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Railway applications — Braking — General vocabulary

Applications ferroviaires — Freinage — Vocabulaire général

Железнодорожный транспорт — Системы торможения — Основные термины

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Foreword

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Introduction

This document provides unambiguous definitions of generic terminology used in the field of railway braking. The terms and definitions reflect those used in numerous published International Standards.

The braking includes all factors that have a bearing on the stopping, slowing or immobilization performance of the train (e.g. train resistance, gradient) and may involve the conversion and dissipation of braking energy.

Railway applications — Braking — General vocabulary

1 Scope

This document defines terms for brakes and braking in rolling stock.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Basic definitions

3.1.1
braking
process generating controlled forces which result in the deceleration of the train, or maintaining a constant speed on a falling gradient, or preventing a stationary train from moving

3.1.2
brake
brake system
combination of *brake unit(s)* (3.1.3) with their trainwide/local control device(s) ensuring one or more braking function(s)

Note 1 to entry: Brakes and brake systems can also be used for other functions e.g. shunting, de-icing of friction brake units.

3.1.3
brake unit
device or assembly of components, that generates a braking force

Note 1 to entry: See Annex E.

Note 2 to entry: For tread brake and disc brake, it consists of the brake actuator, the friction material (pads or block) and the disc (for disc brake units).

Note 3 to entry: The *magnetic track brake* (3.7.3.3) unit includes two magnet assemblies (one per rail).

Note 4 to entry: The primary purpose of the brake unit might not be to generate a braking force, for example elements of the traction system can also function as a brake unit.

3.2 Brake system compatibility

3.2.1
brake system compatibility
ability of the brake systems of coupled rail vehicles/trains to achieve the specified levels of braking performance, functionality and safety

3.3 Performance

3.3.1
braking performance
parameters and their values used to quantify braking as described in applicable braking standards

3.3.2
deceleration
result of a force acting contrary to the direction of movement

3.4 Purposes of braking

3.4.1
stopping
braking from an initial speed to a standstill

3.4.2
slowing
braking from an initial speed to a final speed, but not standstill

3.4.3
drag braking
continuous brake application
braking on a falling gradient to maintain a substantially constant speed value

3.4.4
stationary braking
braking used to prevent a stationary train from moving, using the holding, *immobilizing* (3.4.6) or *parking* (3.4.7) functions

3.4.5
holding
braking which is used to prevent a stationary train from moving, under the specified conditions and for a specified time, when the brake system energy used is being replenished

Note 1 to entry: Holding is usually achieved by the application of the service brake.

3.4.6
immobilizing
braking which is used to prevent a stationary train from moving, under the specified conditions and for a specified time, using just the brake system energy stored on the train

Note 1 to entry: Immobilizing is usually achieved by the application of the service brake or parking brake equipment.

3.4.7
parking
braking which is used to prevent a stationary train from moving, under the specified conditions and for an indefinite period of time, without the need for any brake system energy replenishment following application

Note 1 to entry: Parking is usually achieved by the application of the parking brake equipment.

3.5 Mechanics of braking

3.5.1
braking force
force generated by the brake system to stop, slow or hold the rail vehicle/unit/train stationary, or when drag braking the train

Note 1 to entry: It does not include external forces which contribute to the overall deceleration of the rail vehicle, unit or train (e.g. train resistance, gradient).

3.5.2
retarding force
force transmitted between the rail vehicle/unit/train and the external environment in reaction to an applied braking force

Note 1 to entry: For wheel/rail adhesion dependent brakes, the retarding force can be lower than or equal to the braking force depending on the available wheel/rail adhesion.

Note 2 to entry: The retarding force can be calculated for a single brake equipment type.

3.5.3
decelerating force
sum of longitudinal forces acting on a moving train during braking (combination of retarding forces with all other external and internal forces acting on a moving train)

Note 1 to entry: External forces can be caused by, for example, aerodynamic resistance, rising gradient or head wind.

Note 2 to entry: Internal forces can be caused by, for example, rolling resistance.

Note 3 to entry: External forces can also provide an accelerating effect (negative deceleration) in certain circumstances (e.g. falling gradient, tail wind).

Note 4 to entry: The general assessment is usually done on straight and level track to reduce the number of variables.

3.5.4
retention force
force transmitted between the rail vehicle/unit/train and the external environment in reaction to an applied braking force, used to hold the rail vehicle/unit/train stationary against the external forces (e.g. due to gradient or wind loads)

Note 1 to entry: For wheel/rail adhesion dependent brakes, the retention force can be lower than or equal to the braking force depending on the available wheel/rail adhesion.

3.5.5
static mass
mass of the rail vehicle/unit/train in a stationary condition

Note 1 to entry: Static mass is usually determined at the wheel-rail interface.

3.5.6
equivalent rotating mass
equivalent mass resulting from the moment of inertia of the wheels including coupled rotating parts

3.5.7
dynamic mass
sum of the static mass and the equivalent rotating mass

3.5.8
wheel/rail adhesion
physical phenomenon at the wheel-rail interface used to generate a retarding force

3.5.9
coefficient of wheel/rail adhesion
ratio of the tangential force at the wheel-rail interface and the force at this interface acting perpendicular to the surface of the rail

Note 1 to entry: Usually the term “required adhesion” or “demanded adhesion” defines the minimum level of adhesion to transmit the applied braking force (retarding force equal to braking force).

Note 2 to entry: Usually the term “available adhesion” defines the level of adhesion for which the effort that can be transmitted from the wheel to the rail according to the actual conditions is maximum.

3.6 Kinematics and dynamics of braking

3.6.1
fully-established brake
state in which all relevant brake units are assumed to be generating their braking force corresponding to the brake demand

Note 1 to entry: The brake demand will be determined by the driver or the train control system.

Note 2 to entry: The term “fully-established brake” is not to be confused with the term “*full service brake application*” (3.8.3).

3.6.2
free running distance
s_a
distance travelled during the *delay time* (3.6.12)

3.6.3
build-up distance
s_{ab}
distance travelled during the *build-up time* (3.6.14)

3.6.4
braking distance with a fully-established brake
s_f
distance travelled with a fully-established brake to a point when achieving standstill or the final speed

3.6.5
braking distance
s_g
distance travelled from the commencement of the brake application until achieving standstill or the final speed

3.6.6
distance during release time
s_{cd}
distance travelled during the *release time* (3.6.15)

3.6.7
slowing distance
s_{sl}
distance travelled from the initiation of brake demand until achieving the final speed

3.6.8
stopping distance
s
distance travelled from the initiation of brake demand until standstill

3.6.9
equivalent free running distance
$s_{a,e}$
distance travelled during *equivalent response time* (3.6.22)

Note 1 to entry: During the equivalent response time, it is assumed that there is no braking force applied.

3.6.10
equivalent braking distance
$s_{f,e}$
distance travelled during the *equivalent braking time* (3.6.23)

Note 1 to entry: During the equivalent braking time it is assumed that the fully established braking force is applied.

3.6.11
reaction time
t_r
time taken by the driver, or any train control system able to trigger a brake demand (e.g. automatic signalling equipment, passenger alarm system, driver vigilance system), to receive the information that a brake demand is required and to initiate that demand

3.6.12
delay time
t_a
period of time commencing when a change in brake demand is initiated and ending when achieving *a* % of the fully-established braking parameter

Note 1 to entry: See Annex A.

Note 2 to entry: Braking parameter can be taken as braking force, deceleration or brake cylinder pressure.

Note 3 to entry: The delay time includes the propagation time of the trainwide brake control signal to the *local brake control device* (3.10.1.12).

3.6.13
release delay time
t_c
period of time commencing when a change in brake demand is initiated and ending with reduction to *c* % of the previously fully-established braking parameter

Note 1 to entry: See Annex B.

Note 2 to entry: Braking parameter can be taken as braking force, deceleration or brake cylinder pressure on train or vehicle level.

Note 3 to entry: The release delay time includes the propagation time of the trainwide brake control signal to the *local brake control device* (3.10.1.12).

3.6.14
build-up time
t_{ab}
period of time commencing at the end of the delay time and ending when achieving an increase from *a* % to *b* % of the established braking parameter

Note 1 to entry: See Annex A.

Note 2 to entry: Braking parameter can be taken as braking force, deceleration or brake cylinder pressure.

3.6.15
release time
t_{cd}
period of time commencing at the end of the delay time and ending when achieving a decrease from *c* % to *d* % of the established braking parameter

Note 1 to entry: See Annex B.

Note 2 to entry: Braking parameter can be taken as braking force, deceleration or brake cylinder pressure.

3.6.16
response time (build-up)
t_b
sum of the delay time and the build-up time

Note 1 to entry: See Annex A.

3.6.17
response time (release)
t_d
sum of the delay time and the release time

Note 1 to entry: See Annex B.

3.6.18
braking time with a fully-established brake
t_f
time elapsed from achieving a *fully-established brake* (3.6.1) until standstill or commencing brake release

3.6.19
braking time
t_g
elapsed time from the commencement of brake application until standstill (stopping) or completion of brake release and achieving the final speed (slowing)

3.6.20
slowing time
t_{sl}
total time from initiation of the brake demand until achieving the final speed being the sum of brake system delay time and braking time

Note 1 to entry: This excludes the *reaction time* (3.6.11).

3.6.21
stopping time
t
total time from initiation of the brake demand until standstill, being the sum of brake system delay time and braking time

Note 1 to entry: This excludes the *reaction time* (3.6.11).

3.6.22
equivalent response time
$t_{a,e}$
sum of delay time and half of the build-up time

Note 1 to entry: See Annex A and Annex C.

Note 2 to entry: During the equivalent response time period, it is assumed that there is no braking force applied.

3.6.23
equivalent braking time
$t_{f,e}$
sum of the braking time with *fully-established brake* (3.6.1) and half of the *build-up time* (3.6.14)

Note 1 to entry: During the whole of this period it is assumed the fully established braking force is applied.

3.6.24
nominal deceleration
result of a decelerating force acting on a train determined without safety margin or a confidence level on a set of given conditions (e.g. dry rail, straight and level track)

Note 1 to entry: In Europe, typical test conditions and a method to determine the nominal deceleration are defined in EN 16834[5] or alternatively in EN 13452-1[1] for urban rail brake systems.

3.6.25
safe deceleration
guaranteed emergency brake rate
GEBR
result of a decelerating force acting on a train determined with a specified confidence level on a set of given conditions (e.g. variation of braking force, equipment failures and/or degraded environmental and operating conditions)

Note 1 to entry: In general, it is the result of nominal deceleration multiplied by one or more correction factors.

Note 2 to entry: For ETCS application, the safe deceleration is calculated using the nominal deceleration and the train-side correction factors (e.g. Kdry_rst and Kwet_rst), the confidence level (EBCL) and the weighting factor for reduced adhesion.

3.6.26
instantaneous deceleration
absolute value of the first derivative of speed with respect to time at some instant during speed reduction

3.6.27
free running acceleration
a_a
mean value of acceleration throughout the *delay time* (3.6.12) when there is no braking force applied and no deceleration due to the brake system

3.6.28
increasing brake deceleration
a_{ab}
variation in deceleration while the braking force is increasing from zero up to that associated with a fully-established brake demand

3.6.29
deceleration with a fully-established brake
a_f
deceleration equal to a mean value with respect to the braking distance and based on fully established braking forces for all functioning brake equipment types within specific speed range(s)

3.6.30
braking deceleration
a_g
deceleration throughout the *braking distance* (3.6.5)

3.6.31
equivalent free running acceleration
$a_{a,e}$
assumed zero brake deceleration throughout the *equivalent response time* (3.6.22)

Note 1 to entry: During the equivalent response time it is assumed there is no braking force applied.

3.6.32
equivalent brake deceleration
$a_{f,e}$
assumed constant brake deceleration throughout the *equivalent braking time* (3.6.23)

3.6.33
decreasing brake deceleration
a_{cd}
variation in deceleration while the braking force is reducing from fully-established to zero

3.6.34
mean deceleration
a
deceleration which is equal to a mean value with respect to the stopping or slowing distance in a specific speed range

3.6.35
jerk
first derivative of the deceleration with respect to time associated with a change in deceleration

Note 1 to entry: Determined in the direction of travel.

3.6.36
braking jerk limit
maximum allowed value of jerk during braking in order to comply with passenger comfort requirements

3.6.37
braking energy
energy which is dissipated or transferred during the braking process

Note 1 to entry: It corresponds to the reduction in rail vehicle or train kinetic and potential energy.

3.6.38
brake system energy
energy that is used to fulfil the brake application and release

3.6.39
braking power
power (braking energy per unit of time) which is dissipated during the braking process

3.6.40
braked weight percentage
lambda
λ
way of assessing the brake performance of a rail vehicle or train, expressed as a percentage

Note 1 to entry: Braked weight percentage is determined using EN 16834[5].

3.6.41
braked weight
way of expressing the brake performance of a rail vehicle or train

Note 1 to entry: Braked weight is expressed in tonnes.

Note 2 to entry: Braked weight is determined using EN 16834[5].

3.6.42
braking torque
resultant torque generated by the *brake pad force* (3.7.3.2.1) and coefficient of friction operating at the mean swept radius of the brake pad on the disc face

Note 1 to entry: This is typically used when assessing the performance of disc brakes during dynamometer testing.

3.6.43
standstill
condition in which the rail vehicle/unit/train is stationary and all vehicle movement relative to the rail has stopped

3.7 Types and characteristics of brakes

3.7.1
wheel/rail adhesion dependent brake
brake system which transmits a braking force via the wheel/rail contact area

3.7.2
wheel/rail adhesion independent brake
brake system which does not transmit a braking force via the wheel/rail contact area

3.7.3
friction brake
brake system which generates a braking force by friction between two or more surfaces

3.7.3.1
tread brake
type of friction brake system which generates a braking force between the running surface of a wheel (tread) and one or more brake blocks

3.7.3.1.1
brake block force
force applied by the brake block to the running surface of a wheel (tread)

Note 1 to entry: The brake block force is an example of a *brake application force* (3.7.6).

3.7.3.1.2
braking force at the wheel tread
tangential force generated by the coefficient of friction between the brake block and the wheel tread

3.7.3.2
disc brake
type of friction brake system which generates a braking force by applying one or more brake pads against a brake disc

3.7.3.2.1
brake pad force
force applied by a brake pad to the brake disc

Note 1 to entry: The brake pad force is an example of a *brake application force* (3.7.6).

3.7.3.2.2
braking force at the brake disc
tangential force generated by the coefficient of friction between the brake pads and the brake disc

3.7.3.2.3
disc braking force at the wheel tread
braking force at the brake disc multiplied by the ratio of the mean swept radius of the brake pad on the disc face and the wheel radius

3.7.3.3
magnetic track brake
MTB
type of friction brake system which generates a braking force between the rail surface(s) and pole shoe(s) attracted magnetically into contact

Note 1 to entry: The pole shoe attraction can be generated by an electro-magnet or a permanent magnet.

3.7.4
dynamic brake
brake system which generates a braking force using the motion of the rail vehicle or its functional elements, using an energy transfer system not using consumable friction materials

Note 1 to entry: Energy transfer systems include electro-dynamic, aerodynamic and hydro-dynamic brake systems.

3.7.4.1
hydro-dynamic brake
type of dynamic brake system which generates a braking force using a hydraulic transfer system

Note 1 to entry: Hydraulic transfer systems include viscous shear transmission retarders and accumulator storage systems.

3.7.4.2
aerodynamic brake
type of dynamic brake system which generates a braking force by aerodynamic resistance

3.7.4.3
eddy current brake
type of dynamic brake system which generates a braking force using electro-magnetic induction in the reaction part

Note 1 to entry: The reaction part of the system can be the running rail (linear eddy current brake) or a brake disc (rotary eddy current brake).

3.7.4.4
electro-dynamic brake
type of dynamic brake system which generates a braking force by using the energy recovery capability of the electric traction system

Note 1 to entry: The energy can be stored and used on board, or transferred into the traction energy supply system, or dissipated by resistors.

3.7.4.5
rheostatic brake
type of electro-dynamic brake which dissipates the braking energy recovered by heating resistors

3.7.4.6
regenerative brake
type of electro-dynamic brake which transfers the braking energy recovered into the traction energy supply system and/or onboard storage systems

3.7.5
parking brake
brake system dedicated to perform the *parking function* (3.4.7)

3.7.6
brake application force
force applied directly on the friction elements (e.g. brake block/wheel, brake pads/disc)

Note 1 to entry: For the magnetic track brake, the brake application force is generated by the magnetic attraction of the pole shoes on the head of the rail.

Note 2 to entry: For brake disc calipers, the term "clamping force" is also used to refer to the brake application force.

Note 3 to entry: For the tread brake, the term "single brake block force" is also used to refer to the brake application force.

3.8 Brake application and release

3.8.1
emergency brake application
pre-defined brake application that achieves the specified emergency braking performance and level of safety

Note 1 to entry: The braking performance of the emergency brake application is typically equal to or higher than the maximum service brake application.

Note 2 to entry: The safety level needs to take into account the usable brake equipment types.

3.8.2
service brake application
application of a graduable braking force in order to control the speed of a train, including slowing or stopping and temporary immobilization

Note 1 to entry: Service brake application is the most commonly used method of brake operation.

3.8.3
full service brake application
maximum available service brake application

3.8.4
safety brake application
brake application specific to urban rail vehicles/units/trains intended to achieve a higher level of system integrity than that achieved with a service brake application or an emergency brake application

Note 1 to entry: The performance of the safety brake application can be lower than achieved by a full service brake or emergency brake application.

3.8.5
irreversible brake application
irretrievable brake application
brake application which cannot be released by the driver before specific conditions are reached

Note 1 to entry: Examples of specific conditions include either

a) the train achieves a defined speed, or

b) the expiry of the time limit of the brake application.

3.8.6
graduable brake application and release
function to increase or reduce the braking force either in steps or continuously

3.8.7
brake mode
setting, in brake systems with pneumatic *trainwide indirect brake* (3.9.1.8) architecture, that defines the distributor valve build-up and release timings

Note 1 to entry: In Europe in the "EN-UIC" design, the brake modes "G" for goods timings and "P" for passenger timings are defined in EN 14198[2].

3.8.8
brake position
setting that defines the behaviour of the *local brake control device* (3.10.1.12) (e.g. distributor valve) in regard of brake application and release timings and braking forces that can include additional brake units

Note 1 to entry: Selecting the brake position does not necessarily need the operation of a lever, etc. on the rail vehicle.

Note 2 to entry: In Europe in the "EN-UIC" design, the brake position (e.g. "P", "G", "R", "R+ Mg") is defined in EN 14198[2].

3.8.9
overcharge function
function, in brake systems with pneumatic *trainwide indirect brake* (3.9.1.8) architecture, to equalize the control pressures of all the distributor valves in the train to the *normal working pressure* (3.10.4.2) in the brake pipe

Note 1 to entry: This function can be achieved by a temporary increase of the pressure in the brake pipe above the normal brake pipe pressure to release all the brakes in the train. This is followed by the *assimilation process* (3.8.10).

Note 2 to entry: This can be initiated by the driver or automatically after a brake application.

3.8.10
assimilation process
controlled pressure reduction, in brake systems with pneumatic *trainwide indirect brake* (3.9.1.8) architecture, down to the *normal working pressure* (3.10.4.2) at a rate that does not initiate a brake application, and that follows the temporary increase of the brake pipe pressure

3.8.11
quick release function
facility, in brake systems with pneumatic *trainwide indirect brake* (3.9.1.8) architecture, to accelerate the full release of the brakes by filling the brake pipe with a higher air flow for a limited time

Note 1 to entry: It can be used in long trains with single pipe air brake architecture.

3.8.12
high pressure quick release function
release which is similar to the quick release function, where the air is supplied to the brake pipe at a higher pressure than the normal working pressure

3.8.13
direct release function
systematic complete reduction of braking force in one step when any level of brake release is demanded

Note 1 to entry: This feature is associated with a brake application device known as a "triple valve" which is generally used in long freight trains.

3.9 Brake control

3.9.1 General definitions

3.9.1.1
brake demand
signal sent to the brake system representing the braking requirement of the driver and/or any train control system (e.g. automatic signalling equipment, passenger alarm system, driver vigilance system)

3.9.1.2
main brake system
trainwide continuous brake system which provides at least an automatic operation, inexhaustibility and the specified safety level for emergency braking, service braking and to keep the train stationary

3.9.1.3
trainwide brake control
system architecture where the brake demand is converted into a signal which is transmitted along the train

3.9.1.4
local brake control
system architecture where the trainwide brake control signal and/or other locally generated brake control signals are converted into an output signal to the brake equipment, resulting in a braking force being generated on the rail vehicle concerned

Note 1 to entry: The action may be executed in a *local brake control device* (3.10.1.12).

3.9.1.5
continuous train brake
system architecture where the trainwide brake control signals are transmitted to all rail vehicles along the train

3.9.1.6
automatic train brake system
continuous train brake system where the loss or interruption of the trainwide brake control signal causes an automatic application of one or more devices of the brake system

Note 1 to entry: The initiation of an automatic brake application will take precedence over other local brake/release commands.

Note 2 to entry: In case of an unintended train separation, the automatic function results in the brake application on all parts of the train.

3.9.1.7
inexhaustible train brake
system architecture where sufficient energy is stored on-board the train for assuring the specified braking performance and safety level, in all operating conditions

Note 1 to entry: The term "inexhaustibility" is often used when discussing the ability of a brake system to sustain a specified braking performance and safety level.

3.9.1.8
trainwide indirect brake
system architecture where an increase of the brake demand corresponds to a reduction in the value of the trainwide brake control signal

3.9.1.9
trainwide direct brake
system architecture where an increase of the brake demand corresponds to an increase in the value of the trainwide brake control signal

3.9.2 Types of control

3.9.2.1
pneumatic control
system where the trainwide brake control or local brake control is achieved by the action of air pressure differences and/or flow rates

3.9.2.2
hydraulic control
system where the trainwide brake control or local brake control is achieved by the action of hydraulic pressure differences and/or flow rates

3.9.2.3
electric/electronic control
system where the trainwide brake control or local brake control is achieved by the action of electronic signals, electric voltage differences and/or current flow rates

3.9.2.4
mechanical control
system where the trainwide brake control or local brake control is achieved by the action of mechanical force differences and/or displacement

3.9.2.5
energize to apply
principle whereby the application of a brake actuator/system requires an energy supply

3.9.2.6
energize to release
principle whereby the release of a brake actuator/system requires an energy supply

3.9.3 Types of combined control

3.9.3.1
electro-pneumatic control
EP control
system where the control of the pneumatic output is achieved by the action of an electrical signal

3.9.3.2
electro-pneumatic assist
EP assist
system where the pneumatic trainwide brake control signal is assisted in its propagation by electro-pneumatic equipment operating in parallel

3.9.3.3
electro-hydraulic control
EH control
system where the control of the hydraulic output is achieved by the action of an electrical signal

3.9.3.4
electro-mechanical control
system where the control of the mechanical output is achieved by the action of an electrically controlled actuator

3.9.4
brake blending
architecture where the control of the output from two or more brake systems is combined to fulfil the brake demand

Note 1 to entry: The braking force provided by one brake system replaces/supplements the braking force provided by one or more other systems.

Note 2 to entry: Brake blending generally follows a preference, such as minimizing the use of friction brakes.

Note 3 to entry: Brake blending can be performed on a local or a trainwide basis.

3.10 Brake system components

NOTE For additional explanations, see Annex D.

3.10.1 Components used for the command and control of braking

3.10.1.1
brake control device
component or combination of components to enable the brake demand to be converted into a trainwide or local brake control signal

3.10.1.2
trainwide brake control line
components used to transfer the trainwide brake control signal throughout the train

3.10.1.3
local brake control line
components used to transfer the local brake control signal to the brake actuators on an individual rail vehicle

3.10.1.4
driver's brake interface
brake demand device providing the interaction between the driver and the trainwide brake control device or directly to the trainwide brake control line

Note 1 to entry: It can comprise several interfaces (e.g. levers, handles, buttons, valves, switches) for service, emergency and stationary brake.

Note 2 to entry: This interface may be combined with the driver's interface for traction control.

Note 3 to entry: The level of brake demand can be a function of the position of the driver's brake interface or the time during which it occupies a particular position in its range of movement.

3.10.1.5
brake demand device
device to receive the braking request from the driver or other systems and convert that to a brake demand signal corresponding to the braking request

Note 1 to entry: Examples of other systems are:

— passenger alarm;

— automatic train protection;

— automatic train operation.

3.10.1.6
driver‘s brake valve
device, specific to pneumatic or hydraulic applications, combining the driver's brake demand device (brake handle) and trainwide control device (e.g. brake pipe control device)

3.10.1.7
passenger alarm system
control system that can initiate a brake demand following an action request from the passenger

Note 1 to entry: The passenger alarm system can initiate a service brake or an emergency brake demand.

Note 2 to entry: In Europe, the passenger alarm system initiates a brake demand if the train is at standstill or departing a platform or the alarm is not acknowledged by the driver, in accordance with EN 16334[4].

3.10.1.8
emergency push button
emergency handle
emergency brake demand device for the driver that is independent and separated from other driver's brake demand devices

Note 1 to entry: It is commonly fitted with a red mushroom button.

Note 2 to entry: This device can also function as an emergency brake trainwide control device.

3.10.1.9
emergency valve
trainwide control device for pneumatically controlled brake systems to cause an emergency brake application by venting the brake pipe

3.10.1.10
tripcock
device to initiate an emergency brake demand when operated mechanically by contact with a feature of the railway infrastructure

Note 1 to entry: It is used for legacy signalling and control systems, e.g. London Underground.

Note 2 to entry: This device can also function as an emergency brake trainwide control device.

3.10.1.11
trainwide brake control device
device accepting inputs where at least one represents a brake demand, and then generates the trainwide control line signals

3.10.1.12
local brake control device
device accepting inputs where at least one is the trainwide brake control signal and generates the local brake command signal

Note 1 to entry: For a local parking brake control device, it is possible for there to be no input from the trainwide brake control signal (e.g. handbrake wheel).

3.10.2 Sensors/indicators

3.10.2.1
pressure gauge
device for displaying the magnitude of fluid pressure

Note 1 to entry: This display can be analogue or digital.

Note 2 to entry: In pneumatic systems, a pressure gauge is also known as “manometer".

3.10.2.2
brake indicator
device showing the operational status of the brake actuators

Note 1 to entry: The device can display the status using colour codes and/or labels.

3.10.3 Control assemblies

3.10.3.1
brake panel
assembly of brake system components mounted together on a common structure

Note 1 to entry: The panel includes the connections between pneumatic, electrical or hydraulic components.

3.10.3.2
brake cabinet
brake module
enclosure containing one or more brake panels and/or other components

3.10.3.3
manifold
pipe bracket
interface between the rail vehicle pipework and an associated component or group of components

3.10.3.4
distributor valve
triple valve
local brake control device (3.10.1.12) to control a pneumatic output pressure as an inverse function of the variation of a brake pipe pressure (input pressure)

Note 1 to entry: The distributor valve is capable of providing graduated application and graduated release.

Note 2 to entry: The triple valve is capable of providing graduated application and direct release (see 3.8.13).

Note 3 to entry: It can include additional features (e.g. a relay function, accelerator function).

3.10.3.5
brake pipe accelerator
device connected to the brake pipe that, in response to a brake control signal, assists the propagation of the brake control signal throughout the train by locally venting the brake pipe

Note 1 to entry: This applies to service or emergency brake control signals.

3.10.3.6
electro-pneumatic converter
control device, or combination of devices for converting an electrical brake control input signal to a proportional or inversely proportional pneumatic output signal, that operates using either a closed-loop or open-loop principle

Note 1 to entry: The control signals can employ analogue or digital conversion techniques.

3.10.3.7
relay valve
device where the output pressure or flow amplifies the control pressure signal(s) from one or more control devices

Note 1 to entry: Control pressure can also be referred to as "pilot pressure".

3.10.3.8
load dependent relay valve
relay valve where the output pressure or flow amplification corresponds to the signal coming from the vehicle load sensing equipment

3.10.3.9
load sensing equipment
device, or combination of devices, that provides an output signal corresponding to the vehicle load

Note 1 to entry: This can be continuously variable or a simple changeover signal.

3.10.3.10
average pressure valve
valve in which the output pressure or flow is the mean of two or more input control pressures or flows

3.10.3.11
averaging relay valve
average pressure valve incorporating a relay valve function

3.10.4 Brake control and/or system energy lines

3.10.4.1
brake pipe
BP
trainwide brake control line in an indirect pneumatic brake system

Note 1 to entry: For trains without main reservoir pipe or for specific operations such as rescue, the brake pipe is also the pneumatic brake energy supply line.

3.10.4.2
normal working pressure
operating pressure in the brake pipe at trainwide brake control device level when the brakes are not applied

Note 1 to entry: The normal working pressure at a trainwide brake control level is defined for example:

— for Europe, in EN 14198[2];

— for China, in TB/T2951.1[6];

— for Japan, in JRIS R 1612[7] and JRIS R 1613[8].

3.10.4.3
main reservoir pipe
main air supply pipe
MRP
trainwide pneumatic energy supply line used for various pneumatic systems

3.10.4.4
brake cylinder pipe
pipe conveying fluid to and from one or more brake cylinders

3.10.4.5
pneumatic half coupling
assembly of components used for connecting the brake pipe (BP) or main reservoir pipe (MRP) of a rail vehicle to the BP or MRP, respectively, of an adjacent rail vehicle

Note 1 to entry: Pneumatic half couplings can also be used for connecting other pneumatic functions between two adjacent rail vehicles.

3.10.4.6
end cock
cock used to enable or interrupt the continuity of the brake pipe or main reservoir pipe

Note 1 to entry: It also facilitates safe coupling and uncoupling by venting air pressure in the pneumatic half coupling when the end cock is in the interrupt position.

3.10.4.7
power supply train line
trainwide energy supply line conveying electric energy

3.10.4.8
control train line
trainwide control line when the technology/media is electricity

Note 1 to entry: Control train line can be used, for example:

— to control the service brake;

— as an emergency brake loop;

— for traction control;

— for door control.

3.10.5 Friction brake system components

3.10.5.1
brake actuator
device or assembly of components consisting of e.g. a brake cylinder, levers, calipers, slack adjusters to convert a pneumatic or hydraulic pressure into a brake application force

Note 1 to entry: The slack adjuster is often incorporated in the brake cylinder.

3.10.5.2
brake cylinder
device used in a brake actuator to convert a pneumatic or hydraulic pressure into a force

Note 1 to entry: An active brake cylinder is one in which an input pressure increase causes a corresponding increase in output force.

Note 2 to entry: A passive brake cylinder is one in which an input pressure increase causes a corresponding decrease in output force.

3.10.5.3
spring-applied brake actuator
device that generates a braking force using energy stored in a compressed spring

Note 1 to entry: In some cases, the spring applied principle is used instead of the air or hydraulic pressure applied principle for the service, emergency and/or safety braking.

3.10.5.4
tread brake unit
type of brake unit used in a tread brake system which consists of a brake cylinder, slack adjuster, brake block and its holder, transmission, reaction and fixation elements, and which can be mounted/removed as a complete assembly

Note 1 to entry: Slack adjuster regulation can be but is not always integral to the unit.

3.10.5.5
disc brake unit
type of brake unit used in a disc brake system which consists of a brake cylinder, slack adjuster, brake pads and their holder, transmission, reaction (caliper) and fixation elements, and which can be mounted/removed as a complete assembly

3.10.5.6
slack adjuster
device to compensate wear of brake blocks, wheel tread, pads, discs, and brake rigging or brake caliper pivots, for maintaining the correct operating clearance between brake pads and disc or brake block(s) and wheel

Note 1 to entry: Slack adjusters may be fitted separately in the brake rigging as independent devices.

Note 2 to entry: Wear compensation is generally automatic.

3.10.5.7
brake rigging
assembly, usually of links and levers, in a friction brake system acting between one or more brake cylinder(s) and the brake blocks and/or brake pads

Note 1 to entry: When associated with a disc brake, the term "brake caliper" or "caliper assembly" may be used.

Note 2 to entry: The rigging can (but does not always) amplify the magnitude of the brake cylinder output force.

3.10.5.8
brake caliper
configuration of links and levers for transferring the force from the brake actuator (e.g. brake cylinder) to the brake pads and disc

Note 1 to entry: It may include force amplification.

Note 2 to entry: It also refers to a disc brake unit where the force generated by the actuator is directly applied to the brake pads and disc without amplification or transmission device.

Note 3 to entry: The term "caliper assembly" is sometimes used when one actuator applies the brake pads on more than one disc.

3.10.5.9
brake disc
rotor having one or more co-planar annular friction faces on to which brake pads are applied in order to establish a braking torque

Note 1 to entry: The brake disc is used to dissipate braking energy.

3.10.5.10
friction face
surface of a brake disc, brake pad, brake block, magnetic pole shoe or *end piece* (3.10.5.16) that provides the interface for transferring the brake application force

3.10.5.11
brake block
friction element(s) that exerts a brake application force to the wheel tread to generate a braking force

Note 1 to entry: Friction element is an assembly of friction material and an associated fixing element.

3.10.5.12
brake pad
friction element(s) that exerts an application force on one friction face of a brake disc to generate a braking force

Note 1 to entry: Friction element is an assembly of friction material and an associated fixing element.

3.10.5.13
brake block holder
device that fixes the brake block in position and transmits the application force to the brake block

3.10.5.14
brake pad holder
device that fixes the brake pad in position and transmits the application force to the brake pad(s)

3.10.5.15
pole shoe
friction element of a magnetic track brake that produces the braking force on top of the rail

3.10.5.16
end piece
friction element of a magnetic track brake that is a specially shaped pole shoe used to guide the magnet when attracted to the rail

3.10.6 Brake system energy storage

3.10.6.1
main reservoir
container designed to store air under pressure for train brake systems that use pneumatic control and/or actuation

Note 1 to entry: The air in the main reservoir is also used by other pneumatic systems.

3.10.6.2
brake supply reservoir
auxiliary reservoir
container designed to store air under pressure which is protected and dedicated for use by the brake systems on the rail vehicle

Note 1 to entry: When used in systems with triple valve or distributor valves, it is generally known as an "auxiliary reservoir".

Note 2 to entry: Separate brake supply reservoirs may be provided for different brake systems.

3.10.6.3
distributor control chamber
A-chamber
dedicated air volume connected to, or part of, a brake distributor valve

Note 1 to entry: The pressure in the control chamber is compared to the local brake pipe pressure within the distributor valve and used to determine the distributor valve output pressure.

3.10.6.4
control reservoir
container designed to store compressed air, the volume of which is intended to cause a desired pressure/timing characteristic

Note 1 to entry: When used in a driver's brake valve, as a brake pipe pilot pressure storage, it is also known as an "equalizing reservoir".

3.10.7 Compressed air supply

3.10.7.1
air dryer
device to remove moisture from compressed air (to the level specified) for use by the brake system and other pneumatic systems

3.10.7.2
liquid separator
device to remove oil and water from compressed air (to the level specified) for use by the brake system and other pneumatic systems

3.10.7.3
aftercooler
device used to reduce the temperature of the air following compression

3.10.7.4
safety valve
valve in a system which opens in order to prevent the compressed air pressure exceeding a specified value

3.10.8 Ancillary air system equipment

3.10.8.1
drain valve
drain cock
device through which undesired liquid (mainly oil and water) can be expelled from a compressed air system

Note 1 to entry: Typically, a drain valve is either automatically or manually operated, whereas a cock is manually operated.

3.10.8.2
vent valve
vent cock
device used to expel air from a compressed air system

Note 1 to entry: Typically, a vent valve is either automatically or manually operated, whereas a cock is manually operated.

3.10.8.3
isolating cock
manually operated device used to either allow or prevent the passage of air between one part of a system and another part

Note 1 to entry: When in the closed position, the output side may be vented.

Note 2 to entry: It may be fitted with a latching handle to keep it in the open or closed position.

3.10.9 Hydraulic pressure supply

3.10.9.1
hydraulic pump
machine used for increasing the pressure of hydraulic fluid used by the brake system and other hydraulic systems

3.10.9.2
pressure limiting valve
valve in a hydraulic system which opens to prevent the pressure exceeding a specified value

3.10.10 Hand brake equipment

3.10.10.1
hand brake
parking brake system that generates a braking force for a parking purpose only by human effort

Note 1 to entry: It can use components of other brake systems.

3.10.10.2
hand brake wheel
parking brake demand device for a hand brake, whereby the human effort is converted into a torque

3.10.11 Parking brake equipment

3.10.11.1
spring-applied parking brake actuator
device that generates parking brake application force using energy stored in a compressed spring

3.10.11.2
manual release for spring-applied actuator
local mechanism that enables brake release by human effort when a remote method of release is not available

3.10.11.3
anti-compound device
device that prevents the simultaneous implementation of two brake application forces by one brake actuator (e.g. the service and parking brake)

3.10.11.4
scotch
device positioned between wheel and rail, used to prevent rail vehicle or train movement

3.10.11.5
brake slipper
device positioned between wheel and rail, used to reduce the speed of the vehicle or train using the friction between itself and the rail

3.11 Wheel slide protection (WSP)

3.11.1
wheel slide
condition where the circumferential speed of a wheel or wheelset is lower than the true train speed

3.11.2
true train speed
instantaneous train speed over the ground

3.11.3
circumferential speed
tangential speed at the wheel tread due to the rotation of the wheel

3.11.4
wheel slide protection system
WSP
system designed to make the best use of available wheel-rail adhesion during braking (when the available adhesion is less than the wheel-rail adhesion demanded)

Note 1 to entry: In some cases, it improves the available wheel-rail adhesion for the following wheels.

3.11.5
wheel rotation monitoring
WRM
system that continuously monitors wheel or wheelset rotation and indicates any rotation anomaly

3.11.6
wheel lock
condition of wheel slide when the wheel or wheelset ceases to rotate during braking, while the train is in motion

3.12 Types of brake test

3.12.1
routine brake test
procedure that is made regularly and in specified operating conditions, in order to verify the correct operation of the brake system

3.12.2
static brake test
procedure carried out on a stationary train in order to verify the correct functionality of the brake system and/or to determine its static braking performance (e.g. parking brake)

3.12.3
dynamic brake test
procedure carried out on a moving train in order to verify the correct functionality of the brake system and/or to determine its dynamic braking performance (e.g. stopping distance)

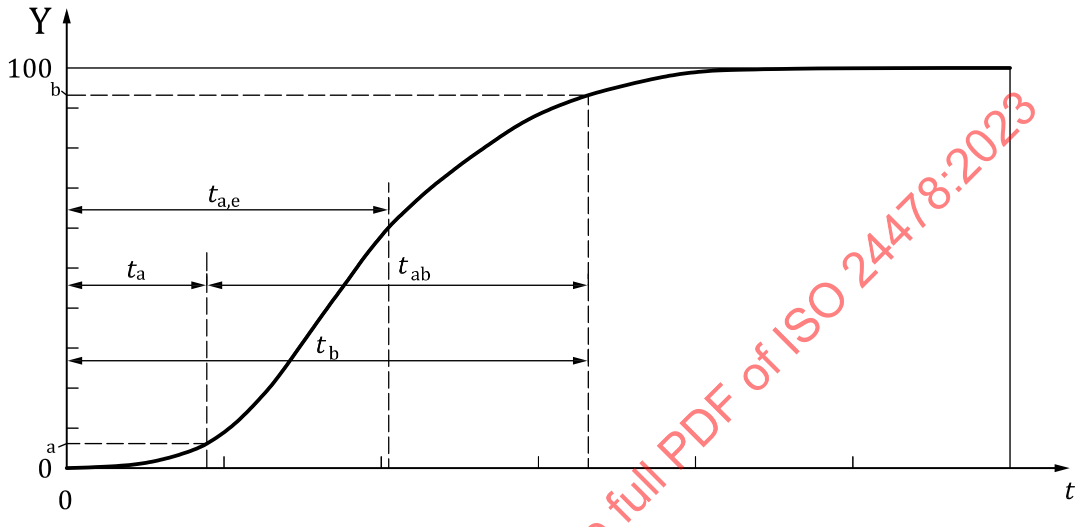
4 Symbols and abbreviated terms

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

a	deceleration, expressed in metres per second squared (m/s^2)
v	speed, expressed in metres per second (m/s)
t	time, expressed in seconds (s)
s	distance, expressed in metres (m)
ETCS	European train control system
EBCL	emergency brake confidence level

Annex A
(informative)

Delay time and build-up time for brake application



Key

t time

t_a delay time (3.6.12)

t_{ab} build-up time (3.6.14)

t_b response time (build-up) (3.6.16)

$t_{a,e}$ equivalent response time (3.6.22)

Y deceleration/force/pressure, in %

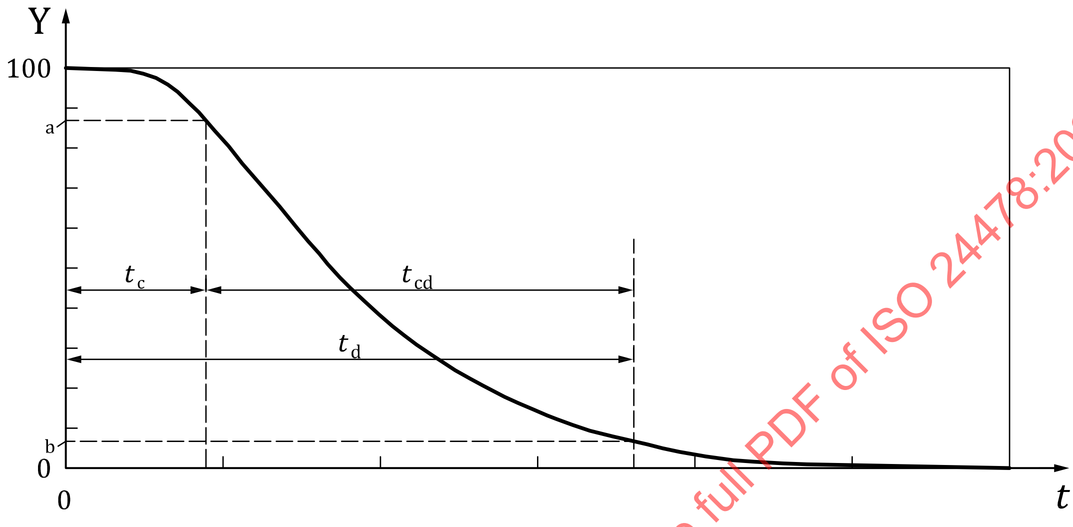
a Employed for the commencement of braking (typical values for *a* and *b* are set out in ISO 24221).

b Employed when the braking parameter build-up has been substantially achieved (typical values for *a* and *b* are set out in ISO 24221).

Figure A.1 — Delay time and build-up time for brake application

Annex B
(informative)

Delay time and release time for brake release



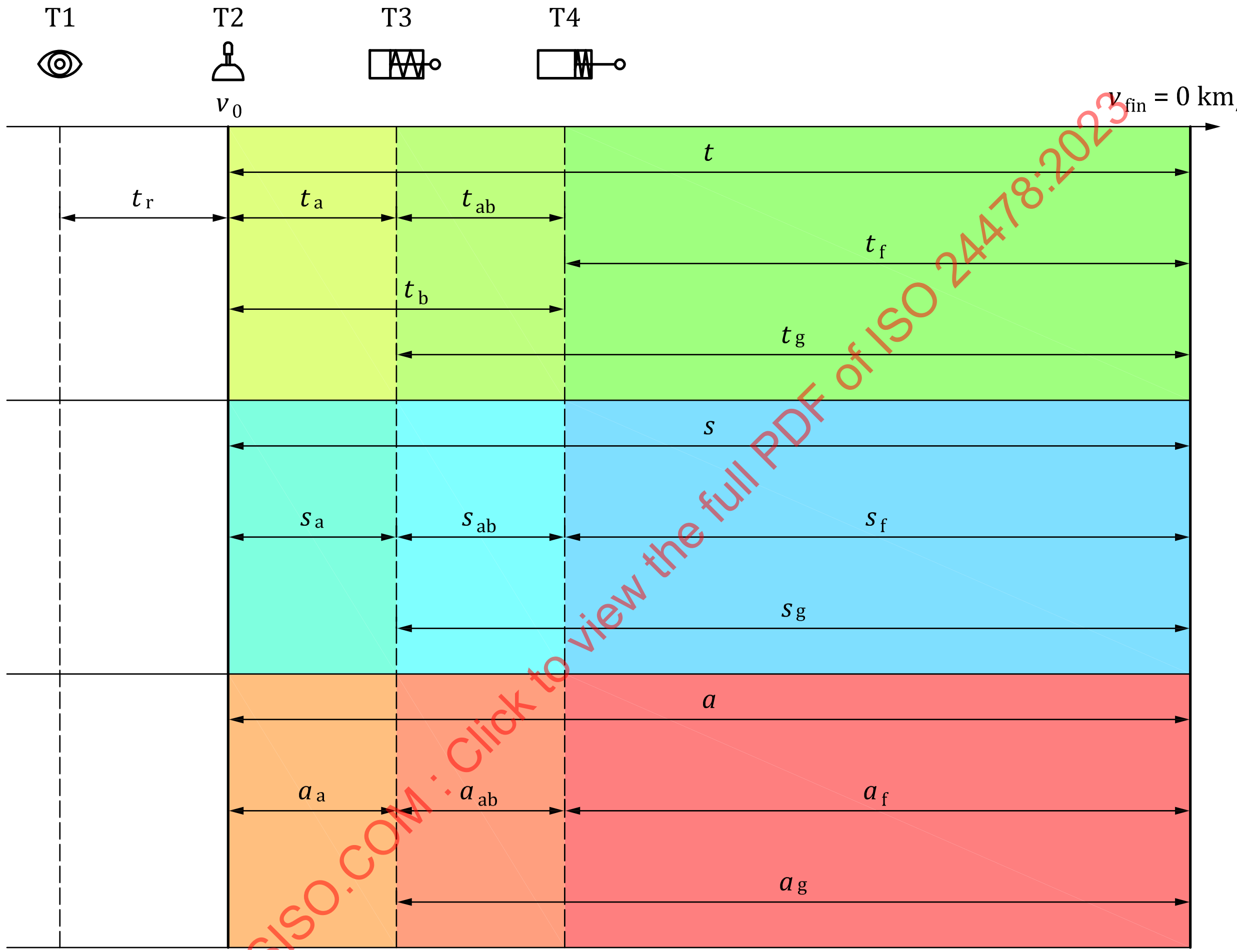
Key

t time
t_c release delay time (3.6.13)
t_{cd} release time (3.6.15)
t_d response time (release) (3.6.17)
Y deceleration/force/pressure, in %
a Employed for the commencement of release (typical values for *c* and *d* are set out in ISO 24221).
b Employed when the braking parameter release has been substantially achieved (typical values for *c* and *d* are set out in ISO 24221).

Figure B.1 — Delay time and release time for brake release

Annex C
(informative)

Brake chart



Key

T1	identification of the need for a brake application	s_a	free running distance (3.6.2)
T2	initiation of a brake demand	s_{ab}	build-up distance (3.6.3)
T3	commencement of a brake application	s_f	braking distance with a fully-established brake (3.6.4)
T4	fully-established brake (3.6.1)	s_g	braking distance (3.6.5)
t_r	reaction time (3.6.11)	s	stopping distance (3.6.8)
t_a	delay time (3.6.12)	a_a	free running acceleration (3.6.27)
t_{ab}	build-up time (3.6.14)	a_{ab}	increasing brake deceleration (3.6.28)
t_b	response time (build-up) (3.6.16)	a_f	deceleration with a fully-established brake (3.6.29)
t_f	braking time with a fully-established brake (3.6.18)	a_g	braking deceleration (3.6.30)
t_g	braking time (3.6.19)	a	mean deceleration (3.6.34)
t	stopping time (3.6.21)		

Figure C.1 — Application: stopping