BS EN 14198:2016

BSI Standards Publication

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

National foreword

This British Standard is the UK implementation of EN 14198:2016. It supersedes BS EN 14198:2004 which is withdrawn.

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

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

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

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

The UK participation in its preparation was entrusted to Technical Committee RAE/4/-/1, Railway applications - Braking.

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

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

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Bahnanwendungen - Bremsen - Anforderungen an die Bremsausrüstung lokbespannter Züge

This European Standard was approved by CEN on 16 October 2016.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 14198:2016) 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of an identical text or by endorsement, at the latest by May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14198:2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2008/57/EC.

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

EN 14198:2016 includes the following significant technical changes with respect to EN 14198:2004:

— restructure of the whole document (brought in line with TSI);

— new Clause 6 "Performances";

— new Annex A "Vehicle requirements";

— new Annex B "Train related brake performance categories";

— modified clauses: 1 "Scope", 2 "Normative references", 3 "Terms and definitions", 4 "Symbols and abbreviations", 5 "Requirements", Annex C, Annex D;

— deleted clauses: 6 "Test conditions".

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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

This European Standard 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 standard (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 European Standard 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 European Standard does not apply to Urban Rail rolling stock braking system, which is specified by EN 13452-1.

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

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

EN 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 13749:2011, *Railway applications - Wheelsets and bogies - Method of specifying the structural requirements of bogie frames*

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

EN 14531-1, *Railway applications - Methods for calculation of stopping and slowing distances and immobilization braking - Part 1: General algorithms utilizing mean value calculation for train sets or single vehicles*

EN 14531-2, *Railway applications - Methods for calculation of stopping and slowing distances and immobilization braking - Part 2: Step by step calculations for train sets or single vehicles*

EN 14535-1, *Railway applications — Brake discs for railway rolling stock — Part 1: Brake discs pressed or shrunk onto the axle or drive shaft, dimensions and quality requirements*

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

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

EN 14601, *Railway applications — Straight and angled end cocks for brake pipe and main reservoir pipe*

EN 15220, *Railway applications - Brake indicators*

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

EN 15329, *Railway applications - Braking - Brake block holder and brake shoe key for railway vehicles*

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

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

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

EN 15612, *Railway applications — Braking — Brake pipe accelerator valve*

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

EN 15734-1, *Railway applications - Braking systems of high speed trains - Part 1: Requirements and definitions*

EN 15807, *Railway applications - Pneumatic half couplings*

EN 16185-1, *Railway applications - Braking systems of multiple unit trains - Part 1: Requirements and definitions*

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

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

EN 16241, *Railway applications - Slack adjuster*

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

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

EN 16452, *Railway applications - Braking - Brake blocks* prEN 16834, *Railway applications - Braking - Brake performance*

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

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

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*

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

NF F 11-100:1995, *Matériel roulant ferroviaire — Qualité de l'air comprimé destiné aux appareils et circuits pneumatiques*

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

UIC 541-5:2005, *Brakes — Electropneumatic brake (ep brake) — Electropneumatic emergency brake override (EBO)*

UIC 541-6:2010, *Brakes — Electropneumatic brake (ep brake) and Passenger alarm signal (PAS) for vehicles used in hauled consists*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14478 [1)] and the following apply.

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

3.2
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 positions G, P, R and others
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

3.4
automatic brake application
automatic application of the brakes when the brake line is interrupted

1) EN 14478 is under revision and the next edition will include several of the definitions currently contained in this document.

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 and transmit train wide command for traction and brake release

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 prEN 16834

3.14
braked weight
weight which 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 or the pre-control brake cylinder pressure on a single vehicle, starting from the beginning of the pressure drop down to 0,4 bar

Note 1 to entry: The pressure in the brake pipe is increased up to the normal working pressure, starting from 1,5 bar below it, in less than 2 s.

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations 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
RER	Le Réseau Express Regional (Network of Express Train Lines in and around Paris, France)
UIC	International Union of Railways (*Union internationale des chemins de fer*)
UK	United Kingdom
WSP	Wheel Slide Protection system

5 Requirements

5.1 General requirements of the train braking system

The purpose of the train braking 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 – normative references;

— the brake performances defined in Clause 6;

— the design principles in accordance with the requirements of this standard;

— 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.

5.2.3 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 specified, e.g. for the Nordic countries.

The CEN technical report 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.

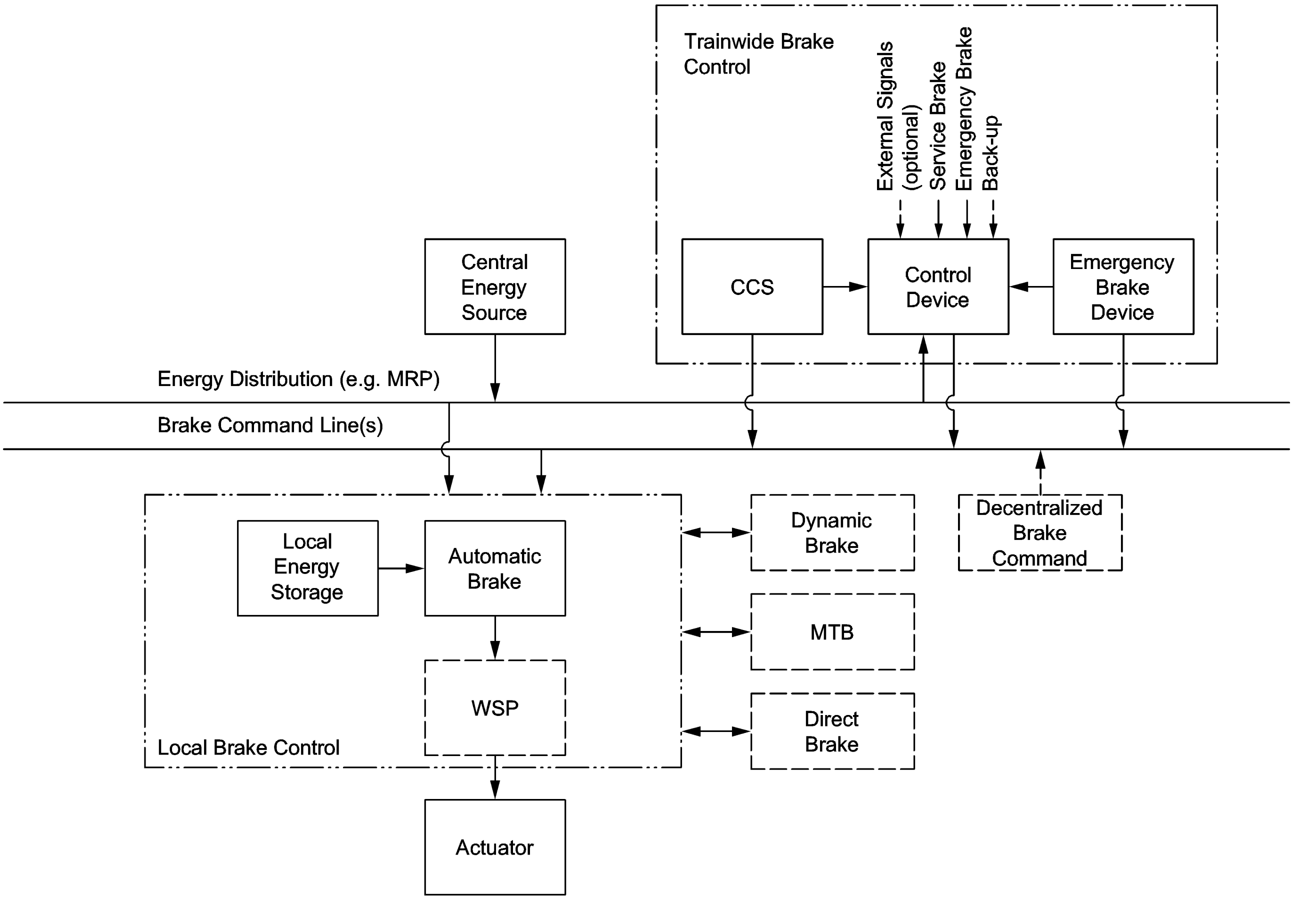

Figure 1 — Basic structure of the main brake system (functions in dotted lines are optional)

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 braking 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 braking 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. The design of the passenger alarm decentralized device 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

— to secure the train on a gradient during a hill start 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 braking 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 braking 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;

— check 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.

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 the 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 EN-standards. The applicable EN-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 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 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 designed in accordance with EN 15355 satisfy these requirements. Relay valves shall be designed in accordance with EN 15611.

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 to the brake pipe:

— 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 ± 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 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.

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 satisfy this requirement.

5.4.4.3 Brake modes

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

— G – "Goods" for freight services with slow application and release times (EN 15355). 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 – "Passenger" for passenger and freight services with quick application and release times (EN 15355).

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 P–mode is subdivided into further brake positions:

— P – for passenger (and freight) services with limited brake performances (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 G, P, R and R+X 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.

5.4.4.4 Brake pipe pressure control system

Units with a driver’s cab shall be equipped with a driver's brake control command system. If the control command of the automatic brake is communicated via the brake pipe, it shall comply with the requirements listed in Annex E.

NOTE The brake pipe pressure control system is a system contributing to the interoperability of the railways. It has been specified in UIC 541–03. TC 256/SC 3/WG 47 intends to convert this UIC leaflet into an EN and to update the technical content. Until that EN is available the technical requirements are listed in Annex E of this document.

5.4.4.5 Ep-assist

An ep-assist system as described in 5.4.4.10 is a supplementary means to control the brake pipe pressure using electrically controlled application and release signals which are distributed in the train by using the ep-assist control lines.

5.4.4.6 Interactions with other systems

5.4.4.6.1 Brake applications initiated by other systems

Brake applications, initiated by other safety systems than the driver’s brake handle, shall result in an inhibition of the leakage compensating air flow of the brake pipe pressure control system, if these systems are located on the brake command vehicle.

NOTE The exhaust capacity of the exhaust valves used by CCS systems and the related piping installation will affect the intended brake performance. It is an open point and is currently under investigation.

If the emergency brake application is initiated by a decentralized device (i.e. not on the command vehicle) this shall operate an exhaust valve capable of the following characteristics:

a) providing an opening of at least 19 mm; or

b) venting a 400 l air reservoir connected to the brake pipe interface of the exhaust valve in accordance with Figure E.1 so that:

   1) a pressure reduction in the reservoir of 1,2 bar below the normal working pressure shall be achieved in less than 10 s;

   2) the pressure in the reservoir shall finally drop to a value of less than 2,5 bar even with the driver’s brake valve in the running position (feeding the system).

When the driver supports the brake application by putting driver's brake valve into the emergency brake position, the leakage compensating air flow of the brake pipe pressure control system shall be inhibited.

5.4.4.6.2 Automatic train control system

The brake pipe pressure control system can convert service brake applications initiated by an automatic train control system into a corresponding brake pipe pressure.

A release command coming from the automatic train control system shall not be capable of overriding any brake application command initiated by the driver.

It shall be possible for the driver to isolate the automatic train control system.

5.4.4.7 Emergency brake application

5.4.4.7.1 General concept

The emergency brake is the brake having the highest level of integrity.

The application and distribution of this function shall be possible at any time and with highest reliability by:

— the driver;

— the train safety systems, initiated by the infrastructure and signalling systems (CCS);

— any other train safety systems, initiated by (decentralized) on board systems.

The central functions shall follow the “energize to release” principle.

Actions of the emergency brake application shall initiate automatically and maintain until cancelled by a deliberate action:

— commanding the emergency brake force for each specific brake position;

— venting the brake pipe completely;

— commanding the ep-assist brake, if fitted;

— initiating traction cut off;

— cut off the supply to the brake pipe;

— displaying the reason for the automatic brake application to the driver, if a diagnosis system is fitted;

— interrupting the emergency brake loop, if fitted.

Table 2 sets out the design features that need to be incorporated in those components that generate the emergency brake command.

Table 2 — Features to be incorporated into the interface devices

	Driver's brake controller	Push button	CCS	Other safety systems	Automatic BP vent (train separation)
Vent brake pipe	●	●	●	●	— a
Cut off traction	●	●	●	O / S	S
Cut off air supply to brake pipe via brake pipe control unit	●	●	O	O	— a
Generate ep-assist brake apply signal	O	O	O	— a	— a
If ep-assist considered in the brake performance	●	●	●	— a	— a
Suspend ep-assist release signal	●	●	S	— a	— a
Open brake loop if fitted	●	●	●	— a	— a
Input to monitoring system	●	●	●	O	S
Provide emergency brake performance	S	S	S	S	S
Suspend the dynamic brake	— a, b	O	— a	— a	— a

● Mandatory feature.

O Optional feature.

S Action is derived from the venting of the brake pipe.

a Not applicable, no direct action.

b Dynamic brake may remain active if fitted.

The device for venting the brake pipe shall be capable of venting a 400 l reservoir connected to the brake pipe interface in accordance with E.4.

If an electrical brake command line is fitted additionally and intended to replace the brake pipe for certain commands (for example from the CCS system) it shall follow the energize-to release-principle and shall be de-energized to apply the emergency brake.

If more than one brake influences the same wheelset, adequate precaution shall be taken to prevent overbraking.

The traction force shall be reduced to 0 within 2 seconds and in a controlled manner respecting jerk limits.

It shall only be possible to reactivate traction after the emergency brake demand is released and by a conscious action of the driver.

The components generating the brake forces in a train shall be fitted in form of multiple decentralized units in order to limit the lack of brake force as a result of a malfunction to a tolerable value.

The local brake command units themselves and the command chain below may be designed without redundancy if a single point failure will be limited in its degradation by a sufficient number of brake force generators not influenced by the considered failure.

Each mechanical or electrical or pneumatic failure of an independent unit of the brake system, which may occur locally in the train, shall not have more effects than the isolation of this unit.

5.4.4.7.2 Demand phase

5.4.4.7.2.1 General

If the emergency brake is applied by venting the brake pipe by an electrical command, it shall principally be designed such that venting the brake pipe is achieved with the magnetic valves de-energized (de-energize to brake). If it is found necessary to do it the other way round an equivalent safety level shall be proven.

It shall be possible to initiate an emergency brake application independently of whether the cab is active or not active.

5.4.4.7.2.2 Brake lever in the driver’s desk

The brake lever is the driver's interface to the brake controller and the emergency braking features listed in 5.4.4.7.1.

The emergency brake shall be applied with the same device used by the driver for service braking.

The emergency brake position on the handle shall be a notched and extreme position beyond the full service brake position.

The lever shall remain in the emergency position until it is removed by the driver.

The system shall allow the driver to cancel an emergency brake which has been applied by the driver at any time.

The brake handle shall be placed in the easy access area of the driver’s desk. Details are given in prEN 16186-2[2].

The brake handle shall be operated so that the brake demand increases by moving the lever towards the driver.

For GB domestic trains it is permitted to increase the brake demand by moving the lever away from the driver and for the emergency brake position to be furthest from the driver.

The design of the brake lever shall provide an emergency brake position where the brake pipe is vented without any further control mechanism and via the full cross section or by using a pilot pressure circuit in combination with an exhaust valve. It is permitted to use an electric circuit in combination with an exhaust valve if an equivalent safety level is demonstrated.

2) EN 16186-2 will be published after the publication of this document. Pending this publication, the requirements are given in prEN 16186-2.

If the venting of the brake pipe is controlled, using a pilot pressure circuit or an electric circuit, the second independent device in accordance with 5.4.4.7.2.3 shall be capable of directly venting the brake pipe with a full cross section.

If further brake systems are commanded in emergency cases beside the pneumatic brake they shall be applied either by venting the brake pipe or by de-energizing the emergency brake loop, if available.

The brake pipe shall not be vented into the driver's cab. The exhaust pipe shall use the same diameter as the pipe connecting the driver's brake valve to the brake pipe. The design of the exhaust pipe shall prevent the outlet of the pipe from becoming blocked (for example by freezing conditions).

5.4.4.7.2.3 Brake push button or comparable device

Secondary emergency brake operation:

In cases of failures of the regular operator's brake lever provision shall be made for at least one additional device.

This device shall be a red coloured push button, in a shape of a mushroom. After activation it shall remain in the "applied" position until the driver resets the device as an intended action.

The design and the installation shall avoid the risk of obstacles preventing the operation of the push button.

The operation of the push button shall result in the emergency brake features as set out in 5.4.4.7.1.

In cases of an architecture consisting of an indirect brake the brake pipe shall be vented directly by operating this device. Alternatively if the venting of the brake pipe is with a pilot pressure circuit, the regular operator's brake lever shall be capable of directly venting the brake pipe with a full cross section.

Devices dedicated to any other emergency functions (not braking), which may also appear in a push button (mushroom) design shall follow the requirements of prEN 16186-2[3)].

5.4.4.7.2.4 Brake application from auxiliary desk

If the driver cannot reach one of the regular emergency brake devices from the rear view position then an additional emergency brake application device shall be installed in an easy access area in relation to that rear view position.

It is permitted to arrange this device together with others on an auxiliary panel allowing the driver also to control traction from the rear view position.

5.4.4.7.2.5 Brake application by train systems

The brake system shall have interfaces with the following train systems:

— CCS systems;

— the driver's vigilance device;

— the passenger alarm system, if fitted;

— a central train wide diagnosis system, if fitted (for example a derailment detection, on board hot axle box detection, etc.).

The interface of these systems with the brake system shall provide the emergency brake features as set out in 5.4.4.7.1.

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3) EN 16186-2 will be published after the publication of this document. Pending this publication, the requirements are given in prEN 16186-2.

It shall be possible to test the function of each of the interfaces of the train systems regularly prior to operation. Each path dedicated to ensure the overall functionality shall be tested exclusively.

The equipment shall be capable of being isolated independently. The isolation of one system in cases of faults shall not cause other train systems to be shut down. The status of being isolated shall be clearly visible to the driver (at least during train preparation).The failure of one system shall not cause a subsequent failure in another one.

5.4.4.8 Service Brake command

5.4.4.8.1 General requirements

The service brake function shall allow the driver to adjust (by application or release) the brake force between a minimum and a maximum value as specified in 5.4.4. in order to control the speed of the train.

It shall not be able to activate the service brake command in more than one location in the train. To meet this requirement, it shall be possible to isolate the service brake function of the other non-active cabs in the train formation.

When the train is operating at more than 15 km/h, any service brake command shall automatically cut off the traction. This cut off shall be maintained as long as the traction command is not cancelled by the driver. It is permitted to provide a separate function to command the friction brake intentionally with traction at speed higher than 15 km/h for specific purposes (de-icing, cleaning of brake components).

The components following in the chain after the service brake command device may be the same as for emergency braking.

5.4.4.8.2 Application by the driver

In a locomotive hauled train the standard device to apply the service brake is the driver’s brake valve. This device shall be capable of controlling the brake pipe pressure.

If a dynamic brake is fitted it shall be possible for the driver:

— to control that dynamic brake independently. The installation of a separate lever to exclusively command the dynamic brakes is recommended or

— to control the dynamic brake proportionally to the pneumatic brake of the train by gradually applying the dynamic brake in relation to the pressure reduction in the brake pipe.

As an option:

— to automatically compensate for a lack of dynamic brake force in relation to the pneumatic brake by a blending system;

— to distribute the brake forces automatically if a trainwide brake management system is fitted.

The following devices shall be located in the easy reach area and the access to each device shall be ergonomically optimized (details are given in prEN 16186-2)[4]:

— the combined traction-/brake control device if available;

— the brake control being used for the regular braking functions, i.e. service braking and emergency braking; depending on the design concept;

4) EN 16186-2 will be published after the publication of this document. Pending this publication, the requirements are given in prEN 16186-2.

— the lever for the electro-dynamic brake (if available);

— if applicable a control device for the sanding system (as a device to support braking under low adhesion conditions).

5.4.4.8.3 Brake lever in the drivers desk

The brake lever shall allow the driver to gradually apply and release the brakes of the main brake system and it shall be operated so that the brake demand increases by moving the lever towards the driver. The final brake position shall activate the emergency brake as specified in 5.4.4.7.

For GB domestic trains it is permitted to increase the service brake demand by moving the lever away from the driver.

It shall be possible for the driver to inhibit the brake control in an active cab, such as when there is another vehicle with an active brake control device ahead or when assisting a train from the rear.

5.4.4.8.4 Combined traction- and brake control lever

The control of the electro dynamic brakes may be combined with the traction lever. If so, the control range for traction is away from the driver, the control range for braking is towards the driver.

In that case precaution shall be taken by means of the component design that an unintended switch over from one function into the other cannot occur, for example by a notch in the 0-position.

For GB domestic trains it is permitted to increase the brake demand by moving the lever away from the driver and to increase the traction by moving the lever towards the driver.

5.4.4.8.5 Application by an automatic train control system

Reserved.

5.4.4.8.6 Brake application from an auxiliary desk

If the operational concept also includes shunting services from the rear view position the driver shall have easy access to a device for operating the direct brake.

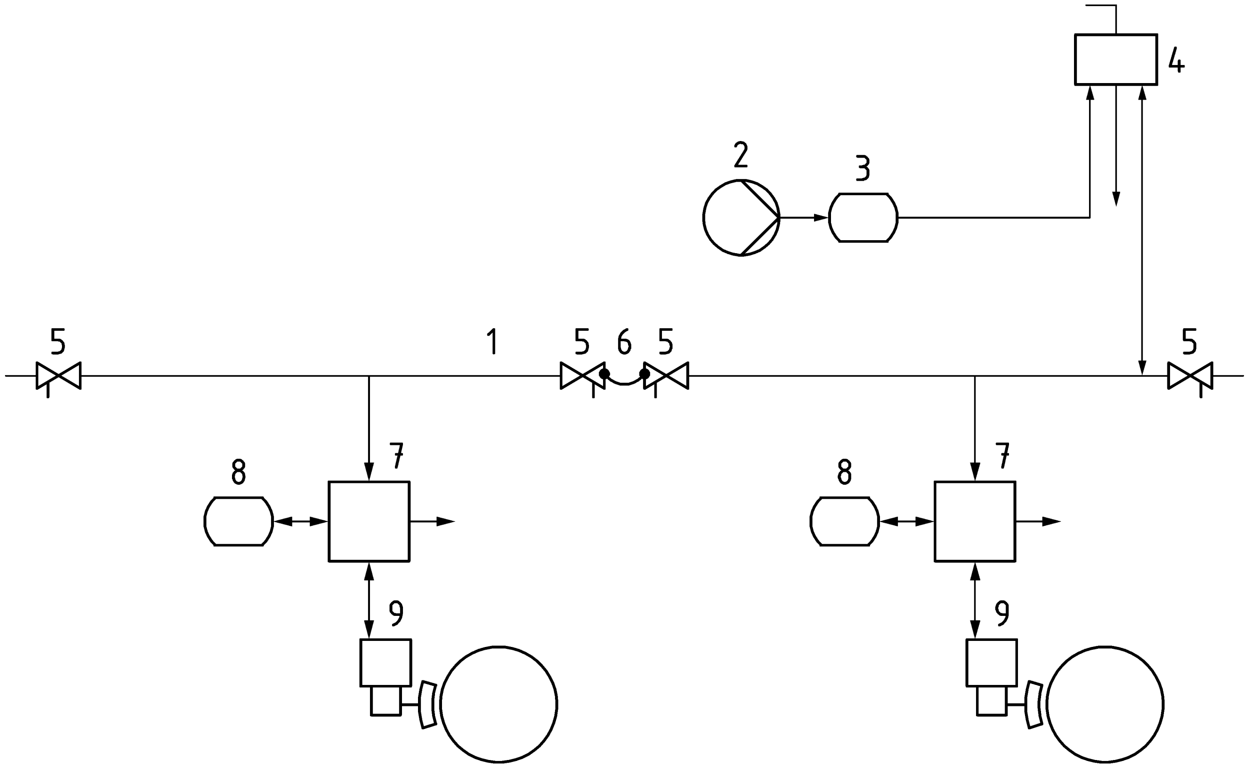
It is permitted to arrange this device together with others on an auxiliary panel allowing the driver also to control traction from the rear view position.

5.4.4.9 Brake command distribution, energy supply

5.4.4.9.1 Single pipe brake

To operate trains with a single pipe brake command line which is called “brake pipe” (BP) the compressed air is used as a brake command and as the means to charge the local reservoirs on each vehicle.

NOTE This system design is in use for most of the freight traffic rolling stock.



Key

1 brake pipe

2 train air supply unit

3 main air reservoir

4 brake pipe pressure control system

5 end cocks

6 brake pipe half coupler

7 distributor valve

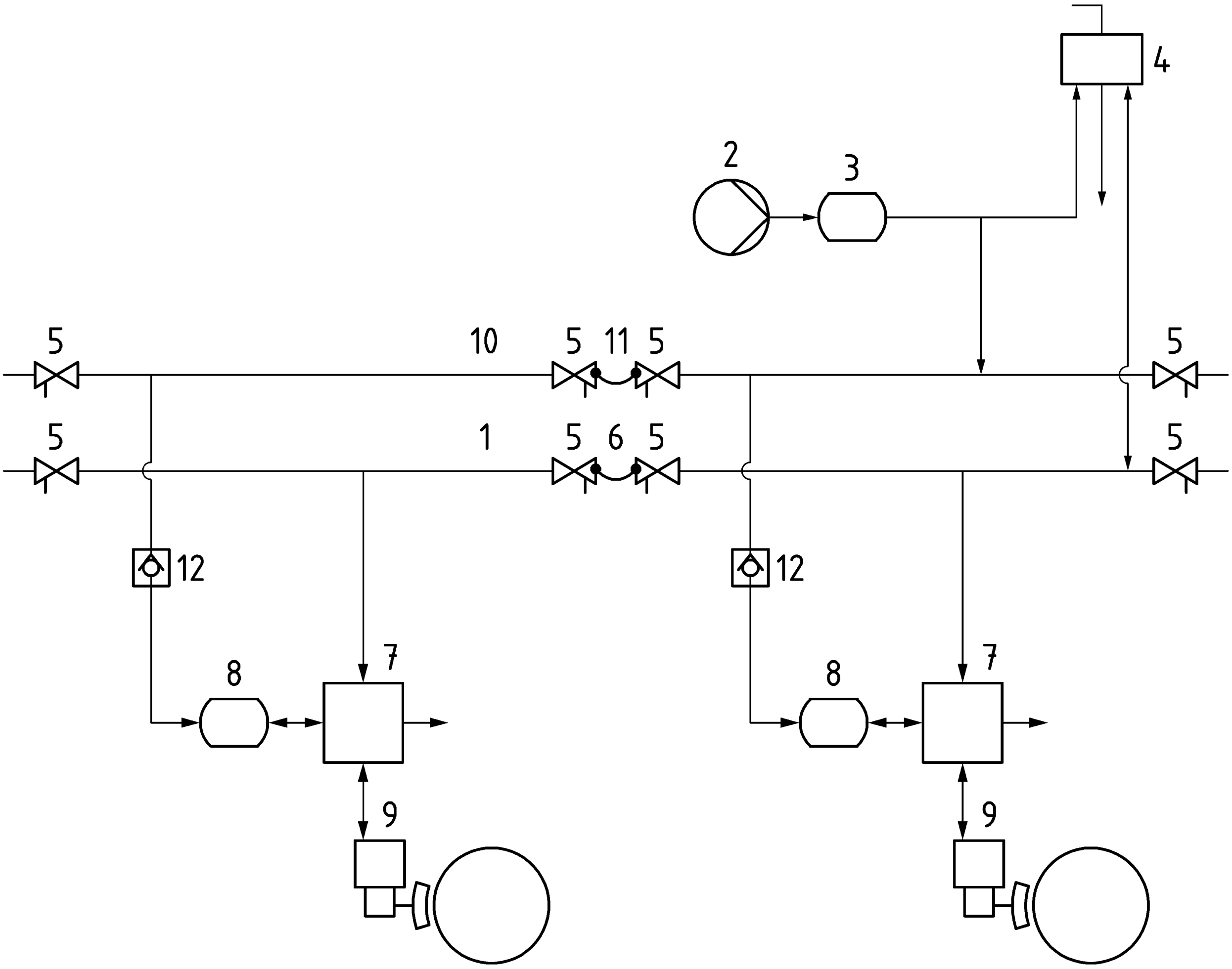
8 local brake reservoir

9 local brake force generation system (actuator)

Figure 2 — Single pipe brake design

5.4.4.9.2 Two pipe brake

If required by the brake system architecture or if other consumers than the brakes are to be supplied then the compressed air shall be supplied by a second continuous air pipe, which is called the main reservoir pipe (MRP). This design is applicable for most passenger rolling stock as well as for freight rolling stock.



Key

1 brake pipe
2 train air supply unit
3 main air reservoir
4 brake pipe pressure control system
5 end cocks
6 brake pipe half coupler
7 distributor valve
8 local brake reservoir
9 local brake force generation system (actuator)
10 main reservoir pipe
11 main reservoir pipe half coupler
12 brake reservoir filling device

Figure 3 — Two pipe brake design

The "EN-UIC" brake system shall be capable of applying and releasing the friction brake only when the brake pipe is connected. The performance doesn't need to be the same as with the MRP coupled.

The MRP is mandatory for the following additional brake equipment consuming compressed air:

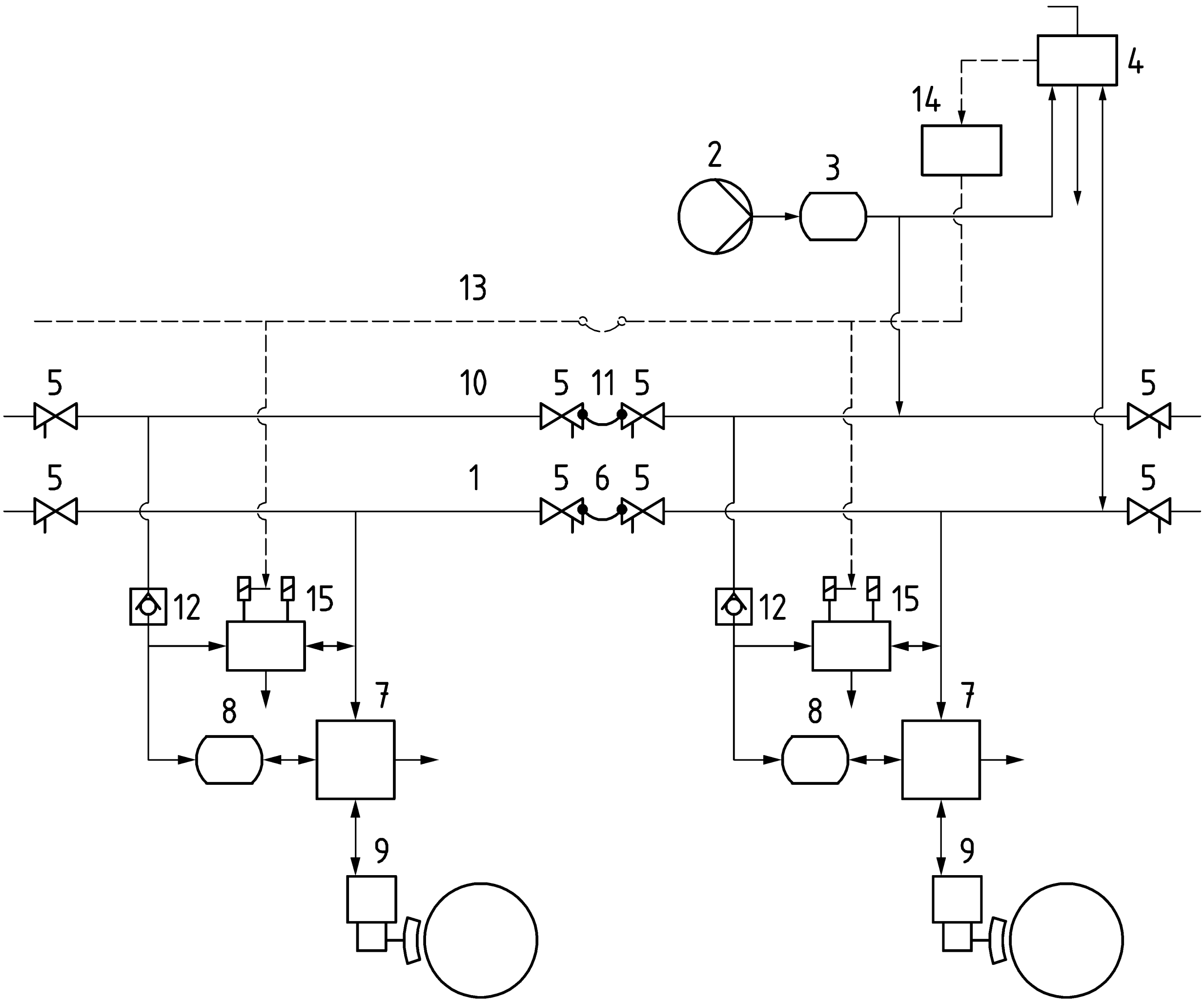
— ep-assist function;

— magnetic track brake;

— other brake systems (for example eddy current brake, if available), if they can be controlled by the continuous brake line.

The supply function of the MRP supports the inexhaustibility of the brake. The MRP supply pressure to the local brake reservoir may be reduced (for example to 5,4 bar) to reduce the risk of overcharging the brake pipe/brake cylinder pressure in the case of malfunction of the local brake control.

5.4.4.10 Ep-assist providing distributed control of the brake pipe pressure



Key

1	brake pipe	10	main reservoir pipe
2	train air supply unit	11	main reservoir pipe half coupler
3	main air reservoir	12	brake reservoir filling device
4	brake pipe pressure control system	13	ep-assist train control line
5	end cocks	14	ep-assist train control device
6	brake pipe half coupler	15	local ep-assist control device
7	distributor valve	—	pneumatic path
8	local brake reservoir	--	electric path
9	local brake force generation system (actuator)		

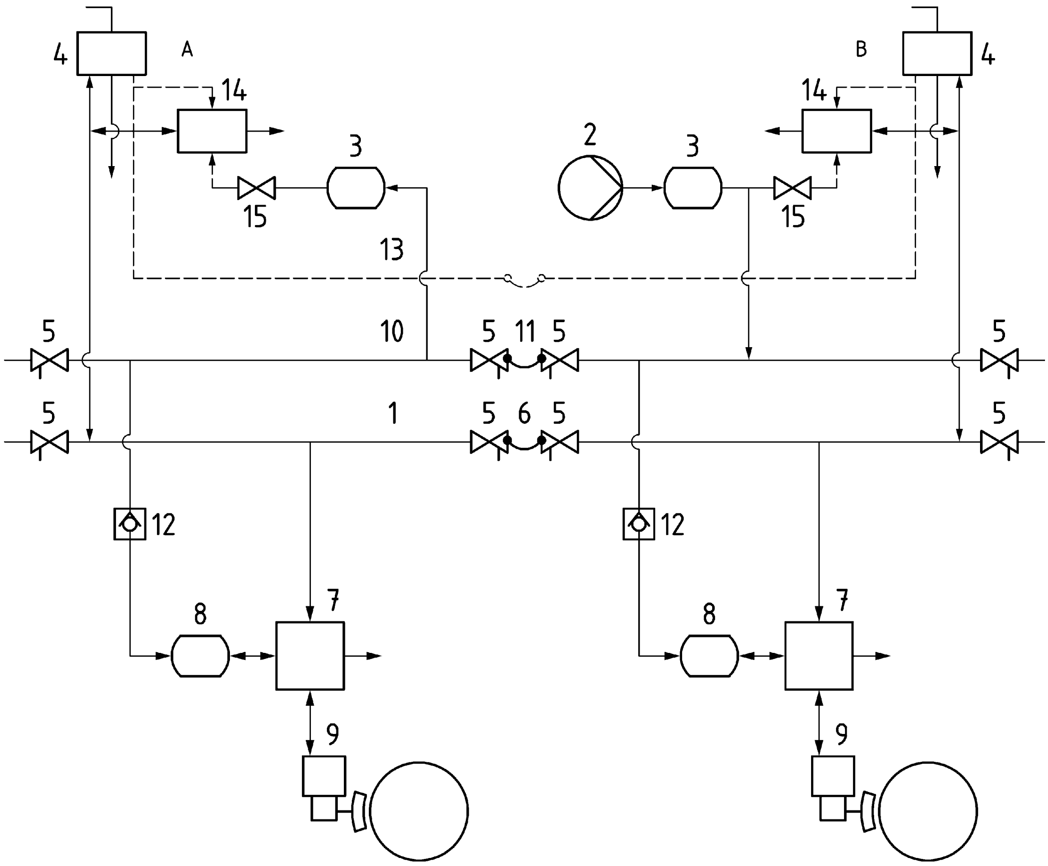
Figure 4 — Two pipe brake design with ep-assist

The ep-assist provides a fast venting and filling of the brake pipe pressure resulting in a faster and simultaneous application and release of the brakes in long trains both for service and emergency brake application and can be used instead of emergency brake accelerator valves (compliant with EN 15612) which are only active for emergency brake application.

NOTE An ep-assist control function in accordance with UIC 541–5 and UIC 541–6 is a method to provide this function.

5.4.4.11 "Ep control" providing remote control of the brake pipe pressure

This ep control system provides a faster venting of the brake pipe pressure at both ends of the train resulting in a faster application of the brakes in long trains both for service and emergency brake applications. A permitted architecture is shown in Figure 5.



Key

1	brake pipe	10	main reservoir pipe
2	train air supply unit	11	main reservoir pipe half coupler
3	main air reservoir	12	brake reservoir filling device
4	brake pipe pressure control system	13	ep-control train line
5	end cocks	14	ep-control train device, in coordinated action with 4
6	brake pipe half coupler	15	ep-control brake release cut off device
7	distributor valve	A	Non active cab
8	local brake reservoir	B	Active cab
9	local brake force generation system (actuator)		

NOTE The brake release function is only available at active cab.

Figure 5 — Architecture for remote control

5.4.5 Design requirements

5.4.5.1 Installation of the brake equipment on a vehicle

The BP and the MRP shall be fitted with end cocks as specified in EN 14601 at the end units that can be decoupled in normal service and also between units of train sets that can be operated individually.

The connections between adjacent vehicles are made by pneumatic half couplings as set out in the EN 15807.

The brake pipe shall be installed in such a way that it is free of water traps and achieves the required propagation speed.

NOTE Proven design is to apply as a minimum bending radius in the brake pipe: 5 × Da = outside diameter.

Other components than end cocks and half couplings that can reduce the cross-section of the continuous BP or can obstruct the brake pipe (for example filters) are not fitted. Low points in the pipe work are permissible providing that they do not constitute a water trap and providing that an easily accessible drainage device is fitted.

The metal pipes shall be either non-ferrous or if steel is used they shall be in accordance with the requirements of EN 10220, EN 10305-4, EN 10305-6, EN ISO 1127 or equivalent standard.

The design of the pipes and the selection of material shall be such that they shall not burn, shall not burst and shall not corrode.

The number of pipe connections shall be as low as possible. Any necessary pipe connections should be accessible without causing any disassembly of other equipment.

Connections from the brake pipe to the distributor and other exhaust valves shall not adversely impact the operation of the equipment.

This should be achieved by the pipe connection:

— being as short as possible;

— being without unnecessary bends;

— having the same cross section as the brake pipe (for exhaust valves at least).

Threads cut into the pipes are not permitted.

The number of flexible connections shall be as low as possible. Where flexible connections are used for BP, MRP and exhaust connections of brake pipe pressure control systems, their reinforcement shall preferably be non-metallic. However if metallic reinforced flexible connections are used (for example to enhance their fire protection) then the flexible hose connection shall be electrically isolated from the rest of the vehicle.

For flexible connections the requirements of EN 854 shall be met if applicable. The nominal diameter of the flexible connection shall not influence the function of the system.

Electric cables and flexible connections shall be installed without twisting and/or excessive bending. They shall also be fixed to withstand the mechanical and climatic stresses that may occur in railway operation. Electric cables shall be shielded or screened if required.

A minimum clearance of the brake components required under all operational conditions shall be demonstrated. Special attention shall be given to the limit values of wear of brake blocks and brake pads, etc, taking into account the maximum suspension movements, the minimum permissible wheel diameter, the moving angles and vehicle movements at ramps and in curves, etc.

In principle the minimum distance between two components that move relatively to each other shall be at least 20 mm. In case this distance cannot be realized verification is required to confirm that no unacceptable hazards occur.

In Table 3 are listed the minimum inside diameters of the continuous BP and MRP related to types of vehicle.

Table 3 — Minimum inside diameters of the continuous BP and MRP related to types of vehicle

Dimensions in millimetres

Vehicle type	Min BP diameter	Min MRP diameter
locos	32	25
coaches	25	25
wagons	32	25[a]

[a] If fitted.

5.4.5.2 Leakage

The expected safety and high availability of the air brake requires sufficient tightness of the air equipment. Accepted target values for new or overhauled individual vehicles are as follows:

— starting with the MRP charged up to the normal working pressure the maximum leakage in the MRP shall not be more than 0,2 bar in 3 min;

— the leakage in the BP shall not be more than 0,1 bar in 3 min starting from the normal working pressure for coaches and locomotives;

— the leakage in the BP shall not be more than 0,2 bar in 5 min starting from the normal working pressure for wagons.

5.4.6 Brake functions at vehicle level

5.4.6.1 General

The local control command system of the air brake shall:

a) be arranged in a manner that the units control the brake cylinder pressure on the basis of:

   1) per vehicle;

   2) per bogie or

   3) per axle;

b) respect the requirements as set out as follows.

5.4.6.2 Distributor valve

For the design and functions of this component refer to EN 15355. The maximum BP volume of 25 l shall be assigned to any distributor valve.

5.4.6.3 Ep-assist providing local control of the brake pipe

For the design and functions of this subsystem refer to UIC 541-5 and UIC 541-6.

5.4.6.4 Emergency brake accelerators

For the design and functions of this subsystem refer to EN 15612.

5.4.6.5 Additional "EN-UIC" devices

For the other "EN-UIC" brake components refer to Table D.1.

5.4.6.6 Reservoirs

For all vehicles the energy storage shall be designed in such a way that after a brake application with the maximum brake cylinder pressure and the maximum unit specific brake cylinder stroke the pressure in the local brake reservoir shall be at least 0,3 bar more than the brake cylinder pressure when there is no air supply from the MRP-system, nor from the brake pipe.

5.4.6.7 Parking brake

Locomotives and coaches shall be equipped with a parking brake.

The provision with parking brakes is not mandatory for all freight wagons.

NOTE 1 The percentage of wagons equipped with hand brakes is specified in UIC 535–3.

For units designed to be operated in general operation the parking brake shall brake at least 50 % of the wheelsets of the unit concerned but a minimum of two wheelsets.

NOTE 2 The type of parking brake applicable for:

— locomotives is: spring applied brake, hand brake;

— coaches is: spring applied brake, hand brake;

— wagons is: hand brake.

For GB domestic trains it is permissible not to fit parking brakes to each coach. Sufficient parking brakes need to be available in the train formation to satisfy national operating requirements.

Parking brakes may be applied as a result of:

— a direct driver's command or

— automatic application of the spring applied parking brake when the cab is shut down or

— by manually applying hand brakes distributed along the train or

— an automatic command when the cab is shut down which leads to the application of the pneumatic brake (as a pre-stage) followed by an automatic substitution of the pneumatic brake in case of the air pressure dropping down.

A remotely controlled parking brake (for example spring applied brake) shall be designed in accordance with the "energize to release principle".

The developed brake force shall be equal to or greater than the required brake force as a result of a calculation considering the requirements as set out in 5.3.2.7.4.

The parking brake shall still be capable of manual release even when the full service brake is applied.

In the case of a driver controlled parking brake the status of the actuator (not released = red, released = green, compressed air not available = indication not valid) should be indicated in a clear and concise manner and without using electrical energy.

Friction brake wear shall be automatically compensated by a device that permits operation of the power brake and the parking brake.

The design of a spring applied brake shall consider:

— the force developed by the parking brake should not compound with the force developed by the air brake on the same wheelset. If a compounding of the brake forces from the parking brake with those from the power brake can occur the brake system equipment shall tolerate this without detriment;

— an unintended application of the parking brake shall be indicated to the driver. Addition technical solutions may be considered to prevent the spring applied brake applying in the event of an unintended loss of the release pressure. If there is the risk of an unacceptable level of wear and tear this shall be further mitigated by carrying out additional examinations, for example an examination of the equipment concerned either immediately after the event, or at the end of the scheduled train service, etc.;

— an unintended release of the parking brake by filling the BP via leakages from the several air reservoirs shall be prevented. This may be achieved by a special device connected to the BP which ensures any leakages into the BP are exhausted;

NOTE 3 Further details are not yet developed into an EN-standard.

— for rescuing or maintenance purposes it shall be possible to release the parking brake manually. This should be possible from both sides of the train or from inside the train. The parking brake shall reset automatically when it is again released using the normal method for example by filling the release pipe with compressed air.

5.4.6.8 Brake indicators

Provision shall be made to enable the train staff (including local staff) to check the brake command and brake response status along the entire train.

Suitable means to achieve this is the provision of:

— easily visible “Brake applied – Brake released” indicators on each side of the vehicle in accordance with EN 15220 if vehicles are fitted with disc brakes or if the status of the brake is not easily perceptible; this equipment is mandatory for locomotives when intended to be used driverless and in shut-down mode in a free train formation;

— internal pressure indication for locomotives and driving trailers;

— internal pressure gauges or other status indicators for coaches;

— a diagnosis system providing information into the driving cab, if fitted.

With the exception of WSP valves it is not allowed to fix any other devices between the brake cylinders and their indicators. If the intention is to also check the operation of the WSP valve then the indicator shall be between the WSP valve and the brake cylinder.

In vehicles with several local brake control units, separate indicators shall be provided for each control unit.

In the active driver's desk the indication of the following information is mandatory in all operational conditions:

— main reservoir pipe (MRP) pressure;

— brake pipe (BP) pressure;

— the brake cylinder pressure of the related vehicle;

— pressure in the equalizing reservoir if fitted with a time depending brake pipe pressure control system;

— if the pressure of the equalizing reservoir and the brake pipe are displayed on the same gauge, they shall be differentiable. For example the equalizing reservoir may be indicated by a triangular tip to differentiate it from the needle for the brake pipe.

If gauges are used, the following shall apply:

— minimum accuracy: class 1.6 in accordance with EN 837-1:1996;

— diameter for brake pipe pressure gauge and reservoir pipe pressure gauge: greater or equal to 80 mm;

— diameter for brake cylinder pressure gauge: greater or equal to 60 mm.

The gauges shall be designed such that in the case of an internal failure or a failure in the piping to the gauge the leakage is limited to a tolerable amount without affecting the mission of the train in accordance with EN 837-1.

If a system other than a gauge is used, its safety level shall be the same as a gauge to guarantee that the pressure value is correct.

5.4.6.9 Friction brake elements

5.4.6.9.1 General requirements

The friction brake shall be designed such that it is capable of taking over the duty of an emergency brake application related to the maximum permitted speed as specified in 6.5 (thermal capacity).

Each wheelset shall be provided with a brake force application system that shall be available for use during emergency braking.

The brake force application system shall be designed to:

— have sufficient thermal capacity and/or cooling to prevent the occurrence of unacceptably high temperatures that could adversely affect braking or the structural integrity of the brake components; this shall take into account any planned braking duty cycle, including drag braking (braking to control the speed) and two successive emergency operations from maximum speed at all load conditions as specified in 6.3 on level track with fully functional brake installation without the effect of any adhesion independent brakes;

— accept the loads that will arise from the brake forces and from the dynamic environment associated with its particular location on the vehicle in accordance with EN 13749:2011, Annex C and Annex D.

NOTE In the case where the performance is limited (for example on locomotives when operating alone or trains with isolated equipment) the maximum speed needs to be reduced by operational rules to match the available braking capacity.

The friction brake used shall be a disc brake or a tread brake.

A slack adjuster shall be provided for each brake unit and shall be designed with sufficient capacity to compensate the wear of the friction brake components, for example pads, discs, callipers, wheels. If applicable the slack adjuster shall be in accordance with EN 16241.

It shall be possible to incorporate parking/handbrake functions.

It shall be possible to visually check the conditions of the mechanical brake components without the need to remove any other items of train equipment.

The composition of the brake friction materials shall be selected so that the best compromise is ensured between:

— the technical characteristics of the brake;

— the wear and service life of the pads and blocks;

— aggressiveness to the brake disc and the wheel rim;

— limiting the noise emission;

— not preventing train detection using track circuits.

5.4.6.9.2 Tread brake

The friction materials for the brake blocks and their geometrical form are defined in EN 15329 and EN 16452.

The application point of the tread brake shall be aligned with the wheel so that uneven wear of the blocks is avoided so that it is possible to fully use the wearable material. Suspension movements shall be considered.

5.4.6.9.3 Disc brakes

The disc brake consists of axle-/or wheel-mounted brake discs and the associated brake actuators and callipers.

Brake discs shall be characterized in accordance with EN 14535-3. Axle-mounted brake discs shall be in accordance with EN 14535-1 and wheel-mounted brake discs in accordance with EN 14535-2.

Aspects of sufficient cooling respectively shielding aspects shall be considered for the discs as well as for the surroundings.

The dimensions of the discs and the clearance between the rails shall be in accordance with EN 15273-2 for the smallest permissible wheel diameter.

5.4.6.9.4 Brake pads

The properties of the brake pads shall comply with the principals set out in UIC 541-3. The pad holders shall comply with EN 16451.

Brake pads shall use materials that prevent the generation and emission of any products that are hazardous to health.

They shall be consistent with the maintenance policy for the train throughout its full service life (of the pad), for example the method of attachment between the brake pads and the brake pad holders shall be compliant with UIC 541-3 and EN 16451.

The requirements of this standard shall be maintained over the whole usable thickness of the brake pads.

The coefficient of friction shall be as independent as possible of the initial speed, the worn profile of the friction couple, the pressure and temperature in the contact area and weathering effects.

5.4.6.9.5 Actuators, callipers

The friction radius and force application point of the callipers shall be aligned with each other so that uneven wear of the pads is avoided so that it is possible to fully use the wearable material. Suspension movements shall be considered. The same applies for block brake systems as far as applicable.

The brake actuators and callipers shall accept the loads that will arise from the brake forces and from the dynamic environment associated with its particular location on the vehicle in accordance with EN 13749.

5.5 Direct EP brake control

This type of brake control is normally not used in trains for general operation. If it is considered for a train under this scope see EN 16185-1 for further details.

5.6 Additional brake systems

5.6.1 Dynamic brakes

5.6.1.1 General requirements

Dynamic brakes may be applied exclusively and independently from other brakes or in combination with them.

The following operational applications are permitted for the dynamic brakes:

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

— applied in service brake, applied in emergency brake application, but not considered in the brake performance;

— applied in service brake, applied in emergency brake application and considered in the brake performance.

Where the brake performance of the dynamic brake or of a brake system linked to the traction system is included in the performance of the emergency braking in normal mode it shall be subject to a safety analysis covering the hazard “after activation of an emergency command, loss of the brake force”. In case of electro-dynamic brakes using the regenerative mode, this analysis shall cover failures leading to absence on-board the unit of the voltage delivered by the external power supply.

The dynamic brake shall be commanded by one or more of the following:

— a separate dynamic brake handle to command the dynamic brake alone;

— a combined traction/brake handle to command the dynamic brake alone;

— the brake handle to command both the dynamic brake and the friction brake (automatic brake) acting in a coordinated manner (either in service brake only or service and emergency brake);

— an automatic train control system (for example cruise control); if permitted by the brake architecture;

— an automatic train protection system if permitted by the brake architecture.

For operation on significant and/or long gradients the dynamic brake should be capable of being applied independently from the friction brakes of the train.

The dynamic brake shall be designed so that it automatically provides a determined braking characteristic in relation to speed.

When the dynamic brake is operated independently from the use of the automatic brake handle in all brake positions G/P/R the rate of increase shall be equal or less than 30 kN/s, the rate of decrease should be equal or less than 30 kN/s.

Within complex trains, having distributed traction units, the maximum allowed increase/decrease rates for ED-brake are linked to each consist of traction units (e.g. locomotives in multiple traction at various locations of the train – locomotive-consists in front/middle/end of the train).

For combined braking controlled by the automatic brake, the timing for apply/release the dynamic brake force shall be similar to that achieved by the friction brake, as defined in Annex A. The ED- brake command for an automatic brake application should be derived from the brake pipe (pressure drop) locally for each individual controllable unit.

It shall be possible to vary the dynamic brake in a minimum of 6 levels of braking from “OFF” up to and including “MAXIMUM”, when it is used for combined braking. When only a separate application is available a variation of at least 4 steps shall be provided.

The availability of the dynamic brake should be continuously monitored and displayed to the driver along with the dynamic brake force achieved as a proportion of the force demanded. This requirement is mandatory, if the dynamic brake is active in any coupled locomotive. An audible and/or visual warning should be provided to the driver in the event of a dynamic brake unit failure.

The operation of the emergency push button should suspend the dynamic brake if the performance of the dynamic brake cannot be ensured.

In the event of a failure of the dynamic brake during brake application of the trainwide brake system or if there is a degradation of the dynamic brake performance below the level of the air brake (main brake system), the air brake shall come into operation automatically.

5.6.1.2 Electro dynamic brakes

Electrical locomotives are supplied with a nominal voltage of 15 kV AC (16,7 Hz) or 25 kV AC (50 Hz) or 3 kV DC or 1,5 kV DC or 750 V DC. The corresponding AC-networks are generally capable and the DC networks are under certain conditions capable of dissipating the electrical energy which is returned to the main power supply during braking. This enables the distribution of electrical energy for use by other trains or consumers. The capacity (of dissipation) generally is in the same range as that of the provided traction power.

NOTE With 25 kV AC there are isolated gaps for change of phases. Passing these gaps means the regenerative electro dynamic brake will not be available.

Electrical locomotives should make use of these features and should return the electrical energy which is gained from electro-dynamic brake to the main power supply.

The main power supply networks of the railways may not always be fully receptive – this is a permitted service condition and features and controls shall be incorporated into the brake system to take account of it.

In addition, in the event that the supply to the catenary is lost, the train shall detect this and shall suspend the regenerative brake so that it does not impede the line voltage dropping to 0 V.

If the regenerative mode is not available rheostatic braking should be applied if fitted and should be used before other types of brakes.

If lines of networks are to be operated with regenerative braking, restrictions and conditions such as those specified in EN 50163 or imposed by the infrastructure shall be respected.

The maximum brake force of the electro-dynamic brake for each wheel set should be of that value, which is implied by the maximum adhesion coefficient (see 6.6), in order to cover a maximum range of speed without additional application of the friction brake.

In the event of a fault in a power unit, only the electric brake of this damaged unit should be unavailable.

If the rheostatic brake is used for emergency braking the brake resistors shall be designed such that they are capable of dissipating the maximum power and the maximum current generated by the electro-dynamic brake without time restriction (100 % duty cycle).

If the capacity is less than 100 % only that reduced capacity can be regarded in the brake performance.

If the capacity is such that time restrictions shall be observed the brake resistors shall at least dissipate two consecutive emergency brakings at the rate of 100 % electro-dynamic power.

An automatic protection of the resistors against thermal overload or overcurrent may be incorporated into the design.

5.6.1.3 Hydrodynamic brake

Hydrodynamic brakes may be used providing they can be integrated into the brake architecture supporting the wear and tear behaviour and providing a contribution to the brake performance similar to the electro-dynamic brake. The following operational applications are permitted:

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

— applied in service brake, applied in emergency brake application but not considered in the brake performance;

— applied in service brake, applied in emergency brake application and considered in the brake performance.

Hydrodynamic braking is provided by a torque converter, which basically consists of two turbine wheels in a common converter housing, one is the rotor connected with the wheelset of the vehicle, the second is the stator fixed to the transmission housing. When braking the transducer housing is filled with a fluid (e.g. oil) and thereby the movement of the rotor is obstructed. Due to friction of the fluid between the rotor and the stator, the kinetic energy is converted into heat, which shall be dissipated by a heat exchanger.

The brake performance of the hydrodynamic brakes depends on the capacity of the heat exchanger and cooling system.

If hydrodynamic brakes are included in the brake performances no time limit is permitted on its operation and the control-command shall be considered to be sufficiently reliable and safe. At least a qualitative examination shall be carried out.

It is permitted to operate the engine at higher speed than the idle speed to achieve the full cooling capacity and to automatically provide a determined braking characteristic in relation to speed.

Hydrodynamic braking shall be possible from maximum speed, but is limited by the performance characteristic (power curve).

During standstill the availability of the hydrodynamic brake shall be indicated.

5.6.1.4 Eddy current brake

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 trains for general operation but may be considered for future applications. As it is presently used for High Speed Trains for further details see EN 15734-1.

5.6.2 Direct brake

5.6.2.1 General Requirements

The direct brake is not designed for use as a main brake system on a train level. It is used as:

— an adjustable and fast-acting brake for shunting movements of locomotives or when traction units are running alone;

— an additional brake system for vehicles that can be operated individually where the failure of a control unit (for example distributor valve) would lead to a loss of brake force of more than 50 % and where no other brake system is available as a backup;

— a holding brake for ensuring the time-limited standstill of a train (for example when stopping at a station or during a hill start).

Locomotives and traction units that can be operated individually shall be equipped with a direct brake in addition to the main brake system (air brake). It is permitted to equip driving trailers with a direct brake to provide a holding brake.

NOTE 1 The direct brake can be used as a holding brake in order to keep the train stationary when carrying out a brake test on the main brake system of the train.

NOTE 2 The direct brake can be used as a holding brake that is initiated automatically by train control systems (such as the door release command).

5.6.2.2 Application of the direct brake by the driver

The device to control the direct brake shall be separate from the brake controller of the main brake system.

Where it is intended for locomotives to operate in multiple traction it is permitted to couple and control the direct brakes from the lead locomotive. This can be achieved by transferring electrical/electronic commands or by a dedicated pneumatic inter vehicle connection.

Where position-dependent brake controllers are provided for the direct brake they shall be equipped with the following positions:

— full release position (latched);

— full brake position (latched);

— at least 5 stable brake steps between these latched positions.

Where time-dependent brake controllers are provided for the direct brake they shall be equipped at least with the following positions:

— release position (spring return to lap);

— lap position (latched);

— brake position (spring return to lap).

Optionally the time-dependent brake controllers should have the following additional positions:

— full brake position (latched) and/or

— full release position (latched).

It is permitted to reconfigure the time-dependent brake control system so that the direct brake handle can be used as a back-up for the main brake controller.

5.6.2.3 Functional requirements

For wheelsets fitted with a direct brake, it shall operate in parallel with the vehicle's main brake system.

A brake demand shall always have priority over a brake release demand that may have already been initiated.

If brake signals are sent simultaneously from the direct brake and the vehicle's main brake system, the one with the highest brake force demand shall take effect.

The compressed air supply of the direct brake shall be designed such that no single point failure in the local energy supply of the main brake system will lead to a complete loss of the direct brake and no failure in the direct brake system shall lead to a complete loss of the main brake.

The brake development time for full service braking triggered via the direct brake shall be (3 ± 1) s, measured between 5 % and 95 % of the maximum brake cylinder pressure.

The release time shall be (4 ± 1) s, starting from the reduction in maximum brake cylinder pressure until the pressure falls below 0,4 bar.

The maximum brake force generated by the direct brake shall not exceed a maximum adhesion level of 0,25, if used as a static holding brake. For other uses the maximum adhesion level shall comply with 6.6.

NOTE The maximum brake force of the direct brake can be different from the brake force of the vehicle's main brake system.

An error message shall be displayed in the active driver's desk if a release command is issued from the active driver's desk and the direct brake remains applied anywhere in the train formation.

In the case of electro-pneumatically and electronically controlled direct brakes the following requirements apply:

- the brake command shall be based on the “energize to release” principle;
- an error message shall be displayed in the active driver's desk if an application command is issued from the active driver's desk and the speed of 60 km/h has been exceeded;
- no single point failure of the direct brake control valves shall result in an unintended brake application or the event shall be brought to the driver’s attention.

In the case of faults and for maintenance purposes and rescue purposes, it shall be possible to isolate and release the direct brake by an intentional action. For a vehicle in normal operation mode, this status shall be signalized in the driver's cab (for example display message, pressure gauge display).

The direct brake shall be integrated into the vehicle diagnostic system, if available.

5.6.2.4 Interaction with the WSP system

A failure in wheel-slide protection system shall not lead to a direct brake force reduction of more than 50 %. One means to achieve this is for the wheel-slide protection to be deactivated in a reliable manner in the latched position “Full service braking”. On leaving the latched position “Full service braking”, the wheel-slide protection shall be immediately reactivated.

Alternative solutions which provide at least the same level of safety are also permitted.

5.6.2.5 Interaction with other systems

The direct brake shall not be adversely affected by any brake management system which is used in accordance with 5.7.

The direct brake shall be functionally independent of the dynamic brake. It is permitted to automatically substitute the dynamic brake by the direct brake, when the dynamic brake becomes less effective, such as low speed.

When the direct brake is actuated at the same time as the dynamic brake, the adhesion demand shall be in accordance with 6.6. The requirement shall be met by an adequate reduction of the brake force of the dynamic brake.

The direct brake shall be controllable in any case, even if a traction force is active.

5.6.3 Magnetic Track brake

The design and test requirements shall be in accordance with EN 16207.

5.7 Brake management

5.7.1 Brake blending at vehicle level

Brake blending at vehicle level normally means that more than one brake system may act upon the same wheelset.

The following blending modes may be considered:

— substitution: restraining and venting of the air brake when dynamic brake is active;

— fixed blending: adding constant brake force of air brake to dynamic brake;

— programmed blending: adding air brake to dynamic brake according to an agreed characteristic (feedback from dynamic brake only on/off);

— continuous blending: adding air brake to dynamic brake according to effective brake force of dynamic brake.

From the economical point of view any brake request shall initiate the dynamic brake prior to others, for example the movement of the driver's brake valve or an automatic brake application by one of the train protection systems if the dynamic brake is capable of respecting the required brake performances.

If not it shall be fully or partially substituted by the main brake system.

Brake blending shall respect the maximum adhesion demand as set out in 6.6.

5.7.2 Manual mode

It shall be possible for the driver to apply the dynamic brake of a traction unit independently from the main brake system.

A dynamic brake which has been applied separately by the dynamic brake handle may be substituted automatically by the local friction brake at low speed only (e.g. shunting speed max. 40 km/h).

5.7.3 Brake blending at train level

The service brake requires a brake blending as an interaction of those brakes which are designed for the use during service braking. In that case more than one brake system may act upon the same wheelset.

For the service brake, the principle of brake management is to optimize the use of those brakes which work in a regenerative manner and/or are free of wear.

Up to their maximum brake force the subordinate brake systems shall be activated in the following hierarchy:

— the regenerative electro dynamic brake in order to achieve the highest possible level of converting brake energy into electrical energy;

— rheostatic electro dynamic brake;

— further free of wear systems, if available;

— friction brake;

— optional: arrangement to command the electro dynamic/dynamic brake exclusively when a drag brake is required for maintaining speed.

The management of the combinations possible regarding certain preferences and failure strategies applicable in the design of the blended brake should be assisted by a computer aided system and its brake management software.

The above mentioned hierarchy defines the so-called preference mode in which the brake management system shall act under normal service conditions.

As a response to more unfavourable conditions (e.g. low adhesion) the driver should be enabled to select a different brake management, where all the braked wheelsets should contribute an amount of braking force such that there is the same adhesion demand at all wheels. If more than one brake system is in action in the same running gear, the free of wear type should be preferred.

If the brake blending is limited to simple conditions with not more than two brake systems the responsibility for the blending may be left with the driver.

The braking force of the train shall respond proportionally to the movement of the brake lever (alternatively the pulse duration of a time dependant brake handle) between the first step and the maximum brake force. It is accepted the first step can achieve at least 10 % of the maximum service brake power.

5.7.4 Jerk / ramps

In the case of service braking including full service braking with blending or without blending the jerk for speeds > 5 km/h should for reasons of passenger comfort be limited to the following values:

— max da/dt = 0,6 m/s^3. Subject to the approval by the transport authority, this may be raised up to 1,0 m/s^3 in accordance with EN 13452-1.

In the case of emergency braking with or without blending effects as a result of failures in the system the jerk for speeds > 5 km/h should be limited to the following values:

— max da/dt = 2,0 m/s^3. Subject to the approval by the transport authority, this may be raised up to 4,0 m/s^3 in accordance with EN 13452-1.

To provide the driver with confidence of the brake application, the blending process of the dynamic and the pneumatic brake shall not result in a significant change of deceleration of the train during the transition phases. A recommended value of the acceptable change is 20 % of the instantaneous deceleration.

To achieve this requirement it is permissible to ramp off the dynamic brake while the pneumatic brake is being established.

The jerk levels may be exceeded during WSP activity.

5.8 Wheel slide protection

Vehicles shall be equipped with a wheel slide protection system when demanded and as set out in the Table 4.

Table 4 — Application of WSP

<table>
<tr><th rowspan="2">Range of speed
v
km/h</th><th rowspan="2">Brake equipment</th><th colspan="3">Rate of adhesion τ
and corresponding λ</th></tr>
<tr><th>$\tau \leq 0,11$
and $\lambda \leq 125$ %</th><th>$0,11 < \tau \leq 0,12$
and
$125 < \lambda \leq 135$ %</th><th>$\tau > 0,12$
and $\lambda > 135$ %</th></tr>
<tr><td>$v > 150$</td><td>All brakes acting on the wheel</td><td>WSP mandatory</td><td>WSP mandatory</td><td rowspan="7">WSP mandatory</td></tr>
<tr><td rowspan="6">$v \leq 150$</td><td>Disc brakes only</td><td>WSP recommended</td><td>WSP mandatory</td></tr>
<tr><td>Dynamic brake acting on the wheel</td><td>WSP recommended</td><td>WSP mandatory</td></tr>
<tr><td>Disc and block (all kind)</td><td rowspan="4">No requirements</td><td rowspan="4">WSP recommended</td></tr>
<tr><td>Composite blocks only</td></tr>
<tr><td>Cast iron or sinter metal blocks only</td></tr>
</table>

The use of adhesion (τ) shall be determined in accordance with 6.6. Table 4 applies to vehicles with wheels having a diameter equal to or greater than 840 mm.

For vehicles with wheel diameters less than 840 mm and a $\lambda > 125$ % and a $\tau > 0,11$ the use of WSP is mandatory.

The wheel slide protection shall respect the requirements as set out in EN 15595. The requirement on the wheel slide protection system above shall apply to the two brake modes: emergency brake and service brake.

Dynamic brake function shall be taken into account when determining utilization of adhesion.

In the case of vehicles that are capable of running alone, there shall be a means of ensuring that a fault in the WSP (e.g. reference speed higher than vehicle speed) does not result in a continuous release of the brakes on the entire vehicle.

There is no need for two independent WSP systems on a single unit where there is a brake system that cannot be influenced by the WSP (e.g. direct brake).

5.9 Compressed air supply

5.9.1 General requirements

Locomotives designed to operate trains with air brakes shall be equipped with at least one air supply and air treatment system.

Where locomotives are equipped with more than one air supply a control system shall be provided to manage the duty cycle so that short operation times are avoided and to share the duty between the air supply systems.

The air pressure in main reservoir shall be regulated automatically. A switch or display operation shall be provided in the driver's desk to enable the driver to switch the compressors on and optionally off.

The maximum design pressure shall be 10 bar. For domestic traffic lower pressures as set out in national rules may apply.

A safety valve shall be provided to protect the main reservoir. A second safety valve may be located between the compressor and the air dryer.

The pressure at which the safety valve fully opens depends on the design of the reservoirs (see EN 286-3 and EN 286-4.)

Auxiliary compressors (for pantograph operation) are not part of the scope of this standard.

5.9.2 Capacity

The air supply and main reservoir storage shall be sized to provide sufficient capacity to satisfy the demand of the consumers (brakes and other systems) whilst still maintaining a minimum of 6,5 bar in the reservoir pipe.

For locomotives intended for use in general operation: the air supply should be specified by contract or as a default at least 1800 Nl/min (Central Europe) after any air treatment. For locomotives intended to be used in a fixed formation or for specific purposes (for example push pull) an air consumption calculation should be done.

NOTE For locomotive typical main reservoir size: 800 l.

5.9.3 Air quality

The minimum air quality shall comply with NF F 11-100:1995, Subclause 8.3.

NOTE The EN-standards for the components of the air brake system can define a quality below that of NF F 11–100 provided they operate properly.

5.10 Enhancement of wheel/rail adhesion

Locomotives shall be fitted with the means to compensate for insufficient wheel-rail adhesion during braking. This shall be based upon the application of a suitable substance (standard application is sand) to the wheel-rail interface when the level of adhesion available at this interface is less than the level of adhesion demanded by the brake and it shall be available at all times during braking.

This system may also be used as an aid to reducing wheel spin in traction mode – however, its use in traction mode shall be limited in such a way that its availability for use during emergency braking is ensured at all times.

Sanding for driving trailers is permitted.

It shall be possible to deposit the substance used in an effective, reliable and repeatable manner in all train operating conditions during service and emergency braking. Equipment heating and ventilating devices, etc. may be incorporated into the low adhesion compensation system if required.

The use of sanders and the amount of sand shall be in line with the requirements of the infrastructure.

If there is no specification from the infrastructure, the laid sand on the rail shall not exceed more than 5 g per meter per wheel during braking.

NOTE Higher quantities of sand delivery increase the risk of preventing train detection using track circuits.

The following shall be considered when selecting the substance to be used to compensate for insufficient wheel rail adhesion and the equipment used to deposit the substance at the wheel rail interface:

— excessive wheel wear;

— excessive rail wear;

— detrimental effects on train detection systems;

— improvement of adhesion.

The driver shall be provided with a manual control for use at the driver's discretion.

Automatic sanding during emergency brake application is permitted for a speed higher or equal than 15 km/h when WSP activities are detected.

A means shall be provided for testing the correct function of the wheel-rail adhesion compensation system during train maintenance, including a means for checking that the rate and consistency of deposition of the substance used is within acceptable limits and that speed and other vehicle system interlocks (for example WSP) are active.

It shall be possible to check the quantity of the substance used for compensating low levels of wheel/rail adhesion both locally at all storage positions on the train and remotely from the active driver’s cab as an option. This option should also provide an audible or visual warning to the driver in the event that the quantity falls below the minimum level prescribed for normal train operation.

6 Performances

6.1 General aspects

The required brake performance of a rail vehicle depends on the intended service. At the vehicle level it is determined in accordance with Annex A, the maximum required speed and the signalling distances provided by the infrastructure. The assessment of compliance with the specification shall be in accordance with prEN 16834.

The brake performance of locomotives, coaches and freight wagons, in brake position G is not the result of a performance oriented design process. The assessment tests are carried out in position P and the brake performance in G is generated from the rules as set out in prEN 16834. It is permitted to take into account a braked weight in G+E, P+E or R+E.

If load compensating brake systems are not fitted or do not cover the maximum braking load for example as set out in 6.3 then specific operational rules may be necessary.

If adhesion independent brakes are used, the effort generated by these brakes shall be in addition to the effort generated by the adhesion dependent brakes. The maximum overall average retardation shall not exceed 2,5 m/s^2.

For vehicles on which brake performance are above 170 % of lambda (λ), this shall be achieved with the assistance of adhesion independent brakes.

For locomotives to achieve equivalent performances compared with those of coaching stock in position R+ it is permitted to define a specific assessment. For example locomotives in R+E_{160}, this means an assessment at an initial speed of 140 km/h instead of 120 km/h (see also prEN 16834).

The brake performance can be specified in terms of decelerations, stopping distances and lambda (λ) values. An example for European railways using lambda at the train level is set out in Annex B. The diagrams show a selection of suggested curves in the defined categories as an aid to the design of the brake system. Preferably one or more of the curves should be selected in the design phase to define the brake performance in order to be compatible with the infrastructure requirements. This is also applicable to trains hauled by locomotives, intended for use in fixed or predefine formations.

Categories P - S1 or S2 and P - SS applying P for freight may be used in combination with brake mode G along the train for the purpose to reduce longitudinal forces in train formations where length and load potentially initiate higher forces than can be managed in brake mode P purely.

The stopping distance for an emergency brake application at train level shall not be longer than that related to the full service brake.

Freight services aiming for higher speed and brake performances above category P - S1 or S2 and P - SS may require an advanced vehicle design similar to that of passenger coaches, for example:

— a bogie-design for higher speeds (more than 120 km/h);

— an ep-assist feature

— a double pipe break design

— a brake design for category R_{min} - $R+_{max}$;

— an electrical energy-supply on board for WSP-system;

— a brake status monitoring system.

6.2 Performance calculation

6.2.1 General

The emergency braking performance of each vehicle shall be calculated in order to provide the following information:

— nominal performance/normal mode in accordance with 6.2.2 on dry rails and on level track;

— degraded mode (considering single point failures) in accordance with 6.2.4;

— degraded conditions in accordance with 6.2.5 respecting humidity on friction elements

NOTE 1 These brake performances are requested in the Rolling stock register.

For the methodology and formulas see EN 14531-1 and EN 14531-2.

The verification of the calculated values shall be performed in accordance with prEN 16834.

The performance contribution of each (local) subsystem which can be isolated separately shall be recorded in the technical file of the vehicle.

The braking performance required for safety shall be achieved by the emergency brake. The emergency braking performance calculation shall be performed for:

— all relevant load conditions as set out in 6.3;

— the following initial speeds for locomotives, coaches and trains in fixed formation hauled by locomotive up to maximum design speed: 30 km/h; 100 km/h; 120 km/h; 140 km/h; 160 km/h; 200 km/h; 230 km/h; 300 km/h.

For locomotives and coaches intended for general operation a calculation of the deceleration when applying the maximum service brake shall be performed in accordance with EN 14531-1 and EN 14531-2 with a brake system in normal mode with nominal value of the friction coefficients used by friction brake equipment for the load condition “design mass under normal payload” as defined in EN 15663 at the design maximum speed.

NOTE 2 Other additional conditions can be considered if required.

Conventional rolling stock may also form a train of predefined formation and therefore it is permitted to consider this formation for determining the brake performances.

The calculation of the performances shall be carried out during the design phase and then revised (correction of the parameters) after having carried out physical tests.

Brake performances shall be assessed in line with prEN 16834.

6.2.2 Calculations for nominal mode

The calculations shall declare the performances:

a) for locomotives coaches and trains in fixed formations hauled by locomotives in terms of:

   1) stopping distances,

   2) deceleration values and brake build-up times and

   3) braked weight in accordance with prEN 16834;

b) for wagons in terms of:

   1) stopping distances or

   2) deceleration values and brake build-up times or

   3) braked weight in accordance with prEN 16834.

The calculations for the technical file shall consider:

c) the wheel diameters (if fitted with disc brakes):

   1) new wheel;

   2) half worn wheel;

   3) worn wheel;

d) the load conditions as set out in 6.3;

e) the efficiency of brake rigging and callipers as set out in prEN 16834 / EN 14531-1 / EN 14531-2;

f) all brake positions fitted to the vehicle considered.

6.2.3 Equivalent response and delay time

For units assessed in fixed formation(s) or pre-defined formation(s), hauled by locomotives, the equivalent response time and the delay time evaluated for an emergency brake command shall be lower than the following values:

a) equivalent response time:

   1) 3 s for units of maximum design speed higher or equal to 250 km/h;

   2) 5 s for other units;

b) delay time: 2 s.

For units designed and assessed for general operation, the equivalent response time and delay time for emergency brake command should be compatible with brake performances required.

6.2.4 Calculations for degraded mode

A declaration of the failure event and the failure result means:

— **for a locomotive:** the worst case failure mode in the brake calculation is expected to be the loss of a distributor (or relay valve) resulting in the loss of 50 % (or 100 %) of the brake forces, which is potentially mitigated by the application of the direct brake;

— **single coach or wagon:** no brake force at all with the consequence that operation is only possible and permitted as part of a train, no further calculation necessary;

— **fixed or predefined formation trains:** single point failure leading to the longest stopping distance.

6.2.5 Calculations for degraded conditions

The calculations for degraded conditions are relevant for advanced Control Command and Signalling systems (such as ETCS), when the brake performances are assessed in terms of the Gamma model (deceleration and brake build up time).

NOTE 1 The emergency braking performance calculations for degraded conditions are required by TSI Loc and Pas. They are relevant for advanced Control Command and Signalling systems (such as ETCS).

Degraded conditions do not affect the assessment of the braking performance when using the Lambda model (braked weight percentage) as set out in the prEN 16834.

NOTE 2 Other additional degraded conditions can be considered if required.

6.3 Relevant load conditions

6.3.1 Locomotives

The brake performance calculation shall consider the “design mass in working order” (as described in EN 15663).

6.3.2 Coaches

The brake performance calculation shall consider the following load conditions (as described in EN 15663):

— minimum load: “design mass in working order”;

— normal load: “design mass under normal payload”;

— maximum braking load: load condition lower or equal to “design mass under exceptional payload”. In case that the maximum braking load condition is lower than “design mass under exceptional payload”, it shall be justified and documented in the vehicle technical file.

The maximum braking load is based on the maximum expected density of standing passengers on board in addition to the normal load and shall be specified and agreed for each project. For this purpose the following categories should be considered:

— 0 kg/m^2 in the standing area for trains with restricted seat reservation system no standing passengers at all;

— 160 kg/m^2 in the standing area for regional trains and long distance trains;

— 300 kg/m^2 in the standing area for trains that are worked intensely with a medium volume of passengers as found in for example Vienna, Munich, Birmingham;

— 500 kg/m^2 in the standing area for trains that are worked intensely with high volumes of passengers such as found in inner cities and suburbs for example Paris RER, Berlin DC-Network, London.

All other conditions (seats occupied, luggage areas, etc.) shall be in line with the definition for the design mass under exceptional payload in accordance with EN 15663.

6.3.3 Wagons

The brake performance calculation shall consider the following load conditions:

— empty;

— intermediate load: change over load for wagons with empty-loaded changeover device; or

— intermediate load: mass when the maximum braked weight is achieved for wagons with continuous load compensation;

— loaded: “design mass under normal payload” as described in EN 15663.

6.4 Service braking

The minimum brake performance (in the first braking step) shall provide the driver with a detectable retardation. Further steps shall increase the retardation in proportion to the increasing demand.

For vehicles fitted with the “EN-UIC” brake the maximum service brake shall provide at least 95 % of the brake forces of the emergency brake without any adhesion independent brakes.

Higher service brake performance could be specified at the design phase to achieve maximum benefit from the dynamic brakes. Nevertheless the maximum values and the rate of change shall not generate unacceptable longitudinal forces or wear or damage in the wheel/rail contact. This effort is applicable for the whole consist in case of several locomotives working in multiple units.

During the transition from a full service brake application to an emergency brake application on level track a maximum reduction of deceleration of 0,2 m/s^2 for a maximum duration of one second is permitted.

For Locomotives: During the transition from a full service brake application and additional brake force demanded by an independent control command, separate from the regular train wide control command to an emergency brake application on level track a maximum reduction of deceleration of 0,2 m/s^2 is permanently permitted.

Performances of service braking being declared for the rolling stock register are only considered for locomotives operating with dynamic brake. The performance of additional brake systems like magnetic track brakes are considered in the different brake positions.

6.5 Thermal capacity

For additional brakes the permitted fields of application and mechanical performance characteristics are defined in the 5.6 of this document

A generally valid basic principle is that each vehicle in a train shall be able to brake its own weight (static plus dynamic). In addition, the vehicle brake shall be dimensioned so that:

a) it allows two consecutive emergency brake applications in normal mode from the maximum speed on level track for the highest value of the relevant load conditions as defined in 6.3 considering a time interval necessary to achieve the maximum speed again. For locomotives this applies for:

   1) the dynamic brake;

   2) the friction brake, if the dynamic brake is not used during emergency braking;

   3) the friction brake limited to a single brake application if the dynamic brake is used <u>during</u> emergency braking;

b) it allows operation on a slope of 21 ‰:

   1) at 80 km/h during 46 km as the reference case for the thermal capacity for locomotives and coaches;

   2) at 70 km/h during 40 km as the reference case for the thermal capacity for wagons which means a braking power of 45 kW per wheel during 34 minutes for a nominal wheel diameter of 920 mm and an axle load of 22,5 t unless otherwise defined, including one emergency brake application at the end of the line;

c) if it is intended to be operated on any gradients of the main railways within the scope of this document it shall perform without sustaining any mechanical or thermal damage.

If a failure of the brakes (for example ineffective brakes) at the vehicle or train level is allowed during operation (for example as defined in the specification), this shall also be taken into account in the load conditions.

If requirements are specified for the energy conversion of the brakes that are more or less severe than those of the generally valid basic requirements, they shall be respected.

6.6 Adhesion

6.6.1 General requirements

The brake system (including the electro-dynamic brake systems) of the unit shall not assume wheel/rail adhesion that lead to an unintended slip and sliding of the wheel sets or the wheels during a brake application on dry rails for all relevant load conditions as defined in 6.3. The unit or vehicle brake system shall be verified by a physical test on dry rails (except for wagons).

During service and emergency brake applications the brake distance increased of the unit shall not be longer than the maximum value permitted by EN 15595 when assessed on simulated low adhesion conditions as set out in EN 15595.

Conformity with the limit values of wheel rail adhesion demand as specified in 6.6.2 and 6.6.3 shall be verified by calculation for each wheelset or wheels with the smallest possible wheel diameter (worn wheel) and in the range of the load cases considered.

All values shall be rounded to the second digit.

6.6.2 Emergency brake application

During emergency brake application in the speed range > 30 km/h, the wheelsets or wheels of the unit shall not assume wheel/rail adhesion higher than 0,15.

When the speed is greater than 250 km/h the wheel/rail adhesion shall decline from 0,15 to 0,1 at a speed of 350 km/h in a linear manner.

6.6.3 Service brake application

During service brake application in the speed range > 30 km/h, the wheelsets shall not assume a wheel/rail adhesion demand greater than in 6.6.2 except for electro-dynamic brakes.

For electro-dynamic brakes it is permitted:

a) to assume a limit value of 0,20. When a blending mode is used this limit value shall be considered for the addition of the brake forces on each wheelset or single wheel;

b) to disregard any limit value, when the dynamic brake is commanded by an independent control command, separate from the regular train wide control command;

c) to disregard any limit value if a trainwide brake management system is active. If in this case the demanded brake forces cannot be applied to the rails for the reason of limited adhesion, the brake management system shall be capable of distributing the brake demand in such a way that the limited values of adhesion as set out in 6.6.2 are respected. This mode of brake force distribution shall also be available to the driver's discretion;

d) In cases a), b) und c) the adhesion dependent brakes shall not result in a retardation greater than 1,5 m/s^2 at a speed > 30 km/h.

6.7 Parking brake performance

The design calculation shall follow EN 14531-1 and take into account:

— static friction coefficient between the components of the friction pairs;

— maximum adhesion coefficient between wheel and rail of 0,12;

— minimum static efficiency of the mechanism (e.g. brake rigging);

— minimum spring forces or a mechanism which allows to apply respective clamping forces.

NOTE Some infrastructures can require the effect of wind to be considered.

If required the braked weight for the parking brake shall be determined in accordance with prEN 16834.

Annex A
(normative)

Vehicle requirements

Table A.1 — Brake positions, timings and brake performances

Vehicle type	Brake mode	Build up time	Release time	Max. permissible brake cylinder pressure	Braked weight percentage in lambda λ %		
		s	s	bar	Load condition		
					Empty	Intermediate	Full load
S-Wagon	G	18 - 30	45 - 60	3,8 +0,2/-0,15	Same as defined for P	Same as defined for P	
S-wagon S1 Changeover[a]	P	3 - 5 (6)[k]	15 - 20	3,8 +0,2/-0,15	100 - 125 (130)[h]	55 - 125	65 - 100[d]
S-wagon S2 Variable load relay[b]					100 - 125	100 ÷ 125 up to 65 of the full admissible load (limit for load compensation)[e]	
SS-wagon (Variable load relay)[c]					100 - 125	100[f] - 125[g]	
Passenger coach					105 - 125	Min = 105 (related to maximum braking load)	
Passenger coach	R	3 - 5 (6)[k]	15 - 20	—	126 - 170	Min = 126 (related to maximum braking load)	
	< R >				150 - 170	Min = 135 (related to maximum braking load)	

Vehicle type	Brake mode	Build up time	Release time	Max. permissible brake cylinder pressure	Braked weight percentage in lambda λ %		
		s	s	bar	Load condition		
					Empty	Intermediate	Full load
Locomotive	G	18 - 30	45 - 60	3,8 +0,2/-0,15	Min = 65	—	—
	P	3 - 5	15 - 20		105 - 125		
	R			—	126 - 149		
	< R >				150 - 170		

It is permitted to use shorter times in P and R than in the table above for operating trains in fixed formation.

NOTE Alternative goods release timings for locomotives and domestic wagons in the UK: 30–45 s.

a A unit “S1” is a unit with empty/load device. Maximum load per axle is 22,5 t.

b A unit “S2” is a unit with a variable load relay. Maximum load per axle is 22,5 t

c A unit “SS” shall be equipped with a variable load relay. Maximum load per axle is 22,5 t.

d The maximum mean retardation force admitted (for running speed at 100 km/h) 16,5 kN per wheelset. This value comes from the maximum braking energy input permitted on a clasp braked wheel with a nominal new diameter in the range of [920 mm; 1 000 mm] during braking (the braked weight shall be limited to 18 t per wheelset).

e The maximum mean retardation force admitted (for running speed at 100 km/h) is 16,5 kN per axle. This value comes from the maximum braking energy input permitted on a clasp braked wheel with a nominal new diameter in the range of [920 mm; 1 000 mm] during braking (the braked weight shall be limited to 14,5 t per wheelset). Usually a unit, with v_{max} = 100 km/h and fitted with a variable relay is designed to obtain λ = 100 % up to 14,5 t per wheelset (limit for load compensation), and by consequence 65 % for 22,5 t per wheelset.

f The maximum mean retardation force admitted (for running speed at 120 km/h) is 16 kN per wheelset. This value comes from the maximum braking energy input permitted on a clasp braked wheel with a nominal new diameter in the range of [920 mm; 1 000 mm] during braking (the braked weight shall be limited to 18t per wheelset). The mass/axle is limited to 20 t per axle and the corresponding λ is 90 %.

In other cases, the requirement is to fulfil the 100 % till the SS load limit. If it is required $\lambda \geq$ 100 % with mass/axle > 18 t then it is necessary to consider another kind of brake (for example: disc brake).

g λ shall not exceed 125 %, considering for brake only on wheels (brake blocks), the maximum mean retardation force admitted of 16 kN per wheelset (for running speed at 120 km/h).

h Only for two stage load brake (changeover command) and P10 (cast iron blocks with 10 ‰ phosphor) - or LL-brake blocks.

k With a variable load relay.

Annex B
(informative)

Train related brake performance categories

The train services may be subdivided into the categories in accordance with the following Table B.1.

Table B.1 — Train related brake performance categories

Train category	Type of service	Train related brake performance in lambda λ %
G	Freight: not relevant for design (UIC)	(50 – 125)
P - S1 or S2[a]	Accelerated freight (UIC)	(65 – 125)
P - SS	Accelerated freight (UIC)	(90 – 125)
R	Advanced freight service	> 125
P	Conventional passenger service	≥ 91
R_{min}	Advanced passenger service	≥ 125
$R_{1(UIC)}$	Advanced passenger service	≥ 135
$R_{2(Germany)}$	Advanced passenger service	≥ 143
R_{max}	Advanced passenger service	≤ 170
$R+_{min}$	High performance passenger service	(170 – 184)
$R+_{Germany}$	High performance passenger service	≥ 194
$R+_{max}$	High performance passenger service	≤ 225
[a] S2 with automatic load compensation only.		

Tables B.2 and B.3 give a survey on the minimum brake performance required by the infrastructure and the intended speed.

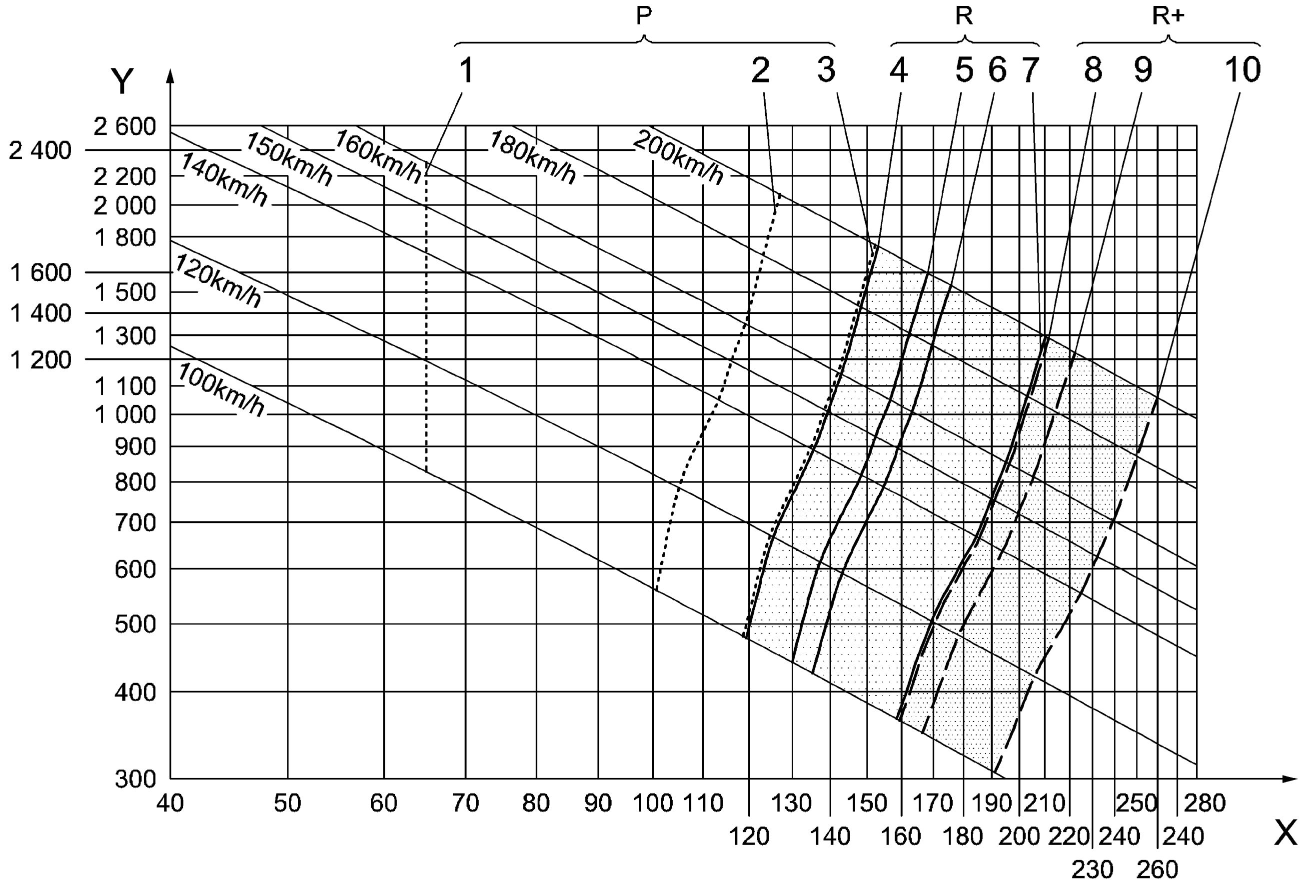
Table B.2 — Passenger trains

Infrastructure class	I1	I2	I3	I4	I5	I6	I7
Stopping distance m	700	1 000	1 200	1 300	1 400	1 500	> 1 500
Train class Brake position	Maximum speed km/h						
P	100	120	130	140	140	140	140
R_{min}	110	130	140	150	160	160	160
$R_{1(UIC)}$	115	135	150	150	160	160	200
R_{max}	120	140	150	160	160	160	200
R+ Germany	140	160	160	160	160	160	200

Table B.3 — Freight trains

Infrastructure class		I1	I2	I3	I4	I5	I6	I7
Stopping distance m		700	1000	1200	1300	1400	1500	> 1500
Train class	Maximum speed by vehicle km/h	Maximum speed km/h						
G	90	70	90	90	90	90	90	90
P - S1 or S2	100	85	100	100	100	100	100	100
P - SS	120	90	120	120	120	120	120	120
P - SS	140	90	120	140	140	140	140	140
R	> 120	RESERVED						

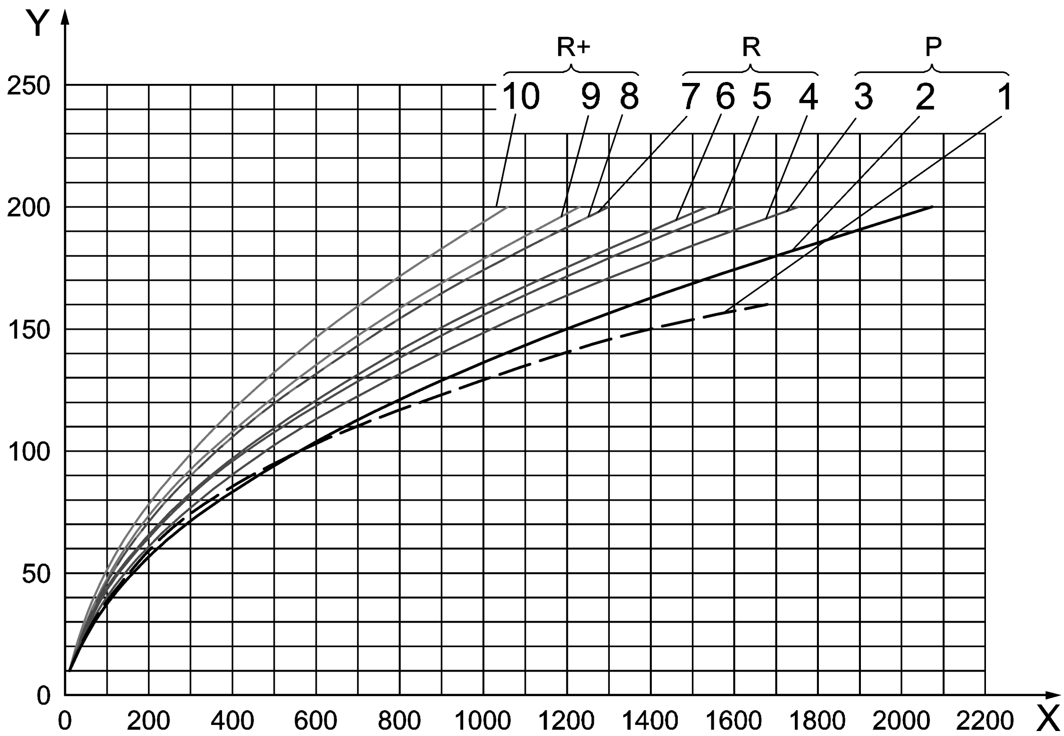
Figures B.1 and B.2 are showing the correlation between braked weight percentage of a train and stopping distances for train with a maximum length of 400 m.



Key

1	P - S1 or S2
2	$P_{(passenger\ coach)}$
3	P_{max}
4	R_{min}
5	$R_{1(UIC)}$
6	$R_{2(Germany)}$
7	R_{max}
8	$R+_{min}$
9	$R+_{Germany}$
10	$R+_{max}$
X	braked weight percentage, in %
Y	stopping distance, in m

Figure B.1 — Train brake performance categories, stopping distance over braked weight percentage (using the assessment sheet from prEN 16834 for train length ≤ 400 m)



Key

1	P - S1 or S2
2	$P_{(passenger\ coach)}$
3	P_{max}
4	R_{min}
5	$R_{1(UIC)}$
6	$R_{2(Germany)}$
7	R_{max}
8	$R+_{min}$
9	$R+_{Germany}$
10	$R+_{max}$
X	stopping distance, in m
Y	initial speed, in km/h

Figure B.2 — Brake performance categories, speed vs stopping distances (for train length ≤ 400 m)

Annex C
(informative)

Explanation of “proven design” concept

This Annex provides further explanations for the concept of proven design.

Extract from British Railway Group Standard GM/RT2045 (www.rgsonline.co.uk) for demonstration of “proven design”.

There shall be appropriate scrutiny of the design of new systems and components. In addition appropriate integrity and reliability tests shall be undertaken to ensure that any new major components, sub-assemblies or friction materials that affect brake performance will operate reliably and safely. These tests shall be undertaken on those components, sub-assemblies and friction materials that have not previously demonstrated satisfactory service experience in brake systems. The tests can be undertaken on a test rig, provided that all the forces and conditions, including climatic, that could reasonably be expected to be met in service are covered.

Before they are put into fleet-wide service all new major components or sub-assemblies that employ new principles of operation, new friction materials or complete brake systems shall be subject to and satisfactorily complete, a service trial. The trial shall normally be of 12 months duration, and shall cover representative climatic conditions and duty cycles on a sufficient number of vehicles.

If a service trial of 12 months is not considered necessary, a risk analysis shall be undertaken to determine the minimum length of the trial. A risk analysis shall also be undertaken to determine whether a component should be the subject of the assessment procedures above.

Annex D
(informative)

Corresponding standards EN – UIC

Table D.1 — Corresponding standards EN — UIC

Function	Component	EN	UIC
Brake command line	Brake pipe	EN 14198	UIC 540
Energy distribution	Brake pipe. As an option an additional main reservoir pipe can be used	EN 14198	UIC 540
	End cocks	EN 14601	UIC 541–1
Coupling elements	pneumatic half coupling	EN 15807	UIC 541–1
Central energy source	Compressed air generation unit	—	—
Local brake control – automatic/service brake	Distributor valve	EN 15355	UIC 540 UIC 543 UIC 547
	Distributor isolating device	EN 15355	UIC 541–1
	Quick release valve	EN 15355	UIC 541–1
	Control handle for quick release	EN 15355	UIC 541–1
	Brake pipe accelerator valve	EN 15612	UIC 541–1-REV 6
Local brake control – amplifier/relay	Pneumatic relay valve	EN 15611	UIC 541–04
	Automatic variable load sensing device	EN 15625	UIC 541–04
	Empty-loaded change over devices	EN 15624	UIC 541–1
	Brake indicators	EN 15220	UIC 541–3
Local energy storage	Air reservoir (called auxiliary or brake reservoir)	EN 286–3 EN 286–4	UIC 541–07

Function	Component	EN	UIC
Train wide brake control – control device	Driver brake valve	EN 14198, Annex E	UIC 541–03
Train wide brake control – Emergency brake device	Emergency exhaust valve	—	—
Decentral brake command	Passenger alarm system	EN 16334	UIC 541–1 UIC 541–5 UIC 541–6
	As option ep-assist system		UIC 541–5 UIC 541–6
Brake force generation	Brake discs mounted to the axle	EN 14535–1	—
	Brake discs mounted to the wheel	EN 14535–2	—
	Brake pads		UIC 541–3
	Brake pad holder	EN 16451	UIC 541–3, A.4
	Brake block	EN 16452	UIC 542
	Brake block holder	EN 15329	UIC 541–4 UIC 542
	Brake triangles		UIC 542
	Brake rigging (wagon design)		UIC 541–1, UIC 542
	Slack adjuster	EN 16241	UIC 542
WSP	WSP	EN 15595	UIC 541–05
Additional brake systems	Magnetic track brake	EN 16207	UIC 541–06
Markings	Markings	EN 15877–1 EN 15877–2	UIC 545

Annex E
(normative)

Brake pipe pressure control system

E.1 General requirements

The purpose of the brake pipe pressure control system is to control the automatic air brake in the train. As this standard is mainly dealing with the "EN-UIC" air brake architecture the brake pipe pressure control system is intended to control all the local distributor valves in a train, which are in accordance with EN 15355.

Units with a cab shall be equipped with a brake pipe pressure control system. If the cab is not activated, the brake pipe pressure control system shall be isolated.

It shall be possible for the driver to inhibit at least the release function of the brake pipe pressure control system in an active cab for the purpose of leakage test or when there is another vehicle with an active brake pipe pressure control system ahead.

The system shall provide the following functions:

— release position;

— service brake application;

— emergency brake application;

— overcharge function;

— quick release function.

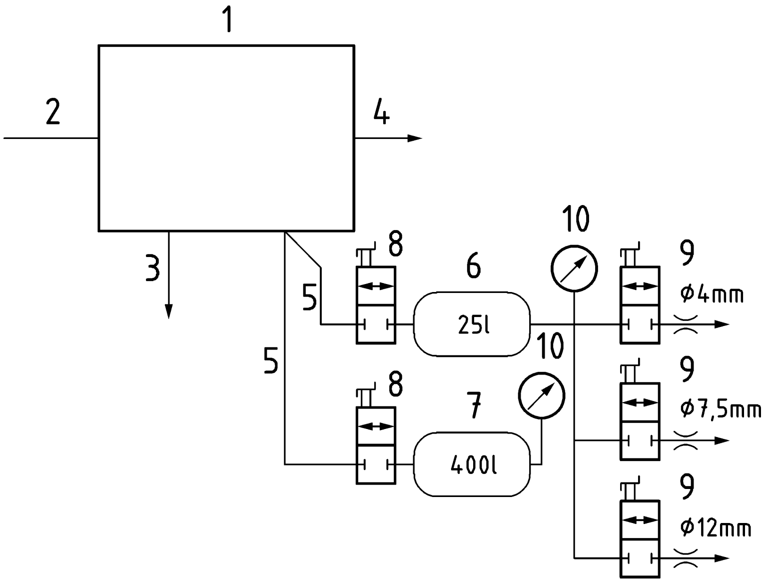
For units, which are operated only in trains with a dual pipe air brake architecture it is not mandatory to realize the quick release function.

If the ep-assist system is activated the quick release function as defined in E.6 shall be inhibited.

A release command shall not be capable of overriding a brake command.

The brake pipe pressure control system (with active or inactive ep-assist) shall not influence the normal operation of emergency brake accelerator valves, which are designed in accordance with EN 15612, i.e. that any pressure reduction in the brake pipe, with the exception of emergency brake applications, shall be in the range of the insensitivity of the emergency brake accelerator.

To verify the functionality of a new designed brake pipe pressure control system a test bench in accordance with Figure E.1 shall be exercised. For testing of the functions described below, each brake application shall be initiated in a stabilized release position (normal working pressure in the BP).



Key

1 brake pipe pressure control system

2 main reservoir pipe interface; 8 bar to 10 bar; nominal inner diameter 32 mm

3 exhaust pipe for emergency brake application; length 1,5 m; nominal inner diameter 32 mm

4 exhaust pipe for service brake application

5 brake pipe interface; length in total 5 m; nominal inner diameter 32 mm

6 reservoir 25 l

7 reservoir 400 l

8 2/2 directional control valve; minimum nominal inner diameter 32 mm

9 2/2 directional control valve; minimum nominal inner diameter 19 mm

10 pressure measurement device

Figure E.1 — Test bench for verification of the functionality of a brake pipe pressure control system

E.2 Release position

In the release position the brake pipe pressure control system shall maintain the normal working pressure in the brake pipe at (5,0 ± 0,05) bar.

For a single vehicle or if an air reservoir of 25 l is connected to the brake pipe (Figure E.1) interface of the brake pipe pressure control system the following requirements shall be satisfied in the release position of the system:

a) if an outlet of 4 mm is opened on the reservoir, the brake pipe pressure drop shall not be higher than 0,15 bar;

b) if an outlet of 7,5 mm is opened on the reservoir, the brake pipe pressure drop shall be at least 0,6 bar;

c) if an outlet of 12 mm is opened on the reservoir, the brake pipe pressure drop shall be at least 1,5 bar.

If the requirements b) and c) cannot be satisfied in cases of higher leakage compensating air flows in the release position of the brake pipe pressure control system a special device shall be provided to indicate a high air flow into the brake pipe. The indication should lead to an automatic reduction of the airflow.

The brake pipe pressure control system shall be capable of being adjusted during maintenance activities so that normal working pressure in the brake pipe can be set to (5,0 ± 0,05) bar.

E.3 Service brake application

The following requirements shall be met on a single vehicle or with a 25 l air reservoir connected to the brake pipe interface (Figure E.1) of the brake pipe pressure control system:

— it shall be possible to achieve at least 6 braking steps (excluding release) in the brake pipe, including full service braking;

— in the first braking step, the pressure reduction in the brake pipe shall be (0,4 + 0,1) bar below the normal working pressure and a pressure reduction of 0,35 bar below the normal working pressure shall be achieved in 0,5 s to 2,5 s;

— in full service brake application the pressure reduction in the brake pipe shall be (1,6 + 0,2) bar below the actual value of the normal working pressure and a pressure reduction of 1,5 bar below the normal working pressure shall be achieved in 6 s to 10 s;

— if an outlet of 4 mm is opened on the brake pipe, the brake pipe pressure drop in any service brake application shall not be higher than 0,15 bar;

— in the last release step the pressure in the brake pipe shall not be higher than (0,25 + 0,1) bar below the actual value of the normal working pressure;

— if the release position is selected after a full service brake application the pressure rising in the brake pipe from 3,5 bar to 0,2 bar below the normal working pressure shall be achieved in 1 s to 5 s.

The following requirements shall be met with a 400 l air reservoir connected to the brake pipe interface (Figure E.1) of the brake pipe pressure control system:

— with a full service brake application coming from the stable release position a pressure reduction in the reservoir of 1,2 bar below the actual value of the normal working pressure shall be achieved in not more than 10 s;

— if the release position is selected after a full service brake application the pressure rising in the reservoir from 3,5 bar to 0,2 bar below the actual value of the normal working pressure shall be achieved in less than 20 s.

E.4 Emergency brake application

With a 400 l air reservoir connected to brake pipe interface (Figure E.1) of the brake pipe pressure control system a pressure drop of 1,5 bar in the reservoir during emergency brake application coming from the stable release position shall be achieved in less than 2,5 s. The pressure shall finally drop to a value of less than 2,5 bar.

In the emergency brake position of the driver's brake handle the leakage compensating air flow of the brake pipe pressure control system shall be inhibited.

E.5 Overcharge function

This function is used to adjust the pressure in the control chamber of a local brake control device, which is designed in accordance with EN 15355, by temporary rising of the pressure in the brake pipe followed by a slow reduction of both, the brake pipe pressure and the control chamber pressure.

The following requirements shall be met on a single vehicle or with a 25 l air reservoir connected to the brake pipe interface (Figure E.1) of the brake pipe pressure control system:

a) manual overcharge: the brake pipe pressure control system shall be equipped with a device (e.g. an overcharge button) allowing temporary and limited overcharge of the normal working pressure in the brake pipe:

   1) the overcharge pressure shall not exceed 0,8 bar above the normal working pressure;

   2) the gradient of increase shall allow the target pressure to be reached in less than 25 s;

   3) every manual overcharge is followed by assimilation;

b) automatic overcharge function (optional): the automatic overcharge function may increase the BP target pressure when the brakes are fully released following a service or emergency brake application; the level of overcharge (offset) should be:

   1) proportional with the previous braking step;

   2) the pressure rising in the brake pipe shall not be higher than 0,2 bar above the normal working pressure in less than 2 s;

   3) every automatic overcharge is followed by assimilation;

c) assimilation process:

   1) after overcharging the pressure in the brake pipe shall be reduced to the normal working pressure;

   2) the pressure reduction phase shall be started not later than 25 s after initiation of the overcharge function;

   3) during the pressure reduction the average pressure drop in the brake pipe shall be 0,15 bar in 60 s to 75 s;

d) brake application during overcharge or the assimilation process, when a brake application is started:

   1) the pressure should be reduced to a level that would be achieved if the brake application were started from the normal working pressure or;

   2) optionally it is possible to reduce the pressure relative to the initial pressure at the start of the brake application (the service brake performance may be reduced);

e) automatic overcharge memory (optional): when a brake application is started during overcharge or the assimilation process:

   1) the BP pressure level existing at the start of braking should be memorized;

2) when the brakes are fully released, the brake pipe pressure should be raised to the memorized value plus ≤ 0,15 bar but not exceeding the maximum overcharge value;

3) every automatic overcharge memory is followed by assimilation.

E.6 Quick release function

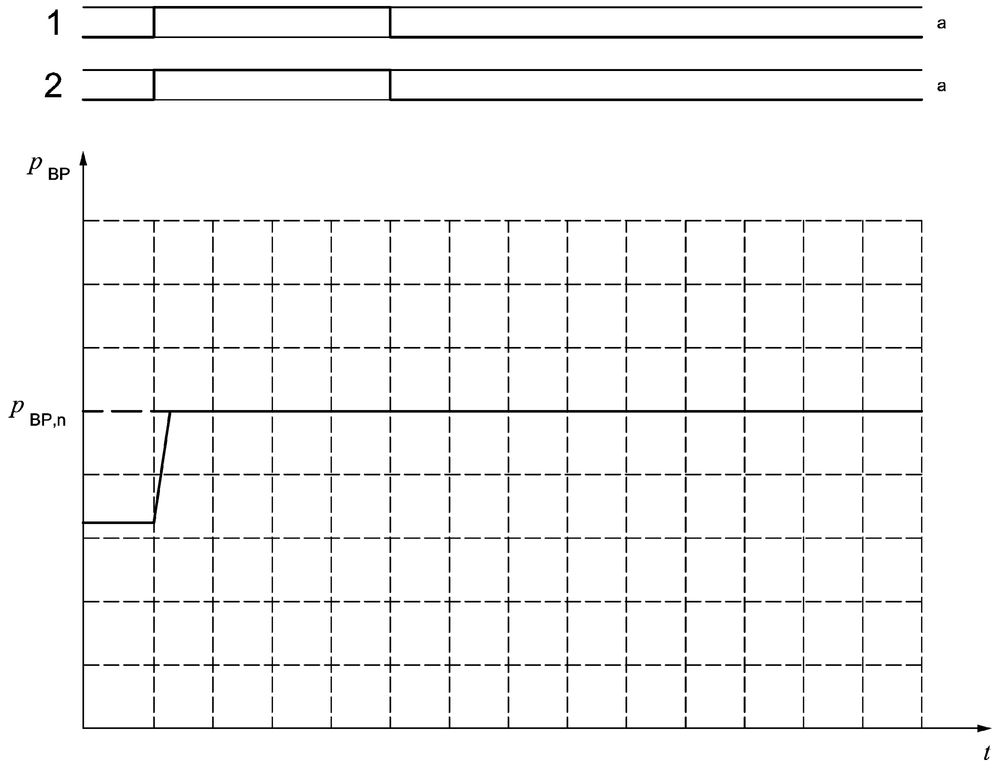
This function is used to fill the brake pipe with a higher air flow for a limited time to accelerate the release application in longer trains with single pipe air brake architecture.

The quick release function shall be activated by the driver only. The quick release command should be inhibited after 60 s of a continuous command.

The quick release function should be activated only directly after a brake application command and if a full release command is activated at the same time.

Any brake application command shall inhibit the quick release function.

The activation of the quick release function shall lead to a higher air flow into the brake pipe (see Figure E.2).



Key

1	QR - status of quick release activation
2	HF - status of high air flow activation
p_{BP}	pressure in the brake pipe
$p_{BP,n}$	nominal pressure in the brake pipe
t	time
a	on off

Figure E.2 — Example for the quick release function with higher air flow

The higher air flow is defined as follows:

— a 400 l air reservoir is connected to the brake pipe interface (Figure E.1) of the brake pipe pressure control system;

— after stabilized full service brake application the quick release function is activated with the normal working pressure in the brake pipe as target pressure;

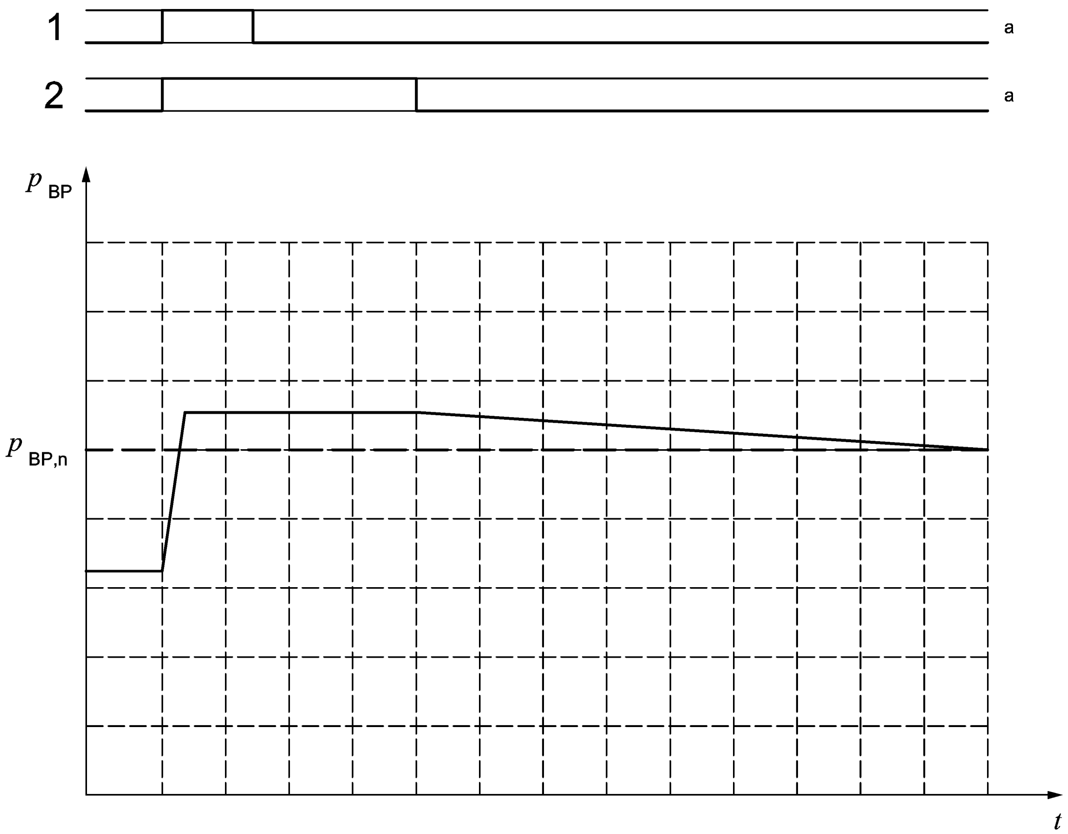
— the pressure rising in the reservoir from 3,5 bar to 0,2 bar below the normal working pressure shall be achieved in less than 10 s. To achieve the time requirement, the target pressure can be higher than normal working pressure but shall not exceed it by more than 0,1 bar.

The higher air flow in the brake pipe shall not be activated for longer than 60 s and shall be deactivated by any brake application command.

Optionally the following functions are permitted in addition to the activation of the higher air flow:

— automatic activation of the overcharge function (see Figure E.3). In that case the value of the maximum pressure rising in the brake pipe shall be the same as for an activation of the overcharge function by the driver (see E.5). After pressure rising the pressure drop and pressure reduction in the brake pipe to the normal working pressure shall be the same as defined for the overcharge function (see E.5);

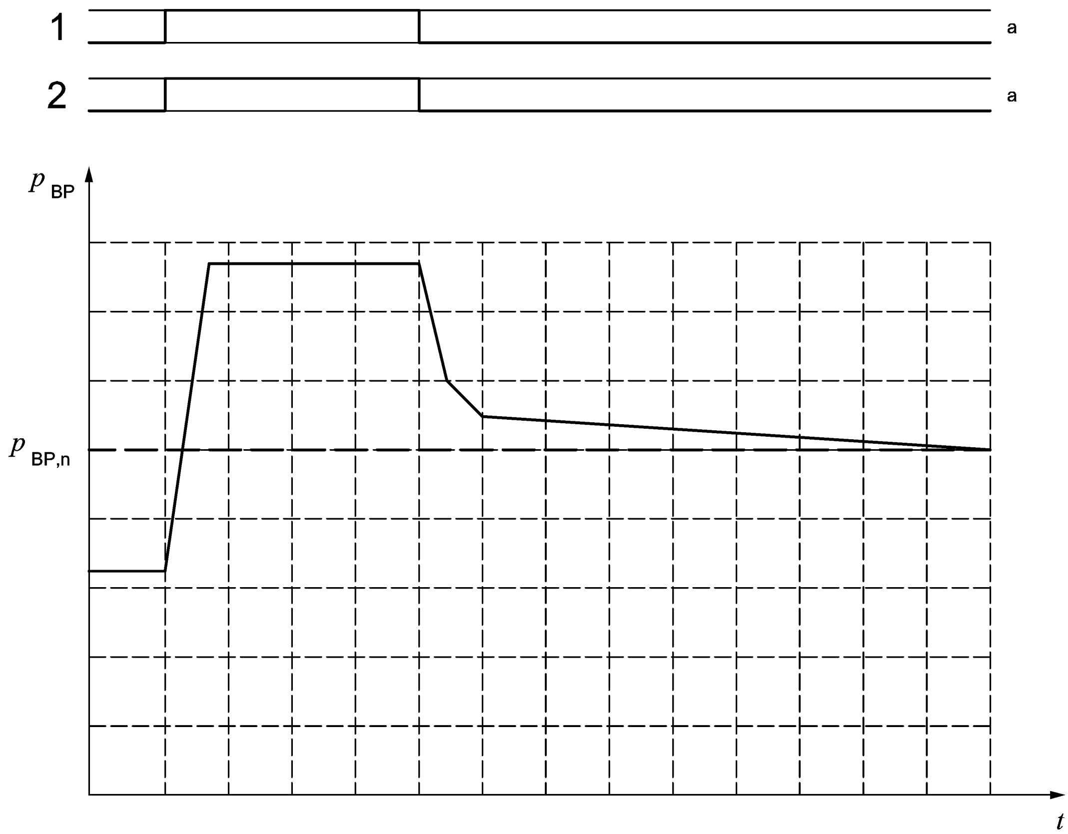
— rising the pressure in the brake pipe above the maximum overcharge pressure value ("high pressure quick release" see Figure E.4). After pressure rising the pressure drop and pressure reduction in the brake pipe to the normal working pressure shall be the same as defined for the overcharge function (see E.5). The risk of overcharging the control chambers of distributor valves which are designed in accordance with EN 15355 should be controlled, for example by limiting the value of the maximum pressure rising dependent on the current value of the brake pipe pressure when the quick release function is activated.



Key

1	QR - status of quick release activation	*t*	time
2	HF - status of high air flow activation	a	<u>on</u>
			off
p_{BP}	pressure in the brake pipe		
$p_{BP,n}$	nominal pressure in the brake pipe		

Figure E.3 — Example for the quick release function with higher air flow and automatic activation of the overcharge function



Key

1	QR - status of quick release activation
2	HF - status of high air flow activation
p_{BP}	pressure in the brake pipe
$p_{BP,n}$	nominal pressure in the brake pipe
t	time
a	on off

Figure E.4 — Example for the high pressure quick release

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared mandates given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the Directive 2008/57/EC[5)].

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 for freight wagons, Table ZA.2 for locomotive and passenger RST, and Table ZA.3 for Safety in Rail Tunnels confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

5) This Directive 2008/57/EC adopted on 17th June 2008 is a recast of the previous Directives 96/48/EC 'Interoperability of the trans-European high-speed rail system' and 2001/16/EC 'Interoperability of the trans-European conventional rail system' and revisions thereof by 2004/50/EC 'Corrigendum to Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system'.

Table ZA.1 — Correspondence between this European Standard and Directive 2008/57/EC EU Regulation 321/2013 of the Commission dated 13 March 2013 relative to the technical interoperability specification relating to the sub-system “rolling stock – freight wagons” for rail systems within the European Union, abrogating Decision 2006/861/EC (published in JOUE *L 104, 12.4.2013, p.1*) and Directive 2008/57/EC

Clause/subclauses of this European Standard	Chapter/§/annexes of the Technical Specification for Interoperability (TSI)	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable.	4.Characterization of the subsystem 4.2 Functional and technical specifications of the subsystem. 4.2.4. Brake 4.2.4.1. General 4.2.4.2. Safety requirements 4.2.4.3.Functional and technical requirements 4.2.4.3.1. General functional requirements 4.2.4.3.2 Brake performance 4.2.4.3.2.1 Service brake 4.2.4.3.2.2 Parking brake 4.2.4.3.3. Thermal capacity 4.2.4.3.4. Wheel slide protection (W S P) Appendix C: Additional optional conditions 9. UIC brake 14. Specific brake thermal capacity	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5 1.2 Reliability and availability 1.3 Health Clause 1.3.2 1.4 Environmental protection Clause 1.4.2 1.5 Technical compatibility 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §3 2.4.2 Reliability and availability 2.4.3 Technical compatibility §3	For a braking system, the fulfilment of the requirements of the Subclause 5.4 of the EN, which satisfies to the chapter C.9 and C.14 of Appendix C of the TSI, gives a presumption of conformity to §4.2.4.2 of the TSI. For other system, this EN 14198 gives safety requirements which cover the safety requirements of the §4.2.4.2 of the TSI, but the demonstration of the fulfilment of the safety TSI requirement remains to be done.

Table ZA.2 — Correspondence between this European Standard, the Commission regulation n°1302/2014 of 18 November 2014 concerning the technical specification for interoperability relating to the "rolling stock locomotives and passenger rolling stock" of the rail system in the European Union (published in the Official Journal L 356, 12.12.2014, p.228) and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the technical specification for interoperability (TSI)	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable.	4.Characterization of the Rolling stock subsystem 4.2 Functional and technical specifications of the subsystem 4.2.4 Braking 4.2.4.1General 4.2.4.2Main functional and safety requirements §4.2.4.2.1.Functional requirements 4.2.4.2.2.Safety requirements 4.2.4.3 Type of brake system 4.2.4.4 Brake command 4.2.4.5 Braking performance 4.2.4.6Wheel rail adhesion profile - Wheel slide protection system §4.2.4.6.1 Limit of wheel rail adhesion profile 4.2.4.7 Dynamic brake - Braking system linked to traction system 4.2.4.8 Braking system independent of adhesion conditions §4.2.4.8.1. General 4.2.4.9 Brake state and fault indication 4.2.4.10 Brake requirements for rescue purposes 4.2.10 Fire safety and evacuation 4.2.10.4 Requirements related to emergencies 4.2.10.4.4 Running capability	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5 1.2 Reliability and availability 1.3 Health Clause 1.3.2 1.4 Environmental protection Clause 1.4.2 1.5 Technical compatibility 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §3 2.4.2 Reliability and availability 2.4.3 Technical compatibility §3	For a braking system, the fulfilment of the requirements of the Subclause 5.4 of the EN gives a presumption of conformity to §4.2.4.2 of the TSI. For other braking systems, this EN 14198 gives safety requirements which cover the safety requirements of the §4.2.4.2 of the TSI, but the demonstration of the fulfilment of the safety TSI requirement remains to be done. The 4.2.4.3 of the TSI mandates to apply the brake principles set out in EN 14198:2004, 5.4 which therefore remains mandatory. Nevertheless as the requirements of the equivalent Subclause 5.4 and Clause 6 of this edition of EN 14198 cover those of the previous edition, the use of this new edition allows to fulfil the TSI requirements.

Table ZA.3 — Correspondence between this European Standard, the Commission regulation n°1303/2014 of 18 November 2014 concerning the technical specification for interoperability relating to "safety in rail tunnels" of the rail system in the European Union (published in the Official Journal L 356, 12.12.2014, p.394) and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the technical specification for interoperability (TSI)	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable.	4.Characterization of the subsystem 4.2 Functional and technical specifications of the subsystem 4.2.3 Subsystem rolling stock 4.2.3.3Requirements related to emergencies §4.2.3.3.4 Running capability	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5 1.2 Reliability and availability 1.3 Health Clause 1.3.2 1.4 Environmental protection Clause 1.4.2 1.5 Technical compatibility 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §3 2.4.2 Reliability and availability 2.4.3 Technical compatibility §3	

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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[27] Commission Regulation (EU) No 321/2013 of 13 March 2013 concerning the technical specification for interoperability relating to the subsystem 'rolling stock — freight wagons' of the rail system in the European Union and repealing Decision 2006/861/EC

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