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Railway applications - Braking systems of multiple unit trains - Part 1: Requirements and definitions

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

Applications ferroviaires - Systèmes de freinage pour trains automoteurs - Partie 1 : Exigences et définitions

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This European Standard was approved by CEN on 13 October 2014 and includes Amendment 1 approved by CEN on 6 April 2020.

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European foreword

This document (EN 16185-1:2014+A1:2020) has been prepared by Technical Committee CEN/TC 256 “Railway Applications”, the secretariat of which is held by DIN.

This document includes Amendment 1 approved by CEN on 4 April 2020.

This document supersedes ⟦A1⟩ EN 16185-1:2014 ⟨A1⟧.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟦A1⟩ ⟨A1⟧.

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of an identical text or by endorsement, at the latest by November 2020, and conflicting national standards shall be withdrawn at the latest by November 2020.

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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 2016/797/EU.

For relationship with EU Directive EU Directive 2016/797/EU, see informative Annex ZA which is an integral part of this document.

This series of European Standards *Railway applications — Braking systems of multiple unit trains* consists of:

— *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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

[A1] This document describes the functionality, constraints, performance and operation of a brake system for use in self-propelling thermal and electric trains operating on routes of the European rail system network. [A1]

This European Standard covers:

— all new vehicle designs of self-propelling thermal and electric trains being operated at a maximum speed up to 200 km/h, in the following text simply called EMU/DMU;

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

This standard does not cover:

— locomotive hauled trains which are specified by EN 14198;

— mass transit rolling stock which is specified by EN 13452-1;

— high speed trains being operated at speeds greater than 200 km/h which are specified by EN 15734-1.

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 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, *Railway applications — Wheelsets and bogies — Method of specifying the 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 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 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*

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 15734-1:2010,[1] *Railway applications — Braking systems of high speed trains — Part 1: Requirements and definitions*

EN 16185-2, *Railway applications — Braking systems of multiple unit trains — Part 2: Test methods*

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

EN 16334, *Railway applications — Passenger Alarm System — System requirements*

EN 45545 (all parts), *Railway applications — Fire protection on railway vehicles*

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 50126 (all parts), *Railway applications — The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)*

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

EN 50553, *Railway applications — Requirements for running capability in case of fire on board of rolling stock*

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

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1) This document is currently impacted by the corrigendum EN 15734-1:2010/AC:2013.

UIC 541-3, Brakes — Disc brakes and their application — General conditions for the approval of brake pads

UIC 541-4, Brakes — Brakes with composite brake blocks — General conditions for certification of composite brake blocks

UIC 544-1, Brakes — Braking power

UIC 557, Diagnosis on passenger rolling stock

3 Terms and definitions

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

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

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

3.3
brake weight percentage
brake performance in accordance with UIC 544-1

3.4
driver's vigilance device
dead man device
brake control interface through which a human driver is caused positively/voluntarily to communicate his vigilance

[SOURCE: EN 14478:2005, 4.9.3.1]

3.5
dynamic brake
brakes in which the brake force is produced by the movement of the vehicle or its functional elements, but not involving friction

3.6
emergency brake loop
EBL
dedicated safety loop used to initiate an emergency brake application

3.7
Ep assist
electrically commanded assist system to locally vent and feed the brake pipe

3.8
direct ep-brake
continuous brake system using electrical command signals to directly apply and release the brakes

3.9
holding brake
service brake application to prevent a train from moving for a limited time

3.10
local control unit
control unit acting on a system at a level lower than the multiple unit (for example on a bogie or vehicle basis)

3.11
pilot pressure circuit
pressure circuit using components of reduced dimensions in order to control a limited flow rate which is subsequently amplified

3.12
reference speed
signal generated and generally used by the WSP system as an indication of the train speed used for comparison with the instantaneous wheel set speed as part of the control set algorithm

3.13
regenerative (mode of electro-dynamic braking)
converting the braking energy into electrical energy and generating an energy flow into the main energy supply

3.14
rheostatic (mode of electro-dynamic braking)
converting the braking energy into electrical energy and dissipating the electrical energy in a resistor

3.15
safety loop
hardwired electrical loop following the energize to release principle

Note 1 to entry: A safety loop may be used on vehicle level as well as train level. This European Standard assumes a train wide functionality. Examples of safety loops are:

— emergency brake loop;

— passenger alarm;

— door status traction interlock.

3.16
maximum braking load
load condition lower or equal to “design mass under exceptional payload” as defined in EN 15663

〚A1〛 *Note deleted* 〚A1〛

4 Symbols and abbreviations

For the purposes of this document, the following symbols, units and abbreviations apply:

BP	Brake pipe
BCU	Brake control unit
C	Brake cylinder
CR	Conventional rail
DMU	Diesel multiple unit
EBL	Emergency brake loop
ECB	Eddy current brake
EMC	Electromagnetic compatibility
EMU	Electrical multiple unit
ETCS	European train control system
CCS	Control, command and signalling
H	Hydrodynamic/Hydrostatic brake
IM	Infrastructure Manager
MMI	Man-machine interface
MRP	Main reservoir pipe
MTB	Magnetic track brake
RST	Rolling stock
RU	Railway undertaking (train operator)
SRT	Safety in Railway Tunnels
TEN	Trans European Conventional rail network
TSI	Technical Specification for Interoperability
WSP	Wheel slide protection
λ	Effective braking power
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, subject to the operator using and maintaining the system in the intended manner:

a) the braking performances defined in Clause 6;

b) the design principles in accordance with the requirements of this European Standard;

c) the design principles listed in the standards on brake systems referred to in Clause 2;

d) keeping within the specified 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.

e) the brake force applied is greater than the maximum design level:

   1) impact on standing passengers;

   NOTE No limits are so far defined to secure passengers.

   2) impact on track shifting forces;

   3) excessive jerk;

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

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

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

   2) required emergency brake performance not achieved;

   3) required parking brake performance not achieved;

g) there is no brake force when demanded:

   1) no emergency brake 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;

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

   1) undue local brake application (pneumatic or parking);

   2) locked axle not detected;

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

The hazards in the previous list shall be assessed in accordance with EN 50126 (all parts).

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, while 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 comply with the following requirements:

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

k) independently from the service brake:

1) it shall be possible for the driver to immediately initiate the emergency brake by using the same lever which is used for service braking or by using another independent device;

2) the train protection system (technical intervention system) shall be capable of initiating the emergency brake;

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

m) provide service brake effort as high as requested.

The required performance levels for different EMU/DMU categories are given in Clause 6 and Annex A. The compliance of these performance levels and the safety of the braking system shall be fully demonstrated as specified in EN 16185-2.

A brake system which is considered to be safe shall incorporate the following items:

n) a continuous, automatic and inexhaustible brake system;

o) an energize to release brake command line, as a minimum for the emergency brake;

p) decentralized brake actuators, developing the brake force; using locally stored energy;

q) proven design components, see Annex B.

An accepted bench mark safety level for a brake system is the UIC-architecture as described in EN 14198.

If other system architectures are selected, they shall meet the requirements n) to q) in an equivalent manner.

The components shall withstand any duties expected to occur during their period in service. The safety implication of any failures shall be limited by appropriate means, as described in this European Standard.

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

r) functions at train level (in the sense used in EN 14198) shall be designed as energized to release;

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

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

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

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 shall not emit toxic fumes. This shall be achieved by selecting appropriate materials, by an appropriate system architecture and installation arrangement.

The braking system shall be consistent with the train fire protection requirements according to EN 45545 (all parts).

Running capability under fire shall be satisfied as well. This shall be achieved by being consistent with the requirements in accordance with EN 50553.

5.1.3 Reliability and availability

To comply with the essential requirements 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 the conditions as specified in EN 50125-1. They shall work properly in those climatic zones, for which they have been designed and where they will be operated.

For certain lines, further requirements may be required, e.g. for the Nordic countries.

5.1.5 Train configuration

EMU/DMU can be configured as:

— fixed formations with distributed traction equipment applied to any of the vehicles or as trains with power units (at least one) and additional vehicles without traction equipment;

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

— single vehicle - also known as a railcar;

— trains with or without tilting equipment;

— single deck or double deck trains.

EMU/DMU with the same brake control architecture may be formed together and their functionality shall be the same as a single unit as far as braking is concerned.

The maximum train length over which the functionality and the performances of the brake system shall be specified. If not defined a train formation of at least 200 m should be considered.

5.1.6 Maximum speed and line parameters

The conventional rail network includes lines of different line characteristics which are determined by the topographic conditions, the track parameters, the signalling equipment, etc. The line conditions over which the train will be operated shall be specified.

5.1.7 Coupling compatibility/capability

EMU/DMU of the same type shall be equipped with couplers at each end of the unit to provide the pneumatic, electrical and electronic connections or others necessary for brake control and shall provide full functionality. This can be achieved by:

1) fully automatic coupler providing full functionality (preferred option);

2) combination of automatic and manual connection or;

3) fully manual connections.

If trains of a different type are coupled then the pneumatic connection may provide sufficient functionality of the brake system to allow hauling a damaged unit by another interoperable unit without

adapter. In that case relying upon the pneumatic brake solely may result in operational restrictions; the railway undertaking shall specify the functionalities and the performances of the brake system.

For rescue purposes by a conventional traction unit with a train hook as defined in EN 15566 a special adapter for example in accordance with EN 15020 shall be provided.

For the trainsets equipped with 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 brake systems that are not compatible with the UIC brake pipe an equivalent response as if equipped with UIC brake pipe shall be provided and may require electrical supply on board. In both cases demand is communicating using the BP connection to the unit and the trainset being rescued shall respond in the form of a proportional brake force.

The recommended minimum rescuing speed is 100 km/h.

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 50121-3-1 and/or EN 50121-3-2 with regard to EMC when applicable.

CE-marking is not required.

5.1.10 Operation in very long tunnel

The brake design shall take into account the particular safety conditions in very long tunnels as set out in the SRT TSI.

This should be achieved by being consistent with the requirements in accordance with EN 50553.

5.2 Brake equipment types

5.2.1 Basic architecture for EMU/DMU braking

EMU/DMU trains should 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 dynamic brakes.

5.2.2 Dynamic brakes

Applicable dynamic brakes are:

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

— developing a retarding force at the wheel/rail interface;

— preferably returning the braking energy to the main power supply, which is called the regenerative mode;

— developing a retarding force independent from the main power supply with the braking energy being dissipated by sufficiently dimensioned brake resistors, which is called the rheostatic mode;

— a blending between the regenerative and rheostatic mode may be considered if the reliability of the function can be demonstrated, especially if also used for emergency braking.

The following operational applications are permitted:

— applied in service brake only, not applied in emergency cases;

— applied in service brake, applied in emergency cases but not considered in the brake calculation;

— applied in service brake, applied in emergency cases and considered in the brake calculation.

If the regenerative brake is included in the emergency brake calculation, the effect of the absence of the external power supply shall be considered and mitigated.

If the rheostatic brake is included in the emergency brake calculation, the resistor shall have sufficient thermal capacity to perform an emergency brake application following the most demanding service braking duty specified and the control-command shall be considered to be sufficiently reliable and safe. The performance of such dynamic brake shall not depend on the return of energy into the network, nor does it depend on receiving electrical energy from the network.

The (linear) eddy current brake is characterized by non-contacting electromagnetic forces in the magnetic shoe/rail interface. This type of brake is presently not used in EMU/DMU, but may be considered for future applications. As it is presently used for High Speed Trains see EN 15734-1:2010, 5.5[2)] for further details.

5.2.3 Friction brakes

Applicable friction brakes are:

— disc brakes, designed as wheel mounted, axle mounted, or transmission mounted discs;

— tread brakes;

— if appropriate, other types of brakes, e.g. drum brakes.

5.2.4 Magnetic track brakes

In order to keep stopping distances within specified limits on certain lines EMU/DMUs may be equipped with additional magnetic track brakes. They will only be applied in emergency cases or separately activated by the driver. It is permissible to include their contribution for emergency braking as a means of maintaining the envisaged braking performance. When magnetic track brakes are used, these shall be either:

— electromagnetically excited, battery supported track brakes, which are kept in an upper position and clearance free in the bogie frame in the released status;

— permanently magnetically excited track brakes which are kept in an upper position and clearance free in the bogie frame in the released status. It is permissible for this type of track brake to also fulfil the parking brake function, if a sufficient brake force development can be demonstrated to comply with 5.11;

— track brakes, which are constantly kept in the lower position are permitted when agreed between the RU and IM.

NOTE For further information, see EN 16207.

2) This document is currently impacted by the corrigendum EN 15734-1:2010/AC:2013.