.3	Recognition that stowage hooks also used for towing
7.2	New requirements for structural design of bogies added
7.6	Wheelsets required to comply with ENs and dimensions mandated
7.7	New section on machine mass measurement added
7.9	Requirements for when lifeguards fitted and design forces reduced
7.10	New section on obstacle deflectors aligned with requirements of TSI

Clause 8	Running safety section amended to align with latest edition of EN 14363
Clause 9	Brakes section extensively modified to align with requirements of emerging ENs and TSI, and to clarify testing
Clause 10	Alternative buffing and drawgear now permitted and requirements added
10.5	Marking of machine required where Berne rectangle not achieved
10.6 & 10.7	Clarity added when shunters handrail and step required
11.1	Dimensions of machine for operation of track machine aligned with requirements of TSI
11.3	Requirements for hot axle box detection aligned with requirements of EN 15437-1
11.4	New section on on-board hot box detection added
11.5	New section on other signalling systems added
12.2	Requirements for data recorder aligned with requirements of EN 62625-1
Clause 13	Section on warning horns and lights amended to align with requirements of TSI
14.2.2	Position of handrails no longer mandated, handrails to comply with EN 14033-3
14.2.3	Section on doorways amended to align with requirements of TSI
14.3.4	All forward facing windows now windscreens but reduced requirements from EN 15152 to only certain clauses
14.3.5	Reduced requirements for side windows and other glazing now included
14.6	Area of visibility requirements relaxed
14.8	Section on controls and indicators amended to align with requirements of TSI
14.10.1	Requirements for sanding and brake gauges added
14.10.4	Requirement for storage of tools added
14.11	New section on driver's vigilance device added
15.3	Section on fire precaution amended to align with requirements of TSI
15.4	New requirement for front end to be yellow added
16.1	New requirement to demonstrate compliance to environmental conditions where there is no previous experience
16.3	Requirements for fuel tank amended
Clause 17	New section on aerodynamic effects added
Clause 18	New section on design for recovery added
Clause 19	Requirements for machine marking aligned with EN 15877-2 and use of identification plate de-mandated
Clause 20	User information extensively amended and incorporates requirements in former Annexes G and I
Annexes	All annexes reviewed and updated
Annexes E and F	Now Informative
Annex H	Now Normative

Annex J	New annex giving clause-by-clause comparison with Loc&Pas TSI
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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, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard was prepared to meet the essential requirements of EU Directives to facilitate an open market for goods and services.

This document is the first of a series of three parts of the European Standard: *Railway applications — Track — Railbound construction and maintenance machines*:

- Part 1 covers the safety and technical requirements for the machines in running mode; this is a harmonized standard with the Technical Specification for Interoperability (TSI) for Locomotives and Passenger Rolling Stock Commission decision 2011/291/EU, which itself meets the essential requirements to ensure the interoperability of the rail system as described in Article 1 of European Directive 2008/57/EC;
- Part 2 covers the railway specific requirements for the machines in working and travelling modes;
- Part 3 covers the safety requirements for the machines in working and travelling modes; this is a harmonized standard with the European Machinery Directive 2006/42/EC.

The risks that exist in all mechanical, electrical, hydraulic, pneumatic and other components of machines and which are dealt with in the relevant European Standards are not within the scope of this European Standard. Where necessary, references are made to appropriate standards of this type.

1 Scope

This European Standard defines the specific technical railway requirements for running of machines and other vehicles used for construction, maintenance and inspection of track, structures, track formation and fixed electric traction equipment. Special national conditions applicable to specific member states are shown in Annex B.

This European Standard applies to all railbound machines and other vehicles – referred to as machines – running exclusively on the railway (utilizing adhesion between the rail and wheels) and used for construction, maintenance and inspection of track, structures, infrastructure and fixed electric traction equipment.

This European Standard applies to machines that are intended to operate signalling and control systems. Other machines are dealt with in other European Standards, see Annex I.

This European Standard is written for 1 435 mm nominal track gauge; special requirements can apply for running on infrastructures with narrow gauge or broad gauge lines, urban railways, railways utilizing other than adhesion between the rail and wheels and road-rail machines which are not included in this standard.

This European Standard covers the railway specific requirements for movements of the machine as a train and movements to reach work sites.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 286-3, *Simple unfired pressure vessels designed to contain air or nitrogen — Part 3: Steel pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock*

EN 286-4, *Simple unfired pressure vessels designed to contain air or nitrogen — Part 4: Aluminium alloy pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock*

EN 10220, *Seamless and welded steel tubes — Dimensions and masses per unit length*

EN 10305-4, *Steel tubes for precision applications — Technical delivery conditions — Part 4: Seamless cold drawn tubes for hydraulic and pneumatic power systems*

EN 10305-6, *Steel tubes for precision applications — Technical delivery conditions — Part 6: Welded cold drawn tubes for hydraulic and pneumatic power systems*

EN 12080, *Railway applications — Axleboxes — Rolling bearings*

EN 12663-1:2010+A1:2014, *Railway applications — Structural requirements of railway vehicle bodies — Part 1: Locomotives and passenger rolling stock (and alternative method for freight wagons)*

EN 12663-2:2010, *Railway applications — Structural requirements of railway vehicle bodies — Part 2: Freight wagons*

EN 13103, *Railway applications — Wheelsets and bogies — Non-powered axles — Design method*

EN 13104, *Railway applications — Wheelsets and bogies — Powered axles — Design method*

- EN 13260, *Railway applications — Wheelsets and bogies — Wheelsets — Product requirements*
- EN 13261, *Railway applications — Wheelsets and bogies — Axles — Product requirements*
- EN 13262, *Railway applications — Wheelsets and bogies — Wheels — Product requirements*
- EN 13715, *Railway applications — Wheelsets and bogies — Wheels — Tread profile*
- EN 13749:2011, *Railway applications — Wheelsets and bogies — Method of specifying the structural requirements of bogie frames*
- EN 13979-1, *Railway applications — Wheelsets and bogies — Monobloc wheels — Technical approval procedure — Part 1: Forged and rolled wheels*
- EN 14033-2:2017, *Railway applications — Track — Railbound construction and maintenance machines — Part 2: Technical requirements for travelling and working*
- EN 14033-3:2017, *Railway applications — Track — Railbound construction and maintenance machines — Part 3: General safety requirements*
- EN 14067-4:2013, *Railway applications — Aerodynamics — Part 4: Requirements and test procedures for aerodynamics on open track*
- EN 14067-6:2010, *Railway applications — Aerodynamics — Part 6: Requirements and test procedures for cross wind assessment*
- EN 14198, *Railway applications — Braking — Requirements for the brake system of trains hauled by a locomotive*
- EN 14363:2016, *Railway applications — Testing and Simulation for the acceptance of running characteristics of railway vehicles — Running Behaviour and stationary tests*
- EN 14531-1:2015, *Railway applications — Methods for calculation of stopping and slowing distances and immobilization braking — Part 1: General algorithms utilizing mean value calculation for train sets or single vehicles*
- EN 14531-2, *Railway applications — Methods for calculation of stopping and slowing distances and immobilization braking — Part 2: Step by step calculations for train sets or single vehicles*
- EN 14535-1, *Railway applications — Brake discs for railway rolling stock — Part 1: Brake discs pressed or shrunk onto the axle or drive shaft, dimensions and quality requirements*
- EN 14535-2, *Railway applications — Brake discs for railway rolling stock — Part 2: Brake discs mounted onto the wheel, dimensions and quality requirements*
- EN 14601, *Railway applications — Straight and angled end cocks for brake pipe and main reservoir pipe*
- EN 15152:2007, *Railway applications — Front windscreens for train cabs*
- EN 15153-1:2013+A1:2016, *Railway applications — External visible and audible warning devices for trains — Part 1: Head, marker and tail lamps*
- EN 15153-2:2013, *Railway applications — External visible and audible warning devices for trains — Part 2: Warning horns*

- EN 15179:2007, *Railway applications — Braking — Requirements for the brake system of coaches*
- EN 15220:2016, *Railway applications — Brake indicators*
- EN 15227:2008+A1:2010, *Railway applications — Crashworthiness requirements for railway vehicle bodies*
- EN 15273-1, *Railway applications — Gauges — Part 1: General - Common rules for infrastructure and rolling stock*
- EN 15273-2:2013, *Railway applications — Gauges — Part 2: Rolling stock gauge*
- EN 15313, *Railway applications — In-service wheelset operation requirements — In-service and off-vehicle wheelset maintenance*
- EN 15329, *Railway applications — Braking — Brake block holder and brake shoe key for railway vehicles*
- EN 15355, *Railway applications — Braking — Distributor valves and distributor-isolating devices*
- EN 15437-1:2009, *Railway applications — Axlebox condition monitoring — Interface and design requirements — Part 1: Track side equipment and rolling stock axlebox*
- EN 15528, *Railway applications — Line categories for managing the interface between load limits of vehicles and infrastructure*
- EN 15551, *Railway applications — Railway rolling stock — Buffers*
- EN 15566:2016, *Railway applications — Railway rolling stock — Draw gear and screw coupling*
- EN 15595:2009+A1:2011, *Railway applications — Braking — Wheel slide protection*
- EN 15611, *Railway applications — Braking — Relay valves*
- EN 15612, *Railway applications — Braking — Brake pipe accelerator valve*
- EN 15624, *Railway applications — Braking — Empty-loaded changeover devices*
- EN 15625, *Railway applications — Braking — Automatic variable load sensing devices*
- EN 15663, *Railway applications — Definition of vehicle reference masses*
- EN 15806:2010, *Railway applications — Braking — Static brake testing*
- EN 15807, *Railway applications — Pneumatic half couplings*
- EN 15827:2011, *Railway applications — Requirements for bogies and running gears*
- EN 15839, *Railway applications — Testing for the acceptance of running characteristics of railway vehicles — Freight wagons — Testing of running safety under longitudinal compressive forces*
- EN 15877-1:2012, *Railway applications — Marking on railway vehicles — Part 1: Freight wagons*
- EN 15877-2:2013, *Railway applications — Markings of railway vehicles — Part 2: External markings on coaches, motive power units, locomotives and on track machines*

EN 16116-2, *Railway applications — Design requirements for steps, handrails and associated access for staff — Part 2: Freight wagons*

EN 16207, *Railway applications — Braking — Functional and performance criteria of Magnetic Track Brake systems for use in railway rolling stock*

EN 16404, *Railway applications — Re-railing and recovery requirements for railway vehicles*

EN 45545-2:2013+A1:2015, *Railway applications — Fire protection on railway vehicles — Part 2: Requirements for fire behaviour of materials and components*

EN 50121-3-1, *Railway applications — Electromagnetic compatibility — Part 3-1: Rolling stock - Train and complete vehicle*

EN 50121-3-2, *Railway applications — Electromagnetic compatibility — Part 3-2: Rolling stock - Apparatus*

EN 50125-1, *Railway applications — Environmental conditions for equipment — Part 1: Rolling stock and on-board equipment*

EN 50153:2014, *Railway applications — Rolling stock — Protective provisions relating to electrical hazards*

EN 50238-1:2003, *Railway applications — Compatibility between rolling stock and train detection systems — Part 1: General*

EN 62625-1:2013, *Electronic railway equipment — On board driving data recording system — Part 1: System specification (IEC 62625-1:2013)*

EN ISO 7010:2012, *Graphical symbols — Safety colours and safety signs — Registered safety signs (ISO 7010:2011)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

ISO 8573-1:2010, *Compressed air — Part 1: Contaminants and purity classes*

ISO 11112, *Earth-moving machinery — Operator's seat — Dimensions and requirements*

UIC 520:2003, *Wagons, coaches and vans — Draw gear — Standardisation*

UIC 527-1:2005, *Coaches, vans and wagons — Dimensions of buffer heads — Track layout on S-curves*

UIC 541-03:1984, *Brakes — Regulations concerning manufacture of the different brake parts — Driver's brake valve*

UIC 541-1, *Brakes — Regulations concerning the design of brake components*

UIC 541-5:2006, *Brakes — Electropneumatic brake (EP brake) — Electropneumatic emergency brake override (EBO)*

UIC 544-1:2014, *Brakes — Braking performance*

3 Terms and definitions

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

3.1

railbound construction and maintenance machine

on-track machines and infrastructure inspection machines

3.2

on-track machines

OTM

machine specially designed for construction and maintenance of the track and infrastructure and used in different modes: working configuration, travelling configuration, running configuration as a self-propelling vehicle, running configuration as a hauled vehicle, when:

- it is running on its own rail wheels,
- it is designed to have characteristics necessary for the operation of track based train detection systems

3.3

infrastructure inspection machine

machine used to monitor the condition of the infrastructure which, with the exception of machines which are incorporated into passenger trains, are considered to be on track machines

Note 1 to entry: Infrastructure inspection machines designed to be incorporated into passenger trains are not considered as railbound construction machines and will meet passenger car standards.

3.4

railway infrastructure

all installations required for the running of railway vehicles

EXAMPLE Tracks, level crossings, overhead line equipment and signals.

3.5

train

operational formation consisting of one or more machines/vehicles

3.6

demountable module

removable unit which is capable of being attached with dedicated fastening system to a machine, to perform a specific function

3.7

semi-permanently coupled machines

machines which require a workshop environment to couple and uncouple (because there is no operational need or requirement to couple or uncouple between the machines)

3.8

running mode

configuration of a machine when it allows movement along the track, all moveable parts stowed within the applicable gauge, with the machine interacting with the signalling and control systems

3.9

travelling mode

configuration of a machine when it allows movement along the working track, all moveable parts stowed (but not secured) within the applicable gauge, and when the machine does not require to interact with the signalling and control systems (in this condition there is no need to ensure operation of signalling systems or for cab based signalling equipment)

Note 1 to entry: A machine in travelling mode does not need to meet the operational requirements for the movement of trains on the railway network.

3.10

working mode

mode when the machine is used to perform any of its permitted designed working tasks

3.11

accreditation body

body recognized by a competent authority in relation to EN ISO/IEC 17025 that defines the requirements in terms of quality management and technical skill

4 Machine categorization

4.1 General rules

The application of all requirements of this European Standard is not possible in every case because of the differences in the design of machines. The machines are therefore divided into seven categories as shown in Table 1.

In order to use this European Standard, it is necessary to establish in which category the machine belongs. The corresponding requirements for the categories are defined in Annex A.

Table 1 — Machine categories by maximum running speed

		Self-propelled machine running speed (v)		Non-self-propelled machine ^b
		≥ 100 km/h	< 100 km/h	
Can be incorporated into a train ^a with a speed of:	$v \geq 100$ km/h	Category 1	Category 2	Category 3
	$v < 100$ km/h	--	Category 4	Category 5
Cannot be incorporated into a train		--	Category 6	Category 7
^a These machines could have restrictions for their position in a train. ^b These types of machines are permitted to have a self propelling function in travelling and working mode only.				

4.2 Demountable modules

A demountable module shall be checked for conformity as part of the machine to all relevant clauses in all parts of EN 14033 when any of the following apply:

- a) It has been manufactured or modified to suit the particular machine or type of machine.

- b) It is used to carry personnel during running or travelling.
- c) It is positioned on the machine by other than gravity or twist locks.
- d) It has electrical, pneumatic or hydraulic connections to the machine.
- e) It is connected to the machine by twist locks and is used for lifting any load.
- f) It is connected to the machine by twist locks and has moveable components which are able to exceed the gauge profile of the machine.

Where a demountable module is designed and intended to be fitted to a wagon then the combination of module and wagon shall be checked for conformity to all relevant clauses in all parts of EN 14033.

5 Rolling stock gauge

5.1 General rules

The maximum dimensions of the machine shall correspond to the rules of EN 15273-2 according to the basic principles set up in EN 15273-1.

The associated rules for each gauge, the corresponding reference profile (e.g. G1) and the critical points near the limits of this gauge shall be shown in the documentation according to EN 15273-2:2013, Annex Q.

The reference profile shall be marked on the machine.

Machines intended to run on infrastructures with a gauge different to the kinematic gauge G1 from EN 15273-2 shall conform to the specific rules of those infrastructures and the corresponding restrictions shall be shown in the documentation.

NOTE The G1 profile in EN 15273-2:2013, Figure A.4, meets the cross acceptance gauging requirements for the majority of mainland European countries.

5.2 Stowing of moveable machine parts in running positions

5.2.1 Component locks

Except as shown in 5.2.2 all moveable parts of the machine that can exceed the gauge defined in 5.1, including those parts that are prevented from abnormal movement by their operating mechanism safety features, shall be stowed and held by efficient red painted locks. It is not permitted to paint the machine red in the areas of the locks. The locks shall be designed so that foreign objects such as pieces of ballast cannot prevent their locking function. There shall either be two independent locking devices or the devices shall be designed as a failsafe concept.

When in use all locks shall withstand the foreseeable forces encountered during normal operation or exceptional operation of the equipment being retained.

It is preferable that the control of locking should be possible from working or running position.

5.2.2 Exemption from locking

Pantographs used for traction and insulated pantographs used for measuring are permitted not to have locks.

5.2.3 Secondary support

Where a part is able to fall onto the track, slings, chains or similar devices shall be fitted in order to prevent them from falling onto the track in case of a failure.

5.2.4 Indication of locked state

It shall be obvious when checking the machine that moveable parts of the machine are locked in their stowed position. This check shall be possible either by direct sight from one side of the track or by other means. Furthermore, for self-propelled machines an indication to the driver of the machine shall show when a moveable part of the machine is not stowed and locked.

5.2.5 Running

When in running mode all control circuits not related to running shall be deactivated.

Locking devices shall not require power to remain locked when running.

It shall not be possible to open the locks in the running mode.

6 Frame

6.1 Design of the machine frame and attachments

The machine frame and attachments shall be able to withstand either the static loads of EN 12663-1:2010+A1:2014, 6.1 to 6.5, or the static loads according to EN 12663-2:2010, 5.2.1 to 5.2.4, without exceeding the permissible values given therein except for the acceleration in x-direction according to EN 12663-1:2010+A1:2014, Table 13 or EN 12663-2:2010, Table 10, which shall be ± 3 g.

The corresponding structural categories of EN 12663-1 or EN 12663-2 are as follows:

- for machines not permitted to be loose shunted or hump shunted: F-II;
- for all other machines: F-I.

In addition machines with a driving cab shall meet the requirements of EN 12663-1:2010+A1:2014, 6.2.3, and for Table 6 and Table 7 only shall be considered as category L.

For machines with a maximum speed greater than 140 km/h, the fatigue strength of the machine frame and attachments shall comply with EN 12663-1:2010+A1:2014, 6.6 or 6.7.

For machines with a maximum speed ≤ 140 km/h and > 100 km/h the fatigue life of the machine frame and attachments shall be determined by the manufacturer based on the intended use and mileage declared in the instruction handbook. This is permitted to be assessed by a comparison with the fatigue history of existing machines.

For machines with a maximum speed ≤ 100 km/h a fatigue strength assessment is not needed.

For articulated machines, the joint between two parts of a machine which share the same running gear shall comply with the requirements of EN 12663-1:2010+A1:2014, 6.5.3. For machines with a maximum speed greater than 140 km/h a fatigue strength assessment with the fatigue loads according to EN 12663-1:2010+A1:2014, 6.7.5, shall be made.

NOTE There are additional strength requirements for travelling and working modes which are described in EN 14033-2.

6.2 Lifting and jacking points

The machine frame shall incorporate lifting points by which the whole machine is capable of being safely lifted or jacked. The location of the lifting and jacking points shall be defined. EN 16404 is permitted to be used as guidance on how to achieve these requirements. Brackets used for re-railing shall either conform to the choices given in EN 16404 or, if different from those choices, be carried on the machine.

To facilitate the work during repair or inspection or when re-railing the machine, the machine shall be provided on both long sides with at least two lifting points, at which the machine can be lifted in empty or laden condition. These lifting points shall be identified according to 19.1.

If it is intended to use bogie drop equipment it is recommended to provide these lifting points at a minimum distance of 1 400 mm in the longitudinal direction from the centre line of individual wheelsets.

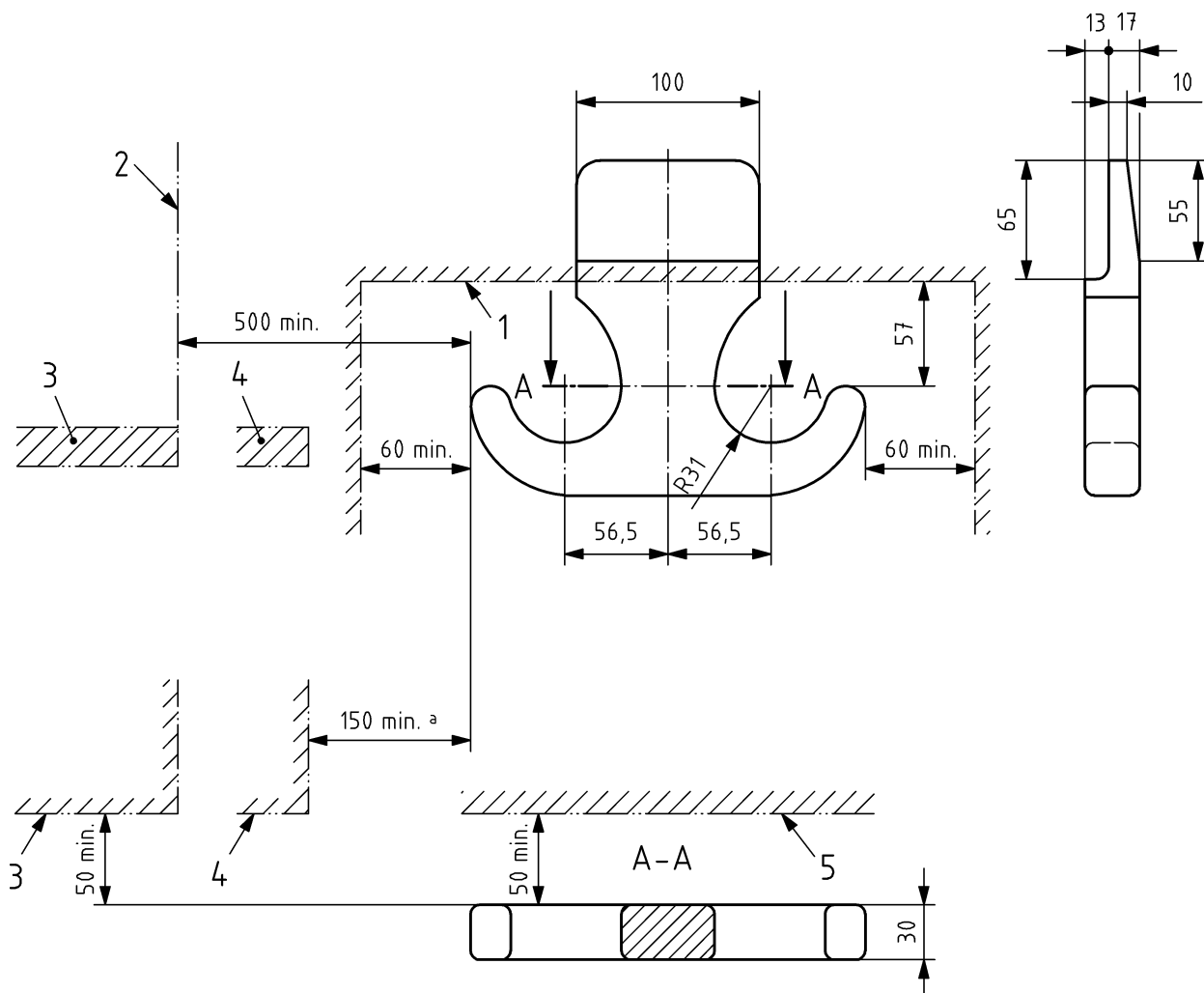
NOTE Laden is equivalent to maximum mass as defined in 7.7.3.

To allow positioning of jacking devices, clearances shall be provided under the lifting points which shall not be blocked by the presence of non-removable parts. The lifting and jacking load cases according to EN 12663-2 shall apply for lifting and jacking under workshop and servicing conditions.

6.3 Hook for stowage on boats and for towing

Machines suitable for transport on boats shall be fitted with stowage hooks in accordance with Figure 1. It is permitted to use this hook for towing within depots. Each installed hook shall be capable of withstanding a force of 50 kN exerted outwards at an angle of 30° from the centre line of the track.

Dimensions in millimetres

**Key**

- | | | | |
|---|--|------|--|
| 1 | space required for projecting parts | 4 | gangway or end platform step board |
| 2 | buffer fixing plane | 5 | other projecting parts, e.g. control-handles |
| 3 | step board | min. | minimum value |
| a | If the dimension cannot be complied with, protective plates shall be mounted above the draw-hook | | |

Figure 1 — Stowage and towing hook**7 Bogie and running gear****7.1 General**

The performance requirements for bogies and running gear fall into two related areas, covering functionality and safety, as required by TSI essential requirements. Functionality relates to such things as speed, load capacity, ride quality and operating life. Safety covers gauging, structural integrity, dynamic performance, resistance to derailment and maintenance, etc. In this standard, for bogies and running gear, essential safety requirements are addressed in Clause 5 (gauging), 7.2 (structural design), Clause 8 (running safety i.e. dynamic performance and resistance to derailment) and Clause 20 (maintenance).

A validation plan covering all necessary validation activities and the strategy for demonstrating compliance shall be established. For machines, which are often produced in small numbers and derived from previous designs, EN 15827:2011, 9.1, 9.2 (structural integrity design), 9.3 (dynamic performance validation) and 9.4 (use of existing validation record), provides useful guidance in order to complete this validation plan.

NOTE Using this guidance can lead to, for example:

- using simulation in support of, or in place of, testing;
- using evidence that a component has functioned in a comparable operating environment with only the planned level of scheduled attention to demonstrate the performance without any further analysis or test data;
- using a large reserve of safety to cover small changes to avoid further testing.

The requirements of this clause do not concern wheels or rollers used for specific working conditions and which are retracted during running.

The running gear shall be able to negotiate the horizontal and vertical radii given in Table B.1.

7.2 Structural design

7.2.1 Structural design of the bogie frame

For machines which include a bogie frame, the integrity of the structure of a bogie frame, all attached equipment and body to bogie connection, shall be demonstrated based on calculations as set out in EN 13749:2011, 6.2.

The hypothesis (formulas and coefficients) taken to evaluate the loads due to bogie running in line with the standard EN 13749:2011, Annex C, shall be justified and documented in the technical documentation shown in 20.3.1.

Machine bogies are considered to be produced in “small numbers” within the meaning of EN 13749:2011, 6.2.1.

7.2.2 Other components

Body/bogie connection, axle boxes, axles, wheels, suspension components and attachments and connections shall meet the requirements listed in EN 15827. It is permitted to amend the validation methods of EN 15827 to the validation methods described in the following standards:

- EN 13979-1: monobloc-wheels;
- EN 13103: approval process for non-powered wheelsets;
- EN 13104: approval process for powered wheelsets;
- EN 14363: running characteristics of vehicles;
- EN 15839: freight wagons – test of running safety under longitudinal compressive forces.

7.3 Wheel diameter

The minimum worn diameter shall not be smaller than 330 mm.

7.4 Static axle loading

The maximum permissible static axle load depends on the wheel diameter. In the running condition, the limits shall comply with the values given in Table 2.

Table 2 — Static axle loading

Wheel diameter $\varnothing$ d^a mm	Maximum permissible static axle load t
$\varnothing \geq 840$	22,5
$840 > \varnothing \geq 760$	20
$760 > \varnothing \geq 680$	18,5
$680 > \varnothing \geq 630$	17
$630 > \varnothing \geq 550$	14,5
$550 > \varnothing \geq 470$	12,5
$470 > \varnothing \geq 390$	10,5
$390 > \varnothing \geq 330$	9
^a d = minimum worn diameter $\varnothing$ = diameter	

7.5 Wheel profile

The wheel profile shall comply with the requirements of EN 13715 or another profile if satisfactory riding as required in Clause 8 of this standard can be achieved.

7.6 Shape and dimensions of the axles and wheelsets

The axles shall comply with the requirements of EN 13261, EN 13103 and EN 13104. The design of the axles shall additionally take into account the forces generated when working.

Except as shown below, the wheels shall comply with the requirements of EN 13262 and EN 13979-1.

Other types of wheels made of ferromagnetic steel may also be used, if verification can be provided of the ability to safely transmit horizontal, vertical and braking forces.

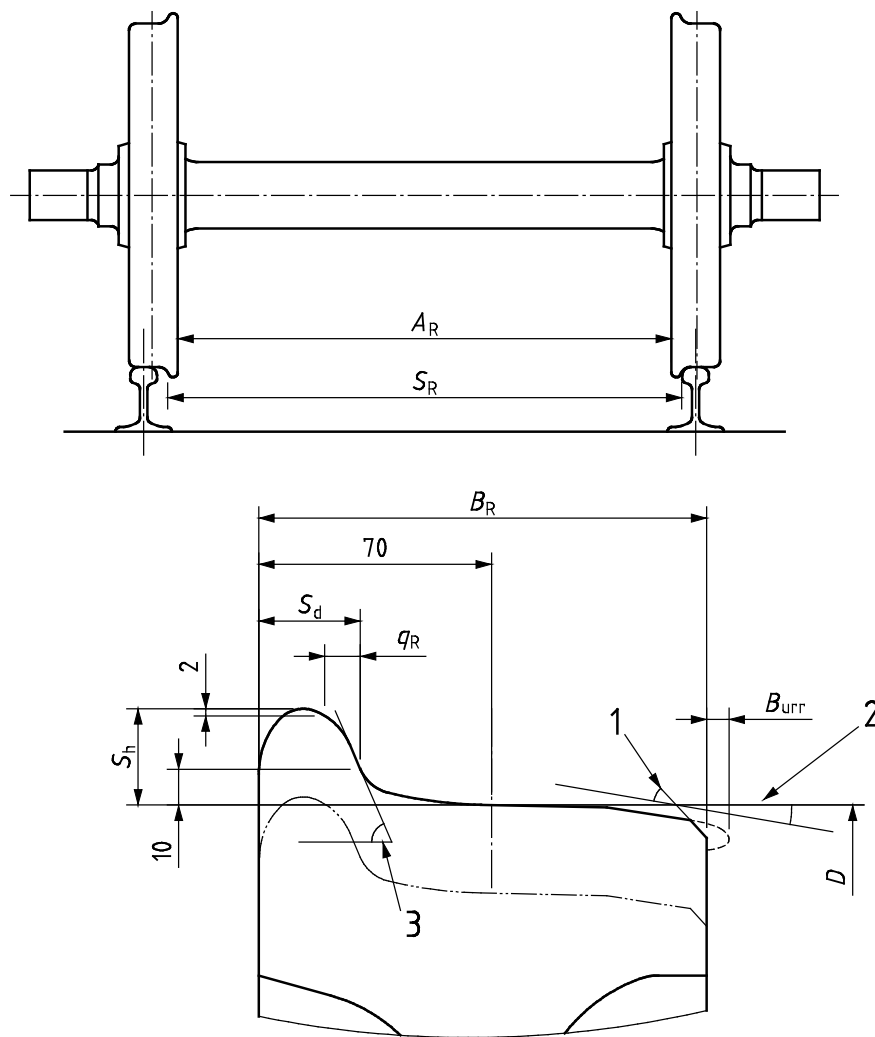
The wheelsets shall comply with the requirements of EN 13260, EN 13103 and EN 13104. The design of the wheelsets shall additionally take into account the forces generated when working.

The axlebox bearings shall, as a minimum, be in accordance with the requirements of EN 12080. It is permissible to use bearings with higher requirements where it is technically required (e.g. high lateral forces or high axle loads in working mode).

The dimensions of the wheelset shall comply with Table 3, as explained in Figure 2.

Table 3 — Wheelset dimension

Designation		Wheel diameter D [mm]	Minimum value [mm]	Maximum value [mm]
1 435 mm	Front-to-front dimension (S_R) $S_R = A_R + S_{d, left} + S_{d, right}$	$330 \leq D \leq 760$	1 415	1 426
		$760 < D \leq 840$	1 412	
		$D > 840$	1 410	
	Back to back distance (A_R)	$330 \leq D \leq 760$	1 359	1 363
		$760 < D \leq 840$	1 358	
		$D > 840$	1 357	

**Key**

- 1 chamfer
- 2 reverse slope
- 3 flange angle

Figure 2 — Wheelset dimensions**7.7 Machine mass measurement****7.7.1 Axle arrangement and axle loads**

In running configuration the distribution of the wheelsets and their loads shall comply with the requirements of EN 15528.

Except as shown in 10.4 of this standard, the distance from the buffer face to the first axle shall be less than or equal to 3 830 mm for machines with individual axles. For machines with bogies, the distance from the buffer face to the bogie centre shall be less than or equal to 3 830 mm.

It is recommended to design the machine for compliance with line category C2 according to EN 15528. The distances between the axles of machines shall comply with the conditions shown in Table 4.

Table 4 — Distance between wheelsets

Characteristics	Minimum	Maximum
Machines with bogies		
Distance between axles of 2 axle bogies	1 800 mm ^a	
Distance between the axles of a bogie		4 500 mm
Distance between axles of a bogie having more than 2 axles	1 500 mm ^a	
Machines with individual axles		
Distance between outside axles		
- 2 axle machine	6 000 mm ^b	10 000 mm ^b
- 3 axle and single underframe machine	f	f
- 3 axle and articulated underframe machine	2 × 6 000 mm	c
Ratio: C/L	$\geq 0,54$ ^e	
C = distance between axles L = length of vehicles over uncompressed buffers ^d		
Articulated underframe machines		
Machines with bogies	c	c
Machines with individual axles	c	c
Machines with bogies and individual axles	g	g
^a Special bogies with small wheels can be designed with smaller axle spacing providing they meet the requirements of EN 13715, EN 13260 and EN 15528. ^b This distance is permitted to be different if dynamic stability is proven in accordance with EN 14363. ^c For articulated machines, the ability to negotiate curves shall be demonstrated. ^d In case of asymmetry, L = the distance between the axles plus twice the value of the greatest of the two overhang lengths. ^e Limiting value of 0,45 is acceptable for machines of categories 4, 5, 6 and 7. ^f A 3-axle machine is acceptable if the central axle does not transmit lateral guiding force to the rails. ^g The ability to negotiate curves shall be demonstrated.		

Machines which are required to operate spring operated points without risk of derailment shall have axle loads of at least 5 t.

7.7.2 Operational mass of the machine

The operational mass of the machine is known as the “operational mass in working order” in EN 15663 and corresponds to the following conditions:

- hydraulic tank and hydraulic circuits full;
- fuel tank(s) 2/3 full;
- water tank(s) 2/3 full;
- all other tanks empty;

- without any loads in areas designed to carry such loads;
- without staff on-board.

7.7.3 Maximum mass of the machine without payload

The maximum mass of the machine shall be indicated as “maximum machine mass” according to EN 15877-2:2013, 4.5.4.2. Maximum machine mass is known as the “design mass in working order” in EN 15663 corresponds to the following conditions:

- all tanks 100 % full;
- the permanent tools on board;
- the maximum number of authorized operators on board in running mode (operator mass = 80 kg).

7.7.4 Maximum mass of the machine with payload

Where a machine carries a payload, the maximum mass of the machine with payload shall be indicated as 'maximum machine mass with payload' according to EN 15877-1:2012, Figure 19. Maximum machine mass with payload is known as the 'design mass under normal payload' in EN 15663 corresponds to the following conditions:

- all tanks 100 % full;
- the maximum permitted loading;
- the permanent tools on board;
- the maximum number of authorized operators on board in running mode (operator mass = 80 kg).

7.7.5 Weighing method

For the first machine of a type, the result of the weighing will be the arithmetic average value of a minimum of three successive mass measurements, in the same condition.

For the following machines of the same type, the result of the weighing will be the arithmetic average value of a minimum of two successive mass measurements in the same condition.

The weighing procedure shall give the following values:

- the operational mass of the machine;
- the axle load of each axle;
- the wheel load of each axle.

When measuring the mass, the machine shall be free of all outside influence:

- no scotching of the wheels;
- all internal equipment stopped;
- no contact on the buffer plates;
- no brakes applied;
- machine in running mode.

The operational mass according to 7.7.2 shall be obtained by weighing. The maximum mass according to 7.7.3 is permitted to be obtained by weighing or by calculation from the operational mass.

It is permitted for the determination of the mass conditions as set out in 7.7.2, 7.7.3 and 7.7.4 to be obtained by weighing a machine in a known state and by calculating the variables.

7.8 Design for longitudinal compressive forces

Except as shown below, the requirements for designing for longitudinal compressive forces shall comply with EN 15839 for running machines in any position in regular freight trains:

- Bogied machines with an overhang between 2 520 mm and 3 830 mm and a spacing between 6 500 mm and 15 500 mm between bogie centres are considered satisfactory to be incorporated in goods trains with the brake position in the passenger (P) or goods (G) mode without any restrictions for accommodating longitudinal compressive forces.
- Where a machine exceeds an overhang of 3 830 mm and/or a bogie centre spacing of 15 500 mm the machine shall either be restricted from incorporation into a goods train next to a two axle wagon, or tests according to EN 15839 or calculations shall be carried out to establish whether the longitudinal compressive forces are acceptable.
- Where buffers and screw couplings are in use or the automatic traction coupling (Z-AK) the machine shall be designed to transmit longitudinal compressive forces ≥ 200 kN. The mandatory conditions for machines $\leq 10\,000$ mm axle spacing and with an overhang between 2 520 mm and 3 830 mm are the requirements of EN 15839 and for machines $> 10\,000$ mm axle spacing and/or with an overhang greater than 3 830 mm a compression test according to the requirements of EN 15839 or a calculation shall be effected.
- Where automatic couplings (AK) are in use the machine shall be constructed to transmit longitudinal compressive forces ≥ 500 kN.
- Within a train consisting of railbound machines the internal couplings between the machines are considered satisfactory for incorporation in goods trains with the brake position in the passenger (P) or goods (G) mode without any restrictions for accommodating longitudinal compressive forces.

7.9 Lifeguards

Category 1, 2, 4 or 6 machines shall be equipped with lifeguards at both ends in front of the outer wheels. They shall be installed with the aim of reducing as far as reasonably practicable the risk of derailment due to impact with small obstacles on the line.

A lifeguard shall:

- a) be made of a ductile material;
- b) be able to resist, without permanent deformation, a sustained concentrated proof load of at least 20 kN, for machines with a maximum speed greater than 120 km/h or 10 kN for machines ≤ 120 km/h, applied at its bottom edge horizontally and in a longitudinal direction towards the adjacent wheel. During deformation beyond the proof load, the lifeguard shall resist without failure an ultimate load of at least 35 kN applied;
- c) be able to resist the proof load of 20 kN (or 10 kN as shown in b)) as defined in (b) combined with a transverse load, in either direction, of at least 10 kN;

- d) be designed so that, as the load in (b) or (c) is increased up to the maximum dynamic load that it can sustain during impact with the obstacle, it deforms plastically;
- e) be designed so that, during plastic deformation, it does not foul the track or running gear and that contact with the wheel tread, if it occurs, does not pose a risk of derailment;
- f) be designed so that, under the conditions described above, it remains securely attached.

The lifeguard shall be fitted directly above the top of each running rail. The height of the lower end of the life guard above the rail shall be:

- 30 mm minimum in all conditions;
- maximum height above rail level to be 20 % of wheel diameter but not greater than 130 mm in all conditions;

taking into account in particular wheel wear and suspension compression.

7.10 Obstacle deflector

If a category 1 machine is designed with a maximum speed in excess of 140 km/h, to limit the consequences of hitting a track obstruction it shall be fitted with obstacle deflectors complying with EN 15227:2008+A1:2010, 6.5 and Table 3.

8 Running safety

8.1 Running tests

The running characteristics of a machine or a machine type are permitted to be determined by running tests or by reference to a similar type-approved machine or by simulation, see 8.3.

A “similar type-approved machine” is a machine with similar configuration and running under similar conditions, and can be used as a reference for the test exemption of a new machine, according to the requirements of EN 14363:2016, 5.3.1 and Table U.1 (the column for freight stock is applicable unless the special vehicle is similar to a locomotive, multiple unit or a passenger coach).

NOTE It is common practice that when running tests are required, they are carried out by an authorized testing body or by the manufacturer of the machine, if the manufacturer is authorized as a testing body.

For railbound machines running at a speed of $v \leq 120$ km/h, the requirements for special vehicles in accordance with EN 14363:2016, Annex S are applicable. These requirements also apply to machines running at a speed $v > 120$ km/h, when the conditions of EN 14363 allow the use of an accelerometric simplified method for the type of vehicle to which the machine is similar.

Special vehicles may be designed with very high or low axle loads, unusual axle arrangements or distances, non-standard suspensions, moveable or retractable running gear, etc. If, owing to such design features and lacking positive operating experience the machine could be considered as a new technology vehicle, it shall be tested as such. If not, the requirements according to EN 14363 for special vehicles apply.

Possible fault modes of the machine which adversely affect the running behaviour shall be identified. Some of these fault modes could need to be submitted to specific running tests, the extent, conditions and assessment of which shall be defined.

The following deviations from EN 14363:2016 apply:

- a) when running tests according to EN 14363 are done with wheel profile in a new condition, these are valid for a maximum distance of 50 000 km. After 50 000 km it is necessary to:

- 1) either reprofile the wheels;
 - 2) or calculate the equivalent conicity of the worn profile and check that it does not differ more than 50 % from the value of the test of EN 14363 with a maximum difference of 0,05;
 - 3) or make a new test according to EN 14363 with a worn wheel profile;
- b) normally, tests to determine the applicability of a machine to a series as set out in EN 14363:2016, 5.3.1 are not necessary;
- c) if the required test speed cannot be obtained by the machine itself, the machine shall be hauled for the tests.

8.2 Running safety on track twists

Safety against derailment when running on track twists is permitted to be proved by an approved calculation method, e.g. according to EN 14033-2:2017, 5.2.3.2.2, and this in the configuration of machine as it is in its running configuration. If this is not possible, tests according to the requirements of EN 14363:2016, 6.1, shall be carried out.

8.3 Running simulation

Running behaviour is permitted to be proven by simulation when there is a proven model of the machine.

A model of a machine for simulation of running characteristics shall be proven by comparing the model results against the results of running tests when the same input of track characteristic is used.

A proven model is a simulation model that has been verified by an actual running test that excites the suspension sufficiently and where there is a close correlation between the results of the running test and the predictions from the simulation model over the same test track.

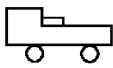
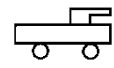
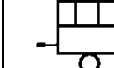
Further guidance on the use of simulation is set out in EN 15827:2011, Annex G.

9 Brakes

9.1 Mandatory braking equipment

Mandatory braking equipment for different machine categories is shown in Table 5.

Table 5 — Compulsory braking equipment

	Self-propelled machine		Non-self-propelled machine, not intended to carry personnel		Non-self-propelled machine permitted to carry personnel		Non-self-propelled machine with driver's cab		Permanently coupled single axle or bogie articulated machine not intended to carry personnel		Permanently coupled single axle or bogie articulated machine permitted to carry personnel	
												
Machine Category	1, 2, 4	6	3, 5	7	3, 5	7	3, 5	7	3, 5	7	3, 5	7
Continuous and automatic brake UIC	x		x		x		x		x		x	
Continuous and automatic brake		x		x		x		x		x		x
Direct brake	x ^a	x					(o)	(o)				
Operation of the automatic brake	x ^b	x ^b					x ^b	x ^b				
Operation of the emergency brake	x	x			x	x	x	x			x	x
Operation of the direct brake	x	x					x					
Dynamic brake	x ^c	x ^c										
Parking brake	x	x	x	x	x	x	x	x				
^a When the length of inseparable multiple machines is not compatible with a direct brake system, this equipment shall not be fitted. ^b See 9.2.4 simplified driver's brake valve. ^c Imposed on specific lines with steep gradients, see Annex B. (o) Optional												

For Category 1, 2, 3, 4 and 5 machines in various train formations a continuous and automatic UIC brake is mandatory. Its architecture shall be compliant with the requirements of EN 14198. Category 6 and 7 machines shall also be equipped with a continuous and automatic brake, but it is not necessary to follow the UIC architecture. Category 6 and 7 machine's brakes shall have an equivalent level of safety as a UIC brake. If the continuous and automatic brake fitted to Category 6 and 7 machines is not compatible with an automatic UIC brake the connections shall be designed such that it is not possible to connect them to standard UIC connections.

The continuous and automatic brake should operate on all wheelsets. If it is incompatible with working conditions, it can be acceptable that some wheelsets are not equipped with brake components; provided that they are not outer wheelsets and that the required brake performance is obtained. Additional equipment may be required depending on the running speed and adhesion coefficient.

Each element of a machine where they are semi-permanently coupled shall be fitted with a minimum of one brake distributor and associated brake actuators.

9.2 Characteristics

9.2.1 Performance

No single point failure of any component shall lead to a total loss of braking force.

For new wheelsets, with wheels less than 760 mm diameter, the manufacturer shall demonstrate by calculation or testing that the wheel and individual braking components have the ability to withstand the thermal input.

The maximum adhesion coefficient for each braked axle, the use of wheel slide protection (WSP), the brake performance and its thermal capacity shall be consistent with:

- wagon (TSI WAG 4.2.4.3) for Category 3 and 5 machines;
- units assessed in fixed or pre-defined formation(s) (TSI LOC&PAS 4.2.4.5 and 4.2.4.6) for Category 1, 2 and 4 machines.

For category 1, 2, 3, 4 and 5 machines emergency braking performance shall be consistent with EN 14198.

The brake performance shall be calculated in accordance with EN 14531-1 or EN 14531-2 or UIC 544-1:2014 and shall be determined in accordance with UIC 544-1:2014.

For machines incorporated in regular freight trains (GCU), brake performances should meet the criteria of Appendix C 9 (UIC brake) of the Wagon TSI.

When the machine is in the travelling and/or working modes the brake performance shall be in accordance with EN 14033-2.

9.2.2 Brake testing

9.2.2.1 Static testing

Each machine shall be statically tested, in conformance with EN 15806, in order to validate pneumatic and electric functioning of machine braking system.

Measurement of static forces at brake blocks or pads shall be considered as a type test of a system (bogie, wheelset). The inexhaustibility check with worn blocks or pads is not necessary if such a type test was previously undertaken.

9.2.2.2 Dynamic testing

For the first machine of a type, dynamic testing is required to be performed by an organization in accordance with EN ISO/IEC 17025.

Simplified dynamic brake tests are permitted if the machine under consideration is of the same type as a reference machine which has previously been tested completely.

NOTE The demonstration of conformity of subsequent machines to the first machine of a type is acceptable by comparison to the first of type test report results.

Where a machine is not fitted with wheel slide protection (WSP) there shall be no observed wheel locking during the dynamic testing of machine.

For self-propelled machines, on-track tests shall be performed from the maximum running speed. If the speed of incorporation into train formation is higher than the self-propelled running speed, the test shall be performed as for a hauled machine.

For hauled machines, on-track tests should be performed according to the slip-test method. If the mass of the machine or safety requirements is not compatible with slip testing, a specific test procedure shall be individually defined.

9.2.2.3 Test report

The test report shall include:

- a) a report of the static test as specified in EN 15806:2010, 6.3;
- b) all results obtained during the test procedure: (UIC 544-1:2014, Appendix F);
- c) the behaviour/deterioration of friction material following test (e.g. cracking, etc.);
- d) for each test:
 - 1) external temperature;
 - 2) weather (dry, wet, rain);
 - 3) rail condition (dry, wet);
 - 4) gradient of the test zone;
 - 5) speed at initiation of braking;
 - 6) measured stopping distance (uncorrected);
 - 7) corrected stopping distance;
 - 8) representative wheel temperatures before each test;
 - 9) date and time of each test;
 - 10) wheel slide and consequences on the wheel and rail (e.g. mark, wheel flat);
 - 11) vehicle mass and its distribution;
 - 12) additional information.

9.2.3 Mechanical characteristics of the brake

Both disc brakes and tread brakes are acceptable.

Brake discs mounted on axles shall be in accordance with EN 14535-1. Brake discs mounted on wheels shall be in accordance with EN 14535-2. Disc brakes shall be arranged that they do not affect the operation of hot box detectors, as shown in 11.3.

The friction material of the brake block shall be made of cast iron or composite material. Composite brake blocks are permitted to be used in the configuration in which the brake blocks have been validated. Measures shall be taken to reduce the side play of brake blocks or brake block holders on the tread area of the wheel. The brake block holders shall be in accordance with EN 15329 and so arranged that they do not prevent the use of wheel scotches on the machine. If brake blocks with different friction values are specified, the brake block holders shall be so designed that it is impossible to use the wrong friction material.

All moving parts shall be designed and/or protected against falling onto the track.