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Railway applications - Braking systems of high speed trains - Part 1: Requirements and definitions

Bahnanwendungen - Bremssysteme für Hochgeschwindigkeitszüge - Teil 1: Anforderungen und Definitionen

Applications ferroviaires - Systèmes de freinage pour trains à grande vitesse - Partie 1 : Exigences et définitions

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Railway applications - Braking systems of high speed trains - Part 1: Requirements and definitions

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Foreword

This document (EN 15734-1:2010) 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of an identical text or by endorsement, at the latest by May 2011, and conflicting national standards shall be withdrawn at the latest by May 2011.

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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 the EU Directive, see informative Annex ZA, which is an integral part of this document.

EN 15734, *Railway applications — Brake systems of high speed trains*, consists of the following parts:

— *Part 1: Requirements and definitions*

— *Part 2: Test methods*

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, 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 European Standard describes the functionality, constraints, performance and operation of a brake system for use in high speed trains as described in the TSI High Speed Rolling Stock, operating on routes of the European railways and their infrastructure systems.

The brake system requirements specified in this European Standard apply to trains that may operate at a maximum speed of up to 350 km/h on lines specifically built for high speed and define graduated values for deceleration related to four speed ranges (see Clause 6).

This European Standard covers:

— all new vehicle designs of high speed trains;

— all major overhauls of the above-mentioned vehicles if they involve redesigning or extensive alteration to the brake system of the vehicle concerned.

This European Standard does not cover locomotive hauled trains, which are specified by EN 14198.

NOTE This document applies the functional subdivision into subsystems as specified in the TSI High speed. The braking system is part of the function: “Accelerate, maintain speed, brake and stop”.

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 837-1:1996, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

EN 854, *Rubber hoses and hose assemblies — Textile reinforced hydraulic type — Specification*

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 13749:2005, *Railway applications — Wheelsets and bogies — Methods of specifying structural requirements of bogie frames*

EN 14198, *Railway applications — Braking — Requirements for the brake system of trains hauled by a locomotive*

EN 14478:2005, *Railway applications — Braking — Generic vocabulary*

EN 14531-6, *Railway applications — Methods for calculation of stopping and slowing distances and immobilisation braking — Part 6: 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*

prEN 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 15020, *Railway applications — Rescue coupler — Performance requirements, specific interface geometry and test methods*

EN 15179, *Railway applications — Braking — Requirements for the brake system of coaches*

EN 15220-1, *Railway applications — Brake indicators — Part 1: Pneumatically operated brake indicators*

EN 15273-2, *Railway applications — Gauges — Part 2: Rolling stock gauge*

prEN 15328, *Railway applications — Braking — Brake pads*

prEN 15329, *Railway applications — Braking — Brake block holder and brake shoe key for rail vehicles*

EN 15355, *Railway applications — Braking — Distributor valves and distributor-isolating devices*

EN 15566, *Railway applications — Railway rolling stock — Draw gear and screw coupling*

EN 15595, *Railway applications — Braking — Wheel slide protection*

EN 15611, *Railway applications — Braking — Relay valves*

EN 15663, *Railway applications — Definition of vehicle reference masses*

EN 15734-2, *Railway applications — Braking systems of high speed trains — Part 2: Test methods*

CEN/TS 45545 (all parts), *Railway applications — Fire protection on railway vehicles*

EN 50121-3 (all subparts), *Railway applications — Electromagnetic compatibility*

EN 50125-1:1999, *Railway applications — Environmental conditions for equipment — Part 1: Equipment on board rolling stock*

EN 50126-1, *Railway applications — The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) — Part 1: Basic requirements and generic process*

EN 50163, *Railway applications — Supply voltages of traction systems*

EN 50215, *Railway applications — Rolling stock — Testing of rolling stock on completion of construction and before entry into service*

UIC 541-03:1984, *Brakes; regulations concerning manufacture of the different brake parts; driver's brake valve*

UIC 544-1:2004, *Brakes — Braking power*

UIC 557:1998, *Diagnosis techniques for coaches*

UIC 648:2001, *Connections for electric cables and air pipes on headstocks of locomotives and driving trailers*

UIC 651:2002, *Layout of driver's cabs in locomotives, railcars, multiple unit trains and driving trailers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14478:2005 and the following apply.

3.1
active cab
single cab in a train consist which is used to control traction and service braking

NOTE It is normally the leading cab.

3.2
brake blending
controlled merging of brake forces resulting from different brake force generating systems

3.3
brake loop
electrical hard wire keeping brakes released when energised

3.4
brake weight percentage
brake performance according to UIC 544-1

3.5
control chamber A
is called "command reservoir" in EN 14478

3.6
direct brake
is called "straight brake" according to EN 14478

3.7
driver's vigilance device
is called "dead man's device" according to EN 14478

3.8
dynamic brake
brakes in which the brake force is produced by the movement of the vehicle or its functional elements, but not involving friction

3.9
parking brake
is called "immobilization braking" in the revised TSI

3.10
Ep assist
electrically commanded assist system to vent and feed the brake pipe

3.11
holding brake
service brake application to stop a slowly moving train to standstill and/or prevent a train from moving for a limited time

3.12
independent brake unit
set of equipment, constituting an independent unit, whose function is to generate a retarding force on a vehicle or a part of a vehicle in response to a train brake signal

3.13
local control unit
control unit acting upon a vehicle related system or sub-system

3.14
normal service brake
2/3 of full service brake, which corresponds with venting the brake pipe by 1 bar

3.15
overbraking
brake application exceeding the available wheel/rail adhesion

3.16
overcharging
pressurising the brake pipe above the level of the nominal release pressure

3.17
passenger communication alarm
functional part of the passenger alarm system providing information from and to the passenger

3.18
pilot pressure circuit
pressure circuit using components of reduced dimensions in order to control a limited flow rate which is subsequently amplified

3.19
power brake
means by which the service and emergency brakes are applied

3.20
reference speed
signal generated and used by the WSP system as an approximation of the train speed used for comparison with the instantaneous wheel set speed as part of the control set algorithm

3.21
regenerative (mode of electro-dynamic braking)
converting the braking energy into electrical energy and generating an energy flow into the main energy supply

3.22
rheostatic (mode of electro-dynamic braking)
converting the braking energy into electrical energy and dissipating the electrical energy in a resistor

4 Symbols, units and abbreviations

For the purpose of this document, the following symbols, units and abbreviations apply.

BP Air brake pipe

EBL Emergency brake loop

ECB Eddy current brake

EP Electro-pneumatic brake

MRP Main reservoir pipe

WSP Wheel slide protection

H Hydrodynamic brake

MMI Man-machine interface

s_B Braking distance

1 bar = 10^5 N/m^2 = 10^5 Pa = 10^{-1} MPa

5 Design principles

5.1 General requirements

5.1.1 Safety

Braking systems shall conform to the following:

a) the braking performances defined in Clause 6;

b) the design principles listed in the document below;

c) the design principles listed in relevant standards on brake systems;

d) the requirements for the operator using and maintaining the brake system in the intended manner;

e) keeping within the required limits, in order to reduce the effects on the track, as specified in 5.1.9 and 5.5.

In the course of the system design the following risks shall be considered and mitigated. As a minimum, the following hazards shall be taken into account:

f) the brake force applied is greater than the level of brake demanded:

   1) impact on standing passengers;

NOTE No limits are so far defined to secure passengers, only reference could be made to the TSI requirement considering longitudinal forces which corresponds to 2,5 m/s².

   2) excessive jerk;

   3) significant damage to the contact surface of the wheels;

g) the brake performance is lower than the level of brake demanded:

   1) keeping traction effort on the whole train while emergency brake is requested;

   2) emergency brake performance not achieved;

   3) parking brake: performance not achieved;

   4) holding brake for brake test not achieved;

h) there is no brake force, when demanded:

   1) emergency brake not activated on the whole train when requested;

2) automatic (emergency) brake not initiated in the case of an unintended train separation (loss of train integrity);

3) parking brake: loss of performance over the time;

i) there is a brake force when a brake demand has not been made:

1) undue local brake application;

2) locked axle not detected;

j) brake component failures that could cause death or injury to personnel or damage to the train or infrastructure, e.g. derailment.

The hazards in this list shall be assessed in accordance with EN 50126-1.

Concluding from the hazards listed above the emergency brake shall have a high level of integrity and shall always be available when the brake system is set up for operation, whereas the service brake, whilst it may share subsystems and components, etc. with the emergency brake, need not achieve the same level of integrity. Nevertheless the service brake shall be designed to conform to the following requirements:

k) the service brake shall be activated on the whole train when requested;

l) in the case of a loss of service brake efficiency and:

1) if detected by the driver there shall be a means available for the driver to immediately apply the emergency brake by using the same lever which is used for service braking;

2) if the driver fails to detect a loss of efficiency then the train protection system (technical intervention system) shall have access to an emergency brake application;

m) cut off traction effort on the whole train while service brake is requested;

n) provide service brake effort at the level requested.

High-speed trains incorporate a speed control system functioning with different deceleration levels. The prescribed performance levels defining the minimum braking power for trains suitable for running on all high-speed lines are given in Clause 6. The compliance of these performance levels and the safety of the braking system shall be fully demonstrated as specified in EN 15734-2.

Accepted benchmark safety level for a brake system is the UIC-architecture as described in EN 14198. It is characterized by the following items:

o) a continuous, automatic and inexhaustible brake system;

p) the medium is compressed air with its favourable properties;

q) an energized (pressurized to release) brake pipe;

r) decentralized brake actuators, developing the brake force;

s) proven design components.

The components used shall withstand during their period in service any normal or exceptional stresses that have been specified. The safety implication of any failures shall be limited by appropriate means; as described in this standard.

Single point failures shall not cause any relevant malfunctions regarding emergency brake application. That means:

t) functions at train level (in the sense used in EN 14198) shall be designed low active;

u) functions at train level shall provide redundancy or a back up function for any electrical command chain applying the emergency brake;

v) the man machine interface shall provide at least two separate means for demanding an emergency brake application;

w) malfunctions on vehicle level (in the sense used in EN 14198) could be tolerated if the loss of a local function is limited to an acceptable effect by means of a sufficient quantity of units in the train.

The acceptance criteria is defined by a reduced deceleration level as specified under degraded mode conditions “B” in the TSI as well as in Clause 6 in this document. Further reductions in the deceleration level are only tolerable when the probability of its occurrence is sufficiently low. At least, a qualitative examination shall be carried out.

Proper functionality of the brake system is also affected by a design of the piping and component design as specified in 5.4.4.

5.1.2 Fire protection

The braking system shall be protected against the effects of fire and toxic fumes. This shall be achieved by selecting appropriate materials, by an appropriate system architecture and installation arrangement.

The braking system shall, in a manner, be consistent with the train fire protection requirements according to CEN/TS 45545-1 to CEN/TS 45545-7 or according to the TSI HS RST. A fire on board the train shall not cause the brakes to automatically apply within the following times:

a) The brakes shall not automatically apply to bring the train to a halt as a result of system failure caused by a fire assuming the fire is in a technical compartment or cabinet, sealed or unsealed, containing electrical supply line and/or traction circuit equipment or a technical area with a combustion engine.

b) The time which is required to continue train operation with a fire declared to be on board is:

   1) 4 min for category A trains according to TSI SRT;

   2) 15 min for category B trains according to TSI SRT.

c) In order to prevent fire, materials with low flammability shall be used and electrical installations shall meet appropriate European Standards.

5.1.3 Reliability and availability

To comply with the essential requirements of the Directive 2008/57/EC and the requirement of the TSI related to Reliability and Availability, the requirements of 5.13 and 5.17 shall be applied.

5.1.4 Environmental condition

The rolling stock and the equipment on board shall perform under conditions as specified in EN 50125-1:1999. They shall function properly in those climatic zones for which they have been designed and where they will be operated.

NOTE For certain lines the operator of the infrastructure and/or the rail authorities may specify further requirements, e.g. for the Nordic countries.

5.1.5 Train configuration

Interoperable high speed trains can be configured as:

— multiple units with distributed traction equipment applied to any of the intermediate coaches or as trains with power cars (at least one) and intermediate coaches without traction equipment;

— a fixed formation train set consisting of single coaches or articulated coaches;

— trains with or without tilting equipment;

— single deck or double deck trains.

Trains of the same type may be coupled together however they shall behave in the same way as a single unit as far as braking is concerned.

Without other particular specifications the functionality and the performances of the brake system shall be fulfilled when formed up to a maximum train length of 400 m.

5.1.6 Maximum speed and line parameters

The brake system requirements specified in this standard apply to trains that may operate at a maximum speed of up to 350 km/h on lines specifically built for high speed and define graduated values for deceleration related to four speed ranges (see Clause 6).

Where trains are permitted to travel at greater speeds the brake requirements shall be specified as a result of a cooperation between the operator and the relevant transport authority [1].

The Interoperable European high speed network also includes lines specifically upgraded for high speed and lines specifically upgraded for high speed but with special features subjected to national rules determined by the topographic conditions, the track parameters, the signalling equipment, etc. Those line conditions shall be specified for trains which shall be designed for and operated on those specific lines.

5.1.7 Coupling compatibility/capability

Interoperable European high speed trains shall:

a) couple automatically and therefore shall be equipped with a coupler at each end of a unit according to TSI High Speed:

   1) if trains of the same type are coupled then the pneumatic, electrical and electronic connections or others necessary for control shall be coupled and they shall provide full functionality;

   2) if trains of a different type are coupled then the pneumatic connection shall provide sufficient functionality of the brake system to allow hauling a damaged unit by another interoperable unit without adapter. Relying upon the pneumatic brake solely in that case operation restrictions may apply;

b) for rescue purpose a coupling with a conventional traction unit with UIC train hook according to EN 15566 by using a special adapter according to EN 15020 shall be provided. The auxiliary coupling device shall be compatible with the pneumatic pipes according to UIC 648.

If the brake demand is communicated using the brake pipe (in accordance with EN 14198) then the trainset being rescued shall respond in the form of a proportional brake force. For the rescued trainset equipped with

1) Transport authority means ERA and/or national representative.

the UIC brake it is not necessary to have electrical energy on board or to be provided with electrical energy by the rescuing trainset or locomotive. For trains with unconventional brakes and not cooperating with the UIC brake pipe an equivalent response as if equipped with UIC brake pipe shall be provided. The recommended minimum rescuing speed is 100 km/h according to EN 15020.

NOTE The method used for communicating the braking performances of a train which requires rescuing services is left to the national railways. For rescue operation restrictions, it is necessary to clearly specify restriction conditions in the onboard documentation.

If a special procedure is not specified the conventional UIC procedure using the brake weight percentage in accordance with UIC 544-1 will be applied.

5.1.8 Longitudinal track forces

The maximum longitudinal force applied to the track by the brake equipment shall always be less than the force that would occur with an acceleration or deceleration of 2,5 m/s^2.

5.1.9 EMC

The brake equipment shall fulfil the requirements of EN 50121-3 (all subparts) with regard to EMC when applicable.

CE marking is not required.

5.1.10 Operation in very long tunnels

The brake design shall take into account the particular safety conditions in very long tunnels.

5.2 Applicable brakes

5.2.1 Basic architecture for high speed braking

Interoperable European high speed trains shall be equipped with brakes which are free of wear and these brakes should play a major part in the brake concept. This could be achieved by application of sufficiently powered electro-dynamic brakes.

The safety and reliability aspects of the brake system is considered to be satisfied by a system architecture in accordance with EN 14198. This is also a benchmark for alternative brake systems, if they are applied in emergency cases.

5.2.2 Dynamic brakes

Applicable dynamic brakes are:

a) The electro-dynamic brake, i.e. operating the traction motors in the generator mode which:

   1) develops a retarding force at the wheel/rail interface;

   2) returns the braking energy to the main power supply;

   3) alternatively, only if the electro-dynamic brake is independent from the main power supply, the braking energy shall be dissipated in the form of heat by sufficiently dimensioned brake resistors;

NOTE 1 The preferred method for dissipating the braking energy from an electro-dynamic brake is to return the energy to the main power supply.

NOTE 2 The member state may allow an exception from this restriction.