INTERNATIONAL STANDARD

ISO 24478

First edition
2023-08

Railway applications — Braking — General vocabulary

Applications ferroviaires — Freinage — Vocabulaire général

Железнодорожный транспорт — Системы торможения — Основные термины

Reference number
ISO 24478:2023(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 2, *Rolling stock*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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)