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Standard**

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**Railway applications — Braking —  
General vocabulary**

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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](http://www.iso.org/members.html).

This corrected version of ISO 24478:2023 incorporates the following correction: footnotes "a" and "b" have been replaced with the symbols "c" and "d", respectively, in Figure B.1.

## 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[4] for urban rail brake systems.