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Title: BS EN 14198 Railway applications - Braking - Requirements for the brake system of trains hauled by locomotives

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Railway applications - Braking - Requirements for the brake system of trains hauled by locomotives

Applications ferroviaires - Freinage - Exigences
concernant le système de freinage des trains tractés
par locomotive

Bahnanwendungen - Bremsen - Anforderungen an die
Bremsausrüstung lokbespannter Züge

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 256.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 14198:2023) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14198:2016+A2:2021.

This document includes the following significant technical changes with respect to EN 14198:2016+A2:2021:

- normative references have been updated;
- definitions have been modified;
- functional requirements at train level for brake modes and positions, for EP assist and for emergency brake application have been modified;
- requirements for direct brake have been modified;
- requirements for brake management have been modified;
- performance requirements for adhesion have been modified;
- Annex A “Vehicle requirements” has been modified;
- Annexe D “Corresponding standards EN – UIC” has been updated;
- Annex E “Brake pipe pressure control system” has been updated;
- Annex F “Venting performance of emergency valves” has been updated;
- Annex ZA has been updated.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s) / Regulation(s).

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

1 Scope

This document specifies basic requirements for the braking of trains hauled by locomotives:

- For trains hauled by locomotives and intended for use in general operation each vehicle is fitted with the traditional brake system with a brake pipe compatible with the UIC brake system.

NOTE This ensures technical compatibility of the brake function between vehicles of various origins in a train (see 5.4).

- For trains hauled by locomotives and intended for use in fixed or predefined formation, the requirements on the vehicle and the train are necessary. In the case of a UIC brake system, this standard applies; if not, the EN 16185 series or the EN 15734 series applies.

If concerned, the UIC brake architecture described in this document (see 5.4) can be used for brakes for multiple unit train and high speed trains and urban rail described in the EN 13452 series, the EN 16185 series and the EN 15734 series.

This document also takes into account electrical and electronic control functions and additional brake systems like dynamic brakes and adhesion independent brakes.

The brake system requirements, which are specific for on-track machines are set out in EN 14033-1.

This document does not apply to urban rail rolling stock brake system, which is specified by EN 13452-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 837-1:1996,¹ *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

EN 854:2015, *Rubber hoses and hose assemblies - Textile reinforced hydraulic type - Specification*

EN 10220:2002, *Seamless and welded steel tubes - Dimensions and masses per unit length*

EN 10305-4:2016, *Steel tubes for precision applications - Technical delivery conditions - Part 4: Seamless cold drawn tubes for hydraulic and pneumatic power systems*

EN 10305-6:2016, *Steel tubes for precision applications - Technical delivery conditions - Part 6: Welded cold drawn tubes for hydraulic and pneumatic power systems*

EN 13749:2021, *Railway applications - Wheelsets and bogies - Method of specifying the structural requirements of bogie frames*

EN 14478:2017, *Railway applications - Braking - Generic vocabulary*

EN 14531-1:2015+A1:2018, *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*

¹ Document impacted by AC:1998.

EN 14531-2:2015, *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 14535-1:2019, *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 14535-2:2019, *Railway applications - Brake discs for railway rolling stock - Part 2: Brake discs mounted onto the wheel, dimensions and quality requirements*

EN 14535-3:2015, *Railway applications — Brake discs for railway rolling stock — Part 3: Brake discs, performance of the disc and the friction couple, classification*

EN 14601:2005+A2:2021, *Railway applications - Straight and angled end cocks for brake pipe and main reservoir pipe*

EN 15220:2016, *Railway applications - Brake indicators*

EN 15273-2:2013+A1:2016, *Railway applications - Gauges - Part 2: Rolling stock gauge*

EN 15328:2020, *Railway applications - Braking - Brake pads*

EN 15329:2019, *Railway applications - Braking - Brake block holder and brake block key*

EN 15355:2019+A1:2023, *Railway applications — Braking — Distributor valves and distributor-isolating devices*

EN 15595:2018,² *Railway applications — Braking — Wheel slide protection*

EN 15611:2020+A1:2022, *Railway applications - Braking - Relay valves*

EN 15612:2020, *Railway applications - Braking - Brake pipe accelerator*

EN 15663:2017+A1:2018, *Railway applications - Vehicle reference masses*

EN 15807:2021, *Railway applications - Pneumatic half couplings*

EN 16186-2:2017, *Railway applications - Driver's cab - Part 2: Integration of displays, controls and indicators*

EN 16207:2014+A1:2019, *Railway applications - Braking - Functional and performance criteria of Magnetic Track Brake systems for use in railway rolling stock*

EN 16241:2014+A1:2016, *Railway applications - Slack adjuster*

EN 16334-1:2014+A1:2022, *Railway applications - Passenger Alarm System - Part 1: System requirements for mainline rail*

EN 16451:2015, *Railway applications - Braking - Brake pad holder*

EN 16452:2015+A1:2019, *Railway applications - Braking - Brake blocks*

EN 16834:2019, *Railway applications - Braking - Brake performance*

² Document impacted by AC:2021.

EN 45545-1:2013, *Railway applications - Fire protection on railway vehicles - Part 1: General*

EN 45545-2:2020, *Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behavior of materials and components*

EN 45545-3:2013, *Railway applications - Fire protection on railway vehicles - Part 3: Fire resistance requirements for fire barriers*

EN 45545-4:2013, *Railway applications - Fire protection on railway vehicles - Part 4: Fire safety requirements for rolling stock design*

EN 45545-5:2013+A1:2015, *Railway applications - Fire protection on railway vehicles - Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles*

EN 45545-6:2013, *Railway applications - Fire protection on railway vehicles - Part 6: Fire control and management systems*

EN 45545-7:2013, *Railway applications - Fire protection on railway vehicles - Part 7: Fire safety requirements for flammable liquid and flammable gas installations*

EN 50125-1:2014, *Railway applications - Environmental conditions for equipment - Part 1: Rolling stock and on-board equipment*

EN 50163:2004, *Railway applications - Supply voltages of traction systems*

EN 50553:2012,³ *Railway applications — Requirements for running capability in case of fire on board of rolling stock*

EN ISO 1127:1996, *Stainless steel tubes - Dimensions, tolerances and conventional masses per unit length (ISO 1127:1992)*

ISO 4975:2022, *Railway applications — Braking system — Quality of compressed air for pneumatic apparatus and systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14478:2017 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

general operation

mode of operation of units intended to be coupled with other units in a train formation which is not defined at design stage

³ Document impacted by A1:2016, A2:2020 and AC:2013.

3.2

brake mode

in the “EN-UIC” design, mode that defines the brake force build up and release timings – namely “G” for goods timings, i.e. slow-acting, “P” for passenger timings, i.e. fast timing, typically controlled by the brake distributor in an air brake system

3.3

brake position

in the “EN-UIC” design, position that defines the behaviour of the distributor valve in regard of brake application and release timings and brake cylinder forces, combined with additional brake systems

Note 1 to entry: E.g. brake positions G, P, R and others.

3.4

automatic brake application

automatic application of the brakes when the brake line is interrupted

3.5

power brake

uses compressed air to apply the brake

3.6

unit

assessable entity which may be a single vehicle/locomotive or a group of vehicles that operate in a fixed formation

3.7

train

operational formation consisting of one or more units

3.8

rear view position

position in the front cab, where the driver can observe the rear end of the train and can command the traction and brake system for shunting

3.9

active driving cab

only cab enabled to generate trainwide control signal for traction and service braking

3.10

brake command vehicle

vehicle where the active cab is located

3.11

emergency brake performance

result of an emergency brake application in terms of stopping distances, retardation and brake response time

3.12

locomotive

traction vehicle (or combination of several vehicles) that is not intended to carry a payload and has the ability to be uncoupled in normal operation from a train and to operate independently

3.13**braked weight percentage**

also known as λ (lambda) brake performance in accordance with EN 16834

3.14**braked weight**

performance value that is obtained by multiplying the braked weight percentage by the total mass of the vehicle/train and dividing the result by 100 and is expressed in tonnes

3.15**build-up time**

time to create an emergency brake application on a single vehicle starting from the beginning of the pressure rising until 95 % of the maximum brake cylinder pressure is reached

3.16**release time**

time for reducing the brake cylinder on a single vehicle, starting from the beginning of the pressure drop down to 0,4 bar

4 Symbols and abbreviated terms

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

λ	braked weight percentage
AC	alternating current
BP	brake pipe
CCS	Control Command and Signalling System
CSM	common safety methods
CW	marking for freight wagons depending on compliance with TSI WAG requirements, for application refer to Commission Regulation (EU) No 321/2013, Annex C, Clause 5 "Marking of units"
DC	direct current ("Berlin DC-Network" means network of the S-Bahn Berlin, Germany, which runs on DC)
EMC	electromagnetic compatibility
ETCS	European Train Control System
GE	marking for freight wagons depending on compliance with TSI WAG requirements, for application refer to Commission Regulation (EU) No 321/2013, Annex C, Clause 5 "Marking of units"
MRP	main reservoir pipe
MTB	magnetic track brake
UIC	International Union of Railways (<i>Union internationale des chemins de fer</i>)
UK	United Kingdom
WSP	wheel slide protection system

5 Requirements

5.1 General requirements of the train brake system

The purpose of the train brake system is to ensure that the train's speed can be reduced or maintained on a slope, or that the train can be stopped within the maximum allowable braking distance.

Braking also provides the immobilization of a train either for a certain period of time or permanently when it is not in operation or without any energy on board.

Units designed and assessed to be operated in general operation (various formations of vehicles from different origins; train formation not defined at the design stage) shall be fitted with a technically compatible brake system to ensure the brake function in all vehicles of the train.

5.2 General safety requirements

5.2.1 Design principles

The design, construction or assembly, maintenance and monitoring of safety-critical components, and more particularly of the components involved in train movements, shall ensure safety at the level corresponding to the aims laid down for the respective railway network. The braking techniques and the stresses exerted shall be compatible with the design of the tracks, engineering structures and signalling systems. Brake systems shall conform to the following:

- the design principles listed in the standards on brake systems referred to in Clause 2;
- the brake performances defined in Clause 6;
- the design principles in accordance with the requirements of this document;
- keeping within the specified effects on the infrastructure, particularly regarding EMC and noise emissions.

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

- a) the brake force applied is greater than the maximum design level:
 - 1) impact on track shifting forces;
 - 2) excessive jerk (impact on standing passengers);
 - 3) significant damage to the contact surface of the wheels or friction partners;
 - 4) impact on load assumptions in the fatigue life of the components generating the brake force;
- b) 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;
 - 4) holding brake performance not achieved;
- c) 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;
- d) there is a brake force when a brake demand has not been made:
 - 1) undue local brake application (pneumatic or parking);
- e) 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 CSM.

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 comply with the following requirements:

- it shall be activated on the whole train when requested;
- it shall cut off traction effort on the whole train while service brake is requested;
- it shall provide service brake effort as high as requested.

Independently from the service brake:

- 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;
- the train protection systems shall be capable of initiating the emergency brake.

The components shall be of a proven design and 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 standard. For more guidance on proven design see Annex C.

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

Proper functionality of the brake system is also affected by the design of the piping and component design as specified in 5.4.5.

5.2.2 Fire protection

The brake 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 brake system shall be consistent with the train fire protection requirements as set out in the EN 45545 series.

The running capability shall be in accordance with EN 50553:2012³.

5.2.3 Environmental condition

The rolling stock and the equipment on board shall perform under the conditions as specified in EN 50125-1:2014. 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 specified, e.g. for the Nordic countries.

CEN/TR 16251 covers this subject and it may be considered.

5.3 Requirements of the main brake system

5.3.1 General requirements

Trains for general operation shall be equipped with a main brake system providing the following functions:

- emergency braking;
- service braking;
- functions to keep the train stationary.

The functions shall incorporate the features listed below:

- trainwide brake control (driver's cab equipment, CCS, etc.);
- command distribution;
- local brake control;
- brake force generation;
- indication of brake status;
- energy supply for brake force generation and command control of the main brake system.

The structure of the document is considering general functions on a train wide level and particular functions for the different vehicles on a local vehicle level. The local vehicle level is considering different functions for locomotives, coaches and wagons.

Figure 1 shows the basic structure of a brake system (with train and vehicle levels) and transmission paths for brake control signals and energy for brake force generation, including their conversion into brake force.

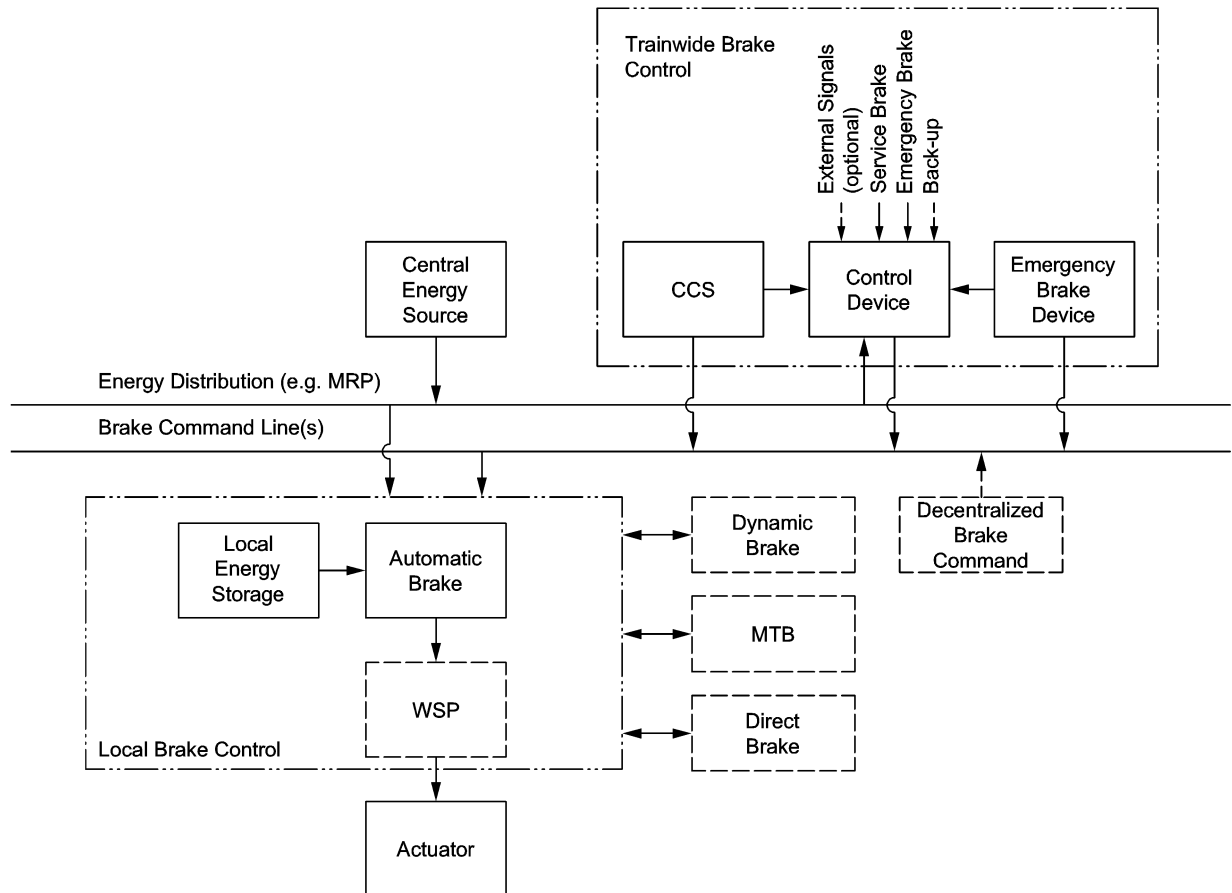


Figure 1 — Basic structure of the main brake system (functions in dotted lines are optional)

5.3.2 General functions on train level

5.3.2.1 Brake control functions

- a) Each unit shall be equipped with a brake command line which is intended to transmit the brake command from the active driving cab to all other units in the train in a dedicated manner.
- b) The trainwide brake control, the continuous brake command line and the local control unit in each single vehicle of the train shall cooperate in a compatible way by using appropriate command signals.
- c) The brake command line shall be capable
 - 1) to receive a brake apply/release command from a trainwide brake control initiated from the active cab of the leading vehicle,
 - 2) to receive an emergency brake application command from a trainwide brake control initiated from decentralized brake command devices if fitted.
- d) The brake command line shall be capable of transmitting the brake command information:
 - 1) full release of the brakes;
 - 2) emergency brake application;
 - 3) gradual application or release for service braking.

- e) Each unit shall be equipped with a local brake control which is connected to the brake command line for the purpose of receiving the brake command information and to control the local brakes accordingly.
- f) The level of brake application may be adjusted locally in proportion to the weight of the vehicle.
- g) If additional brake systems are intended to be used for emergency braking they shall be controlled by the brake command line. In case they are intended for use in service braking these additional brake systems should be capable of being controlled by the brake command line and also independently.
- h) It is permitted to use more than one brake command line (for example pneumatic and emergency brake loop) if they act continuously and automatically.
- i) For the purpose of service braking only it is permitted to establish an additional brake command line which does not need to act automatically.

5.3.2.2 Automatic brake application

Any loss of integrity of the brake command line (for example: an unintended train separation caused by a mechanical failure) shall lead to an immediate brake activation on all vehicles of the train.

A release command shall not be capable to override a brake application command except as set out in 5.3.2.6.

The principle to achieve this requirement is the energizing of the brake command line to release the brake and by de-energizing the brake command line causing an automatic brake application.

5.3.2.3 Inexhaustibility

There shall be sufficient brake energy available on board the train (= stored energy), distributed along the train consistent with the design of the brake system. Repeated brake application and release cycles followed by a subsequent emergency brake application shall achieve at least 85 % of the nominal train brake force.

The nominal brake force is that achieved by an emergency brake application when the local energy storage devices are fully charged.

The system shall indicate to the driver in the event of the brake energy supply being disrupted, the power supply failing or other energy source failure at train level. If the inexhaustibility will no longer be achieved

- the brakes shall not be capable of being released (see “EN-UIC” brake), or
- there shall be an automatic brake application, if the energy in the local storage drops below a predetermined value still capable of providing the full service brake performance.

5.3.2.4 Availability

The main brake system shall provide the emergency brake performance commanded by the trainwide brake control at any time. This shall take priority over any automatic control for reducing brake forces as a result of any fault detection or material protection such as overheating or overcurrent.

5.3.2.5 Graduability

It shall be possible for the driver to incrementally control the value of service brake force during both brake application and brake release.

5.3.2.6 Device for decentralized brake command

The design of the brake command line shall permit the attachment of a device for “decentralized brake command” (such as shown in Figure 1) at any place along the train. Its purpose is to intentionally de-energize the brake command line and to apply the brakes. For details on vehicle level see 5.3.3.3.

This function includes the brake command as part of the passenger alarm system. It is a coordinated function on train level as well as on local level. For details see EN 16334-1. The design of the passenger alarm system shall allow the brake application command to be suspended by an override command initiated from the active driving cab.

5.3.2.7 Brake functions to keep a train stationary

5.3.2.7.1 General

It shall be possible for the train to be kept stationary by the following functions:

- holding brake;
- immobilization brake;
- parking brake.

5.3.2.7.2 Holding brake

It shall be possible to secure the train at standstill during a stop in a station and on line up to a gradient of 40 ‰ unless otherwise specified.

The application of the holding brake shall be possible by the direct brake (see 5.6.2) alone or combined with partial or full service brake initiated automatically or by the driver. The holding brake shall be capable of holding a train under all relevant load conditions as specified in 6.3.

It is recommended that the holding brake is provided by the leading vehicle and/or by the locomotive alone.

The brake shall release either after a certain traction force has been developed or after a certain period of time following the traction command or by a manual command.

5.3.2.7.3 Immobilization brake

It shall be possible to hold a train in a stationary position under all relevant load conditions as specified in 6.3 for a certain period of time and at least on a gradient of 40 ‰ in the event of the brake energy supply being disrupted or the power supply failing. The period of time

- shall last at least 30 minutes for any type of train,
- shall last at least two hours for locomotives and passenger trains.

The immobilization brake is normally initiated by an application of the service brake or emergency brake. The immobilization brake shall not be capable of being released if there is insufficient energy available to reapply it immediately thereafter.

It is permitted to substitute the immobilization brake function by the parking brake if this can achieve the required performance.

5.3.2.7.4 Parking brake

The parking brake shall keep the train stationary in shut down configuration for an indefinite period of time without energy supply until intentionally released. This applies at least for the stabling point (depot).

The “indefinite period of time” may be validated by a design review.

For individual units (vehicles) the parking brake capability shall be included in the vehicle specification. The trainwide capability of the parking brake function shall be determined. If the parking brake is not sufficient it shall be supplemented by extra on-board facilities for example scotches.

When determining the parking brake performance the available adhesion shall be considered; see 6.6 (adhesion section).

It is recommended that the parking brake force generation should be distributed so when applied the train is still capable of being dragged without locking any wheelset.

5.3.2.8 Brake status test

5.3.2.8.1 General

In order to ensure the safety integrity of the brake systems certain functions and features shall be checked.

When at a standstill, as a minimum it shall be possible for the train staff to check from inside and/or outside of the train:

- the continuity of the brake command line along the whole train;
- the availability of the brake energy supply along the train;
- the status of the parking brake (applied, released and optionally isolated);
- the isolation status of the dynamic brake and brake system linked to traction systems;
- the application of the brakes when commanded including their availability to contribute to the brake performance. Typically, this is achieved by indicating the pressure in the brake cylinders;
- the complete release of the brakes as a response to the corresponding command;
- the fault status of the WSP.

If the parking brake always depends directly on the state of the main brake system, it is not required to have an additional and specific indication for the parking brake system.

The brake system shall be designed so that the brake test can be undertaken using one or more of the following methods:

- manual method: the brake status is checked at the outside or inside of the train using for example the brake indicators located on each vehicle;
- semi-automatic brake test performed in the active cab using a display to provide step by step instructions and display electronic status information;
- an automatic brake test (performed by the brake system including target/actual comparison) with a subsequent functional check of the man-machine interfaces in the cab (e.g. brake valve, push button).

Noise emission during brake status tests shall be reduced preferably by fixed installed technical means and shall be as low as reasonably practicable.

5.3.2.8.2 Manual brake test

The steps of a brake test shall comprise:

- a) check if the energy for the brake force generation and the brake control functions is available;
- b) check for leakages if relevant;
- c) check the release status of all brake force generators;
- d) command repeated and dedicated brake applications:
 - 1) activating all relevant components in functional groups; or
 - 2) separately, if required by the function;
 - 3) including the manipulation of the driver's brake lever by the driver;
- e) and check:
 - 1) the status "brakes applied" within a defined time window including the correct response of the involved components; and
 - 2) the continuity of the brake command line along the whole train formation;
- f) send a release command after having received the "brakes applied" status and check the "brakes released" status within a defined time window.

NOTE The final step of a manual brake test is a decision by the staff involved whether the brakes are operating satisfactorily or not.

5.3.2.8.3 Semi-automatic brake test

The semi-automatic brake test may follow the procedures of the manual brake test allowing the driver to follow a step by step guidance on the display initiating the different functional tests and to receive the results directly on the display without any assistance by further staff outside the train.

The main features are:

- brake command by driver;
- remote control by train bus;
- status indication on the display.

5.3.2.8.4 Automatic brake test

The automatic brake test may follow the procedures of the manual brake test initiating the different functional tests without the driver on-board and to receive the results directly on the display without any assistance by further staff outside the train.

With the provision of a data link in addition the automatic brake test shall provide the following functions:

- a) check the fault status of the WSP;
- b) if the test has been finished successfully the result:

- 1) shall be indicated to the driver;
- 2) shall be stored in the on-board data storage; and
- 3) shall supply the relevant brake performance data to the driver with the option to transmit them to an advanced CCS-systems, like ETCS, under his responsibility.

If during the automatic brake test a fault condition is detected, depending on the criticality of the failure, the test run should be stopped indicating a negative result to the driver and asking for a repeated test under the responsibility of the driver.

5.3.2.9 Brake status monitoring

When running, the driver shall be able to check from his driving position in the cab:

- the status of the train brake command line;
- the status of the train brake energy supply;
- the status of the dynamic brake and brake system linked to traction system;
- the status applied or released of at least one part (actuator) of the main brake system (for example a part which is installed on the vehicle fitted with an active cab);
- the reason for a decentralized brake command if the necessary communication system is fitted.

NOTE Status means in this context: availability and/or the level of performance being achieved.

If a spring applied parking brake is fitted to at least one vehicle in the formation and there is an unintended application of the parking brake it shall be indicated to the driver unless

- the parking brake incorporates a suitable device to hold the parking brake in the release position automatically in the event of an unintended loss of the release energy or
- an emergency brake application is initiated.

It is recommended hand brakes are equipped with contacts to detect applied parking brakes to provide a message to the driver. This requirement also applies to other forms of parking brake that do not rely upon manual operation (for example hydraulically applied and released brakes).

If the train vehicles are designed for a push-pull configuration an unintended application of the direct brake in any of the non-active cabs shall either initiate a service or emergency brake request or shall be indicated to the driver.

5.3.3 Additional requirements at the vehicle level

5.3.3.1 Compatibility

The brake equipment of each vehicle shall be compatible with the brake control system of the train and with the brake systems of the other vehicles.

The compatibility shall be achieved in terms of

- a) coupling interface between vehicles in the train,
- b) transporting the brake command from one vehicle to the other,
- c) the characteristics of the local control responding to the central command,

- d) transporting the brake energy from one vehicle to the other, if the brake energy supply is not provided on a local basis,
- e) comparable brake performance in terms of
 - 1) brake force contribution and the permitted load transfer between vehicles, (for details see 5.3.3.4),
 - 2) brake application and release timings,
 - 3) the effect on the dynamic behaviour of the train (including operating isolated vehicles within the formation of the train).

5.3.3.2 Inexhaustibility

The design of the brake system at the local level shall contribute to the inexhaustibility feature. In particular, there shall be sufficient brake energy stored on the vehicle to ensure the application of the required brake forces on that vehicle.

5.3.3.3 Device for decentralized command initiation

The local design of the brake system shall permit attachment of decentralized command initiation devices to de-energize the brake command line and to apply the brakes.

In this regard the interface between the brake system and the passenger alarm system shall be in accordance with EN 16334-1:2014+A1:2022.

The interfaces to systems on vehicles that monitor hazards to normal operation (for example derailment detection, hot axle box detection, device for ensuring the security of loads) are optional.

The following requirements apply:

- the functional characteristics of the brake command line shall not be adversely changed or affected;
- actuation of these devices shall be identifiable from both sides of the vehicle or from inside the vehicle;
- the device should be capable of being isolated or reset from both sides of the vehicle or from inside the vehicle after actuation or in the event of a malfunction.

5.3.3.4 Braking capability

Each individual vehicle of the train shall be equipped with the main brake system capable of dissipating the energy produced during braking so that, when operated in accordance with the vehicle instructions, no damage occurs to the components generating the brake forces (for example: friction surfaces) and to the surrounding parts of the vehicle and the infrastructure.

To permit the operation of trains with isolated vehicles without speed restriction will require the other vehicles to accept a higher braking duty.

Thermal capacity requirements are set out in 6.5.

— For locomotives and coaches:

each vehicle shall be designed so that it is capable to brake its own weight. The consideration of additional braking duty on a vehicle shall be defined, such as permitting loco friction brakes to be intentionally released during normal operation or degraded mode.

— **For wagons:**

the brake equipment shall be able to withstand one emergency brake application without any loss of brake performance due to thermal or mechanical effects.

The braking duty, the vehicle is capable of withstanding without any adverse loss of brake performance due to thermal or mechanical effects, shall be defined and expressed in terms of speed, load, and duration of the brake application.

NOTE 1 The thermal duty for block brakes is generally limited by the capacity of the wheel.

NOTE 2 Degraded conditions will be treated in Clause 6 or in the related component standards.

5.3.3.5 Application of manual parking brake

For the purpose of designing the parking brake it shall be assumed the maximum force that can be applied by a manual operator is 500 N at the mechanical interface (hand brake wheel, lever, etc). It is recommended to use a target value of 250 N when designing new parking brake arrangements.

5.4 “EN-UIC” brake system - based on air brake system

5.4.1 Foreword

The UIC brake is a variant of air brake developed from George Westinghouse's invention at the end of the 19th century. It has been adapted by the European rail industry and it has been formalized into UIC leaflets.

The main characteristic of this brake architecture is that the requirements listed in 5.3.1 can be achieved using compressed air only.

The interoperable brake command and control system presently used in the EU is the system of an indirectly pneumatically controlled brake system defined by European standards. The applicable European standards and the corresponding UIC-leaflets are listed in Table D.1.

5.4.2 General architecture

5.4.2.1 Brake pipe

The “EN-UIC” brake system shall be provided with a continuous brake pipe acting as a brake command line as set out in 5.3.2.1.

The brake command signal is achieved by varying the pressure in the brake pipe below the normal working pressure.

The brake pipe also provides a means to distribute the brake energy supply to the individual vehicles.

5.4.2.2 Brake pipe pressure control system

The pressure level in the brake pipe shall be controlled by the driver's brake valve (corresponding to the control device within the trainwide brake control in 5.3.1, Figure 1) with the following characteristics:

- in the **release condition**: charging the brake pipe with normal working pressure of 5 bar and maintaining that pressure by automatically compensating system leakages;
- in a **service braking condition**: gradually venting and maintaining a lower brake pipe pressure as an input signal for the distributor valves so that the brakes apply;
- in the **full service braking condition**: to command the maximum brake force by a pressure reduction in the brake pipe of 1,6 bar + 0,2 bar and maintaining the pressure at that level;

- in the **emergency brake position**: rapidly dropping the pressure in the brake pipe down to less than 2,5 bar.

NOTE The term condition reflects the option to use position depended or time depended controls.

Leakage from the brake system (such as from brake cylinders, inter-vehicle connections) shall be automatically compensated by the brake pipe pressure control system feeding the brake pipe. This shall not prevent an automatic brake application. This shall be achieved in the release state and all service brake conditions.

In addition the brake pipe pressure control system shall fulfil the requirements in accordance with Annex E.

5.4.2.3 Local brake control

In all types of vehicles a local brake control (distributor) valve shall be fitted and connected to the brake pipe. The variation of the pressure in the brake pipe shall be the command signal for the local brake control (distributor) valve with the purpose to convert:

- the gradual venting of the brake pipe into a gradual pressure increase in the brake cylinders and/or increase in dynamic brake output and
- the gradual increase of the brake pipe pressure into a gradual release in the brake cylinders pressure and/or reduction in dynamic brake output.

Distributor valves shall be designed in accordance with EN 15355:2019+A1:2023. Relay valves shall be designed in accordance with EN 15611:2020+A1:2022.

5.4.2.4 Brake force generation

The vehicle shall be fitted with the appropriate type and size of brake cylinders/actuators.

NOTE To achieve the required retarding force the vehicles are generally equipped with a relay valve in accordance with EN 15611 and/or an appropriate ratio in the brake rigging.

5.4.2.5 Storage of compressed air

Each distributor valve shall be provided with a local reservoir to store compressed air dedicated for the supply to the brake cylinders.

The system shall be capable of charging the local reservoirs

- from the brake pipe via the distributor valve (type of single pipe brake) and/or via a separate device,
- optionally from a second continuous air pipe (main reservoir pipe) providing directly the energy distribution from the main reservoir storage to the local reservoirs (type of two pipe brake).

In both cases a device shall be fitted between the supply line and the local reservoir incorporating, as a minimum, a check valve function. Its function is to protect the pressure in the local reservoirs in the event of loss of the air supply or if the supply pressure is less than the pressure in the reservoir. The device may contain a pressure regulator.

NOTE Distributor valves in accordance with EN 15355 incorporate this check valve function.

5.4.3 Additional brake systems

Additional brake systems (for example electro-dynamic brakes, magnetic track brake, etc.) may be attached to one or more vehicles in a train formation if they can be applied in a coordinated manner or exclusively and intentionally by the driver.

If those additional brake systems are considered in the emergency brake performance they shall be connected to the brake pipe (or an alternative brake command line) so that they can receive the brake application or release command simultaneously with the air brake or faster, when an electrical brake command line is used.

5.4.4 Functional requirements at train level

5.4.4.1 Operational characteristics

The following characteristics shall apply:

- the propagation speed of the emergency brake command signal shall be a minimum of 250 m/s;
- a service brake command shall be transmitted to the last vehicle of the train if the pressure in the brake pipe at the active control has dropped by 0,4 bar below the normal working pressure;
- the graduability (increase or reduction) of the brake pipe pressure control system shall enable at least 6 levels of brake command (in addition to release condition) including full service brake application;
- full service brake application shall be obtained by a reduction of the brake pipe pressure by 1,5 bar $\pm$ 0,1 bar below the normal working pressure;
- it is not permitted to use the compressed air from reservoirs of the brake system and the brake pipe for any purpose other than braking.

These characteristics are achieved by using distributor valves in accordance with EN 15355:2019+A1:2023 and brake pipe pressure control systems in accordance with Annex E.

5.4.4.2 Inexhaustibility in the “EN-UIC” system

Repeated brake application and release cycles followed by a subsequent emergency brake application shall be possible. These application and release cycles shall not be limited to a certain number if the frequency of manipulation is in accordance with the dynamic behaviour of the system as specified in EN 15355:2019+A1:2023.

NOTE Operation of an EN-UIC brake system needs skilled manipulation by the driver.

The inexhaustibility shall be supported by:

- brake pipe pressure control system, maintaining the pressure in the brake pipe, as set out in 5.4.2.2, which means compensating for leakages;
- the distributor valve, maintaining the pressure in the local brake supply reservoir at the corresponding pressure level in the brake pipe when in a service brake position (compensating for leakages). Distributor valves designed in accordance with EN 15355:2019+A1:2023 satisfy this requirement.

5.4.4.3 Brake modes and positions

The local control command system of the air brake shall provide one or two basic brake modes:

- G – for freight services with slow build-up and release times (EN 15355:2019+A1:2023). For coaches this mode is optional;

NOTE 1 These times are selected to reduce the risk of generating excessive longitudinal forces within long and heavy trains and to enable the recharging of the reservoirs of the individual vehicles.

- P – for passenger and freight services with quick build-up and release times (EN 15355:2019+A1:2023).

NOTE 2 These times are selected for passenger services in general and for freight services if the longitudinal forces are limited to a tolerable value.

The G-mode can be subdivided into further brake positions:

- G – for freight services with limited brake performances (see also Clause 6);
- G+X – for freight services with additional brake systems (see also Clause 6).

The P-mode can be subdivided into further brake positions:

- P – for passenger (and freight) services with limited brake performances (see also Clause 6);
- P+X – for passenger (and freight) services with additional brake systems (see also Clause 6);
- R – for rapid (express) services with high brake performances (see also Clause 6);
- R+X – for rapid (express) services with additional brake systems (see also Clause 6).

The relevant brake positions are set out in the Table 1.

Table 1 — Common brake combinations

Brake mode			
G	P		Brake with different response times
slow	quick		
Brake position			
G	P	R	Brake with different levels of brake force
low	low	high	
Pneumatic brake with additional brake system (in combination, blending or substitution)			
G+E	P+E	R+E	Additional brake = electro-dynamic brake
G+H	P+H	R+H	Additional brake = hydro-dynamic brake
	P+Mg	R+Mg	Additional brake = magnetic track brake
		R+WB	Additional brake = eddy current brake (German: Wirbelstrombremse)
		R+E+Mg	Additional brake = electro-dynamic brake and magnetic track brake
		R+E+WB	Additional brake = electro-dynamic brake and eddy current brake

For locomotives and wagons the brake positions G and P are mandatory.

All other brake positions are optional and shall be requested in the vehicle specification.

For details of the timings in different brake positions and for different types of vehicles see Table A.1.