BS EN 16452:2015

BSI Standards Publication

Railway applications — Braking — Brake blocks

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 16452:2015.

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:

INS, RST and ENE speed conversions					
km/h	**mph**	**km/h**	**mph**	**km/h**	**mph**
2	1	80	50	220	135
3	1	100	60	225	140
5	3	120	75	230	145
10	5	140	90	250	155
15	10	150	95	280	175
20	10	160	100	300	190
30	20	170	105	320	200
40	25	180	110	350	220
50	30	190	120	360	225
60	40	200	125		

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

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2015

ISBN 978 0 580 57777 2

ICS 45.040; 45.060.01

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2015.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 16452

July 2015

ICS 45.040; 45.060.01

English Version

Railway applications - Braking - Brake blocks

Applications ferroviaires - Freinage - Semelles de frein

Bahnanwendungen - Bremse - Bremsklotzsohlen

This European Standard was approved by CEN on 28 February 2015.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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

CEN members are the national standards bodies of 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 United Kingdom.

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 16452:2015 E

Contents

Page

Foreword

This document (EN 16452:2015) 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 January 2016, and conflicting national standards shall be withdrawn at the latest by January 2016.

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

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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations 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.

Introduction

For environmental reasons (reduction of rolling noise), this European Standard does not cover cast iron brake block requirements, although cast iron brake block technology is still widely used in Europe. Cast iron has already been replaced by composite materials for new rolling stock builds and major steps have been taken by EEC (TSI) and UIC in 2004 to accelerate the change from cast iron to composite materials.

When published this European Standard will replace the current UIC requirements for technical approval of brake blocks. The requirements of this EN are based on the state of art form UIC leaflet and a European project “Euro Rolling Silently”.

1 Scope

This European Standard gives the requirements for the design, dimensions, performance, and testing of a brake block (otherwise known as brake shoe insert) that acts on the wheel tread as part of a tread brake system. This European Standard does not cover cast iron brake block requirements.

This European Standard is applicable to brake blocks of either “K”, “L”, or “LL” friction level designed to be fitted to tread braked rail vehicles.

This European Standard contains the requirements for interfacing the brake block with the rail vehicle, the testing procedures in order to confirm that it satisfies the basic safety and technical interchangeability requirements, the material control procedures to ensure product quality, reliability and conformity and considers health and environmental needs.

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 13452-1, *Railway applications — Braking — Mass transit brake systems — Part 1: Performance requirements*

EN 13452-2, *Railway applications — Braking — Mass transit brake systems — Part 2: Methods of test*

EN 13715, *Railway applications — Wheelsets and bogies — Wheels — Tread profile*

EN 13979-1:2003+A2:2011, *Railway applications — Wheelsets and bogies — Monobloc wheels — Technical approval procedure — Part 1: Forged and rolled wheels*

EN 14033-1, *Railway applications — Track — Railbound construction and maintenance machines — Part 1: Technical requirements for running*

EN 14033-2:2008+A1:2011, *Railway applications — Track — Railbound construction and maintenance machines — Part 2: Technical requirements for working*

EN 14198, *Railway applications — Braking — Requirements for the brake system of trains hauled by a locomotive*

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

EN 15179, *Railway applications — Braking — Requirements for the brake system of coaches*

EN 15313, *Railway applications — In-service wheelset operation requirements — In-service and off-vehicle wheelset maintenance*

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 15734-2, *Railway applications — Braking systems of high speed trains — Part 2: Test methods*

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

EN 16185-2, *Railway applications — Braking systems of multiple unit trains — Part 2: Test methods*

EN 50126-1, *Railway applications — The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) — Part 1: Basic requirements and generic process*

EN ISO 4287, *Geometrical product specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters (ISO 4287)*

EN ISO 4288, *Geometrical product specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture (ISO 4288)*

UIC 544-1, *Brakes — Braking power*

3 Terms and definitions

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

3.1
application parameter
configuration parameters refer to vehicle mass, operating speed, wheel diameter, braked mass, brake block configuration, brake block force

3.2
Bg configuration
one brake block 320 mm per brake block holder

Note 1 to entry: Bg comes from UIC and means “Bremsklotzsohle geteilt”.

3.3
Bgu configuration
two brake blocks 250 mm per brake block holder

Note 1 to entry: Bgu comes from UIC and means “Bremse geteilt mit unterteilter Sohle”.

3.4
brake block
stator part of a tread brake adapted to generate a friction force when engaged with a wheel tread

3.5
brake block force
force with which the brake block is made to come into contact with the wheel tread

3.6
friction material
consumable portion of the brake block that acts on the wheel tread in order to provide the specified brake performance

3.7
coefficient of friction
3.7.1
mean coefficient of friction
coefficient of friction of the friction material, integrated over distance, for any one condition of braking

3.7.2
instantaneous coefficient of friction
value of coefficient of friction of the friction material at any one instant

3.7.3
static coefficient of friction
coefficient of friction achieved by the friction material at standstill at the point where relative movement between the block friction surface and wheel tread takes place

3.8
K material
friction material with a mean coefficient of friction of 0,25 to 0,30

3.9
L material
friction material with a mean coefficient of friction of 0,15 to 0,25

3.10
LL material
friction material with a mean coefficient of friction of 0,10 to 0,15

3.11
EU-D Rolling stock
rolling stock governed by the requirements of the European Directive 2008/57/EC

3.12
metal pick-up
damage to the brake block surface as a result of the interaction between the brake block and wheel tread

3.13
non EU-D Rolling stock
rolling stock not governed by the requirements of the European Directive 2008/57/EC

3.14
brake block back plate
element onto which the friction material is fixed, acting as the interface between the brake block and brake block holder

3.15
track circuit
integral part of certain signalling systems, the operation of which is essential to ensure the safe operation of the signalling system

3.16
brake type
classification term for air brakes as specified by the UIC in accordance with their action (G = Goods = slow-acting, P = Passenger = quick-acting)

4 Abbreviations

m	[t]	Mass to be braked per wheel (inclusive of the rotational masses)
F_B	[kN]	Nominal application force per wheel
F_b	[kN]	Instantaneous application force per wheel
v	[km/h]	Theoretical initial speed at the brake application initiation

v_i	[km/h]	Instantaneous speed
v_3	[km/h]	Final speed at the end of braking
v_m	[km/h]	Maximum service speed.
$\mu_a = \frac{F_{tR}}{F_b}$	[-]	Instantaneous friction coefficient (brake block): The instantaneous friction coefficient μ_a specified at every instance of the braking time by the ratio between the total brake force F_{tR} and the total application force F_b
$\mu_m = \frac{1}{s_2} \cdot \int_0^{s2} \mu_a \cdot ds$	[-]	Mean friction coefficient: the mean friction coefficient μ_m integrated over the time from where 95 % of the nominal application force F_B is reached over the stopping distance s_2
θ_0	[°C]	Mean initial temperature at the beginning of the brake application
s_2	[m]	Stopping distance from the moment on when $F_b = 0{,}95 \cdot F_B$ to rest
R_z	[µm]	Surface roughness (maximum height of profile)
d	[mm]	Diameter of wheel
e	[mm]	Flange thickness
h	[mm]	Flange height
qR	[mm]	Distance between flange angle
a_1	[mm]	Back-to-back distance between wheels
P	[-]	Brake type – *P* = passenger

5 Overall requirements

5.1 Deviations from requirements

If deviating from some points of the requirements of this standard for a particular assessment, theses deviations shall be reported and explained. The influence on the assessment of the brake block in terms of the acceptance criteria shall be evaluated and recorded. The outcome of this study shall be considered as an integral part of the requirements of this standard when applied to the assessment process of the brake block.

5.2 Functions

The brake block is to be used as part of the friction brake of a vehicle. It shall provide the performance specified, in terms of stopping distance for instance, and in doing so shall fulfil the following requirements:

— create a braking moment or torque;

— facilitate, by frictional engagement with a wheel tread, the conversion into heat of the kinetic and potential energy involved in retarding the vehicle or vehicles which is/are attributed to the use of the tread brake;

— act as part of a holding or parking brake by frictional engagement with a wheel tread.

In achieving the above requirements, the brake block and the wheel shall not suffer damage or degradation other than normal wear and tear.

The brake block shall be considered along with the wheel tread as a friction pair.

5.3 Operational criteria

5.3.1 Friction material performance

The design and manufacture of the brake block shall, for all intended operating conditions and vehicle rescue and recovery conditions, take into account the following criteria for friction material performance:

— all levels of stopping and slowing distances and immobilization braking specified;

— all levels of retardation specified;

— the initial speed of braking for the vehicle in question;

— the braked mass, in tare and laden conditions;

— the quantity of brake energy to be converted and its rate of conversion and dissipation;

— the range of specific pressure of the brake block friction surface on the wheel tread;

— the form and condition of the wheel tread;

— the type of material used in the manufacture of the wheel tread;

— the temperature of the wheel tread;

— the deformation of the wheel under thermal load;

— friction property variation as a function of brake block and wheel tread bedding and conditioning thereafter;

— friction property variation as a function of brake block and wheel tread according to various climatic conditions;

— signalling performance from the interaction of brake block, wheel and rail.

5.3.2 Service performance

The design and manufacture of the brake block shall, for all intended operating conditions and vehicle rescue and recovery conditions, take into account the following criteria for service performance:

— the need to prevent the detachment of any part of the friction material from the brake block back plate throughout its useable thickness;

— unless specifically permitted, the friction material shall be capable of being worn down to a thickness of 10 mm at the thinnest point excluding the back plate, without mechanical degradation of the friction material or the back plate coming into contact with the wheel tread;

— the need to allow interchangeability between brake blocks of the same friction characteristics, and to avoid interchangeability between brake blocks of different friction characteristics;

— the integrity and wear rate of the brake block friction material and wheel tread;

— the need to prevent permanent deformation of the brake block back plate throughout the useable thickness of the friction material;

— the need to comply with environmental and health requirements.

5.3.3 Brake block characteristics

In order to comply with the above requirements the performance of the brake block shall be determined using the test methods described below.

According to proven experience, past certification of the brake block being considered, and function of the application being considered, test obligations and acceptance criteria are provided in Table 1 and Table 2 in 6.2.

The main characteristics to be assessed are as follows:

— brake block design;

— instantaneous and mean dynamic friction coefficients;

— static friction coefficient;

— wet friction behaviour;

— metal pickup formation behaviour;

— behaviour under conditions simulating a locked brake, with an applied braking force;

— brake block and wheel tread wear at different loads and service braking conditions;

— friction behaviour under severe winter conditions;

— influence on signalling systems (shuntage);

— brake block material properties.

6 Acceptance procedure

6.1 Brake block performance requirements

6.1.1 General

The following tests (categories A, B and C) should be conducted and are intended to provide an evaluation of the capability of the brake block to operate under the duty level applicable to the application being considered, and are designated as follows:

Unless specifically requested, for certain applications running in non EU-D rolling stock such as metro, light rail operations, etc., it is not necessary to carry out category A tests. In this case tests according to category B and category C will be sufficient to prove the suitability of a material for use in the application concerned.

6.1.2 Category A

An overall assessment of the brake block performance under a range of conditions. The test schedules provided in Table 1 and Table 2 below do not include every type of application. The test conditions may be adapted to suit the application in question by agreement.

For applications running in non EU-D rolling stock, tests carried out to confirm dynamic friction performance shall follow those shown in the annexes but can be adapted where applicable to the application in question.

6.1.3 Category B

These are tests that are specific to the application being considered and include performance and wear.

It is recommended that these tests are conducted to ensure that the brake block material is suitable for the application in question. Annex J provides guidance on how to design brake dynamometer performance tests for a specific application and the principle for assessment and pass/fail criteria. The final choice of tests to be conducted and the detail of the test concerned will be specified based on application conditions.

6.1.4 Category C

Assessment of the effect of the brake block on the wheel tread and the wheel to rail interface.

Depending on the application being considered, the brake block should fulfil the requirements of Table 1 or Table 2, "category C requirements" below.

6.2 Approval test requirements

See Annex A for summary of dynamometer test program.

Table 1 — Approval test requirements for materials fitted to vehicles operation in EU-D Rolling stock

Material			**NEW**	**EXISTING**	**EXISTING**
Application parameter			**NEW**	**NEW**	**EXISTING**
Requirements	**Specification / Test**	**Acceptance criteria**			
Category A requirements (EU-D Rolling stock)					
Standard design	7.1.1 and Annex S	Annex S	c	c	c
Brake block characterization test	7.1.2, and Annex X	Annex X	a	b	b
Dynamic friction performance	7.2 and Annex C to Annex **I**	7.2 and Annex C to Annex **I**	a	b	b
Static friction performance	7.3 and Annex Q	7.3	a	b	b
Winter conditions (Freight wagons)	7.4, Annex L or Annex M	7.4 or Annex L	a	b	b
Locked brake (fusibility) freight wagon	7.5 and Annex N	7.5	a	b	c
Locked brake (fusibility) other vehicles	7.5 and Annex N	7.5	c	c	c

Material			NEW	EXISTING	EXISTING
Application parameter			NEW	NEW	EXISTING
Requirements	**Specification / Test**	**Acceptance criteria**			
Category B requirements (EU-D Rolling stock)					
vehicle brake test	8.1	-	a	b	b
dynamometer wear test (friction couple)	8.2 and Annex R	-	c	c	c
dynamic friction performance	8.3 and Annex J	-	c	c	c
in service assessment	8.4	-	a	b	b
Category C requirements (EU-D Rolling stock)					
metal pickup	9.1 and Annex K	9.1	a	b	b
influence on track circuit operation (freight wagons and coaches)	9.2 Annex O or Annex P	Annex O or Annex P	a	b	b
influence on track circuit operation (others)	9.2	9.2	c	c	c

a = required

b = required when no previous test results are available and transposable to confirm performance

c = only if requested

New material = friction material not previously used in any application

Existing material = friction material previously approved for other applications

New application parameter = a application parameter in which the friction material was not used previously.

Existing application parameter = a application parameter in which the friction material is already used.

Table 2 — Approval test requirements for materials fitted to vehicles operation in National traffic

Material			**NEW**	**EXISTING**	**EXISTING**
Application parameter			**NEW**	**NEW**	**EXISTING**
Requirements	**Specification / Test**	**Acceptance criteria**			
Category A requirements (Non EU-D Rolling stock)					
Standard design	7.1.1 and Annex S	Annex S	c	c	c
brake block characterization test	7.1.2 and Annex X	Annex X	a	b	b
dynamic friction performance	7.2 and Annex C to Annex I	7.2 and Annex C to Annex I	a	b	b
static friction performance	7.3 and Annex Q	7.3	a	b	b
winter conditions (freight wagons)	7.4, Annex L or Annex M	7.4 or Annex L	c	c	c
Locked brake (fusibility)	7.5 and Annex N	7.5	c	c	c
Category B requirements (Non EU-D Rolling stock)					
vehicle brake test	8.1	-	a	b	b
dynamometer wear test (friction couple)	8.2 and Annex R	-	c	c	c
dynamic friction performance	8.3 and Annex J	-	c	c	c
in service assessment	8.4	-	a	b	b
Category C requirements (Non EU-D Rolling stock)					
metal pickup	9.1 and Annex K	9.1	c	c	c
influence on track circuit operation	9.2 Annex O or Annex P	Annex O or Annex P	c	c	c

a = required

b = required when no previous test results are available and transposable to confirm performance

c = only if requested

New material = friction material not previously used in any application.

Existing material = friction material previously approved for other applications.

New application parameter = a application parameter in which the friction material was not used previously.

Existing application parameter = a application parameter in which the friction material is already used.

6.3 Dynamometer specification

The dynamometer used for conducting the tests provided in the annexes should be suitable for carrying out these tests in the correct manner.

General requirements for conducting dynamometer test programmes are detailed in Annex B.

NOTE Existing documents that define the requirements of dynamometers for Railway Friction Material testing at the time of writing this standard include UIC documents: B126/RP 18, B126/DT 408 and B169/RP 37 and these could be used as reference documents.

7 Category A requirements

7.1 Brake block characteristics

7.1.1 Standard design

Brake blocks used in EU-D Rolling stock should be designed according to the design dimensions and tolerances shown in Annex S.

320 mm long brake block are used in Bg configuration and 250 mm long brake block in Bgu configuration.

Pass/fail criteria: conform to dimensions and tolerances.

7.1.2 Brake block characterization test

Brake blocks used during evaluation and approval testing can be type tested according to Annex X. The results of these tests can be taken into consideration during any future series production batch testing of these properties to confirm that these properties have not changed.

7.1.3 Brake block mechanical characteristics for service operation

7.1.3.1 Shear strength

In order to test the mechanical characteristics of the assembly between back plate and friction material, the brake block is tested according to T.2. At the end of the test there shall not be any indication of detachment of the back plate from the friction material or any other visible mechanical damage.

7.1.3.2 Flexural strength

The brake block material behaviour under bending stress shall be assessed according to T.3. At the end of the test, the brake block shall not show any crack initiation within the friction material or fracture of the back plate. In the case of a brake block that has a groove or slot as shown in T.3 cracking is permitted in the area where the friction material is at its thinnest where the groove meets the back plate.

7.1.3.3 Limitation of permissible mechanical damage

The limitation of permissible mechanical damage of the brake block during dynamometer tests (except for test “locked brakes” in 7.5) and testing service assessment shall be assessed in accordance with Annex U. The damage shall not exceed that defined.

7.2 Dynamic friction performance

7.2.1 Generic requirements for assessment process

Experience shows that in general, the dynamic friction performance of a friction material does not comply fully with all requirements.

For this reason, for a particular application, any deviation from the specification of 7.2 shall be assessed according to EN 50126-1.

The consequences of hazard levels and frequency arising from any deviation shall be evaluated taking into consideration the levels and frequency of the potential hazard shown in Table 3.

Table 3 — Risk levels/frequency hazard

Frequency of occurrence of a hazardous event	**Risk Levels**			
Frequent	Intolerable	Intolerable	Intolerable	Intolerable
Probable	Intolerable	Intolerable	Intolerable	Intolerable
Occasional	Intolerable	Intolerable	Intolerable	Intolerable
Remote	Tolerable	Intolerable	Intolerable	Intolerable
Improbable	Tolerable	Tolerable	Intolerable	Intolerable
Incredible	Tolerable	Tolerable	Tolerable	Intolerable
	Insignificant	**Marginal**	**Critical**	**Catastrophic**
	Severity Levels of Hazard Consequence			

7.2.2 Bedded and non bedded performance

The mean friction coefficient shall not vary by more than ± 15 % between non bedded and bedded states in the same test condition. The friction coefficient of the bedded state shall be defined as the average of measured friction coefficient of the last 5 braking stops carried out during the bedding section.

7.2.3 Variation in mean coefficient of friction in dry condition for a brake to rest

The mean friction coefficient (μ_{m}) in dry condition shall conform with specific range of tolerances defined in the annex applicable to the specific application.

7.2.4 Mean friction coefficient variation under wet conditions

7.2.4.1 Freight wagon

The average of mean friction coefficient in wet conditions shall be evaluated in comparison to the average of mean friction coefficient in dry conditions all other conditions being equal: initial speed (v), total force per wheel (F_{B}), initial temperature (θ_0) and mass to brake per wheel (m) got from brake applications performed only before braking in high initial temperature and simulation of a downhill brake application.

The average of mean friction coefficient in wet conditions, for maximum applied brake force (F_{B}) in every mass to brake per wheel (m) and for each initial speed ≥ 100 km/h (v) shall not vary by more than ± 15 % relative to average mean friction coefficient measured in dry conditions.

For any other configurations the average of mean friction coefficient in wet conditions shall not vary by more than ± 30 % relative to average mean friction coefficient measured in dry conditions.

7.2.4.2 Other vehicles

The mean friction coefficient in wet condition shall conform with specific range of tolerances defined in the annex applicable to the specific application.

7.2.5 Mean friction coefficient variation at high initial temperature

In the case of braking with an initial wheel tread temperature exceeding 110 °C, the mean friction coefficient shall not vary by more than ± 15 % compared to the average mean friction coefficient measured at a wheel temperature below 60 °C in dry conditions, all other test conditions being equal.

7.2.6 Mean friction coefficient variation after simulation of a downhill brake application

The average of mean friction coefficient after simulation of a downhill brake application shall not vary by more than ± 15 % at initial speed (v) ≥ 100 km/h and shall not vary by more than ± 30 % at initial speed (v) < 100 km/h compared to the average mean friction coefficient measured before simulation of a downhill brake application in dry conditions, all other test conditions being equal.

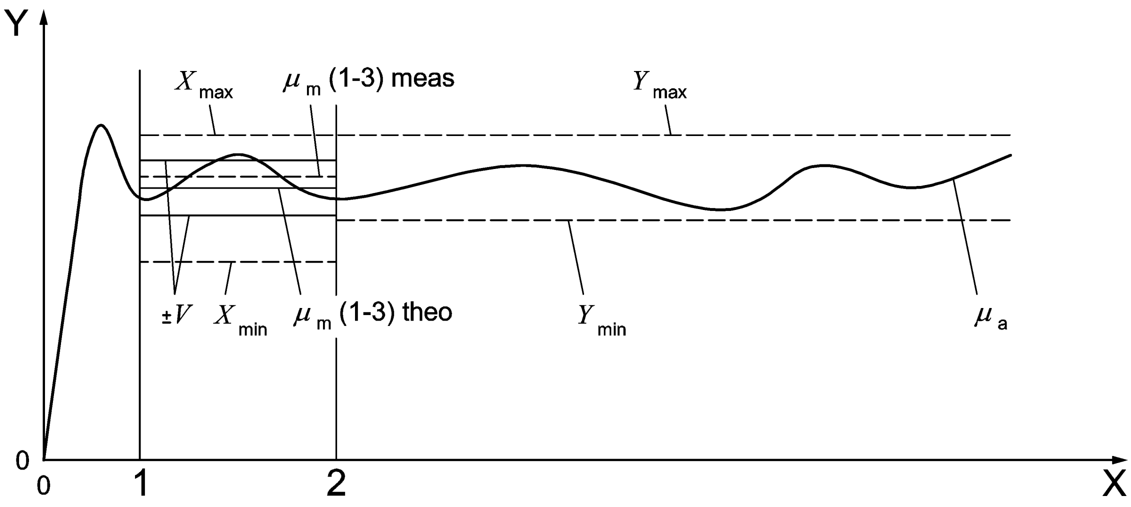
7.2.7 Instantaneous friction coefficient variation during simulation of a downhill brake application

7.2.7.1 Freight wagons

During simulation of a downhill brake application program Annex C, Annex D and Annex E, friction coefficient μ_a recorded according to Figure 1 shall fulfil the criteria given in Table 4.

Table 4 — General requirements for simulation of a downhill brake application

$\mu_m(1-3)$theo	"theo" = the mean coefficient of friction between first and third minute as defined in Table 5.	See Table 5
$\pm V$	Maximum deviation range admissible for $\mu_m(1-3)$meas	± 10 % of $\mu_m(1-3)$theo
$\mu_m(1-3)$meas	"meas" = the mean coefficient of friction measured between first and third minute during simulation of a downhill brake application.	Measured value during the test
X_{min}	Minimum permitted instantaneous coefficient of friction μ_a between first and third minute.	- 30 % of $\mu_m(1-3)$meas
X_{max}	Maximum permitted instantaneous coefficient of friction μ_a between first and third minute.	+ 15 % of $\mu_m(1-3)$meas
Y_{min}	Minimum permitted instantaneous coefficient of friction μ_a after third minute	- 15 % of $\mu_m(1-3)$meas
Y_{max}	Maximum permitted instantaneous coefficient of friction μ_a after third minute	+ 15 % of $\mu_m(1-3)$meas for brake block type K + 30 % of $\mu_m(1-3)$meas for brake block type LL



Key

X time in minutes

Y friction coefficient

1 first minute

2 third minute

Figure 1 — General requirements for simulation of a downhill brake application

Table 5 — Value for $\mu_m(1-3)$theo

Test program	Brake block	Configuration	$\mu_m(1-3)$theo
Annex C	K	2Bgu	0,25
Annex C	K	2Bg	0,25
Annex C	K	1Bgu	0,23
Annex D	LL	2Bgu	0,15
Annex D	LL	2Bg	0,15
Annex E	K	1Bg	0,26

NOTE 1 These conditions apply both to 45 kW and 40 kW under programmes Annex C and Annex D.

NOTE 2 In programmes Annex C and Annex D, the additional programme at 40 kW for 30 min only needs to be conducted if the results at 45 kW for 34 min, including comparison of the brake applications to a stop before and after the simulation of a downhill brake application, are not in compliance with the requirements.

7.2.7.2 Coach

During simulation of a downhill brake application programme Annex F, the friction coefficient shall fulfil the following criteria.

After 2 min of the simulation of a downhill brake application, the instantaneous friction coefficient shall be in the range of 0,12 to 0,30.

During the whole simulation of downhill brake application duration, the instantaneous friction coefficient shall be in the range 0,10 to 0,32 and the maximum variation shall not be more than 0,15.

Within any one minute section during the simulation of a downhill brake application the instantaneous friction coefficient shall not vary by more than ± 15 % of initial friction coefficient measured at the beginning of the one minute section.

7.2.7.3 Other vehicles

During simulation of a downhill brake application, the friction coefficient shall fulfil the following criteria (assuming that the power of the specified drag brake test does not exceed 45 kW).

During the first 2 min of the simulation of a downhill brake application, the instantaneous friction coefficient shall not drop by more than 30 % of the mean friction coefficient value measured during the first two minutes of the test, and shall not increase by more than 15 % of the mean friction coefficient value measured during the first two minutes of the test.

During the whole simulation of downhill brake application duration, instantaneous friction shall not drop by more than 50 % or increase by more than 30 % of the mean friction coefficient value measured during the first two minutes of the test.

Within any one minute section during the simulation of a downhill brake application the instantaneous friction coefficient shall not vary by more than ± 15 % of the initial friction coefficient measured at the beginning of the one minute section.

7.2.8 Variation in instantaneous friction for a brake to rest

The instantaneous friction coefficient variation at the time at which the total brake force is applied during a dynamometer test, shall show that resulting brake torque is constant or at least varies within in the limits set in the annexes, and that it increases at the end of the brake application. The annexes show the optimum variation in instantaneous friction coefficient to avoid wheel locking at brake initiation.

7.3 Static friction coefficient

The static friction coefficient μ_{stat} is assessed according to Annex Q. The average of the 5 measurements of μ_{stat} taken at each force shall be equal or higher than the level shown in Table 6.

Table 6 — Static friction coefficient μ_{stat}

Material type	Program annex		
	Q.1	Q.2	Q.3
K	0,20	0,24	0,24
LL	0,20	—	—

For freight wagons, if the validation of the static coefficient of friction is conducted as per Q.1, it shall be valid for all ether configurations and wheel diameters of 680 mm and above.

7.4 Extreme winter conditions (freight wagons)

7.4.1 General

Friction behaviour under extreme winter conditions shall be assessed by a dynamometer test or by a train brake test.

7.4.2 Dynamometer test

The winter friction properties shall be assessed in conformity with the requirements of Annex L, pass/fail criteria shall conform to the ones defined in L.4.

L.1 Test program for freight wagons with brake blocks type K

L.2 Test program for freight wagons with brake blocks type LL

L.3 Specific requirements for conducting Test Programs L.1 and L.2

L.4 Process of assessment and pass/fail criteria for test programs L.1 and L.2

L.5 Generic flow chart to perform test program

L.6 Detailed flow chart to perform test program (example brake block K)

The test only needs to be performed in brake block configuration prescribed in Annex L, in which case a positive assessment also applies to the other brake block configurations.

7.4.3 Train brake test

The winter friction properties shall be assessed in conformity with prescriptions of Annex M, pass/fail criteria shall conform to the ones defined in M.4.

M.1 Introduction

M.2 Test conditions

M.3 Basis for assessment

M.4 Assessment of measurement data and pass/fail criteria

The test only needs to be performed in brake block configuration prescribed in Annex M, in which case a positive assessment also applies to the other brake block configurations.

The variation between the average of braking distances for every speed range of 100 km/h and 120 km/h in winter condition and in reference condition shall not exceed 10 %.

7.5 Locked brake (fusibility)

7.5.1 Generic prescriptions

The behaviour of the brake block under conditions that simulate a locked brake with a given applied braking force is assessed according to test conditions such as wheel diameter, applied braking force and initial stopping speed. Annex N provides test programmes.

N.1 Test program for freight wagons with brake blocks type K and LL

N.2 Test program for locomotives with brake blocks type K

N.3 Test program for EMU – DMU at speed from 100 km/h to 160 km/h with brake blocks type K

N.4 Test program for High speed train with brake blocks type K

The wheel tread temperature values for acceptance are given in Table 7.

Table 7 — Wheel tread temperature values for acceptance

Wheel temperature [a]		
< 600 [°C]	> 600 [°C]	> 700 [°C] and < 850 [°C]
conform	not conform [b]	not conform [c]

[a] Measured 9 mm under wheel tread surface. It is advised to take into account the maximum temperature value given by any of the 3 thermocouples at any time. Thermocouples to be positioned at 120° to each other.

[b] If the cumulative time over the temperature limit exceeds 25 min.

[c] If the cumulative time over the temperature limit exceeds 5 min in the range 700 °C to 850 °C, or if the maximum temperature exceeds 850 °C.

The above test criteria apply for the acceptance of applications with brake block configuration 2Bgu, 2Bg 1Bgu and 1Bg and wheels with a nominal diameter between 680 mm and 920 mm.

7.5.2 Specific prescriptions for freight wagons

The result of a test carried out with 2Bg or 2Bgu configuration and wheel with nominal diameter of 920 mm is valid for all configurations with wheel diameter between 680 mm and 920 mm.

Tests carried out in either 1Bg or 1Bgu configuration shall be conducted following the basis of N.1 using the following parameters:

— bedding according to programme N.1;

— F_B = ¼ of the maximum force during an emergency braking of the vehicle concerned;

— speed = ¾ of the maximum service speed of the vehicle;

— test time = maximum 1 h following the same principle as N.1.

8 Category B requirements

8.1 Vehicle brake test

The vehicle brake tests shall be conducted according to the requirements of the European Standards below. If specific prescriptions are not included in these ENs, tests shall be conducted according to UIC 544-1.

EN 13452-1, *Railway applications — Braking — Mass transit brake systems — Part 1: Performance requirements*

EN 13452-2, *Railway applications — Braking — Mass transit brake systems — Part 2: Methods of test*

EN 14033-1, *Railway applications — Track — Railbound construction and maintenance machines — Part 1: Technical requirements for running*

EN 14033-2:2008+A1:2011, *Railway applications — Track — Railbound construction and maintenance machines — Part 2: Technical requirements for working*

EN 14198, *Railway applications — Braking — Requirements for the brake system of trains hauled by a locomotive*

EN 15179, *Railway applications — Braking — Requirements for the brake system of coaches*

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

EN 15734-2, *Railway applications — Braking systems of high speed trains — Part 2: Test methods*

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

EN 16185-2, *Railway applications — Braking systems of multiple unit trains — Part 2: Test methods*

Pass/fail criteria:

Conformity with requirements of the relevant ENs and UIC 544-1.

8.2 Dynamometer wear test (friction couple)

In order to assess the brake block/wheel tread friction couple wear, a test that simulates actual service conditions for the application in question is recommended. Brake block and wheel tread wear are measured. An example of brake block/wheel tread friction couple wear test program for freight wagons is given in Annex R.

8.3 Dynamic friction performance

It is recommended that a test is conducted to ensure that the brake block material is suitable for the application in question, Annex J provides a format to design brake dynamometer performance tests for a given application.

8.4 In service assessment

In order to prove the suitability of the material for use in service, the brake block that has successfully met the performance criteria required during dynamometer tests and the associated brake performance tests of the vehicle shall be subject to an in service assessment.

It is recommended that the in service test assessment covers all climate conditions that the brake block would be exposed to during its use.

This assessment should confirm that the brake block under consideration does not cause damage to the wheel or cause any adverse effect to the mechanical integrity of the brake block assembly or introduce any unforeseen operational problems. Brake block and wheel tread wear should also be monitored during this assessment. For new materials the duration of this service assessment should be a minimum of 12 months.

Annex V provides the relevant test programmes and pass/fail criteria.

For freight wagons, if the in service assessment is performed in regime SS it is not necessary to repeat the evaluation in regime S if the SS freight wagons were used in part in heterogeneous train with vehicle in regime S and SS.

NOTE “S and SS come from UIC”.

9 Category C requirements

9.1 Metal pick up

The tests provided in Annex K can be used to assess metal pick up tendency in various applications. Any resulting metal pick up should not exceed more than 5 % of total brake block rubbing surface.

For freight wagons:

If the test is conducted in the 2xBgu configuration, its results shall also apply to the ether configurations in combination with all wheel diameters of 680 mm and above.

If the test is conducted in a different configuration, its results shall only apply to the configuration tested in combination with all wheel diameters of 680 mm and above.

9.2 Influence on track circuit operation (shuntage)

Composite brake blocks can influence the correct operation of the track circuit system. It is important to verify that the brake block friction material does not influence the operation of the track circuit system.

There are two methods available:

Method 1:

Dynamometer test and pass/fail criteria applicable for assessment of brake block for freight wagon (see Annex O). For freight wagons, a positive result at dynamometer test shall be applied for all configurations and all nominal wheel diameters of 680 mm and above.

Method 2:

Track test and pass/fail criteria applicable for assessment of brake block type L. For coach see Annex P. A positive result at test run shall be applied for all configurations and all nominal wheel diameters of 680 mm and above peer vehicle type (coach).

10 Environmental issues

10.1 General

All materials used in the manufacture of the friction material and the resulting wear products shall comply with the relevant environmental health regulations applicable at the time of use.

10.2 Noise

It is recommended to take into consideration the noise level found during braking and take steps in the development of the product to minimize this.

10.3 Odour

The formulation of the friction material should be such that any odour produced by the brake block in normal use is kept to a minimum.

10.4 Smoke, fumes and sparkling

The formulation of the friction material should take into account the need to keep the level of smoke, fumes and sparks produced by the brake block in normal use to a minimum.

10.5 Recycling and disposal

Consideration should be given to the need to recycle as much of the brake block as possible after use. Where re-cycling is not possible, the entire brake block should be capable of being disposed of without the need for special precautions.

11 Marking

As a minimum, the back of each brake block shall be permanently marked with the following:

— manufacturers name or logo;

— date of manufacture (week and year);

— material designation;

— part number.

Annex A
(normative)

Summary of Dynamometer test programs and acceptance criteria

Table A.1 covers friction performance test programs.

Table A.1 — Friction performance test programs

Rolling stock type	Brake block type	Brake block configuration				Friction test program	Acceptance criteria
		1 × Bg	1 × Bgu	2 × Bg	2 × Bgu		
Freight wagon	K	**X**				Annex E	Annex E
			X	**X**	**X**	Annex C	Annex C
	LL			**X**	**X**	Annex D	Annex D
Coach (brake block combined with disc brake)	L	**X**				Annex F	Annex F
Locomotive	K		**X**			Annex G	Annex G
EMU/DMU	K		**X**			Annex H	Annex H
High speed train	K	**X**				Annex I	Annex I
Other applications	All	**X**	**X**	**X**	**X**	Annex J	Annex J

Table A.2 below covers other dynamometer test programs.

Table A.2 — Other dynamometer test programs

Test Program	**Annex**	**Brake block type**	**Brake block configuration**				
			1 × Bg	1 × Bgu	2 × Bg	2 × Bgu	
Metal Pick-up	K.1	K	**X**		**X**	**X**	Freight wagon
		LL			**X**	**X**	Freight wagon
	K.2	K		**X**			Locomotive
	K.3	K		**X**			DMU/EMU,
	K.4	K	**X**				High speed train
Extreme winter braking properties	L.1	K				**X**	Freight wagon
	L.2	LL				**X**	Freight wagon
Simulation of “Locked brake”	N.1	K, LL			**X**	**X**	Freight wagon
	N.2	K		**X**			Locomotive
	N.3	K		**X**			DMU/EMU
	N.4	K	**X**				High speed train
Compatibility with track circuits	Annex O	K	Small scale dynamometer				Freight wagon
		LL					
Static friction coefficient	Q.1	K, LL		**X**	**X**	**X**	Freight wagon
	Q.2	K		**X**			Locomotive and DMU/EMU
	Q.3	K	**X**				High speed train
Simulation of service conditions	R.1	K				**X**	Freight wagon
	R.2	LL				**X**	

Annex B
(normative)

General requirements for conducting dynamometer test programmes

B.1 General

The following general requirements apply to all dynamometer tests unless other more specific requirements are quoted in a specific test, in which case this specific requirement takes priority.

B.2 Rotation and ventilation conditions

Table B.1 — Speed and ventilation conditions

	Speed of the test bench km/h		**Speed of the cooling air** km/h	
	Under dry conditions	**Under wet conditions**	**Under dry conditions**	**Under wet conditions**
During braking at;				
$v \leq 80$ km/h	v	v	v /2	10
$v > 80$ km/h	v	v	40	10
Between the brake applications	100	50	40	10

B.3 Brake application timing t_s

The time to reach 95 % of the demanded F_B should be 4 s ± 0,2 s.

B.4 Bedding

If bedding is done using brake stops to rest then a minimum number of bedding brake stops is to be carried out once to ensure wheel conditioning is as below:

— 40 for organic blocks;

— 80 for sinter blocks.

B.5 Wear

The wear of the brake block will be measured prior to the specific braking stops as indicated in each type of dynamometer program. Wear for each individual section of the test and for the overall wear of the material, shall be calculated in cm^3/MJ.

There are no acceptance criteria for wear values.

B.6 Roughness index of the wheel tread

The roughness of the wheel is to be measured prior to the specific braking stops as indicated in each type of dynamometer program. Measurement of Rz and Ra shall be done following EN ISO 4287 and EN ISO 4288.

NOTE It is authorized to do the test using a resin sample.

B.7 Interruption of the tests

Should there be an interruption to any of the testing programmes before recommencing the program it is necessary to repeat the previous 5 stops carried out before the interruption (drag brakes excluded).

In the case of an interruption prior to the first wet stop, one brake application identical to the last brake application in dry (not including any drag brake application) is required outside of the program in order to conform to the wet conditions.

B.8 Temperatures

Temperatures should be measured on the surface by 3 rubbing thermocouples spaced equally across the wheel tread or by embedded temperature sensors typically 5 mm below the wheel tread surface. The value is established on an average of three individual values. Alternative temperature measurements have to achieve at least an equivalent accuracy.

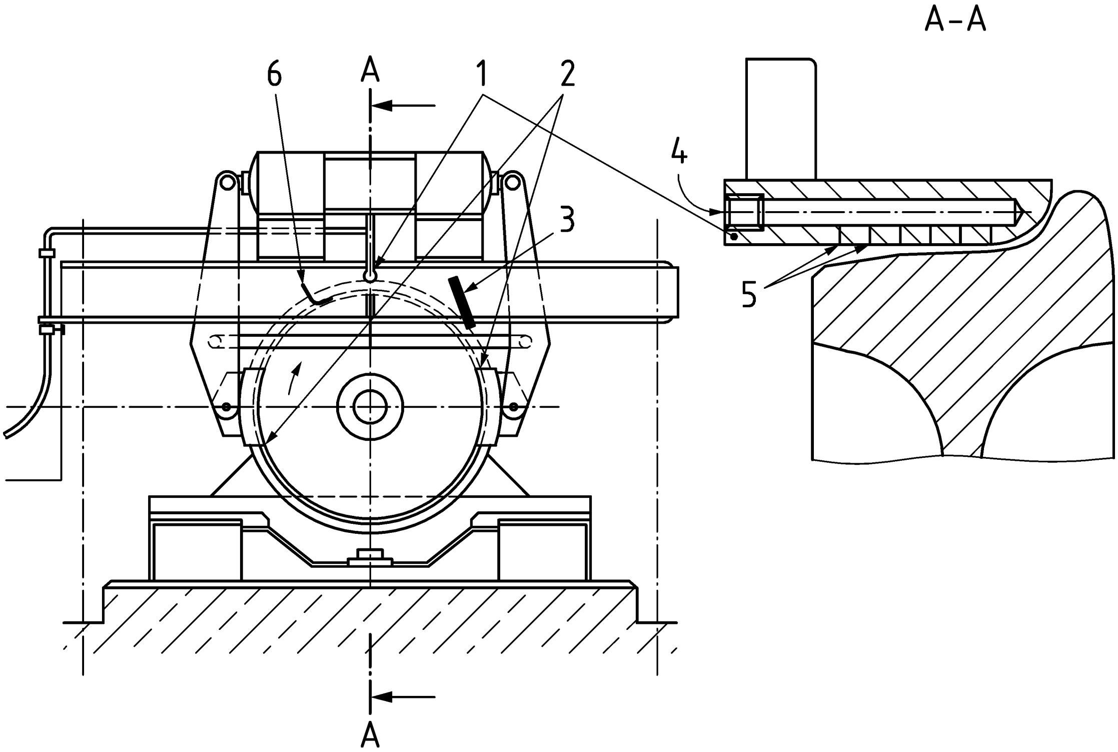
During subsequent brake applications, the initial temperature shall always be achieved by reducing the temperature to this value, prior to the brake application.

If the tests are interrupted according to the point “Interruption of the test” above, then initial temperature for the first stop shall be in the range 20 °C to 60 °C.

B.9 Wet conditions

Concerning the brake applications under wet conditions, the wheel wetting shall not interrupted during each complete set of wet stops (including cooling period). For the first stop of any wet test section after a dry section, the start of the wheel tread wetting takes place only when the temperature of the wheel is below 80 °C.

The wet testing shall be conducted with 6 holes for water spray spaced 15 mm apart with a diameter of 0,5 mm. The spray head should be positioned approximately 5 mm above the wheel tread. During the cooling between wet stop, a gap of at least 2 mm should be maintained between wheel tread and the brake block surface. An example of the wet testing configuration is shown in Figure B.1:



Key

1 spray head

2 leading edge of brake block in the direction of rotation shall be fully bedded

3 water deflection shield

4 water inlet example

5 spray holes

6 position sliding thermocouples

Figure B.1 — Dynamometer wet test configuration

B.10 Test of simulation of downhill

When the requirements for simulation of a downhill are specified in power [kW] in program test, the test shall be performed at constant power and speed.

B.11 Test wheels

It is possible to use either wheels taken from service or new wheels. Before the assembly on the test bench, their diameter shall be adapted to the value indicated in the test program.

During the test the appearance, the surface condition and the position of any metal pick up on the friction face of the brake block shall be registered. A photograph shall be taken during every disassembly.

After every exchange of the friction material, the wheel tread shall be regenerated so that the tread surface condition is consistent for all tests.

Annex C
(normative)

Composite brake blocks (K) (2Bg – 2Bgu)– Demonstration of friction properties for S and SS (S/SS) – braked freight wagons (v_{max} = 120 km/h)

C.1 Program for performance tests

Conditions for Table C.1

Brake shoe Insert configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 1 × Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	1,8 t, 9,0 t and 11,25 t
Water flow rate:	14 l/h

Table C.1 — Program for performance tests

<table>
<tr><th colspan="3" rowspan="3">No. of brake application</th><th>Initial speed</th><th>Total F_B per wheel</th><th>Initial temperature</th><th>Mass to brake per wheel</th><th>weighing after</th><th>Remarks</th></tr>
<tr><td>v</td><td>F_B</td><td>θ_0</td><td>m</td><td></td><td></td></tr>
<tr><td>km/h</td><td>kN</td><td>°C</td><td>t</td><td>No.</td><td></td></tr>
<tr><td colspan="3">1.1 – 1.X</td><td>100</td><td>24</td><td>20 – 100</td><td>9,0</td><td>1.X</td><td>Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface. Measure wheel roughness at end of this section.</td></tr>
<tr><td>1</td><td>3</td><td>5</td><td>100</td><td rowspan="2">38</td><td rowspan="2">50 – 60</td><td rowspan="2">9,0</td><td rowspan="2"></td><td rowspan="2">Brake applications to rest under dry conditions, after a period of cooling</td></tr>
<tr><td>2</td><td>4</td><td>6</td><td>120</td></tr>
<tr><td colspan="3">7 to 26</td><td>100</td><td>7</td><td>20 – 100</td><td>1,8</td><td></td><td>Conditioning stops</td></tr>
</table>

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
27	39		100	7	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
28	40		30					
29	41		120					
30	42		60					
31	43		100	5	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
32	44		30					
33	45		120					
34	46		60					
35	47		100	9	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
36	48		30					
37	49		120					
38	50		60					
51			70	-	-	-		10 kW drag brake application for a period of 15 min done immediately after brake nº 50, without interruption. This is to evenly distribute the residual stress within the wheel.
52	64	76	100	7	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
53	65	77	30					
54	66	78	120					
55	67	79	60					
56	68	80	100	5	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
57	69	81	30					
58	70	82	120					
59	71	83	60					
60	72	84	100	9	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
61	73	85	30					
62	74	86	120					
63	75	87	60					
88	92		100	38	20 – 30	11,25		Brake applications to rest under wet conditions, after a period of cooling
89	93		30					
90	94		120					
91	95		60					

No. of brake application		Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
96		70	-	-	-	96	10 kW drag brake application for a period of 15 min in dry condition done immediately after brake nº 95 without interruption to rest to dry the brake block.
97 98 99 100	109 110 111 112	100 30 120 60	24	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
101 102 103 104	113 114 115 116	100 30 120 60	9	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
105 106 107 108	117 118 119 120	100 30 120 60	38	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
121 122 123 124		100 30 120 60	38	110 – 120 [a]	11,25		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling
125 126 127 128		100 30 120 60	24	50 – 60	11,25	128	Brake applications to rest under dry conditions, after a period of cooling
129		70	-	20 – 60	-		Simulation of a downhill brake application with a power of 45 kW for a period of 34 min
130		70	38	-	11,25	130	Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break
131 to 140		120	24	50 – 60	11,25		Conditioning stops

No. of brake application		Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
141	145	100	38	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
142	146	30					
143	147	120					
144	148	60					
149		70	-	-	-	149	10 kW drag brake application for a period of 15 min done immediately after brake nº 148, without interruption. This is to evenly distribute the residual stress within the wheel. Measure wheel roughness at end of this section.

[a] Should the temperature obtained during the brake applications nos. 120 and 122 be under 110 °C, then the brake applications no. 121 and 123 shall be performed with the temperature achieved at that time.

Conditions for Table C.2

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 1 × Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	9,0 t and 11,25 t

See Note 2 in 7.2.7.1.

Table C.2 – Additional program for performance tests

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
Tests to be conducted using a set of new blocks						
1.1 – 1.X	100	24	20 – 100	9,0	1.X	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
1 3 5	100	38	50 – 60	9,0		Brake applications to rest under dry conditions, after a period of cooling
2 4 6	120					
7 11	100	38	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
8 12	30					
9 13	120					
10 14	60					
15 19	100	9	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
16 20	30					
17 21	120					
18 22	60					
23	70	-	50 – 60	-		Simulation of a downhill brake application with a power of 40 kW for a period of 30 min
24	70	38	-	11,25		Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break
25 to 34	100	24	50 – 60	11,25		Conditioning stops
25 29	100	38	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
26 30	30					
27 31	120					
28 32	60				32	

C.2 Program for simulation brake assessment

Conditions for Table C.3

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\binom{+1}{-2}$ mm] per wheel. 1 × Bgu [2 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\binom{+5}{-0}$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	1,8 t, 9,0 t and 11,25 t
Water flow rate:	14 l/h

Table C.3 – Program for simulation brake assessment

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
1.1 – 1.X	100	24	20 – 100	9,0	1.X	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
1 to 19	100	24	20 – 100	1,8		Conditioning stops
20 to 24 25 to 29 30 to 34	100 120 100	9	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
35 to 39 40 to 44 45 to 49	100 120 100	9	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
50	70	-	-	-		10 kW drag brake application for a period of 15 min in dry condition done immediately after brake nº 49 without interruption to rest to dry the brake blocks.

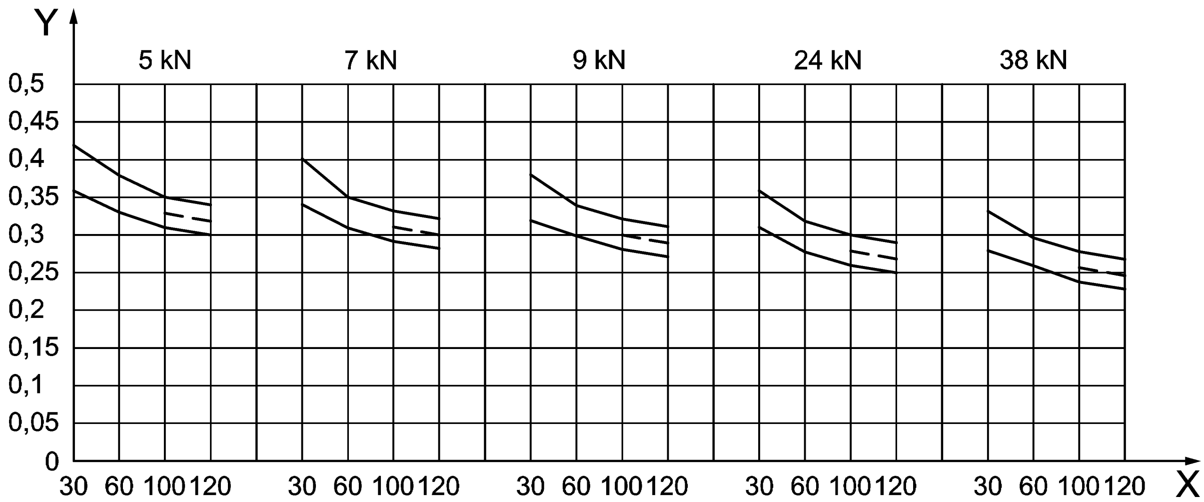
No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
51 to 55	100	24	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
56 to 60	120					
61 to 65	100					
66 to 70	100	38	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
71 to 75	120				75	
NOTE Tests 35 to 49 performed for information.						

C.3 Dispersion range of mean friction coefficients

C.3.1 General

Dispersion range of mean friction coefficients in dry condition applicable for test programs C.1 and C.2.

C.3.2 2Bgu configuration



Key

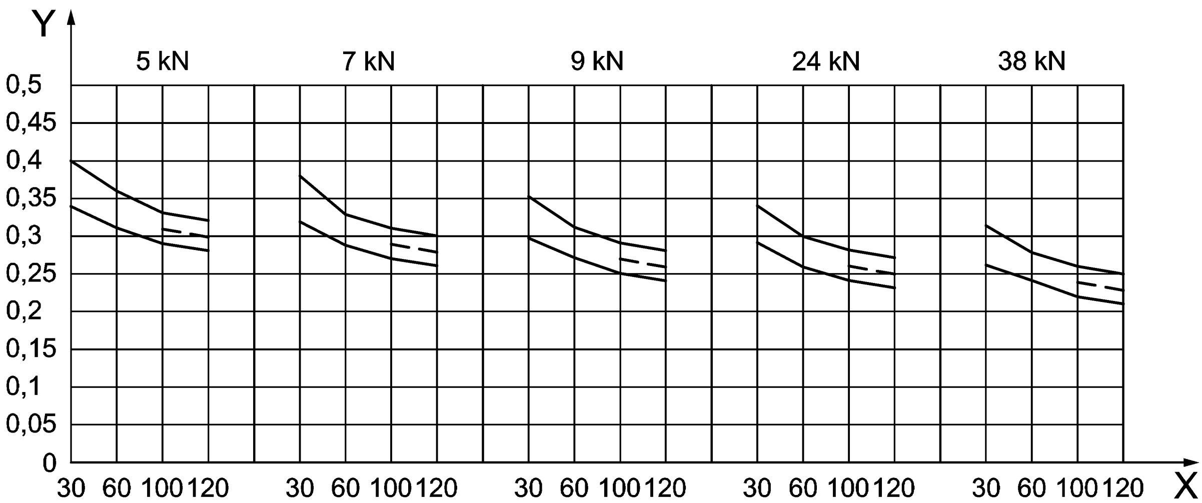
— — —	nominal friction coefficient for 100 km/h and 120 km/h
———	enveloping characteristic line of the tolerances
X	speed in km/h
Y	friction coefficient

Figure C.1 —Dispersion range of means friction coefficient in dry condition, 2Bgu configuration

Table C.4 —Dispersion range of mean friction coefficient in dry condition, 2Bgu configuration

F_B kN	Initial speed v (km/h) ≥	30	60	100	120
5	Maximum	0,420	0,380	0,350	0,340
	Nominal			0,330	0,320
	Minimum	0,360	0,330	0,310	0,300
7	Maximum	0,400	0,350	0,330	0,320
	Nominal			0,310	0,300
	Minimum	0,340	0,310	0,290	0,280
9	Maximum	0,380	0,340	0,320	0,310
	Nominal			0,300	0,290
	Minimum	0,320	0,300	0,280	0,270
24	Maximum	0,360	0,320	0,300	0,290
	Nominal			0,280	0,270
	Minimum	0,310	0,280	0,260	0,250
38	Maximum	0,330	0,300	0,280	0,270
	Nominal			0,260	0,250
	Minimum	0,280	0,260	0,240	0,230

C.3.3 2Bg configuration



Key

— — — nominal friction coefficient for 100 km/h and 120 km/h

——— enveloping characteristic line of the tolerances

X speed in km/h

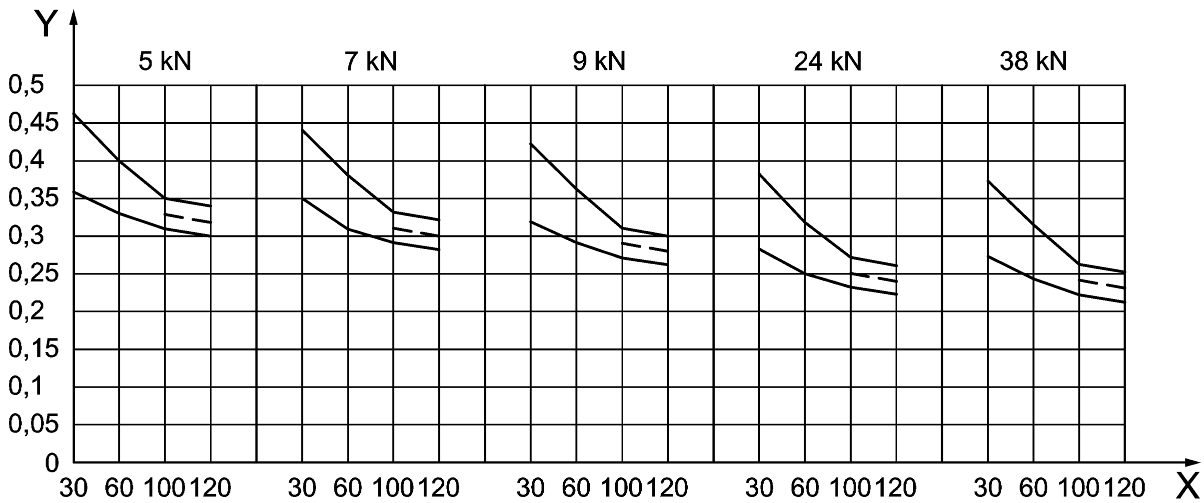
Y friction coefficient

Figure C.2 —Dispersion range of mean friction coefficient in dry condition, 2Bg configuration

Table C.5 —Dispersion range of mean friction coefficient in dry condition, 2Bg configuration

F_B kN	Initial speed v (km/h) ≥	30	60	100	120
5	Maximum	0,403	0,357	0,330	0,320
	Nominal			0,310	0,300
	Minimum	0,341	0,310	0,290	0,280
7	Maximum	0,377	0,334	0,310	0,300
	Nominal			0,290	0,280
	Minimum	0,319	0,290	0,270	0,260
9	Maximum	0,351	0,311	0,290	0,280
	Nominal			0,270	0,260
	Minimum	0,297	0,270	0,250	0,240
24	Maximum	0,338	0,299	0,280	0,270
	Nominal			0,260	0,250
	Minimum	0,286	0,260	0,240	0,230
38	Maximum	0,312	0,276	0,260	0,250
	Nominal			0,240	0,230
	Minimum	0,264	0,240	0,220	0,210

C.3.4 1Bgu configuration



Key

— — —	nominal friction coefficient for 100 km/h and 120 km/h
———	enveloping characteristic line of the tolerances
X	speed in km/h
Y	friction coefficient

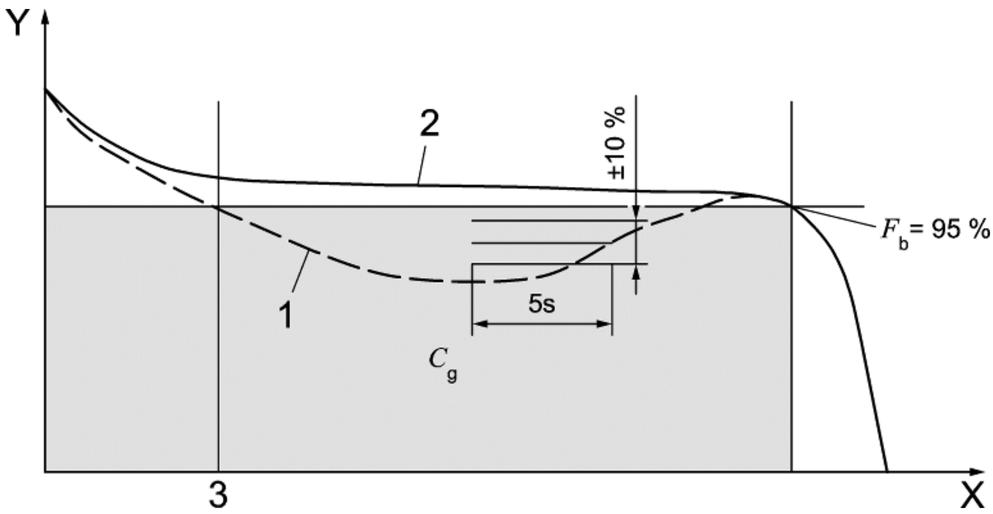
Figure C.3 —Dispersion range of mean friction coefficient in dry condition, 1Bgu configuration

Table C.6 —Dispersion range of mean friction coefficient in dry condition, 1Bgu configuration

F_B kN	Initial speed v (km/h) ≥	30	60	100	120
5	Maximum	0,460	0,400	0,350	0,340
	Nominal			0,330	0,320
	Minimum	0,360	0,330	0,310	0,300
7	Maximum	0,440	0,380	0,330	0,320
	Nominal			0,310	0,300
	Minimum	0,350	0,310	0,290	0,280
9	Maximum	0,420	0,360	0,310	0,300
	Nominal			0,290	0,280
	Minimum	0,320	0,290	0,270	0,260
24	Maximum	0,380	0,320	0,270	0,260
	Nominal			0,250	0,240
	Minimum	0,280	0,250	0,230	0,220
38	Maximum	0,370	0,310	0,260	0,250
	Nominal			0,240	0,230
	Minimum	0,270	0,240	0,220	0,210

C.4 Dispersion range of instantaneous friction coefficients

Dispersion range of instantaneous friction coefficients applicable for test programs C.1 and C.2.



Key

1 example of instantaneous coefficient friction (μ_a), poor profile

2 example of instantaneous coefficient friction (μ_a), good profile

3 30 km/h

Cg grey area, not recommended area for instantaneous friction profile

X instantaneous speed (km/h)

Y friction coefficient (μ)

Figure C.4 — Maximum variation in instantaneous friction values

Specification

From the moment F_B = 95 % to speed of 30 km/h, instantaneous friction shall not vary more than ± 10 % for a period of 5 s.

Annex D
(normative)

Composite brake blocks (LL) – Demonstration of friction properties for S and SS (S/SS) – braked freight wagons (v_{max} = 120 km/h)

D.1 Program for performance tests

Conditions for Table D.1

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\binom{+1}{-2}$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\binom{+5}{-0}$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	1,8 t, 9,0 t and 11,25 t
Water flow rate:	14 l/h

Table D.1 — Program for performance tests

<table>
<tr><td colspan="3" rowspan="3">No. of brake application</td><td>Initial speed</td><td>Total F_B per wheel</td><td>Initial temperature</td><td>Mass to brake per wheel</td><td>weighing after</td><td>Remarks</td></tr>
<tr><td>v</td><td>F_B</td><td>θ_0</td><td>m</td><td></td><td></td></tr>
<tr><td>km/h</td><td>kN</td><td>°C</td><td>t</td><td>No.</td><td></td></tr>
<tr><td colspan="3">1.1 – 1.X</td><td>100</td><td>60</td><td>20 – 100</td><td>9,0</td><td>1.X</td><td>Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface. Measure wheel roughness at end of this section.</td></tr>
<tr><td>1</td><td>3</td><td>5</td><td>100</td><td rowspan="2">100</td><td rowspan="2">50 – 60</td><td rowspan="2">9,0</td><td rowspan="2"></td><td rowspan="2">Brake applications to rest under dry conditions, after a period of cooling</td></tr>
<tr><td>2</td><td>4</td><td>6</td><td>120</td></tr>
<tr><td colspan="3">7 to 26</td><td>100</td><td>16</td><td>20 – 100</td><td>1,8</td><td></td><td>Conditioning stops</td></tr>
<tr><td>27</td><td colspan="2">39</td><td>100</td><td rowspan="4">16</td><td rowspan="4">50 – 60</td><td rowspan="4">1,8</td><td rowspan="4"></td><td rowspan="4">Brake applications to rest under dry conditions, after a period of cooling</td></tr>
<tr><td>28</td><td colspan="2">40</td><td>30</td></tr>
<tr><td>29</td><td colspan="2">41</td><td>120</td></tr>
<tr><td>30</td><td colspan="2">42</td><td>60</td></tr>
</table>

No. of brake application			Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
31	43		100	12	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
32	44		30					
33	45		120					
34	46		60					
35	47		100	20	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
36	48		30					
37	49		120					
38	50		60					
51			70	-	-	-		10 kW drag brake application for a period of 15 min done immediately after brake nº 50, without interruption. This is to evenly distribute the residual stress within the wheel.
52	64	76	100	16	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
53	65	77	30					
54	66	78	120					
55	67	79	60					
56	68	80	100	12	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
57	69	81	30					
58	70	82	120					
59	71	83	60					
60	72	84	100	20	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
61	73	85	30					
62	74	86	120					
63	75	87	60					
88	92		100	100	20 – 30	11,25		Brake applications to rest under wet conditions, after a period of cooling
89	93		30					
90	94		120					
91	95		60					
96			70	-	-	-	96	10 kW drag brake application for a period of 15 min in dry condition done immediately after brake nº 95 without interruption to rest to dry the brake blocks.

No. of brake application		Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
97	109	100	60	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
98	110	30					
99	111	120					
100	112	60					
101	113	100	20	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
102	114	30					
103	115	120					
104	116	60					
105	117	100	100	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
106	118	30					
107	119	120					
108	120	60					
121		100	100	110 – 120 [a]	11,25		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling
122		30					
123		120					
124		60					
125		100	60	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
126		30					
127		120					
128		60				128	
129		70	-	20 – 60	-		Simulation of a downhill brake application with a power of 45 kW for a period of 34 min
130		70	100	-	11,25	130	Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break
131 to 140		100	-	50 – 60	11,25		Conditioning stops
141	145	100	100	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
142	146	30					
143	147	120					
144	148	60					

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
149	70	-	-	-	149	10 kW drag brake application for a period of 15 min done immediately after brake n° 148, without interruption. This is to evenly distribute the residual stress within the wheel. Measure wheel roughness at end of this section.
NOTE Some friction materials can create high vibration during laden testing under high braking forces at low speed. This could damage the dynamometer. For this reason, for stops conducted at 100 kN it is permitted to stop braking before coming to rest (lower than 20 km/h). The final speed should be indicated on the test report. Brake stops at 30 km/h with total F_B of 100 kN are not mandatory.						
[a] Should the temperature obtained during the brake applications nos. 120 and 122 be under 110 °C, then the brake applications no. 121 and 123 shall be performed with the temperature achieved at that time						

Conditions for Table D.2

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	9,0 t and 11,25 t

See Note 2 in 7.2.7.1.

Table D.2 – Additional program for performance tests

No. of brake application			Initial speed	Total F_B per wheel	Initial temperatu re	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
Tests to be conducted using a set of new blocks								
1.1 – 1.X			100	60	20 – 100	9,0	1.X	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
1	3	5	100	60	50 – 60	9,0		Brake applications to rest under dry conditions, after a period of cooling
2	4	6	120					
7	11		100	100	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
8	12		30					
9	13		120					
10	14		60					
15	19		100	20	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
16	20		30					
17	21		120					
18	22		60					
23			70	-	50 – 60	-		Simulation of a downhill brake application with a power of 40 kW for a period of 30 min
24			70	100	-	11,25		Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break
25 to 34			100	60	50 – 60	11,25		Conditioning stops
25	29		100	100	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
26	30		30					
27	31		120					
28	32		60				32	

D.2 Program for simulation brake assessment

Conditions for Table D.3

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\binom{+1}{-2}$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\binom{+5}{-0}$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	1,8 t, 9,0 t and 11,25 t
Water flow rate:	14 l/h

Table D.3 – Program for simulation brake assessment

No. of brake application	Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
1.1 – 1.X	100	60	20 – 100	9,0	1.X	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
1 to 19	100	100	20 – 100	1,8		Conditioning stops
20 to 24 25 to 29 30 to 34	100 120 100	16	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
35 to 39 40 to 44 45 to 49	100 120 100	16	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
50	70	-	-	-		10 kW drag brake application for a period of 15 min in dry condition done immediately after brake nº 49 without interruption to rest to dry the brake blocks.
51 to 55 56 to 60 61 to 65	100 120 100	60	50 – 60	11,25		Brake applications to rest under dry conditions, after a period of cooling
66 to 70 71 to 75	100 120	100	50 – 60	11,25	75	Brake applications to rest under dry conditions, after a period of cooling

NOTE 1 Some friction materials can create high vibration during laden testing under high braking forces at low speed. This could damage the dynamometer. For this reason, for stops conducted at 100 kN it is permitted to stop braking before coming to rest (lower than 20 km/h). The final speed should be indicated on the test report. Brake stops at 30 km/h with Total F_B of 100 kN are not mandatory.

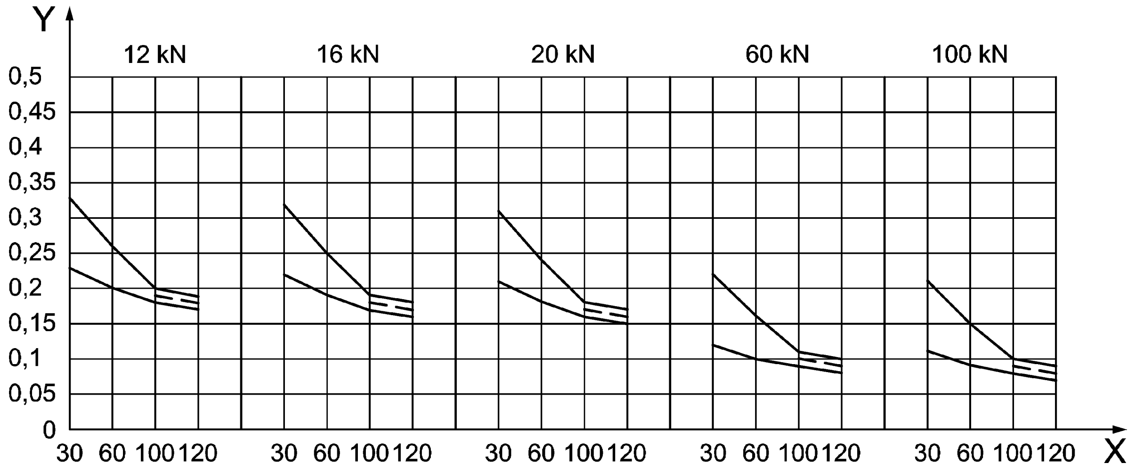
NOTE 2 Tests 35 to 49 performed for information.

D.3 Dispersion range of mean friction coefficients

D.3.1 General

Dispersion range of mean friction coefficients in dry condition applicable for test programs D.1 and D.2.

D.3.2 2Bgu configuration



Key

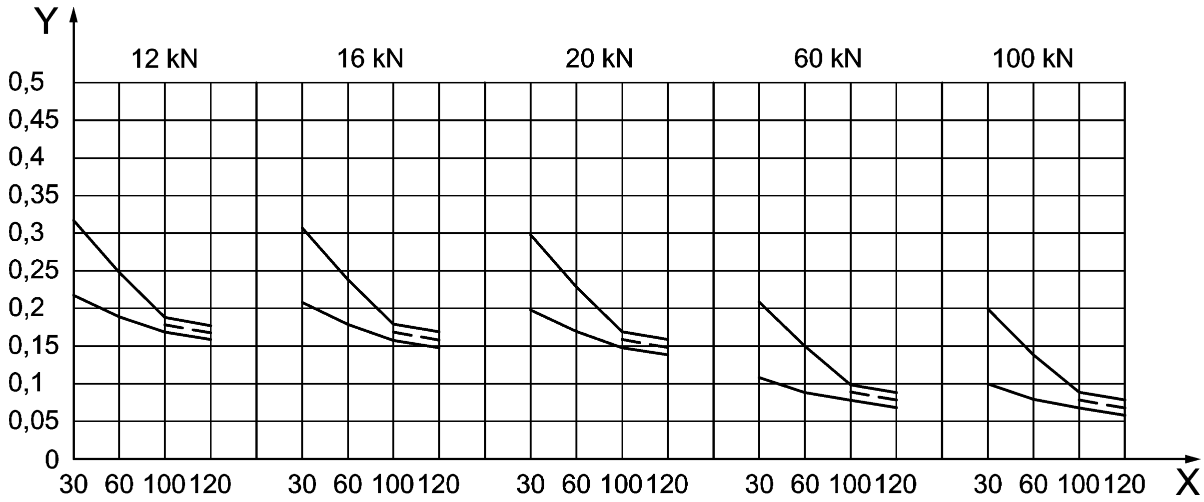
— — —	nominal friction coefficient for 100 km/h and 120 km/h
———	enveloping characteristic line of the tolerances
X	speed in km/h
Y	friction coefficient

Figure D.1 — Dispersion range of means friction coefficient in dry condition, 2Bgu configuration

Table D.4 — Dispersion range of mean friction coefficient in dry condition, 2Bgu configuration

F_B kN	Initial speed v (km/h) ≥	30	60	100	120
12	Maximum	0,330	0,260	0,200	0,190
	Nominal			0,190	0,180
	Minimum	0,230	0,200	0,180	0,170
16	Maximum	0,320	0,250	0,190	0,180
	Nominal			0,180	0,170
	Minimum	0,220	0,190	0,170	0,160
20	Maximum	0,310	0,240	0,180	0,170
	Nominal			0,170	0,160
	Minimum	0,210	0,180	0,160	0,150
60	Maximum	0,220	0,160	0,110	0,100
	Nominal			0,100	0,090
	Minimum	0,120	0,100	0,090	0,080
100	Maximum	0,210	0,150	0,100	0,090
	Nominal			0,090	0,080
	Minimum	0,110	0,090	0,080	0,070

D.3.3 2Bg configuration



Key

— — —	nominal friction coefficient for 100 km/h and 120 km/h
———	enveloping characteristic line of the tolerances
X	speed in km/h
Y	friction coefficient

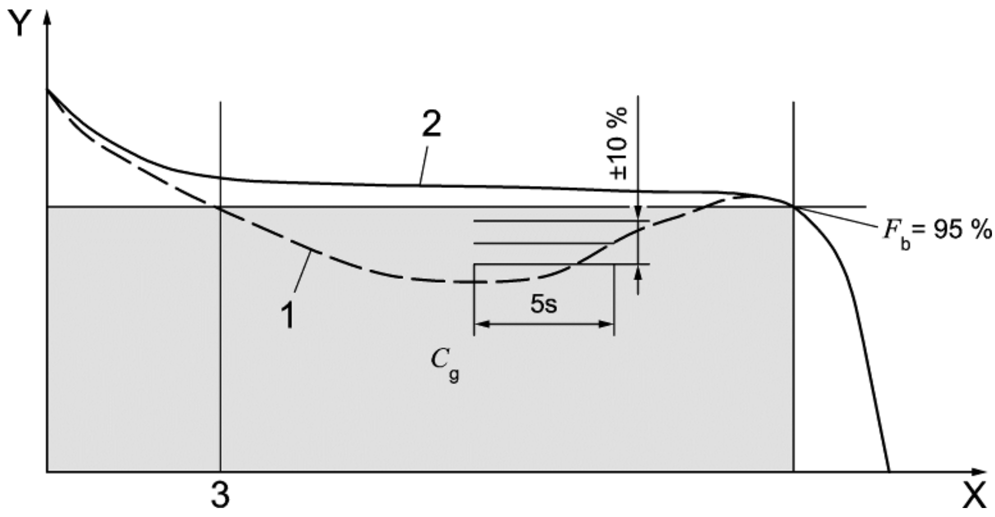
Figure D.2 —Dispersion range of means friction coefficient in dry condition, 2Bg configuration

Table D.5 —Dispersion range of mean friction coefficient in dry condition, 2Bg configuration

F_B kN	Initial speed v (km/h) ≥	30	60	100	120
12	Maximum	0,320	0,250	0,190	0,180
	Nominal			0,180	0,170
	Minimum	0,220	0,190	0,170	0,160
16	Maximum	0,310	0,240	0,180	0,170
	Nominal			0,170	0,160
	Minimum	0,210	0,180	0,160	0,150
20	Maximum	0,300	0,230	0,170	0,160
	Nominal			0,160	0,150
	Minimum	0,200	0,170	0,150	0,140
60	Maximum	0,210	0,150	0,100	0,090
	Nominal			0,090	0,080
	Minimum	0,110	0,090	0,080	0,070
100	Maximum	0,200	0,140	0,090	0,080
	Nominal			0,080	0,070
	Minimum	0,100	0,080	0,070	0,060

D.4 Dispersion range of instantaneous friction coefficients

Dispersion range of instantaneous friction coefficients applicable for test programs D.1 and D.2.



Key

1 example of instantaneous coefficient friction (μ_a), poor profile

2 example of instantaneous coefficient friction (μ_a), good profile

3 30 km/h

Cg grey area, not recommended area for instantaneous friction profile

X instantaneous speed (km/h)

Y friction coefficient (μ)

Figure D.3 — Maximum variation in instantaneous friction values

Specification

From the moment F_b = 95 % to speed of 30 km/h, instantaneous friction shall not vary more than ± 10 % for a period of 5 s.

Annex E
(normative)

Composite brake blocks (K) (1Bg)– Demonstration of friction properties for S and SS (S/SS) – braked freight wagons (v_{max} = 120 km/h)

E.1 Program for performance tests

Conditions for Table E.1

Brake block configuration:	1 × Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	790 $\left(^{+5}_{-0}\right)$ mm (new wheel 840 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	1,8 t, 5,8 t and 9,0 t
Water flow rate:	12 l/h

Table E.1 — Program for performance tests

No. of brake application		Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
1.1 – 1.X		100	20	20 – 100	5,8	1.X	Brake applications to rest under dry conditions to allow bedding of the brake block up to at least 85 % of the friction material surface. Measure wheel roughness at end of this section.
1 to 20		100	8	20 – 100	1,8		Conditioning stops
21	36	100	8	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
22	37	30					
23	38	120					
24	39	60					
25	40	140					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
26	41		100					
27	42		30					
28	43		120	5	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
29	44		60					
30	45		140					
31	46		100					
32	47		30					
33	48		120	12	50 – 60	1,8		Brake applications to rest under dry conditions, after a period of cooling
34	49		60					
35	50		140					
51			70	-	-	-		10 kW drag brake application for a period of 15 min done immediately after brake nº 50, without interruption. This is to evenly distribute the residual stress within the wheel.
52	67	82	100					
53	68	83	30					
54	69	84	120	8	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
55	70	85	60					
56	71	86	140					
57	72	87	100					
58	73	88	30					
59	74	89	120	5	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
60	75	90	60					
61	76	91	140					
62	77	92	100					
63	78	93	30					
64	79	94	120	12	20 – 30	1,8		Brake applications to rest under wet conditions, after a period of cooling
65	80	95	60					
66	81	96	140					

No. of brake application		Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
97 98 99 100	101 102 103 104	100 30 120 60	30	20 – 30	9,0		Brake applications to rest under wet conditions, after a period of cooling
105		70	-	-	-	105	10 kW drag brake application for a period of 15 min in dry condition done immediately after brake nº 104 without interruption to rest to dry the brake blocks.
106 107 108 109	118 119 120 121	100 30 120 60	20	50 – 60	9,0		Brake applications to rest under dry conditions, after a period of cooling
110 111 112 113	122 123 124 125	100 30 120 60	8	50 – 60	9,0		Brake applications to rest under dry conditions, after a period of cooling
114 115 116 117	126 127 128 129	100 30 120 60	30	50 – 60	9,0		Brake applications to rest under dry conditions, after a period of cooling
130 131 132 133		100 30 120 60	30	110 – 120 [a]	9,0		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling
134 135 136 137		100 30 120 60	20	50 – 60	9,0	137	Brake applications to rest under dry conditions, after a period of cooling
138		70	-	20 – 60	-		Simulation of a downhill brake application with a power of 36 kW for a period of 34 min

No. of brake application		Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
139		70	30	-	9,0		Brake application to rest under dry conditions immediately after simulation of a downhill brake application, without any cooling break
140 to 149		100	30	20 – 60	9,0	140	Conditioning stops
150	154	100	30	50 – 60	9,0		Brake applications to rest under dry conditions, after a period of cooling
151	155	30					
152	156	120					
153	157	60					
158		70	-	-	-	158	10 kW drag brake application for a period of 15 min done immediately after brake nº 144, without interruption. This is to evenly distribute the residual stress within the wheel. Measure wheel roughness at end of this section.

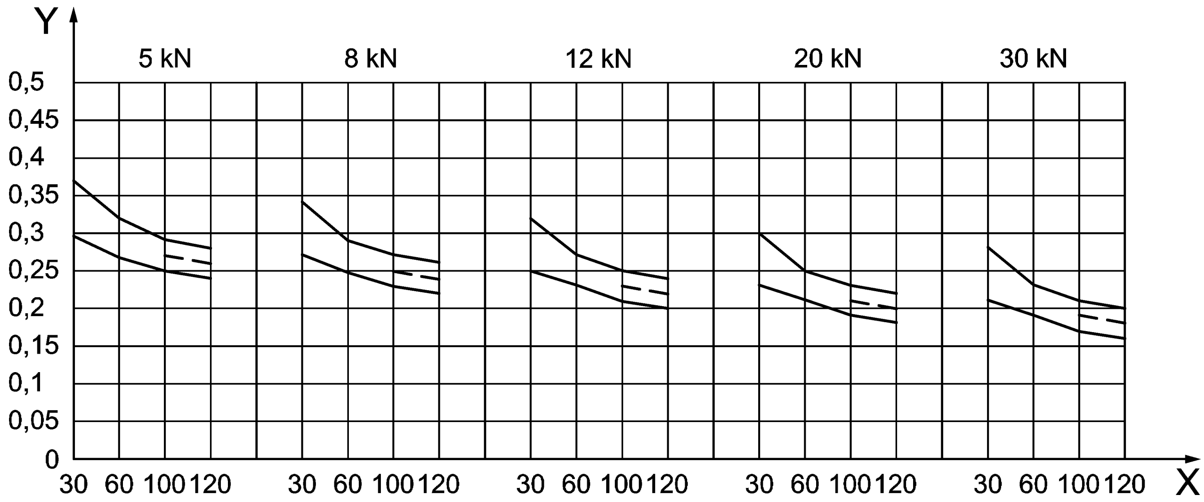
[a] Should the temperature obtained during the brake applications nos. 129 and 131 be under 110 °C, then the brake applications no. 130 and 132 shall be performed with the temperature achieved at that time.

E.2 Dispersion range of mean friction coefficients

E.2.1 General

Dispersion range of mean friction coefficients in dry condition applicable for test program E.1.

E.2.2 1Bg configuration



Key

— — —	nominal friction coefficient for 100 km/h and 120 km/h
———	enveloping characteristic line of the tolerances
X	speed in km/h
Y	friction coefficient

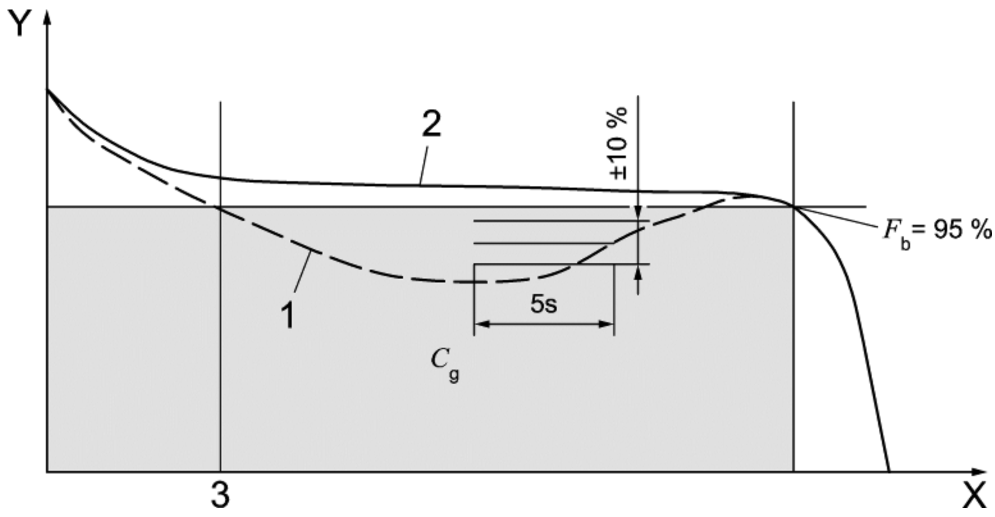
Figure E.1 —Dispersion range of means friction coefficient in dry condition, 1Bg configuration

Table E.2 —Dispersion range of mean friction coefficient in dry condition, 1Bg configuration

F_B kN	Initial speed v (km/h) ≥	30	60	100	120
5	Maximum	0,380	0,330	0,290	0,280
	Nominal			0,270	0,260
	Minimum	0,310	0,28	0,250	0,240
8	Maximum	0,380	0,320	0,290	0,280
	Nominal			0,270	0,260
	Minimum	0,310	0,280	0,250	0,240
12	Maximum	0,380	0,320	0,280	0,270
	Nominal			0,260	0,250
	Minimum	0,310	0,280	0,240	0,230
20	Maximum	0,370	0,310	0,280	0,270
	Nominal			0,260	0,250
	Minimum	0,300	0,270	0,240	0,230
30	Maximum	0,370	0,310	0,260	0,250
	Nominal			0,240	0,230
	Minimum	0,300	0,260	0,220	0,210

E.3 Dispersion range of instantaneous friction coefficients

Dispersion range of instantaneous friction coefficients applicable for test program E.1.



Key

1 example of instantaneous coefficient friction (μ_a), poor profile

2 example of instantaneous coefficient friction (μ_a), good profile

3 30 km/h

Cg grey area, not recommended area for instantaneous friction profile

X instantaneous speed (km/h)

Y friction coefficient (μ)

Figure E.2 — Maximum variation in instantaneous friction values

Specification

From the moment F_b = 95 % to speed of 30 km/h, instantaneous friction shall not vary more than ± 10 % for a period of 5 s.

Annex F
(normative)

Composite brake blocks (L) – Demonstration of friction properties for extra tread brake of coach

F.1 Program for performance tests

Conditions for Table F.1

Brake block configuration:	1 × Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,5 t
Water flow rate:	14 l/h with v < 120 km/h and 22 l/h with v ≥ 120 km/h

Table F.1 — Program for performance test of brake blocks type L when used for coach applications at maximum speed design from 100 km/h to 200 km/h with combined brake system, 1Bg configuration

No. of brake application		Initial speed	Total F_B per wheel	Initial temperatu re	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
1.1 – 1.X		100	21	20 – 100	5,7	1.X	Brake applications to rest under dry conditions to allow bedding of the brake block up to at least 85 % of the friction material surface. Measure wheel roughness at end of this section.
1	25	50	16	50 – 60	2,3		Brake applications to rest under dry conditions, after a period of cooling
2	26	80					
3	27	120					
4	28	140					
5	29	160					
6	30	200					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
7	31		50	6	50 – 60	2,3		Brake applications to rest under dry conditions, after a period of cooling
8	32		80					
9	33		120					
10	34		140					
11	35		160					
12	36		200					
13	37		50	12	50 – 60	2,3		Brake applications to rest under dry conditions, after a period of cooling
14	38		80					
15	39		120					
16	40		140					
17	41		160					
18	42		200					
19	43		50	21	50 – 60	2,3		Brake applications to rest under dry conditions, after a period of cooling
20	44		80					
21	45		120					
22	46		140					
23	47		160					
24	48		200					
49			140	21	110 – 120	2,3		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling
50			200					
51			80					
52			80	16	50 – 60	2,3		Conditioning stops
53			80	21			53	
54	70	86	50	16	20 – 30	2,3		Brake applications to rest under wet conditions, after a period of cooling
55	71	87	80					
56	72	88	120					
57	73	89	140					
58	74	90	50	6	20 – 30	2,3		Brake applications to rest under wet conditions, after a period of cooling
59	75	91	80					
60	76	92	120					
61	77	93	140					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
62 63 64 65	78 79 80 81	94 95 96 97	50 80 120 140	12	20 – 30	2,3		Brake applications to rest under wet conditions, after a period of cooling
66 67 68 69	82 83 84 85	98 99 100 101	50 80 120 140	21	20 – 30	2,3		Brake applications to rest under wet conditions, after a period of cooling
102 103	108 109	114 115	160 200	6	20 – 30	2,3		Brake applications to rest under wet conditions, after a period of cooling
104 105	110 111	116 117	160 200	12	20 – 30	2,3		Brake applications to rest under wet conditions, after a period of cooling
106 107	112 113	118 119	160 200	21	20 – 30	2,3		Brake applications to rest under wet conditions, after a period of cooling
120 121			80 80	16 21	50 – 60	2,3	121	Conditioning stops
122			70	-	50 – 60	-		Simulation of a downhill brake application with a power of 30 kW for a period of 20 min
123			70	21	-	2,3	123	Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break
124 125 126			120 160 200	16	50 – 60	2,3		Brake applications to rest under dry conditions, after a period of cooling.
127 128 129			120 160 200	21	50 – 60	2,3	129	Brake applications to rest under dry conditions, after a period of cooling.

F.2 Program for simulation brake assessment

Conditions for Table F.2

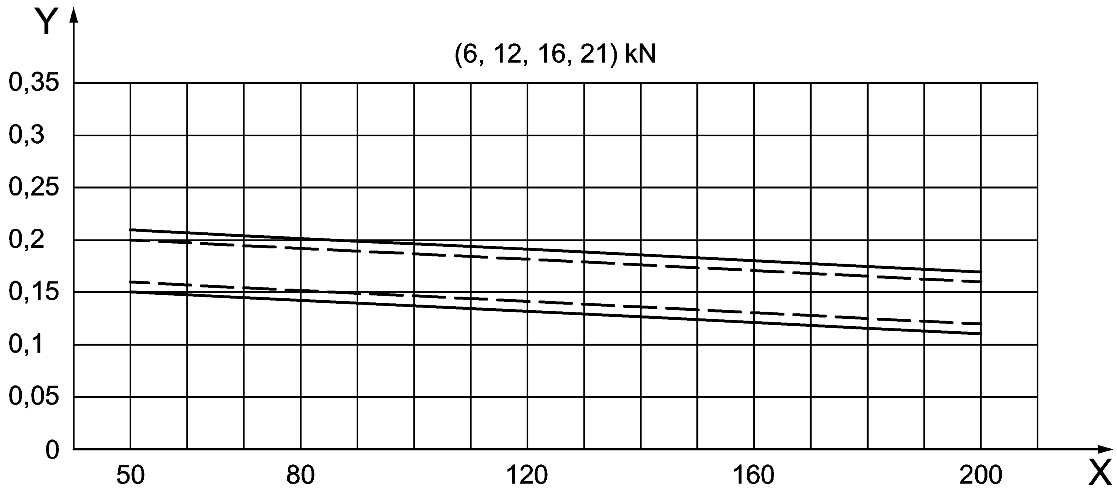
Brake block configuration:	1 × Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,3 t

Table F.2 — Program for simulation brake assessment of brake blocks type L when used for coach applications at maximum speed design from 100 km/h to 200 km/h with combined brake system, 1Bg configuration

No. of brake application	Initial speed	Total F_B per wheel	Initial temperatu re	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
1.1 – 1.X	100	28	20 – 100	5,7	1.X	Brake applications to rest under dry conditions to allow bedding of the brake block up to at least 85 % of the friction material surface.
1 to 5 6 to 10 11 to 15 16 to 20	50 120 160 200	16	50 – 60	2,3		Brake applications to rest under dry conditions, after a period of cooling
21 to 25 26 to 30 31 to 35 36 to 40	50 120 160 200	12	50 – 60	2,3		Brake applications to rest under dry conditions, after a period of cooling
41 to 45 46 to 50 51 to 55 56 to 60	50 120 160 200	21	50 – 60	2,3	60	Brake applications to rest under dry conditions, after a period of cooling

F.3 Dispersion range of mean friction coefficients in dry condition

Dispersion range of mean friction coefficients in dry condition applicable for test programs F.1 and F.2.



Key

— — — enveloping characteristic line of the tolerances for average of mean friction coefficients

——— enveloping characteristic line of the tolerances for Individuals values of means friction coefficients

X speed in km/h

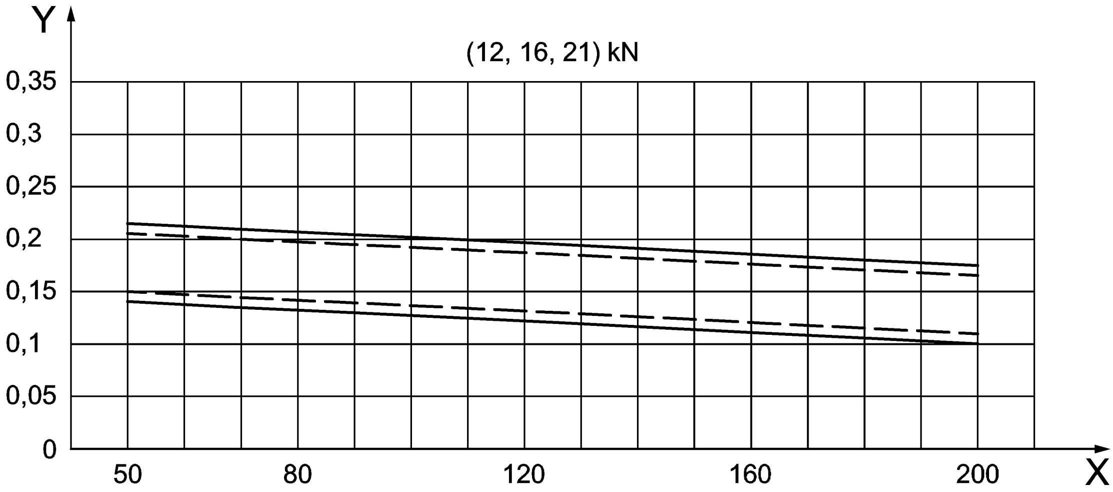
Y friction coefficient

Figure F.1 — Dispersion range of mean friction coefficients in dry condition

Table F.3 — Dispersion range of mean friction coefficients in dry condition

Initial speed v (km/h) ≥		50	80	120	160	200	50	80	120	160	200
F_B kN		Average of means friction coefficients					Individual values of means friction coefficients				
6 12 16 21	Maximum	0,200	0,192	0,181	0,171	0,160	0,210	0,202	0,191	0,181	0,170
	Minimum	0,160	0,152	0,141	0,131	0,120	0,150	0,142	0,131	0,121	0,110

F.4 Dispersion range of mean friction coefficients in wet condition



Key

— — —	enveloping characteristic line of the tolerances for average of mean friction coefficients
———	enveloping characteristic line of the tolerances for Individuals values of means friction coefficients
X	speed in km/h
Y	friction coefficient

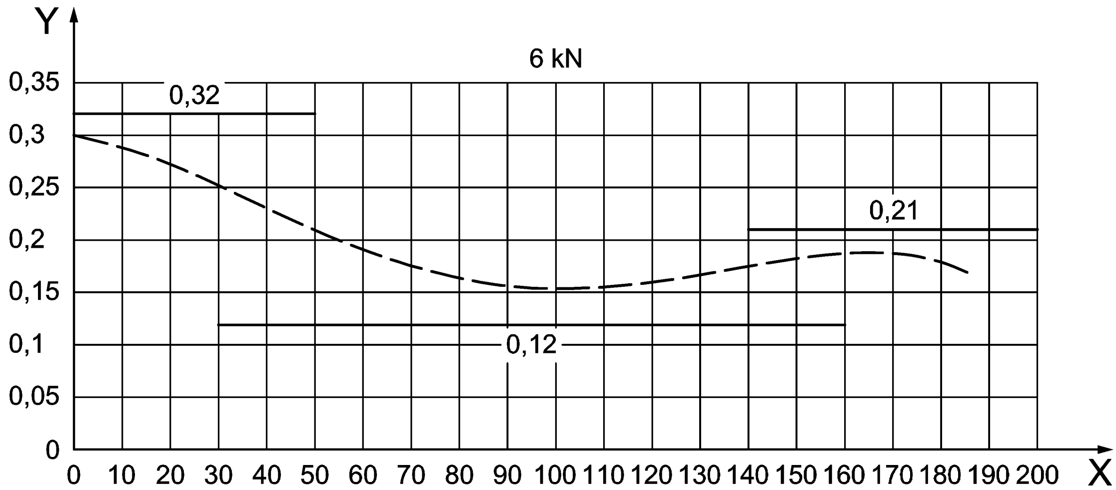
Figure F.2 — Dispersion range of mean friction coefficients in wet condition

Table F.4 — Dispersion range of mean friction coefficients in wet condition

Initial speed v (km/h) ≥		50	80	120	160	200	50	80	120	160	200
F_B kN		Average of means friction coefficients					Individuals values of means friction coefficients				
12 16 21	Maximum	0,210	0,202	0,191	0,181	0,170	0,220	0,112	0,201	0,191	0,180
	Minimum	0,150	0,142	0,131	0,121	0,110	0,140	0,132	0,121	0,111	0,100

F.5 Dispersion range of instantaneous friction coefficients

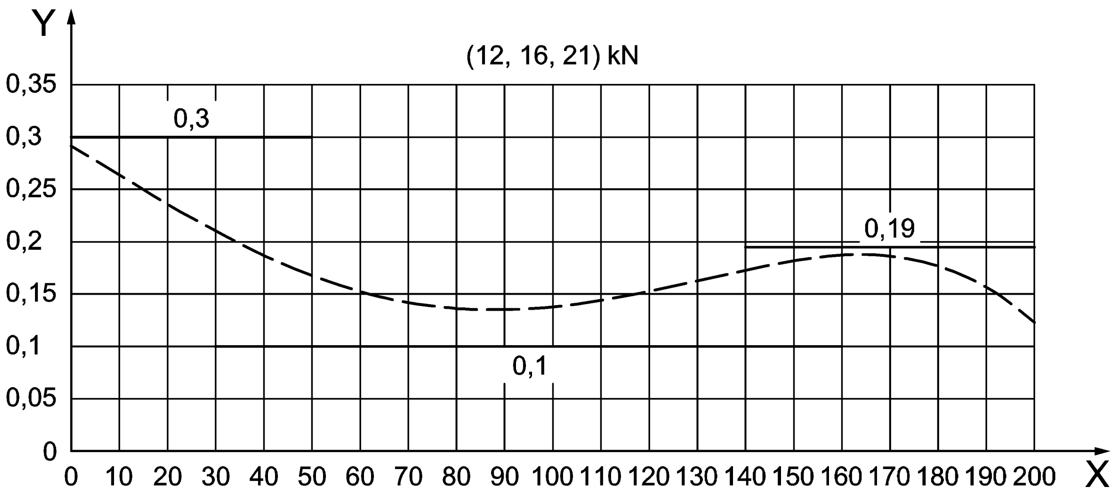
Dispersion range of instantaneous friction coefficients applicable for test programs F.1 and F.2.



Key

— — —	example of instantaneous friction coefficient curve
———	dispersion range of instantaneous friction coefficients for F_B 6 kN and initial speed v ≥ 100 km/h
X	speed in km/h
Y	friction coefficient

Figure F.3 — Dispersion range of instantaneous friction coefficients for F_B 6 kN and initial speed v ≥ 100 km/h



Key

— — —	example of instantaneous friction coefficient curve
———	dispersion range of instantaneous friction coefficients for F_B 12 kN, 16 kN, 21 kN and initial speed v ≥ 100 km/h
X	speed in km/h
Y	friction coefficient

Figure F.4 — Dispersion range of instantaneous friction coefficients for F_B 12 kN, 16 kN, 21 kN and initial speed v ≥ 100 km/h

Annex G
(normative)

Composite brake blocks (K) – Demonstration of friction properties for locomotives

G.1 Program for performance tests

Conditions for Table G.1

Brake block configuration:	1 × Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	1 070 $\left(^{+5}_{-0}\right)$ mm (new wheel 1 150 mm). The accurate diameter shall be given in the test report
To be braked mass per wheel:	11,4 t
Water flow rate:	16 l/h

Table G.1 — Program for performance test of brake blocks type K when used in locomotive applications at maximum speed design from 100 km/h to 200 km/h, 1xBgu configuration, new wheel from 1 100 mm to 1 260 mm

<table>
<tr><th colspan="6" rowspan="3">No. of brake application</th><th>Initial speed</th><th>Total F_B per wheel</th><th>Initial temperatu re</th><th>Mass to brake per wheel</th><th>weighing after</th><th rowspan="3">Remarks</th></tr>
<tr><th>v</th><th>F_B</th><th>θ_0</th><th>m</th><th></th></tr>
<tr><th>km/h</th><th>kN</th><th>°C</th><th>t</th><th>No.</th></tr>
<tr><td colspan="2">1</td><td colspan="2">3</td><td colspan="2">5</td><td>30</td><td>30</td><td rowspan="2">20 – 30</td><td rowspan="2">11,4</td><td rowspan="2"></td><td rowspan="2">Brake applications to rest under wet conditions, after a period of cooling</td></tr>
<tr><td colspan="2">2</td><td colspan="2">4</td><td colspan="2">6</td><td>100</td><td>42</td></tr>
<tr><td colspan="3">7</td><td colspan="3">9</td><td>30</td><td>30</td><td rowspan="2">50 – 60</td><td rowspan="2">11,4</td><td rowspan="2"></td><td rowspan="2">Brake applications to rest under dry conditions, after a period of cooling</td></tr>
<tr><td colspan="3">8</td><td colspan="3">10</td><td>100</td><td>42</td></tr>
<tr><td colspan="6">11.1–11.X</td><td>100</td><td>30</td><td>80 – 100</td><td>11,4</td><td>11.X</td><td>Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface. Measure wheel roughness at end of this section.</td></tr>
</table>

No. of brake application		Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
12	33	30	30	50 – 60	11,4		Brake applications to rest under dry conditions, after a period of cooling
13	34	60					
14	35	100					
15	36	120					
16	37	140					
17	38	160					
18	39	200					
19	40	70	-	-	-		10 kW drag brake application for a period of 10 min done immediately after brake nº 18 and nº 39, without interruption. This is to evenly distribute the residual stress within the wheel.
20	41	30	18	50 – 60	11,4		Brake applications to rest under dry conditions, after a period of cooling
21	42	60					
22	43	100					
23	44	120					
24	45	140					
25	46	160					
26	47	200					
27	48	70	-	-	-		10 kW drag brake application for a period of 10 min done immediately after brake nº 26 and nº 47, without interruption. This is to evenly distribute the residual stress within the wheel.
28	49	30	42	50 – 60	11,4		Brake applications to rest under dry conditions, after a period of cooling
29	50	60					
30	51	100					
31	52	120					
32	53	140					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperatu re	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
54			70	-	-	-		10 kW drag brake application for a period of 10 min done immediately after brake nº 53, without interruption. This is to evenly distribute the residual stress within the wheel.
55	71	87	30	30	20 – 30	11,4		Brake applications to rest under wet conditions, after a period of cooling
56	72	88	60					
57	73	89	100					
58	74	90	120					
59	75	91	140					
60	76	92	160					
61	77	93	200					
62	78	94	30	18	20 – 30	11,4		Brake applications to rest under wet conditions, after a period of cooling
63	79	95	60					
64	80	96	100					
65	81	97	120					
66	82	98	140					
67	83	99	160					
68	84	100	200					
69	85	101	120	42	20 – 30	11,4		Brake applications to rest under wet conditions, after a period of cooling
70	86	102	140					
103			70	-	-	-	103	10 kW drag brake application for 10 min in order to dry the brake blocks
104			60	42	110 – 120	11,4		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling
105			120					
106			140					
107			70	-	50 – 60	-		Simulation of a downhill brake application with a power of 45 kW for a period of 34 min

No. of brake application		Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
108		70	42	-	-		Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break
109 110 111	115 116 117	60 120 140	18	50 – 60	11,4		Brake applications to rest under dry conditions, after a period of cooling
112 113 114	118 119 120	60 120 140	42	50 – 60	11,4		Brake applications to rest under dry conditions, after a period of cooling
121		70	-	-	-	121	10 kW drag brake application for a period of 10 min done immediately after brake nº 120, without interruption. This is to evenly distribute the residual stress within the wheel. Measure wheel roughness at end of this section.
Specific requirements for ventilation conditions for conducting test program. — the speed of the cooling air between brake applications under dry conditions shall be 20 km/h; — the speed of the cooling air after 10 kW drag brake shall be 10 km/h.							

G.2 Program for simulation brake assessment

Conditions for Table G.2

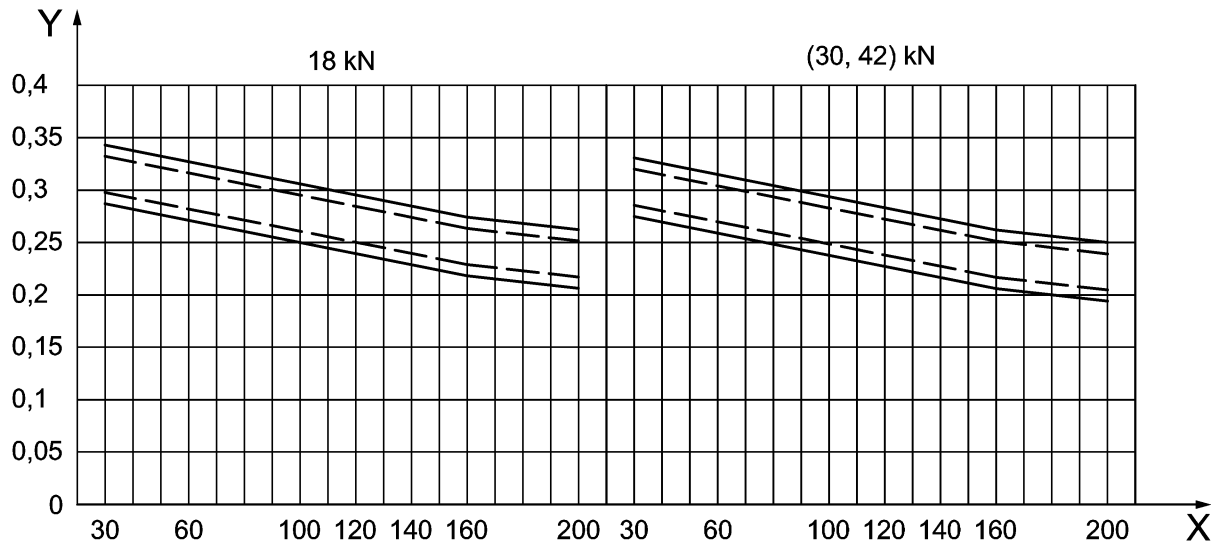
Brake block configuration:	1 × Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	1 070 $\left(^{+5}_{-0}\right)$ mm (new wheel 1 150 mm). The accurate diameter shall be given in the test report
To be braked mass per wheel:	11,4 t

Table G.2 — Program for simulation brake assessment of brake blocks type K when used in locomotive applications at maximum speed design from 100 km/h to 200 km/h, 1xBgu configuration, new wheel from 1 100 mm to 1 260 mm

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
1.1–1.X	100	30	80 – 100	11,4	1.X	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
1 to 5	60	30	50 – 60	11,4		Brake applications to rest under dry conditions, after a period of cooling
6 to 10	30	18				
11 to 15	140	42				
16 to 20	160	30				
21 to 25	60	30				
26 to 30	30	18				
31 to 35	140	42				
36 to 40	160	30			40	
Specific requirements for ventilation conditions for conducting test program. — the speed of the cooling air between brake applications under dry conditions shall be 20 km/h						

G.3 Dispersion range of mean friction coefficients in dry condition

Dispersion range of mean friction coefficients in dry condition applicable for test programs G.1 and G.2.



Key

— — —	enveloping characteristic line of the tolerances for average of mean friction coefficients
———	enveloping characteristic line of the tolerances for Individuals values of means friction coefficients
X	speed in km/h
Y	friction coefficient

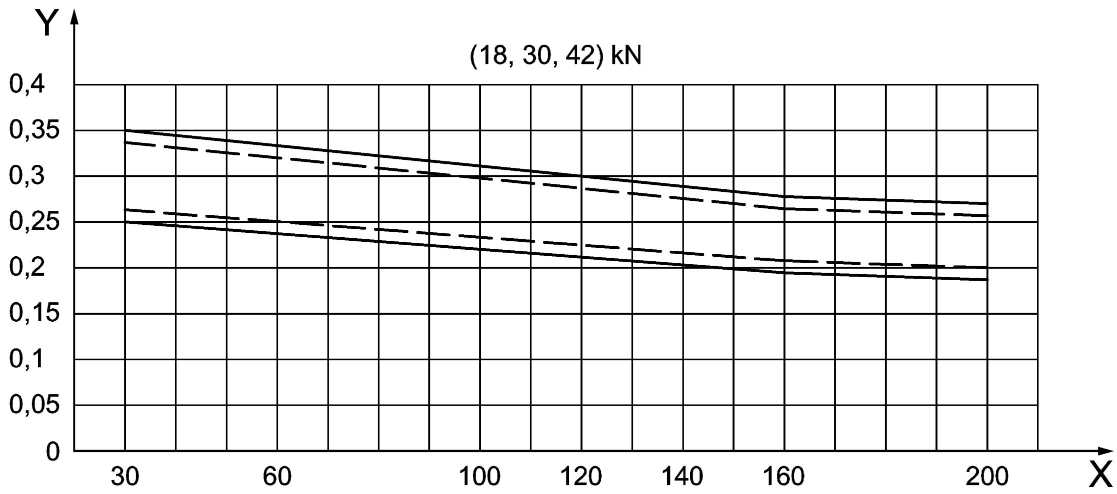
Figure G.1 — Dispersion range of mean friction coefficients in dry condition

Table G.3 — Dispersion range of mean friction coefficients in dry condition

Initial speed v (km/h) ≥		30	60	100	120	140	160	200	30	60	100	120	140	160	200
F_B kN		Average of means friction coefficients							Individuals values of means friction coefficients						
18	Maximum	0,330	0,316	0,298	0,289	0,280	0,270	0,260	0,340	0,326	0,308	0,299	0,290	0,280	0,270
	Minimum	0,290	0,276	0,258	0,249	0,240	0,230	0,220	0,280	0,266	0,248	0,239	0,230	0,220	0,210
30 42	Maximum	0,310	0,296	0,278	0,269	0,260	0,250	0,240	0,320	0,306	0,288	0,279	0,270	0,260	0,250
	Minimum	0,270	0,256	0,238	0,229	0,220	0,210	0,200	0,260	0,246	0,228	0,219	0,210	0,200	0,190

G.4 Dispersion range of mean friction coefficients in wet condition

Dispersion range of mean friction coefficients in wet condition applicable for test program G.1.



Key

— — —	enveloping characteristic line of the tolerances for average of mean friction coefficients
———	enveloping characteristic line of the tolerances for Individuals values of means friction coefficients
X	speed in km/h
Y	friction coefficient

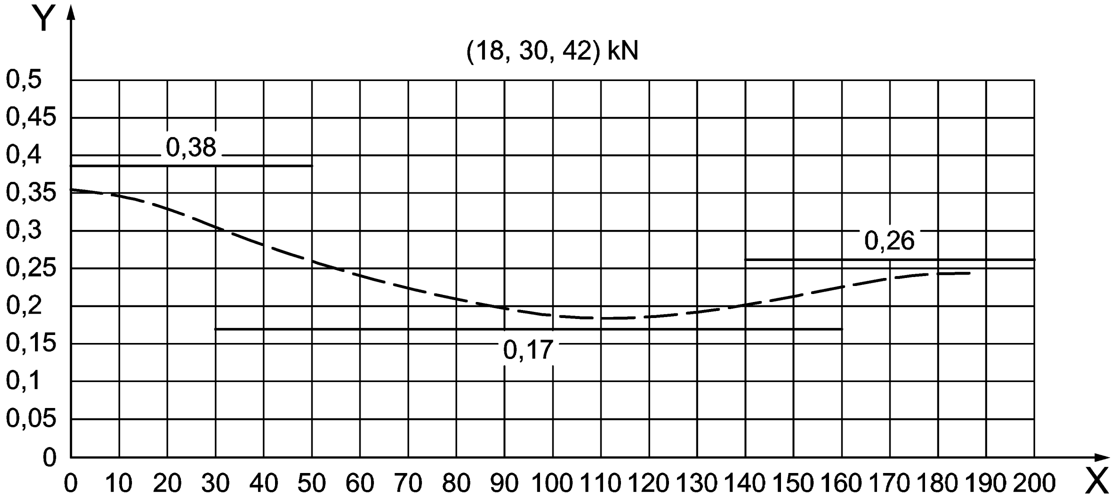
Figure G.2 — Dispersion range of mean friction coefficients in wet condition

Table G.4 — Dispersion range of mean friction coefficients in wet condition

Initial speed v (km/h) ≥		30	60	100	120	140	160	200	30	60	100	120	140	160	200
F_B kN		Average of means friction coefficients							Individuals values of means friction coefficients						
18 30 42	Maximum	0,340	0,324	0,302	0,291	0,280	0,270	0,260	0,350	0,334	0,312	0,301	0,290	0,280	0,270
	Minimum	0,260	0,249	0,235	0,227	0,220	0,210	0,200	0,250	0,239	0,225	0,217	0,210	0,200	0,190

G.5 Dispersion range of instantaneous friction coefficients

Dispersion range of instantaneous friction coefficients applicable for test programs G.1 and G.2.



Key

— — —	example of instantaneous friction coefficient curve
———	dispersion range of instantaneous friction coefficients for F_B 18 kN, 30 kN, 42 kN and initial speed $v \geq 100$ km/h
X	speed in km/h
Y	friction coefficient

Figure G.3 — Dispersion range of instantaneous friction coefficients for F_B 18 kN, 30 kN, 42 kN and initial speed $v \geq 100$ km/h

Annex H
(normative)

Composite brake blocks (K) – Demonstration of friction properties for EMU – DMU

H.1 Program for performance tests

Conditions for Table H.1

Brake block configuration:	1 × Bgu [2 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\binom{+5}{-0}$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.
To be braked mass per wheel:	4,5 t, 7,5 t and 11,0 t
Water flow rate:	14 l/h per wheel at v < 120 km/h and 22 l/h per wheel at v ≥ 120 km/h.

Table H.1 — Program for performance test of brake blocks type K when used in EMU/DMU applications at maximum speed design from 100 km/h to 160 km/h, 1xBgu configuration, new wheel from 840 mm to 1 020 mm

No. of brake application		Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
1.1 – 1.X		100	20	80 – 100	7,5	1.X	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface. Measure wheel roughness at end of this section.
1	16	50	30	50 – 60	4,5		Brake applications to rest under dry conditions, after a period of cooling
2	17	80					
3	18	120					
4	19	140					
5	20	160					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
6	21		50					
7	22		80					
8	23		120	23	50 – 60	4,5		Brake applications to rest under dry conditions, after a period of cooling
9	24		140					
10	25		160					
11	26		50					
12	27		80					
13	28		120	45	50 – 60	4,5		Brake applications to rest under dry conditions, after a period of cooling
14	29		140					
15	30		160					
31	46	61	50					
32	47	62	80					
33	48	63	120	30	20 – 30	4,5		Brake applications to rest under wet conditions, after a period of cooling
34	49	64	140					
35	50	65	160					
36	51	66	50					
37	52	67	80					
38	53	68	120	23	20 – 30	4,5		Brake applications to rest under wet conditions, after a period of cooling
39	54	69	140					
40	55	70	160					
41	56	71	50					
42	57	72	80					
43	58	73	120	45	20 – 30	4,5		Brake applications to rest under wet conditions, after a period of cooling
44	59	74	140					
45	60	75	160					
76	77		140	35	50 – 60	4,5		Brake applications to rest to dry the brake blocks
78	103		50					
79	104		80					
80	105		120	30	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
81	106		140					
82	107		160					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperatu re	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
83	108		50	12	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
84	109		80					
85	110		120					
86	111		140					
87	112		160					
88	113		50	45	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
89	114		80					
90	115		120					
91	116		140					
92	117		160					
93	118		50	23	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
94	119		80					
95	120		120					
96	121		140					
97	122		160					
98	123		50	35	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
99	124		80					
100	125		120					
101	126		140					
102	127		160					
128	148	168	80	30	20 – 30	7,5		Brake applications to rest under wet conditions, after a period of cooling
129	149	169	120					
130	150	170	140					
131	151	171	160					
132	152	172	80	12	20 – 30	7,5		Brake applications to rest under wet conditions, after a period of cooling
133	153	173	120					
134	154	174	140					
135	155	175	160					
136	156	176	80	45	20 – 30	7,5		Brake applications to rest under wet conditions, after a period of cooling
137	157	177	120					
138	158	178	140					
139	159	179	160					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
140	160	180	80	23	20 – 30	7,5		Brake applications to rest under wet conditions, after a period of cooling
141	161	181	120					
142	162	182	140					
143	163	183	160					
144	164	184	80	35	20 – 30	7,5		Brake applications to rest under wet conditions, after a period of cooling
145	165	185	120					
146	166	186	140					
147	167	187	160					
188	189		140	35	50 – 60	7,5		Brake applications to rest to dry the brake blocks
190	210		50	30	50 – 60	11,0		Brake applications to rest under dry conditions, after a period of cooling
191	211		80					
192	212		120					
193	213		140					
194	214		160					
195	215		50	45	50 – 60	11,0		Brake applications to rest under dry conditions, after a period of cooling
196	216		80					
197	217		120					
198	218		140					
199	219		160					
200	220		50	23	50 – 60	11,0		Brake applications to rest under dry conditions, after a period of cooling
201	221		80					
202	222		120					
203	223		140					
204	224		160					
205	225		50	35	50 – 60	11,0		Brake applications to rest under dry conditions, after a period of cooling
206	226		80					
207	227		120					
208	228		140					
209	229		160					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
230	246	262	80	30	20 – 30	11,0		Brake applications to rest under wet conditions, after a period of cooling
231	247	263	120					
232	248	264	140					
233	249	265	160					
234	250	266	80	45	20 – 30	11,0		Brake applications to rest under wet conditions, after a period of cooling
235	251	267	120					
236	252	268	140					
237	253	269	160					
238	254	270	80	23	20 – 30	11,0		Brake applications to rest under wet conditions, after a period of cooling
239	255	271	120					
240	256	272	140					
241	257	273	160					
242	258	274	80	35	20 – 30	11,0		Brake applications to rest under wet conditions, after a period of cooling
243	259	275	120					
244	260	276	140					
245	261	277	160					
278	279		140	35	50 – 60	11,0		Brake applications to rest to dry the brake blocks
280			160	45	100 – 110	11,0		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling
281			100					
282			140					
283			80					
284			60	12	50 – 60	11,0		Brake applications to rest under dry conditions, after a period of cooling
285				45			285	
286			40	-	50 – 60	-		Simulation of a downhill brake application with a power of 45 kW for a period of 20 min
287			40	45	-	11,0		Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
288	50	23	50 – 60	11,0		Brake applications to rest under dry conditions, after a period of cooling. Measure wheel roughness at end of this section.
289	80	45				
290	120	35				
291	140	23				
292	160	45			292	

H.2 Program for simulation brake assessment

Conditions for Table H.2

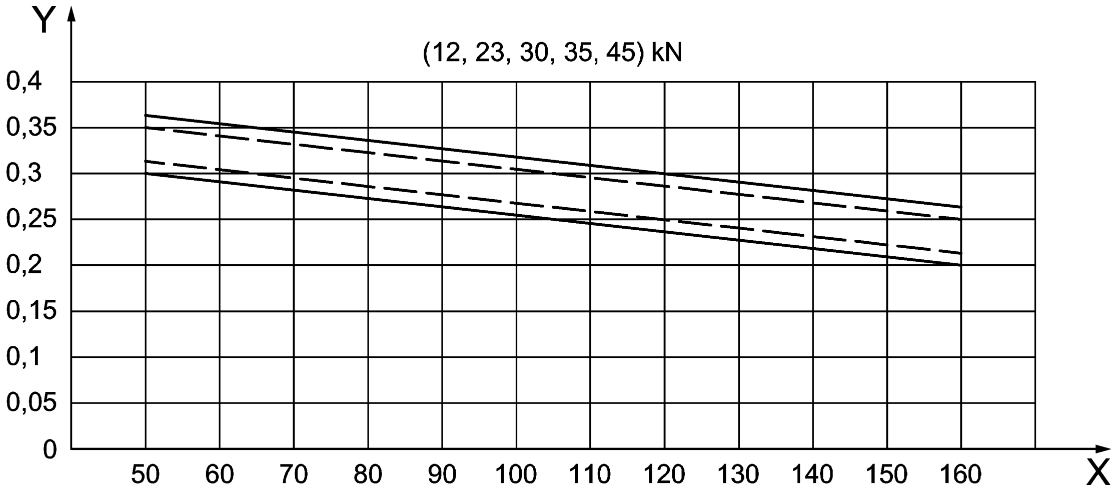
Brake block configuration:	1 × Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.
To be braked mass per wheel:	4,5 t and 7,5 t

Table H.2 — Program for simulation brake assessment of brake blocks type K when used in EMU/DMU applications at maximum speed design from 100 km/h to 160 km/h, 1xBgu configuration, new wheel from 840 mm at 1 020 mm

No. of brake application	Initial speed	Total F_B per wheel	Initial temperatu re	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
1.1 – 1.X	100	20	80 – 100	7,5	1.X	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
1 to 5	120	35	50 – 60	4,5		Brake applications to rest under dry conditions, after a period of cooling
6 to 10	140					
11 to 15	160					
16 to 20	120	30	50 – 60	4,5		Brake applications to rest under dry conditions, after a period of cooling
21 to 25	140					
26 to 30	160					
31 to 35	120	45	50 – 60	4,5		Brake applications to rest under dry conditions, after a period of cooling
36 to 40	140					
41 to 45	160					
46 to 50	120	35	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
51 to 55	140					
56 to 60	160					
61 to 65	120	30	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
66 to 70	140					
71 to 75	160					
76 to 80	120	45	50 – 60	7,5		Brake applications to rest under dry conditions, after a period of cooling
81 to 85	140					
86 to 90	160				90	

H.3 Dispersion range of mean friction coefficients in dry condition

Dispersion range of mean friction coefficients in dry condition applicable for test programs H.1 and H.2.



Key

— — —	enveloping characteristic line of the tolerances for average of mean friction coefficients
———	enveloping characteristic line of the tolerances for Individuals values of means friction coefficients
X	speed in km/h
Y	friction coefficient

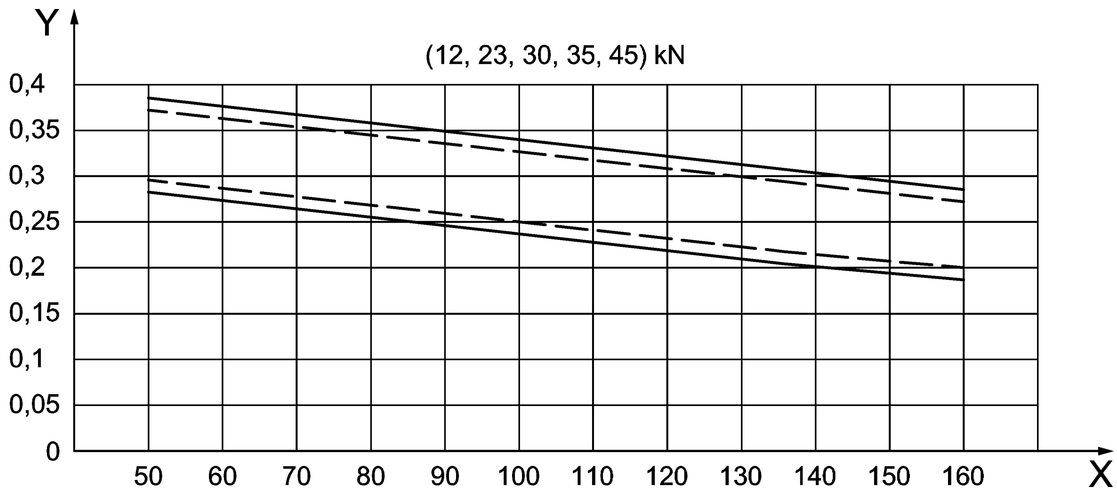
Figure H.1 — Dispersion range of mean friction coefficients in dry condition

Table H.3 — Dispersion range of mean friction coefficients in dry condition

Initial speed *v* (km/h) ≥		50	80	120	140	160	50	80	120	140	160
F_B kN		Average of means friction coefficients					Individuals values of means friction coefficients				
12 23 30 35 45	Maximum	0,350	0,323	0,286	0,268	0,250	0,360	0,333	0,296	0,278	0,260
	Minimum	0,310	0,283	0,246	0,228	0,210	0,300	0,273	0,236	0,218	0,200

H.4 Dispersion range of mean friction coefficients in wet condition

Dispersion range of mean friction coefficients in wet condition applicable for test program H.1.



Key

— — —	enveloping characteristic line of the tolerances for average of mean friction coefficients
———	enveloping characteristic line of the tolerances for Individuals values of means friction coefficients
X	speed in km/h
Y	friction coefficient

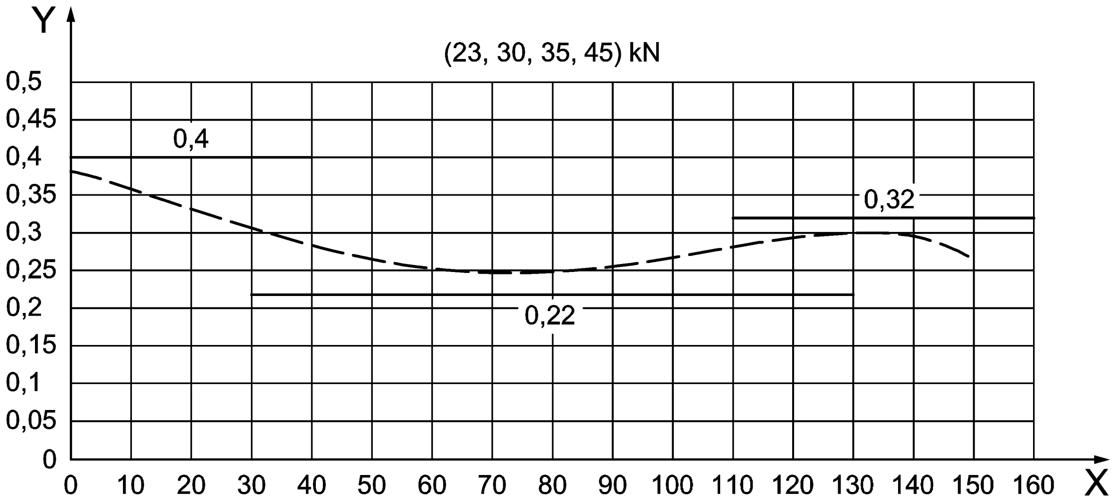
Figure H.2 — Dispersion range of mean friction coefficients in wet condition

Table H.4 — Dispersion range of mean friction coefficients in wet condition

Initial speed v (km/h) ≥		50	80	120	140	160	50	80	120	140	160
F_B kN		Average of means friction coefficients					Individual values of means friction coefficients				
12 23 30 35 45	Maximum	0,370	0,345	0,313	0,296	0,280	0,380	0,355	0,323	0,306	0,290
	Minimum	0,290	0,265	0,233	0,216	0,200	0,280	0,255	0,223	0,206	0,190

H.5 Dispersion range of instantaneous friction coefficients

Dispersion range of instantaneous friction coefficients applicable for test programs H.1 and H.2.



Key

— — —	example of instantaneous friction coefficient curve
———	dispersion range of instantaneous friction coefficients at initial speed v > 100 km/h
X	speed in km/h
Y	friction coefficient

Figure H.3 — Dispersion range of instantaneous friction coefficients at initial speed v > 100 km/h

Annex I
(normative)

Composite brake blocks (K) – Demonstration of friction properties for High speed train (motor bogie)

I.1 Program for performance tests

Conditions for Table I.1

Brake block configuration:	1 × Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	850 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,5 t and 4,0 t (4,0 t/wheel v_i ≤ 200 km/h and 2,5 t/wheel v_i > 200 km/h)
Water flow rate:	14 l/h per wheel at v < 120 km/h and 22 l/h per wheel at v ≥ 120 km/h.

Table I.1 — Program for performance test of brake blocks type K when used in high speed train applications (motor bogie) at maximum speed design from 200 km/h to 320 km/h, 1xBg configuration, new wheel of 920 mm and contribution of brake blocks in emergency braking < 15 % of braking force applied on a motor bogie

No. of brake application		Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
		v	F_B	θ_0	m		
		km/h	kN	°C	t	No.	
1.1 – 1.X		120	23	80 – 100	4,0	1.X	Brake applications to rest under dry conditions to allow bedding of the brake block up to at least 85 % of the friction material surface. Measure wheel roughness at end of this section.
1	18	30	15	50 – 60	4,0		Brake applications to rest under dry conditions, after a period of cooling
2	19	60					
3	20	100					
4	21	160					
5	22	200					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
6	23		70	-	-	-		10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 5 and 22 without interruption. This is to evenly distribute the residual stress within the wheel.
7	24		30	8	50 – 60	4,0		Brake applications to rest under dry conditions, after a period of cooling
8	25		60					
9	26		100					
10	27		160					
11	28		200					
12	29		30	23	50 – 60	4,0		Brake applications to rest under dry conditions, after a period of cooling
13	30		60					
14	31		100					
15	32		160					
16	33		200					
17	34		70	-	-	-		10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 16 and 33 without interruption. This is to evenly distribute the residual stress within the wheel.
35	50	65	30	15	20 – 30	4,0		Brake applications to rest under wet conditions, after a period of cooling
36	51	66	60					
37	52	67	100					
38	53	68	160					
39	54	69	200					
40	55	70	30	8	20 – 30	4,0		Brake applications to rest under wet conditions, after a period of cooling
41	56	71	60					
42	57	72	100					
43	58	73	160					
44	59	74	200					

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
45	60	75	30	23	20 – 30	4,0		Brake applications to rest under wet conditions, after a period of cooling
46	61	76	60					
47	62	77	100					
48	63	78	160					
49	64	79	200					
80 to 84			100	15	50 – 60	4,0		Brake applications to rest to dry the brake blocks
85			70	-	-	-		10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 84 without interruption. This is to evenly distribute the residual stress within the wheel.
86			60	15	110 – 120	4,0		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling
87			100					
88			160					
89			200				89	
90	97	103	300/200/0	8/23	50 – 60	2,5/4,0		Brake applications to rest under dry conditions, after a period of cooling. Measurement of maximum lateral displacement of the rim during braking 94 [a]
91	98	104	270/200/0					
92	99	105	320/200/0					
93	100	106	240/200/0					
94	101	107	360/200/0					
95	102	108	340/200/0					
96		109	70	-	-	-		10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 95 without interruption. This is to evenly distribute the residual stress within the wheel.
110	116	122	300/200/0	8/23	20 – 30	2,5/4,0		Brake applications to rest under wet conditions, after a period of cooling
111	117	123	270/200/0					
112	118	124	320/200/0					
113	119	125	240/200/0					
114	120	126	360/200/0					
115	121	127	340/200/0					

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
128 to 132	100	15	50 – 60	4,0		Brake applications to rest to dry the brake blocks. Measurement of maximum lateral displacement of the rim after cooling of braking 132[a]
133	90	-	20 – 60	-		Simulation of a downhill brake application with a power of 30 kW for a period of 20 min
134	90	23	-	4,0		Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any period of cooling
135 136 137 138	60 100 160 200	15	50 – 60	4,0	138	Brake applications to rest under dry conditions, after a period of cooling

[a] Specific requirements for maximal displacement of the rim;

The maximum displacement of the rim during braking 94 and after cooling of braking 132 shall be measured in conformity with prescriptions of EN 13979–1

Pass/fail criteria:

- Maximum lateral displacement of the rim during braking = + 3 mm/- 1 mm
- Maximum lateral displacement of the rim after cooling = + 1,5 mm/- 0,5 mm

I.2 Program for simulation brake assessment

Conditions for Table I.2

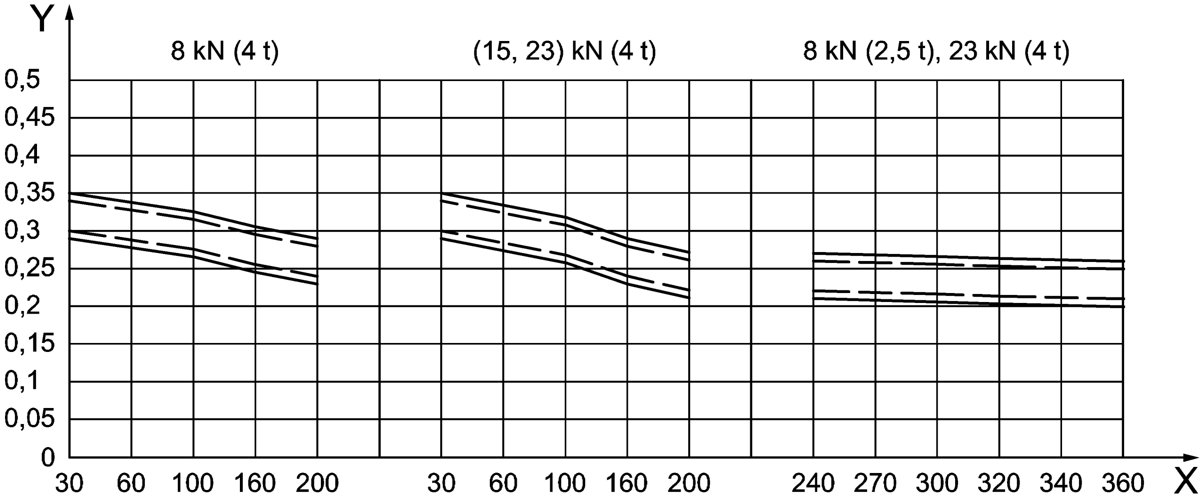
Brake block configuration:	1 × Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	850 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,5 t and 4,0 t (4,0 t/wheel v_i ≤ 200 km/h and 2,5 t/wheel v_i > 200 km/h)

Table I.2 — Program for simulation brake assessment of brake blocks type K when used in high speed train applications (motor bogie) at maximum speed design from 200 km/h to 320 km/h, 1xBg configuration, new wheel of 920 mm and contribution of brake blocks in emergency braking < 15 % of braking force applied on a motor bogie

No. of brake application	Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
1.1 – 1.X	120	23	80 – 100	4,0	1.X	Brake applications to rest under dry conditions to allow bedding of the brake block up to at least 85 % of the friction material surface.
1 to 5 6 to 10 11 to 15	100 160 200	8	50 – 60	4,0		Brake applications to rest under dry conditions, after a period of cooling
16 to 20 21 to 25 26 to 30	100 160 200	23	50 – 60	4,0		
31 to 35	240/200/0	8/23	50 – 60	2,5/4,0		
36 to 40	160	15	50 – 60	4,0		
41 to 45	270/200/0	8/23	50 – 60	2,5/4,0		
46 to 50	160	15	50 – 60	4,0		
51 to 55	320/200/0	8/23	50 – 60	2,5/4,0		
56 to 60	160	15	50 – 60	4,0		
61 to 65	360/200/0	8/23	50 – 60	2,5/4,0		
66 to 70	160	15	50 – 60	4,0		
71	70	-	-	-	71	10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 70 without interruption. This is to evenly distribute the residual stress within the wheel.

I.3 Dispersion range of mean friction coefficients in dry condition

Dispersion range of mean friction coefficients in dry condition applicable for test programs I.1 and I.2.



Key

— — —	enveloping characteristic line of the tolerances for average of mean friction coefficients
———	enveloping characteristic line of the tolerances for Individuals values of means friction coefficients
X	speed in km/h
Y	friction coefficient

Figure I.1 — Dispersion range of mean friction coefficients in dry condition

Table I.3 — Dispersion range of mean friction coefficients in dry condition 8 kN, 4,0 t

Initial speed v (km/h) ≥		30	60	100	160	200	30	60	100	160	200
F_B kN		Average of mean friction coefficients					Individual values of mean friction coefficients				
8	Maximum	0,340	0,329	0,315	0,294	0,280	0,350	0,339	0,325	0,304	0,290
	Minimum	0,300	0,289	0,275	0,254	0,240	0,290	0,279	0,265	0,244	0,230

Table I.4 — Dispersion range of mean friction coefficients in dry condition 15 kN and 23 kN, 4,0 t

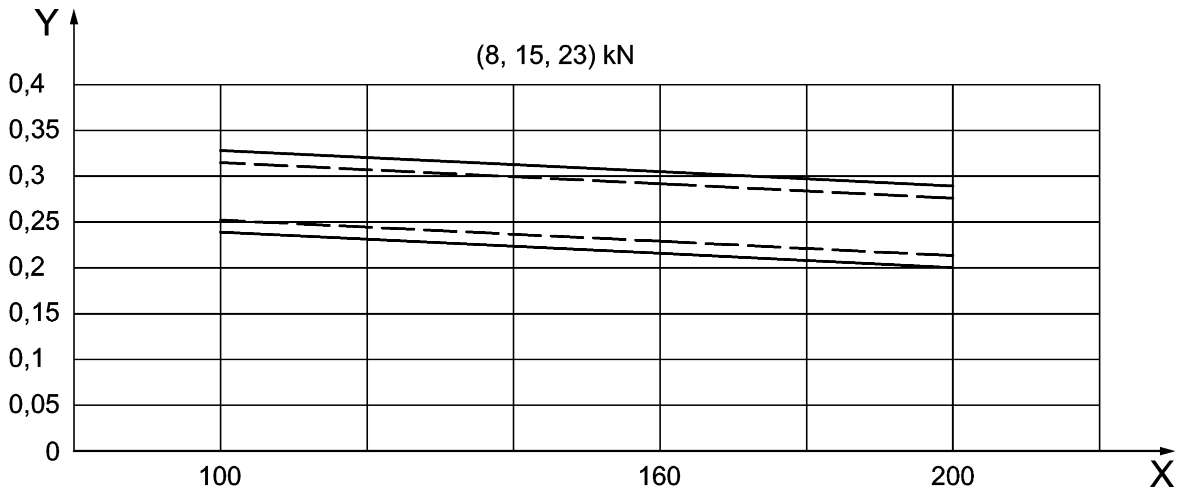
Initial speed v (km/h) ≥		30	60	100	160	200	30	60	100	160	200
F_B kN		Average of mean friction coefficients					Individual values of mean friction coefficients				
15 23	Maximum	0,340	0,326	0,307	0,279	0,260	0,350	0,336	0,317	0,289	0,270
	Minimum	0,300	0,286	0,267	0,239	0,220	0,290	0,276	0,257	0,229	0,210

Table I.5 — Dispersion range of mean friction coefficients in dry condition 8 kN/23 kN, 2,5 t/4,0 t

Initial speed v (km/h) ≥		240	270	300	320	340	360	240	270	300	320	340	360
F_B kN		Average of mean friction coefficients						Individual values of mean friction coefficients					
8/23	Maximum	0,260	0,258	0,255	0,253	0,252	0,250	0,270	0,268	0,265	0,263	0,262	0,260
	Minimum	0,220	0,218	0,215	0,213	0,212	0,210	0,210	0,208	0,205	0,203	0,202	0,200

I.4 Dispersion range of mean friction coefficients in wet condition

Dispersion range of mean friction coefficients in wet condition applicable for test program I.1.



Key

— — —	enveloping characteristic line of the tolerances for average of mean friction coefficients
———	enveloping characteristic line of the tolerances for Individuals values of mean friction coefficients
X	speed in km/h
Y	friction coefficient

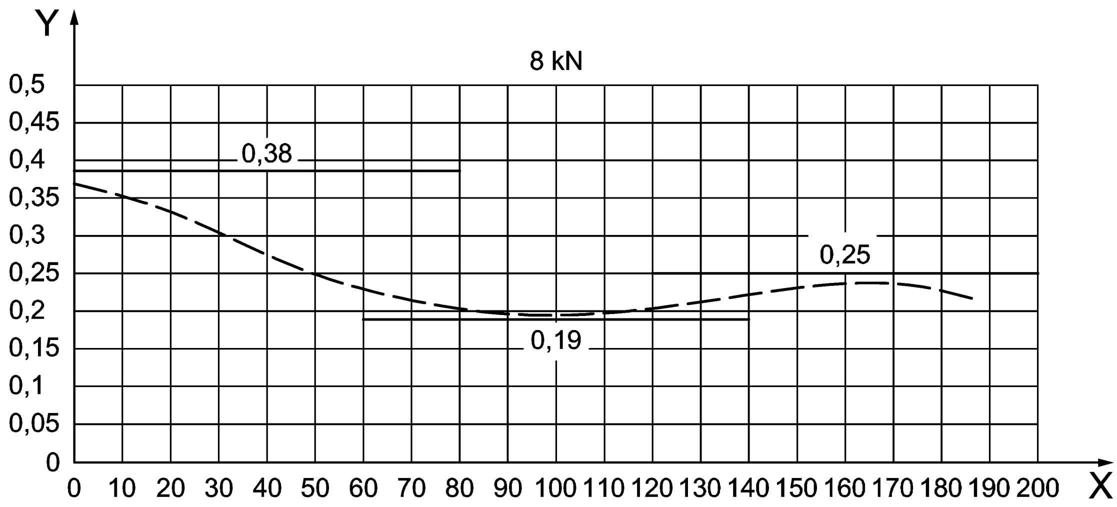
Figure I.2 — Dispersion range of mean friction coefficients in dry condition

Table I.6 — Dispersion range of mean friction coefficients in wet condition 8 kN, 15 kN and 23 kN, 4,0 t

Initial speed v (km/h) ≥		100	160	200	100	160	200
F_B kN		Average of mean friction coefficients			Individual values of mean friction coefficients		
8 - 15 - 23	Maximum	0,320	0,296	0,280	0,330	0,306	0,290
	Minimum	0,240	0,222	0,210	0,230	0,212	0,200

I.5 Dispersion range of instantaneous friction coefficients

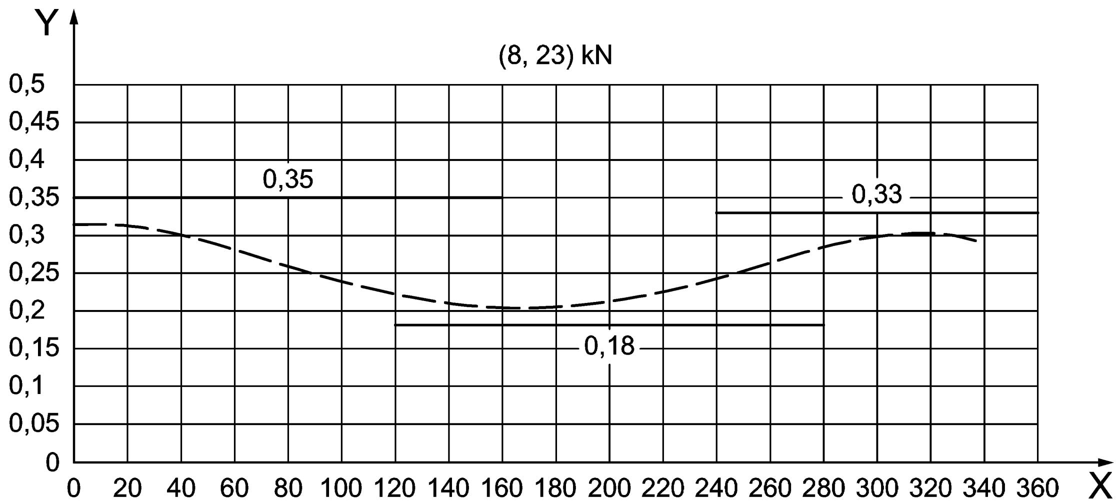
Dispersion range of instantaneous friction coefficients applicable for test programs I.1 and I.2.



Key

— — —	example of instantaneous friction coefficient curve
———	dispersion range of instantaneous friction coefficients at initial speed $v \leq 200$ km/h
X	speed in km/h
Y	friction coefficient

Figure I.3 — Dispersion range of instantaneous friction coefficients at initial speed $v \leq 200$ km/h and F_B = 8 kN



Key

— — —	example of instantaneous friction coefficient curve
———	dispersion range of instantaneous friction coefficients at initial speed $v > 200$ km/h
X	speed in km/h
Y	friction coefficient

Figure I.4 — Dispersion range of instantaneous friction coefficients at initial speed $v > 200$ km/h and F_B = 8 kN/23 kN

Annex J
(informative)

Dynamometer test program – Generic test program

J.1 General

This annex sets out the principle to design brake dynamometer performance tests for a given application. This principle can be applied for design a test program:

- — Category A tests for which there does not exist a standard program to assess a brake block;
- — Category B tests to assess if the brake block material is suitable for a specific application.

J.2 Generic test program

Conditions for Table J.1

Brake block configuration:	XXX per wheel
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	Ø XXX ± 5 mm last machining size before wheel is fully worn to EN 13979–1
To be braked mass per wheel:	m_1 t and m_2 t
Water flow rate:	XXX l/h (without specific requirements 14 l/h should be used)

Table J.1 — Generic test program

<table>
<tr><td rowspan="3" colspan="3">No. of brake application</td><td>Initial speed</td><td>Total F_B per wheel</td><td>Initial temperature</td><td>Mass to brake per wheel</td><td>weighing after</td><td rowspan="3">Remarks</td></tr>
<tr><td>v</td><td>F_B</td><td>θ_0</td><td>m</td><td></td></tr>
<tr><td>km/h</td><td>kN</td><td>°C</td><td>t</td><td>No.</td></tr>
<tr><td colspan="3">1.1 - 1.X</td><td>v_m</td><td>$\frac{2}{3} F_{B2}$</td><td>20 – 100</td><td>m_2</td><td>1.X</td><td>Brake applications to rest under dry conditions to allow bedding of the brake block up to at least 85 % of the friction material surface</td></tr>
<tr><td>1</td><td>3</td><td>5</td><td>$\frac{3}{4} v_m$</td><td rowspan="2">F_{B2}</td><td rowspan="2">50 – 60</td><td rowspan="2">m_2</td><td rowspan="2"></td><td rowspan="2">Brake applications to rest under dry conditions, after a period of cooling.</td></tr>
<tr><td>2</td><td>4</td><td>6</td><td>v_m</td></tr>
<tr><td colspan="3">7 to 26</td><td>v_m</td><td>$\frac{2}{3} F_{B1}$</td><td>20 – 100</td><td>m_1</td><td></td><td>Conditioning stops</td></tr>
</table>

No. of brake application			Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
			v	F_B	θ_0	m		
			km/h	kN	°C	t	No.	
27 28 29 30	39 40 41 42		$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	$\frac{2}{3} F_{B1}$	50 – 60	m_1		Brake applications to rest under dry conditions, after a period of cooling.
31 32 33 34	43 44 45 46		$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	$\frac{1}{3} F_{B1}$	50 – 60	m_1		Brake applications to rest under dry conditions, after a period of cooling.
35 36 37 38	47 48 49 50		$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	F_{B1}	50 – 60	m_1		Brake applications to rest under dry conditions, after a period of cooling.
51			$\frac{3}{4} v_m$	-	-	-		10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 50 without interruption. This is to evenly distribute the residual stress within the wheel.
52 53 54 55	64 65 66 67	76 77 78 79	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	$\frac{2}{3} F_{B1}$	20 – 30	m_1		Brake applications to rest under wet conditions, after a period of cooling.
56 57 58 59	68 69 70 71	80 81 82 83	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	$\frac{1}{3} F_{B1}$	20 – 30	m_1		Brake applications to rest under wet conditions, after a period of cooling.

No. of brake application	Initial speed v km/h	Total F_{B} per wheel F_{B} kN	Initial temperature θ_0 °C	Mass to brake per wheel m t	weighing after No.	Remarks
60 72 84 61 73 85 62 74 86 63 75 87	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	F_{B1}	20 – 30	m_1		Brake applications to rest under wet conditions, after a period of cooling.
88 92 89 93 90 94 91 95	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	F_{B2}	20 – 30	m_2		Brake applications to rest under wet conditions, after a period of cooling.
96	$\frac{3}{4} v_m$	-	-	-	96	10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 95 without interruption to dry the brake block.
97 109 98 110 99 111 100 112	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	$\frac{2}{3} F_{B2}$	50 – 60	m_2		Brake applications to rest under dry conditions, after a period of cooling.
101 113 102 114 103 115 104 116	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	$\frac{1}{3} F_{B2}$	50 – 60	m_2		Brake applications to rest under dry conditions, after a period of cooling.
105 117 106 118 107 119 108 120	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	F_{B2}	50 – 60	m_2		Brake applications to rest under dry conditions, after a period of cooling.
121 122 123 124	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	F_{B2}	110 – 120 [a]	m_2		Brake applications to rest under dry conditions with high initial temperature, after a period of cooling.

No. of brake application	Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	weighing after	Remarks
	v	F_B	θ_0	m		
	km/h	kN	°C	t	No.	
125 126 127 128	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	F_{B2}	50 – 60	m_2	128	Brake applications to rest under dry conditions, after a period of cooling.
129	XXX	-	50 – 60	-		Simulation of a downhill brake application with a power of XX kW for a period of XX min
130	XXX	F_{B2}	-	m_2		Brake application to rest under dry conditions immediately after the simulation of a downhill brake application, without any cooling break
131 to 140	$\frac{3}{4} v_m$	$\frac{2}{3} F_{B2}$	50 – 60	m_2		Conditioning stops
141 145 142 146 143 147 144 148	$\frac{3}{4} v_m$ $\frac{1}{4} v_m$ v_m $\frac{1}{2} v_m$	F_{B2}	50 – 60	m_2	148	Brake applications to rest under dry conditions, after a period of cooling.
149	$\frac{3}{4} v_m$	-	-	-		10 kW drag brake application for a period of 10 min in dry condition done immediately after brake nº 148 without interruption. This is to evenly distribute the residual stress within the wheel.

[a] If the temperature obtained during stop numbers 120 and 122 is below 110 °C, stop numbers 121 and 123 shall be performed with the temperature achieved at the time.

J.3 Definitions

m_1 braked mass per wheel (including rotating mass) in conformity with EN 15663 for design mass, in working order

m_2 braked mass per wheel (including rotating mass) in conformity with EN 15663 for design mass under normal payload or design mass under exceptional payload

F_{B1} total brake block application force per wheel for braked mass m_1.

F_{B2} total brake block application force per wheel, for braked mass m_2.

v_m maximum service speed

J.4 Principle of assessment and pass/fail criteria

Bedded and non bedded performance	Requirements of 7.2.2 are applicable
Mean friction coefficient variation under wet conditions	Requirements of 7.2.4 are applicable for freight wagons
Mean friction coefficient variation at high initial temperature	Requirements of 7.2.5 are applicable
Mean friction coefficient variation after simulation of a downhill brake application	Requirements of 7.2.6 are applicable
Instantaneous friction coefficient variation during simulation of a downhill brake application	Requirements of 7.2.7 are applicable excluding first line of Table 5 and all the Table 6.

Annex K
(normative)

Dynamometer Test program to detect the formation of metal pick-up at the brake block

K.1 Test program for freight wagons with brake blocks type K and LL

Conditions for Table K.1

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 1 × Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	790 $\left(^{+5}_{-0}\right)$ mm (new wheel 840 mm) or 870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,5 t and 9,0 t or 11,25 t
Water flow rate:	12 ℓ/h (wheel of 790 mm) or 14 ℓ/h (wheel of 870 mm)

Table K.1 — Test program for brake blocks type K or LL in conformity with performance tests Annex C, Annex D or Annex E

No. of brake application	Initial speed v km/h	Total F_B per wheel kN			Initial temperat ure °C	Remarks
		2 Bgu 2 Bg (K)	2 Bgu 2 Bg (LL)	1 Bg (K)		
		870 $\left(^{+5}_{-0}\right)$	870 $\left(^{+5}_{-0}\right)$	790 $\left(^{+5}_{-0}\right)$		
1.1 - 1.X	100	25	25	25	20 - 100	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
Rx+1 to Rx+10	100	7	16	8	20 – 100	10 brake applications to stop for the conditioning of the insert, wheel mass 2,5 t

No. of brake application	Initial speed v km/h	Total F_B per wheel kN			Initial temperature °C	Remarks
		2 Bgu 2 Bg (K)	2 Bgu 2 Bg (LL)	1 Bg (K)		
		$870\left(^{+5}_{-0}\right)$	$870\left(^{+5}_{-0}\right)$	$790\left(^{+5}_{-0}\right)$		
1 7 13 19 2 8 14 20 3 9 15 21	100 30 60	7	16	8	20 – 30	Brake applications to rest under wet conditions, after a period of cooling, wheel mass 2,5 t. Check the brake blocks condition at end of this section.
4 10 16 22 5 11 17 23 6 12 18 24	100 30 60	5	12	5		
25 27 29 26 28 30	60 100	5	12	5	50 – 60	Brake applications to rest under dry conditions, after a period of cooling, wheel mass 2,5 t. Check the brake blocks condition at end of this section.
31 to 40 41 to 50	60 100	5	12	5	20 – 30	Brake applications to rest under wet conditions, after a period of cooling, wheel mass 2,5 t Check the brake blocks condition at end of this section.
51 to 60 61 to 70	60 100	7	16	8		
71 73 75 72 74 76	30 60	7	16	8	50 – 60	Brake applications to rest under dry conditions, after a period of cooling, wheel mass 2,5 t Check the brake blocks condition at end of this section.
77	70	–			20 - 30	Drag brake application, under wet conditions, at 15 kW during 10 min
78	70	5	12	5	--	Brake application to rest under dry conditions immediately after the drag brake application, without any cooling break Check the brake blocks condition at end of this section.
79	70	–			20 - 30	Drag brake application, under wet conditions, at 15 kW during 20 min

No. of brake application			Initial speed v km/h	Total F_B per wheel kN			Initial temperature °C	Remarks
				2 Bgu 2 Bg (K)	2 Bgu 2 Bg (LL)	1 Bg (K)		
				870 $\left(^{+5}_{-0}\right)$	870 $\left(^{+5}_{-0}\right)$	790 $\left(^{+5}_{-0}\right)$		
80			70	5	12	5	--	Brake application to rest under dry conditions immediately after the drag brake application, without any cooling break Check the brake blocks condition at end of this section.
				11,25 t Wheel	11,25 t Wheel	9 t Wheel		Additional tests in laden conditions to be performed only if, after test no. 80, the amount of metal pickup is greater than 1 % of the total surface of the inserts
81 82 83 84	85 86 87 88	89 90 91 92	100 30 120 60	38	100	30	50 – 60	Brake applications to rest under dry conditions, after a period of cooling Check the brake blocks condition at end of this section.

K.2 Test program for locomotives with brake blocks type K

Conditions for Table K.2

Brake block configuration:	1 × Bgu [2 brake block of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	1 070 $\left(^{+5}_{-0}\right)$ mm (new wheel 1 150 mm) The accurate diameter shall be given in the test report.
To be braked mass per wheel:	11,4 t
Water flow rate:	16 ℓ/h

Table K.2 — Test program for brake blocks type K in conformity with performance test Annex G

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
			v	F_B	θ_0	m	
			km/h	kN	°C	t	
1.1 - 1.X			100	30	80 - 100	11,4	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
6	to	10	160	6	20 – 30	11,4	Brake applications to rest under wet conditions, after a period of cooling. Check the brake blocks condition at end of this section.
11	to	15	30				
16	to	20	140				
21	to	25	60				
26	to	30	120				
31	to	35	100				
36	to	40	160	3			
41	to	45	30				
46	to	50	140				
51	to	55	60				
56	to	60	120				
61	to	65	100				
66	to	70	160	6	50 – 60	11,4	Brake applications to rest under dry conditions, after a period of cooling.
71	to	75	60				
76	to	80	100				
81	to	85	160	3	20 – 30	11,4	Brake applications to rest under wet conditions, after a period of cooling. Check the brake blocks condition at end of this section.
86	to	90	60				
91	to	95	100				
96	to	100	160	6			
101	to	105	60				
106	to	110	100				
111	to	115	30	6	50 – 60	11,4	Brake applications to rest under dry conditions, after a period of cooling. Check the brake blocks condition at end of this section.
116	to	120	60				
121			70	–	20 – 30	–	5 kW drag brake application for a period of 5 min in wet condition.

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
122	70	6	–	11,4	Brake application to rest under dry conditions immediately after the drag brake application, without any cooling break. Check the brake blocks condition at end of this section.
123	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
124	70	6	–	11,4	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.
125	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
126	70	6	–	11,4	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.
127	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
128	70	6	–	11,4	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.
129	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
130	70	6	–	11,4	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.

K.3 Test program for EMU – DMU with brake blocks type K

Conditions for Table K.3

Brake block configuration:	1 × Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.
To be braked mass per wheel:	7,5 t

Water flow rate: 14 ℓ/h

Table K.3 — Test program for brake blocks K in conformity with performance test Annex H

No. of brake application			Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
			v	F_B	θ_0	m	
			km/h	kN	°C	t	
1.1 – 1.X			100	20	80 – 100	7,5	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to at least 85 % of the friction material surface.
1	to	5	100	6	50 – 60	7,5	Conditioning stops, dry conditions
6	to	10	160	6	20 – 30	7,5	Brake applications to rest under wet conditions, after a period of cooling. Check the brake blocks condition at end of this section.
11	to	15	30				
16	to	20	140				
21	to	25	60				
26	to	30	120				
31	to	35	100				
36	to	40	160	3			
41	to	45	30				
46	to	50	140				
51	to	55	60				
56	to	60	120				
61	to	65	100				
66	to	70	160	6	50 – 60	7,5	Brake applications to rest under dry conditions, after a period of cooling.
71	to	75	60				
76	to	80	100				
81	to	85	160	3	20 – 30	7,5	Brake applications to rest under wet conditions, after a period of cooling. Check the brake blocks condition at end of this section.
86	to	90	60				
91	to	95	100				
96	to	100	160	6			
101	to	105	60				
106	to	110	100				
111	to	115	30	6	50 – 60	7,5	Brake applications to rest under dry conditions, after a period of cooling. Check the brake blocks condition at end of this section.
116	to	120	60				

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
121	70	–	20 – 30	–	5 kW drag brake application for a period of 5 min in wet condition.
122	70	6	–	7,5	Brake application to rest under dry conditions immediately after the drag brake application, without any cooling break. Check the brake blocks condition at end of this section.
123	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
124	70	6	–	7,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.
125	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
126	70	6	–	7,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.
127	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
128	70	6	–	7,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.
129	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
130	70	6	–	7,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake blocks condition at end of this section.

K.4 Test program for High speed train with brake blocks type K

Conditions for Table K.4

Brake block configuration:	1 × Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	850 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,5 t and 4,0 t
Water flow rate:	14 ℓ/h

Table K.4 — Test program for brake blocks type K in conformity with performance test Annex I

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
1.1 – 1.X	100	23	80 – 100	4,0	Brake applications to rest under dry conditions to allow bedding of the brake block up to at least 85 % of the friction material surface.
1 to 5	100	8	50 – 60	4,0	Conditioning stops, dry conditions
6 to 10	160	8	20 - 30	4,0	Brake applications to rest under wet conditions, after a period of cooling.
11 to 15	30				
16 to 20	140				
21 to 25	60				
26 to 30	120				
31 to 35	100				
36 to 40	160	8	20 - 30	4,0	Brake applications to rest under wet conditions, after a period of cooling. Check the brake block condition at end of this section.
41 to 45	30				
46 to 50	140				
51 to 55	60				
56 to 60	120				
61 to 65	100				
66 to 70	160	8	50 - 60	4,0	Brake applications to rest under dry conditions, after a period of cooling.
71 to 75	60				
76 to 80	100				

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
81 to 85 86 to 90 91 to 95 96 to 100 101 to 105 106 to 110	160 30 140 60 120 100	8	20 - 30	4,0	Brake applications to rest under wet conditions, after a period of cooling. Check the brake block condition at end of this section.
111 to 115 116 to 120	30 60	8	50 - 60	2,5	Brake applications to rest under dry conditions, after a period of cooling.
121	70	-	20 - 30	2,5	5 kW drag brake application for a period of 5 min in wet condition.
122	70	8	–	2,5	Brake application to rest under dry conditions immediately after the drag brake application, without any cooling break. Check the brake block condition at end of this section.
123	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
124	70	8	–	2,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake block condition at end of this section.
125	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
126	70	8	–	2,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake block condition at end of this section.
127	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.
128	70	8	–	2,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake block condition at end of this section.
129	70	–	20 - 30	–	5 kW drag brake application for a period of 5 min in wet condition.

No. of brake application	Initial speed	Total F_B per wheel	Initial temperat ure	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
130	70	8	–	2,5	Brake applications to rest under dry conditions, without any cooling break. Check the brake block condition at end of this section.

Annex L
(normative)

Dynamometer test program to demonstrate the extreme winter braking properties

L.1 Test program for freight wagons with brake blocks type K

Conditions for Table L.1

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	865 $\left(^{+10}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,5 t and 7,5 t

Table L.1 — Test program to demonstrate the extreme winter braking properties for freight wagons with brake blocks type K

No. of brake application					Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
					v	F_B	θ_0	m	
					km/h	kN	°C	t	
R.1 - R.X					100	12	20 to100	7,5	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to a contact pattern of 100 % is reached
R.X + 1 to R.X + 20					100	12	20 to 100	2,5	20 brake applications to a stop (dry)
1 to 5					100	9	−5 to 60	2,5	Conditioning stop
6	8	10	12	14	100	9	50 to 60	2,5	Dry brake applications, warm
7	9	11	13	15	120				
16	18	20	22	24	100	9	−5 to −3	2,5	Dry brake applications, cold (reference brake

No. of brake application					Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
					v	F_B	θ_0	m	
					km/h	kN	°C	t	
17	19	21	23	25	120				applications)
									Test snow machine and snow quality
26 to 28					120	9	−5 to 90	2,5	Conditioning stop
a29	a33	a37	a42	a46	20	9	To −3	2,5	Cooling, dry
b29	b33	b37	b42	b46	100	9	To −3	2,5	Cooling, dry, over 240 s
c29	c33	c37	c42	c46	100	9	To −3	2,5	Cooling with artificial snow over 340 s
29	33	37	42	46	100	9	To −3	2,5	Braking with artificial snow
30	34	38	43	47	120	9	−5 to 90	2,5	Conditioning, dry
a31	a35	a39	a44	a48	20	9	To −3	2,5	Cooling, dry
b31	b35	b39	b44	b48	120	9	To −3	2,5	Cooling, dry, over 240 s
c31	c35	c39	c44	c48	120	9	To −3	2,5	Cooling with artificial snow over 900 s
31	35	39	44	48	120	9	To −3	2,5	Braking with artificial snow
32	36	40	45	49	120	9	−5 to 90	2,5	Conditioning, dry
		41			120	9	−5 to 90	2,5	Conditioning, dry

L.2 Test program for freight wagons with brake blocks type LL

Conditions for Table L.2

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	865 $\left(^{+10}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	2,63 t and 7,5 t

Table L.2 — Test program to demonstrate the extreme winter braking properties for freight wagons with brake blocks type LL

No. of brake application					Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
					v	F_B	θ_0	m	
					km/h	kN	°C	t	
R.1 - R.X					100	30	20 to100	7,5	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to a contact pattern of 100 % is reached
R.X + 1 to R.X + 20					100	30	20 to 100	2,63	20 brake applications to a stop (dry)
1 to 5					100	16	−5 to 60	2,63	Conditioning stop
6	8	10	12	14	100	16	50 to 60	2,63	Dry brake applications, warm
7	9	11	13	15	120				
16	18	20	22	24	100	16	−5 to −3	2,63	Dry brake applications, cold (reference brake applications)
17	19	21	23	25	120				
									Test snow machine and snow quality
26 to 28					120	16	−5 to 90	2,63	Conditioning stop
a29	a33	a37	a42	a46	20	16	To −3	2,63	Cooling, dry

No. of brake application					Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
					v	F_B	θ_0	m	
					km/h	kN	°C	t	
b29	b33	b37	b42	b46	100	16	To −3	2,63	Cooling, dry, over 240 s
c29	c33	c37	c42	c46	100	16	To −3	2,63	Cooling with artificial snow over 340 s
29	33	37	42	46	100	16	To −3	2,63	Braking with artificial snow
30	34	38	43	47	120	16	−5 to 90	2,63	Conditioning, dry
a31	a35	a39	a44	a48	20	16	To −3	2,63	Cooling, dry
b31	b35	b39	b44	b48	120	16	To −3	2,63	Cooling, dry, over 240 s
c31	c35	c39	c44	c48	120	16	To −3	2,63	Cooling with artificial snow over 900 s
31	35	39	44	48	120	16	To −3	2,63	Braking with artificial snow
32	36	40	45	49	120	16	−5 to 90	2,63	Conditioning, dry
		41			120	16	−5 to 90	2,63	Conditioning, dry

L.3 Specific requirements for conducting Test Programs L.1 and L.2

L.3.1 General

Table L.3 — Cooling air speed

	Speed of the test bench (km/h)		**Speed of the cooling air (km/h)**	
	Under dry conditions	**With snow**	**Under dry conditions**	**With snow**
During braking	v	v	25	25
Between the brake applications	v	v	25	25

L.3.2 Brake build-up time

The brake build-up time shall be 8 s ± 0,2 s.

L.3.3 Interruptions

If interruptions occur between brake applications No 29 to 49 (e.g. due to equipment problems as a result of iced-over snow nozzles), the programme is to be pursued by repeating the last conditioning brake application and the subsequent cooling operations. These interruptions are to be recorded in the test report.

L.3.4 Temperatures

The test chamber temperature shall be - 7 °C (permitted standard deviation ± 2 K).

A temperature of - 7 °C shall be reached in the test chamber at least 12 h before the start of the programme (brake application No. 1).

The preparation of the iced water (snow machine) shall be activated at least 12 h before the start of the programme.

L.3.5 Snow conditions

Snow quality: dry (no running water when pressed in the hand).

During the cooling periods with artificial snow and the subsequent brake applications with artificial snow, the artificial snow shall not be interrupted.

L.3.6 Other conditions

5 valid brake applications under snow (at 100 km/h and 120 km/h) are required.

Following bedding in and after completion of the test programme, photographs are to be taken of the blocks contact surfaces.

Irregularities during testing on blocks and wheel contact surfaces are to be noted and documented.

L.4 Process of assessment and past fail criteria for test programs L.1 and L.2

The average value from braking distance s1 for brake applications 16, 18, 20, 22 and 24 represents the reference value (100 %) for 100 km/h.

The average value from braking distance s1 for brake applications 17, 19, 21, 23 and 25 represents the reference value (100 %) for 120 km/h.

For each brake application under snow, the deviation between s1 and the relevant reference value is calculated as a percentage. Further, the average value for brake applications from 100 km/h and/or 120 km/h under snow is calculated as a deviation (as a percentage) from the relevant reference value.

The permitted deviation of the average value over a test programme (100 km/h) is ± 15 %.

The permitted deviation of the average value over three test programmes (100 km/h) is ± 10 %.

The permitted deviation of the average value over a test programme (120 km/h) is ± 15 %.

The permitted deviation of the average value over three test programmes (120 km/h) is ± 10 %.

L.5 Generic flow chart to perform test program

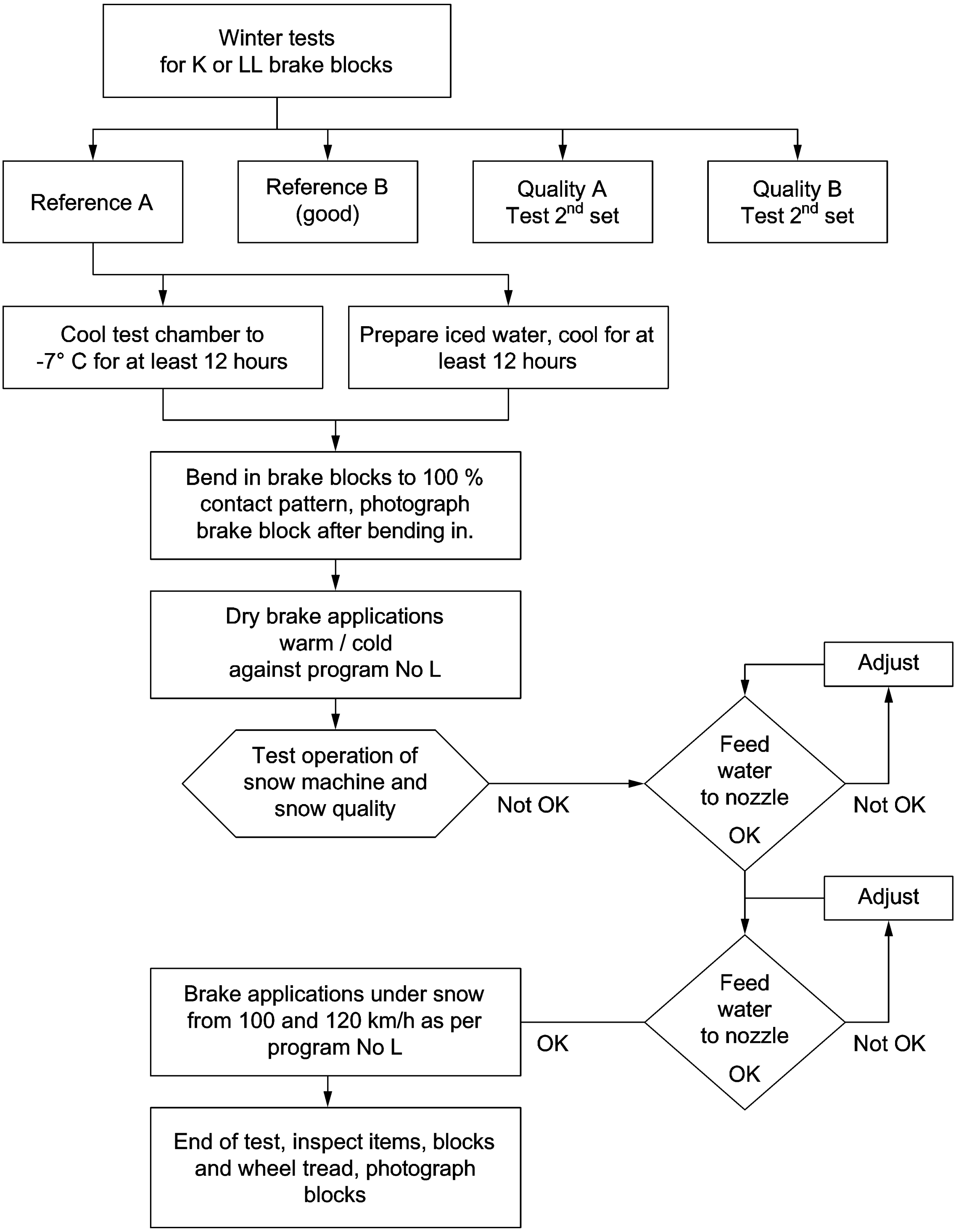


Figure L.1 — Generic flow chart to perform test program

L.6 Detailed flow chart to perform test program (example brake block K)

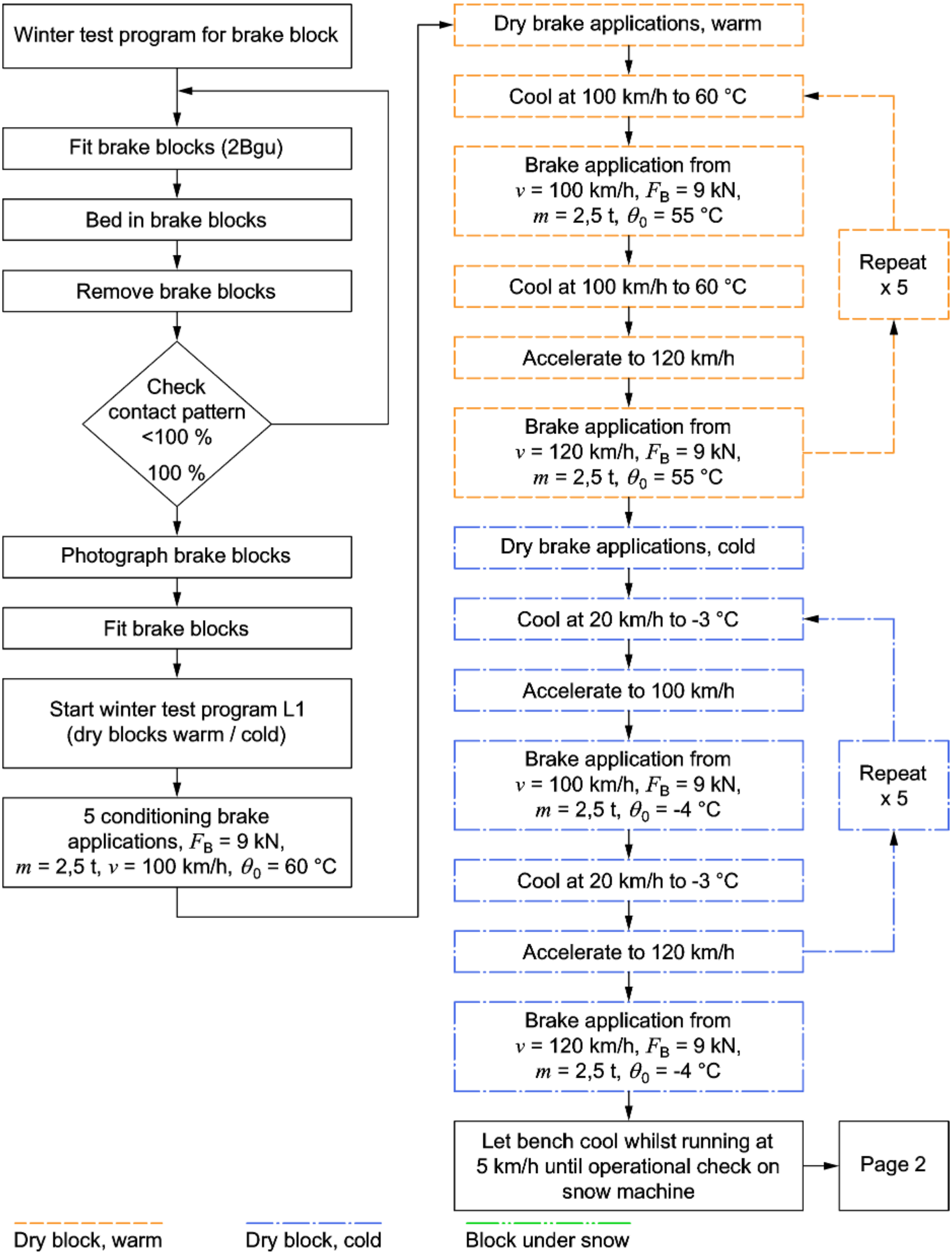


Figure L.2 — Detailed flow chart (Page 1/3)

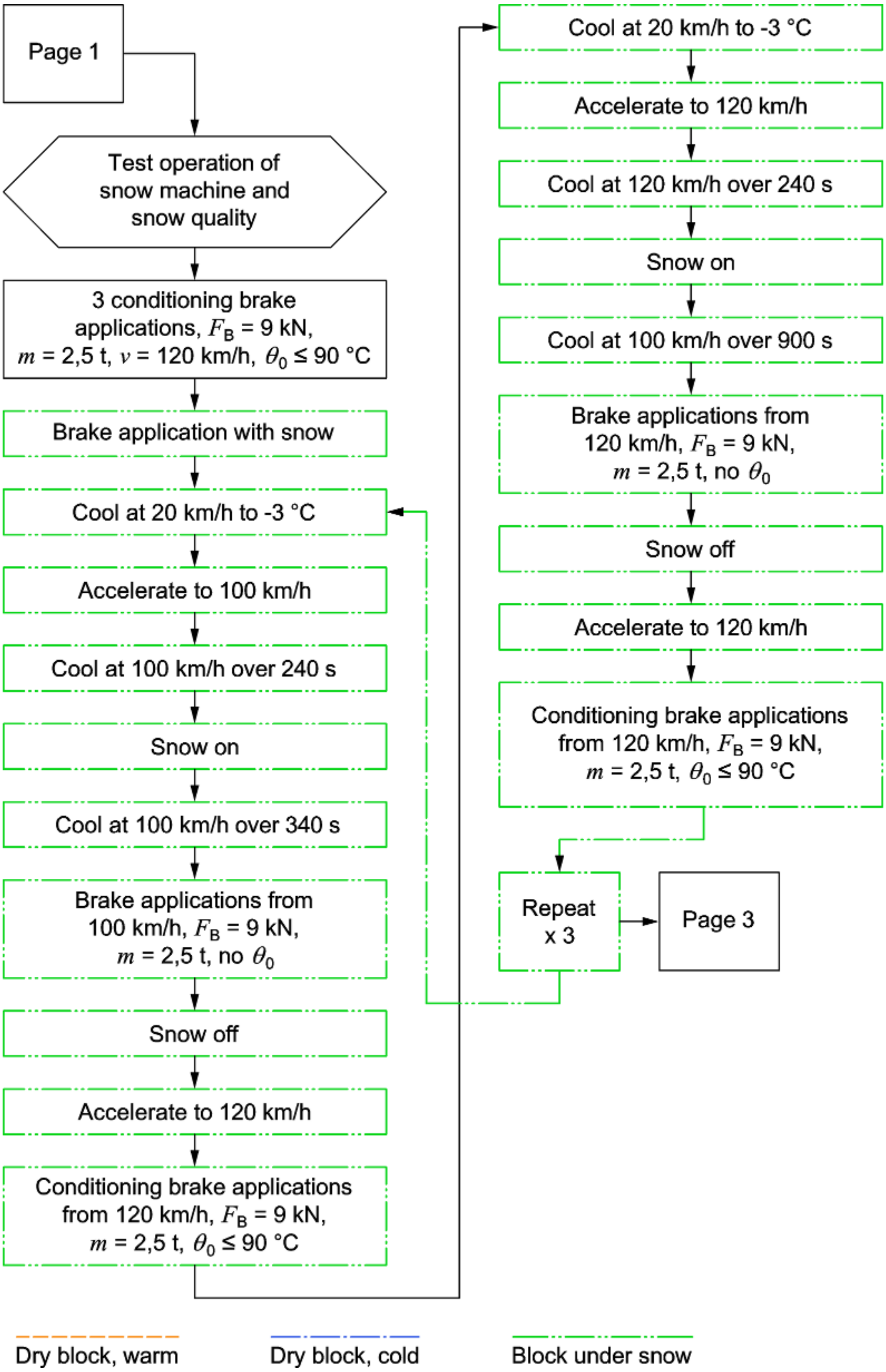


Figure L.3 — Detailed flow chart (Page 2/3)

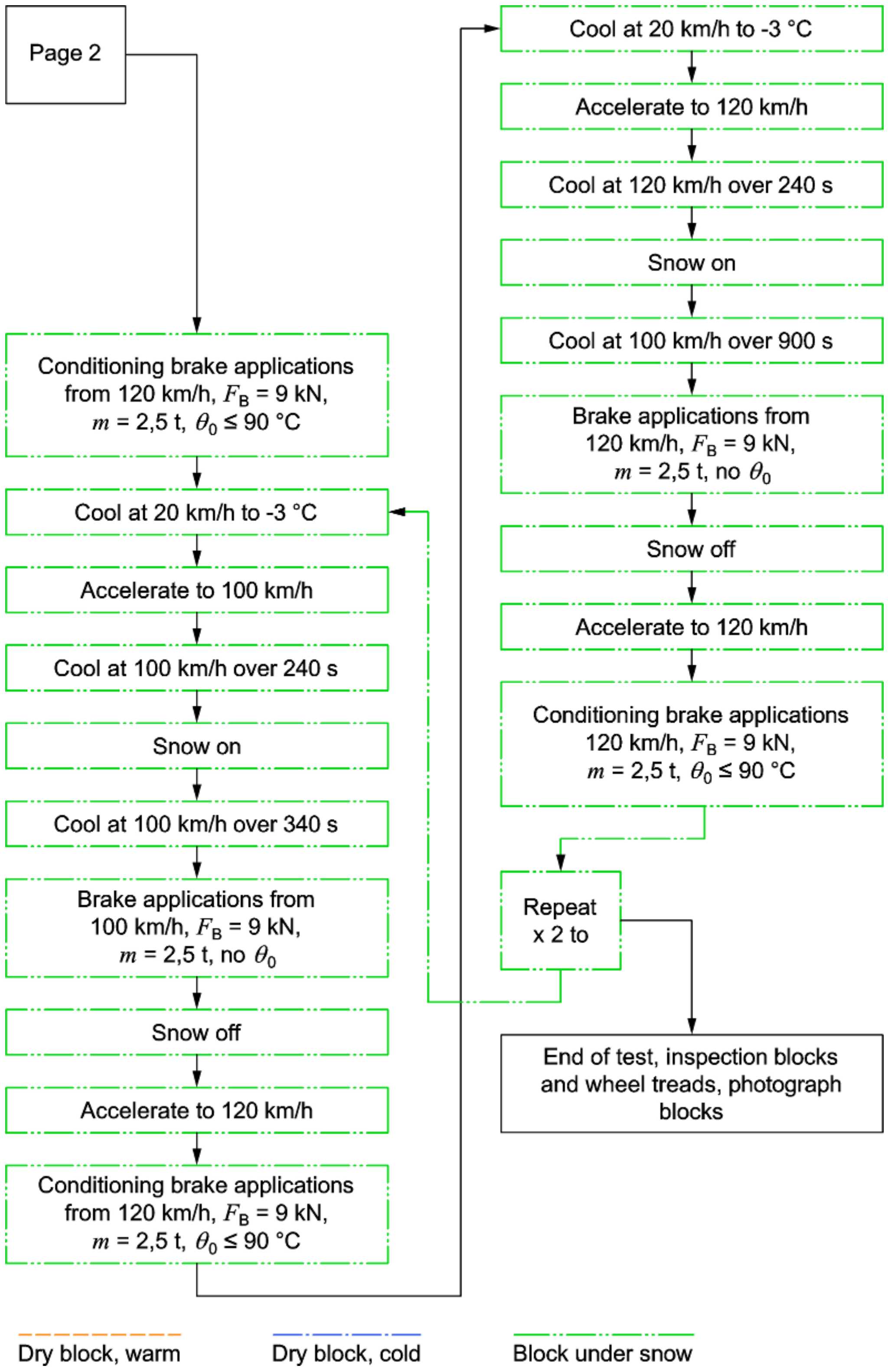


Figure L.4 — Detailed flow chart (Page 3/3)

Annex M
(normative)

Test run to demonstrate the extreme winter braking properties brake blocks K – LL for freight wagons

M.1 General

M.1.1 Introduction

The tests are performed with a train (one locomotive and 5 freight wagons), the main goal is to compare tests between brake test runs without snow fly-off ("reference tests") and those with snow fly-off ("winter tests") and to determine the extreme winter braking properties of composite brake blocks under real conditions of use.

M.1.2 Test freight wagons

Five four-axles empty freight wagons of the same design with the same equipment as regards:

— "Open" bogie design, e.g. Y25;

— max. wheelset load when empty 7 t;

— braking system (for practical reasons, to facilitate the execution of the tests, no restrictions are defined for this point);

— block configuration 2Bgu.

M.1.3 Locomotive

One locomotive at maximum speed ≥ 120 km/h with dynamic and indirect braking disconnected, maximum dynamic mass lower than 100 t.

M.1.4 Documentation

The following documentation shall be available:

— Freight wagon data/Freight wagon data sheet;

— brake design/brake calculation;

— detailed data on brake design/brake equipment;

— complete data on block type used;

— results of tests performed with this block type and application.

M.2 Test conditions

The following test conditions are required for the brake tests:

Period of execution:	Winter semester with snow fly-off
Brake initiation speeds:	60 km/h (for information purposes, to monitor the plausibility and comparability of the efficiency between reference tests and winter tests), 100 km/h and 120 km/h
Brake mode position:	P
Meteorological conditions:	"Winter tests": external temperatures zero to - 10 °C with snow on the line
Reference tests:	No snow fly-off, external temperatures of up to + 5 °C permitted
Test configuration:	Train: 5 empty freight wagons + 1 Locomotive unbraked
Test line:	Max. gradients and curve radii as per UIC 544–1
Specific features:	Reference tests and winter tests are to be performed consecutively within a single period of up to 4 weeks. A running period of at least 10 min is to be observed between brake applications, with a maximum of 4 brake applications performed per hour. Any holding brake applications required should as far as possible to be performed by the MPU brake.

M.3 Bases for assessment

Values to be measured are:

— speed;

— braking distance;

— time;

— brake pipe pressure;

— external temperature.

The required measurement values can, as an alternative, be recorded using a train monitoring device installed on the locomotive.

Classification criteria for "reference" and "extreme winter" tests:

During test runs at speeds of 100 km/h and 120 km/h, the following criteria are to be applied:

Reference test "R"	Snow level 0
	No snow fly-off
Winter test "W"	Snow levels 3 to 5
	Moderate to heavy snow fly-off ("5" indicates that no freight wagons are visible)

Examples of classifications estimated using the aforementioned criteria:

Figure M.1 — Reference test (RO)

Figure M.2 — Extreme winter test (W2-W3)

Figure M.3 — Extreme winter test (W4-W5)

M.4 Assessment of measurement data and pass/fail criteria

For each brake application/test series, the following data shall be indicated in a table in the test report:

— test number;

— date/time;

— location of the brake application;

— gradient;

— brake type;

— theoretical initial speed at the brake application initiation (v);

— actual speed, at the brake application initiation (v_0);

— braking time;

— braking distance measured;

— corrected braking distance;

— external temperature;

— snow levels (0 to 5);

— classification (reference test/extreme winter test);

— comments (e.g. train stationary for a long period prior to brake application).

In short, the following information is to be indicated in a table for each category (reference/winter test/ 60 km/h, 100 km/h or 120 km/h):

— number of tests;

— average value of corrected braking distances;

— standard deviation of corrected braking distances.

The following criteria, which take into account the exceptional meteorological conditions, apply to the execution of the tests:

The number of reference tests shall be at least 8 for each brake initiation speed (100 km/h and 120 km/h), whereby the quotient of the standard deviation and the average braking distance shall not exceed 10 %. The maximum number of tests is 20. Reference tests shall only be performed at snow level 0.

The number of tests under extreme winter conditions shall be at least 8 at snow level 3 or higher for each brake initiation speed (100 km/h and 120 km/h). The quotient of the standard deviation and the average braking distance shall not exceed 20 % to ensure that the braking distance is representative for the assessment.

The permitted deviation in braking distances may not exceed 10 % (100 km/h and 120 km/h).

For the plausibility checks performed using brake applications at 60 km/h, the average braking distances should not differ significantly, regardless of extreme winter conditions, since at this speed no snow fly-off occurs. Significant increase in the braking distances indicates an alteration in the brake rigging efficiency as a result of extreme winter conditions, as a result of which the bogie should be inspected to confirm brake rigging is functional.

The method for assessing test results set out in UIC 544-1 shall be applied.

Annex N
(normative)

Dynamometer Test program to simulate "Locked brake"

N.1 Test program for freight wagons with brake blocks type K and LL

Conditions for Table N.1

Brake block configuration:	2 × Bgu [4 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel. 2 × Bg [2 brake blocks of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.

Table N.1 — Test program for brake blocks type K or LL in conformity with performance tests Annex C or Annex D

No. of brake application	Initial speed	Total F_B per wheel		Initial temperature	Remarks
	v	F_B		θ_0	
	km/h	kN		°C	
		K	LL		
1.1 - 1.X	70	-	-	20 - 80	N cycles of 25 kW drag brake application for a period of 45 min in dry conditions to allow bedding of the brake blocks up to at least 80 % of the friction material surface.
Brake failure	100	9	24	20 - 60	Drag brake application in dry conditions with constant force F_B for a maximum of 60 min[a].

[a] The thickness of the brake blocks shall be continuously measured during the tests and test shall be stopped when using exceeds 16 mm per brake block .

The brake blocks shall be weighed and measured prior to and after the tests

The speed of the cooling air should be 35 km/h.

The hollowness of the wheel tread may not exceed 1 mm, if necessary re-profile before testing.

NOTE The cooling air should be applied in such a way that the conditions specified in the document UIC B 126/DT 408 are observed.

N.2 Test program for locomotives with brake blocks type K

Conditions for Table N.2

Brake block configuration:	1 × Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	1 070 $\left(^{+5}_{-0}\right)$ mm (new wheel 1 150 mm) The accurate diameter shall be given in the test report.

Table N.2 — Test program for brake blocks type K in conformity with performance test Annex G

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Remarks
	v	F_B	θ_0	
	km/h	kN	°C	
1.1 - 1.X	70	-	20 - 80	N cycles of 25 kW drag brake application for a period of 45 min in dry conditions to allow bedding of the brake blocks up to at least 80 % of the friction material surface.
Brake failure	140	11	20 - 60	Drag brake application in dry conditions with constant force F_B for a maximum of 60 min [a].

[a] The thickness of the brake blocks shall be continuously measured during the tests and test shall be stopped when using exceeds 10 mm per brake blocks .

The brake blocks shall be weighed and measured prior to and after the tests.

The speed of the cooling air should be 40 km/h.

The hollowness of the wheel tread may not exceed 1 mm, if necessary re-profile before testing.

NOTE The cooling air should be applied in such a way that the conditions specified in the document UIC B 126/DT 408 are observed.

N.3 Test program for EMU – DMU with brake blocks type K

Conditions for Table N.3

Brake block configuration:	1 × Bgu [2 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\binom{+5}{-0}$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.

Table N.3 — Test program for brake blocks K in conformity with performance test Annex H

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Remarks
	v	F_B	θ_0	
	km/h	kN	°C	
1.1 - 1.X	70	-	20 - 80	N cycles of 25 kW drag brake application for a period of 45 min in dry conditions to allow bedding of the brake blocks up to at least 80 % of the friction material surface.
Brake failure	140	11	20 - 60	Drag brake application in dry conditions with constant force F_B for a maximum of 60 min [a].

[a] The thickness of the brake blocks shall be continuously measured during the tests and test shall be stopped when using exceeds 10 mm per brake block.

The brake blocks shall be weighed and measured prior to and after the tests.

The speed of the cooling air should be 40 km/h.

The hollowness of the wheel tread may not exceed 1 mm, if necessary re-profile before testing

NOTE The cooling air should be applied in such a way that the conditions specified in the document UIC B 126/DT 408 are observed.

N.4 Test program for High speed train with brake blocks type K

Conditions for Table N.4

Brake block configuration:	1Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	850 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm) The accurate diameter shall be given in the test report.

Table N.4 — Test program for brake blocks type K in conformity with performance test Annex I

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Remarks
	v	F_B	θ_0	
	km/h	kN	°C	
1.1 - 1.X	70	-	20 - 80	N cycles of 25 kW drag brake application for a period of 45 min in dry conditions to allow bedding of the brake block up to at least 80 % of the friction material surface.
Brake failure	200	6	20 - 60	Drag brake application in dry conditions with constant force F_B for a maximum of 60 min[a].

[a] The thickness of the brake block shall be continuously measured during the tests and test shall be stopped when using exceeds 12 mm per brake block .

The brake block shall be weighed and measured prior to and after the tests.

The speed of the cooling air should be 40 km/h.

The hollowness of the wheel tread may not exceed 1 mm, if necessary re-profile before testing

NOTE The cooling air should be applied in such a way that the conditions specified in the document UIC B 126/DT 408 are observed.

Annex O
(normative)

Dynamometer test program to demonstrate the compatibility with track circuits

O.1 General

Test program for brake blocks type K or LL in order to prove their compatibility the track circuit operation (shuntage) when they are fitted to freight wagons.

O.2 Short description of the measuring method used

The test is conducted on a small scale dynamometer, as follows:

— 10 brake block segments of a given size are prepared to perform 5 cycles tests defined below.

— cycle test:

  — the brake disc is ground and cleaned;

  — measuring cycles are run to establish a reference point;

  — bedding in of the material to be tested is carried out until a contact surface area of > 90 % is reached;

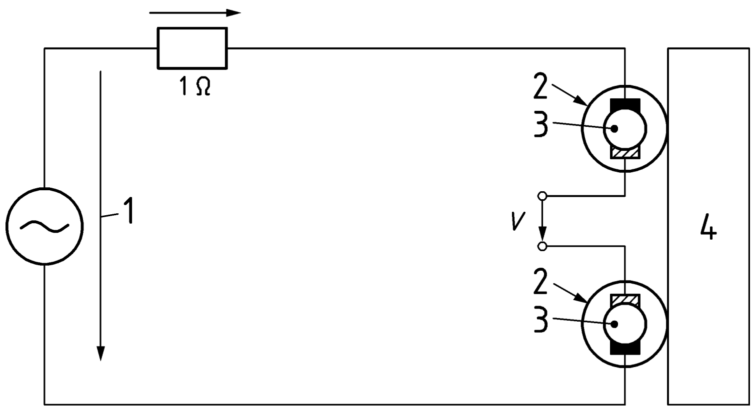
  — conditioning of the brake disc surface is carried out with the friction material concerned, this is under continuous braking until a disc temperature of 400 °C is reached;

  — the disc is cooled down to ambient temperature;

  — measuring cycles are run to assess the influence of composition brake blocks on track circuit operation.

O.3 Schematic diagram of test set up

A schematic diagram of test set up is provided in Figure O.1:



Key

1	applied voltage
2	roller – Rail steel
3	copper
4	brake disc – Wheel steel
(hatched)	carbon brush – Voltage measurement V
(solid)	carbon brush – Test current
V	voltage

Figure O.1 — Schematic diagram of the test set up

O.4 Flow chart to perform test program

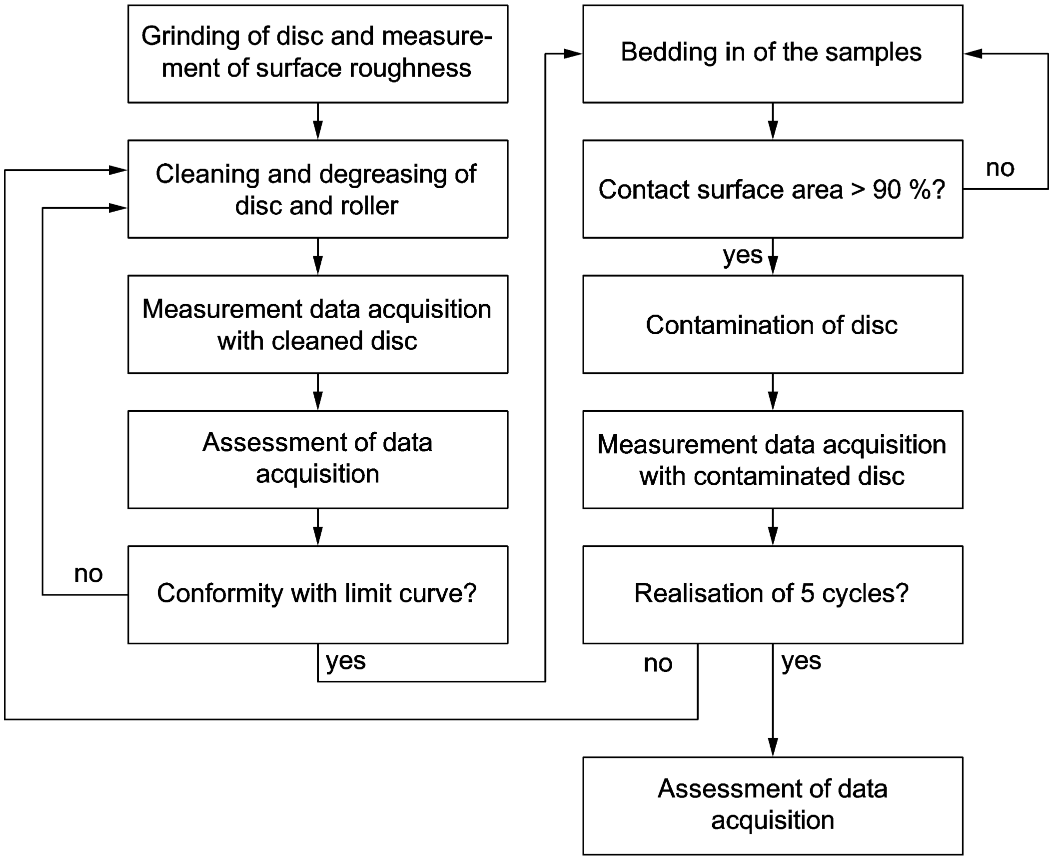


Figure O.2 — Flow chart to perform test program

O.5 Preparation of the disc and the rollers

O.5.1 Grinding of disc

Before the first test of each material of brake block the disc shall be grinded and measurement of surface roughness R_z (maximum height of profile) realized. The surface roughness R_z shall be ≤ 12 µm.

O.5.2 Cleaning and degreasing of disc and roller

The disc shall be cleaned and degreased with emery paper of 180, cloths in micro-fibres and of water/spray acetone in order to eliminate the material residues from last tests and different stains.

The roller and the surface of the carbon brush shall be cleaned and degreased in order to eliminate the particles from dust which adhere.

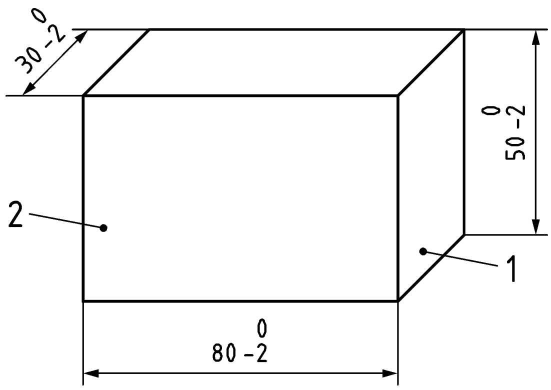
O.6 Preparation of the samples of brake block

O.6.1 Cutting of samples

The cutting of samples shall be realized without lubrication. The friction surface of the sample should be cut near to the friction surface of the brake block. The sample dimensions are provided in Figure O.3.

The use of protective gloves is necessary for the handling of the samples.

Dimensions in mm



Key

1 friction surface of sample

2 other surface

Figure O.3 — Sample

O.6.2 Bedding in of samples

The bedding in of samples shall be performed on the disc once this one is correctly cleaned. Bedding in of the material to be tested shall be carried out until a contact surface area of > 90 % is reached.

Braking test parameter for bedding in:

— speed of 100 km/h;

— braked mass of 0,41 t;

— surface pressure of 40 N/cm^2

O.7 Contamination of disc

Once the samples have a contact surface of at least 90 %, continuous braking can start.

Braking test parameter for continuous braking:

— speed of 70 km/h;

— braking couple of 51 Nm;

— end of phase of contamination when the temperature of the disc is equal at 400 °C or continuous braking time equal at 2 400 s;

— cooling of the disc at temperature < 40 °C.

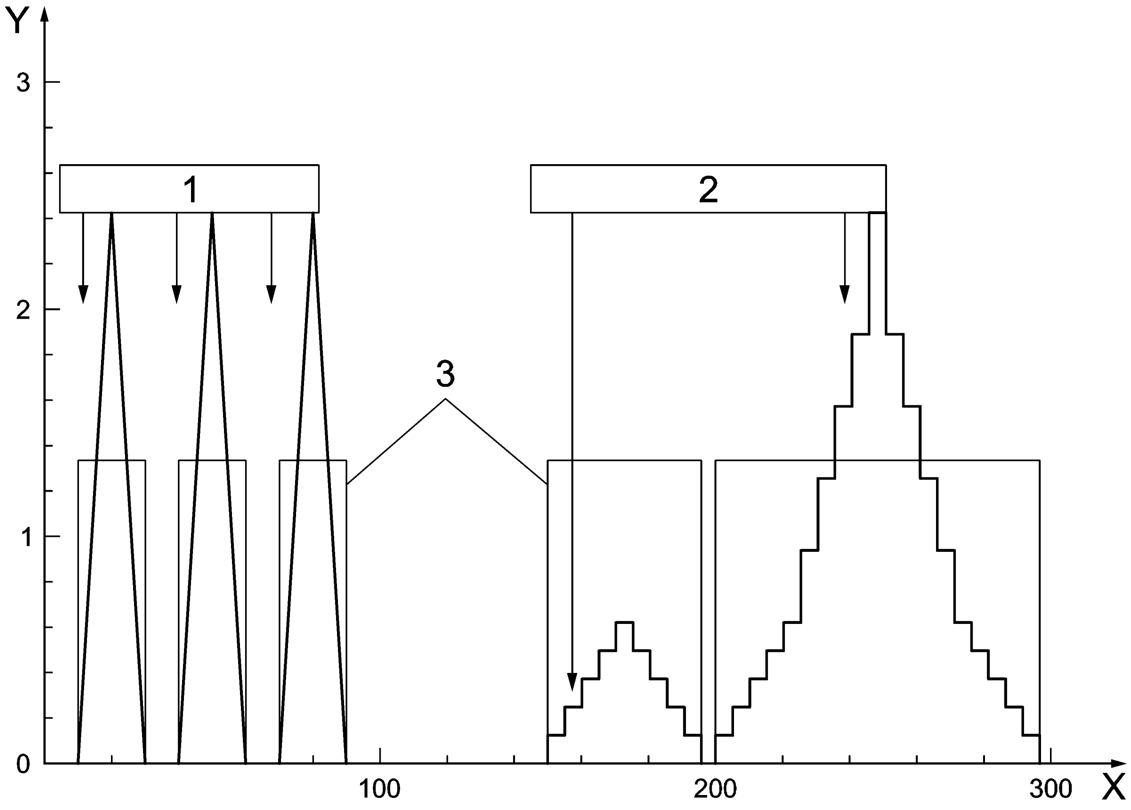
O.8 Measurements

The determination of the electrical resistance of the brake disc that was cleaned or pre conditioned with the fiction material under investigation is based on four different measuring traces on the disc surface where the friction material was applied. Five cycles each with a new friction material are required.

Each cycle comprises a disc cleaning, a braking and a measuring procedure, so that the resistance is measured on 20 traces at a total.

The resistance on each trace is determined both statically and dynamically. The electrical contact to the brake disc is achieved by means of a roller system. The brake disc rotates at a speed of 60 1/min during dynamical measuring. A digital calculator, a power booster and an electronic measuring unit ensure an exact and reproducible test voltage run which covers those voltage values which are critical for successful track circuit operation.

The electrical cycle is defined in Figure O.4.



Key

1 static tests

2 dynamic tests

3 area for measurements

X time (s)

Y voltage (V)

Figure O.4 — Electrical cycle

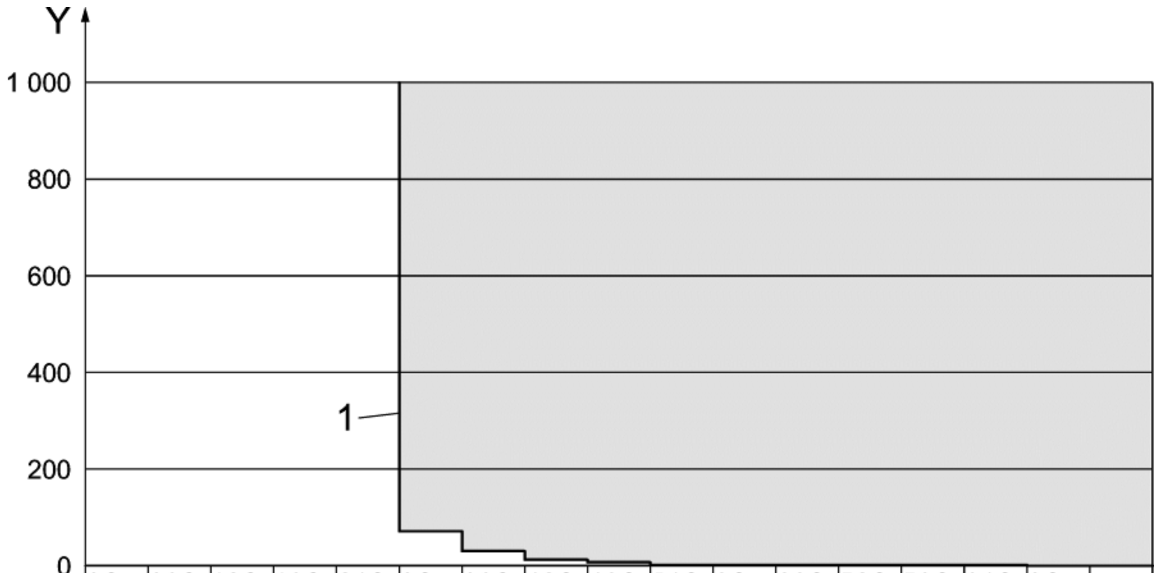
The resulting current and voltage are measured by a four-wire method and digitalized. The frequency of voltage and current is set to 42 Hz. A summation and a verified sliding mean value averaging provide a new resistance value every 10 ms.

O.9 Assessment of the results

An automatic evaluation of the results is achieved by specially developed software so eliminating any human error and making manipulation of the data impossible.

Several hundred thousand resistance values are obtained during the course of the measurements and divided into impedance groups. Limit values are determined relative to the total number of values measured. For high impedance groups this limit value shall be zero, no values may occur in these classes.

Results with the cleaned disc shall be lower than the limit value defined below. If results are higher, the cleaning of the disc shall be carried out once again.



X1	0 Ω 0,6 Ω	0,6 Ω 1,2 Ω	1,2 Ω 1,8 Ω	1,8 Ω 2,4 Ω	2,4 Ω 3 Ω	3 Ω 3,6 Ω	3,6 Ω 4,2 Ω	4,2 Ω 4,8 Ω	4,8 Ω 5,4 Ω	5,4 Ω 6 Ω	6 Ω 6,6 Ω	6,6 Ω 7,2 Ω	7,2 Ω 7,8 Ω	7,8 Ω 8,4 Ω	8,4 Ω 9 Ω	9 Ω 2 000 Ω	→∞
X2	70 000	70 000	70 000	70 000	70 000	71	31	13	6	4	3	2	2	1	1	0	0

Key

1 limit curve

X1 resistance classes

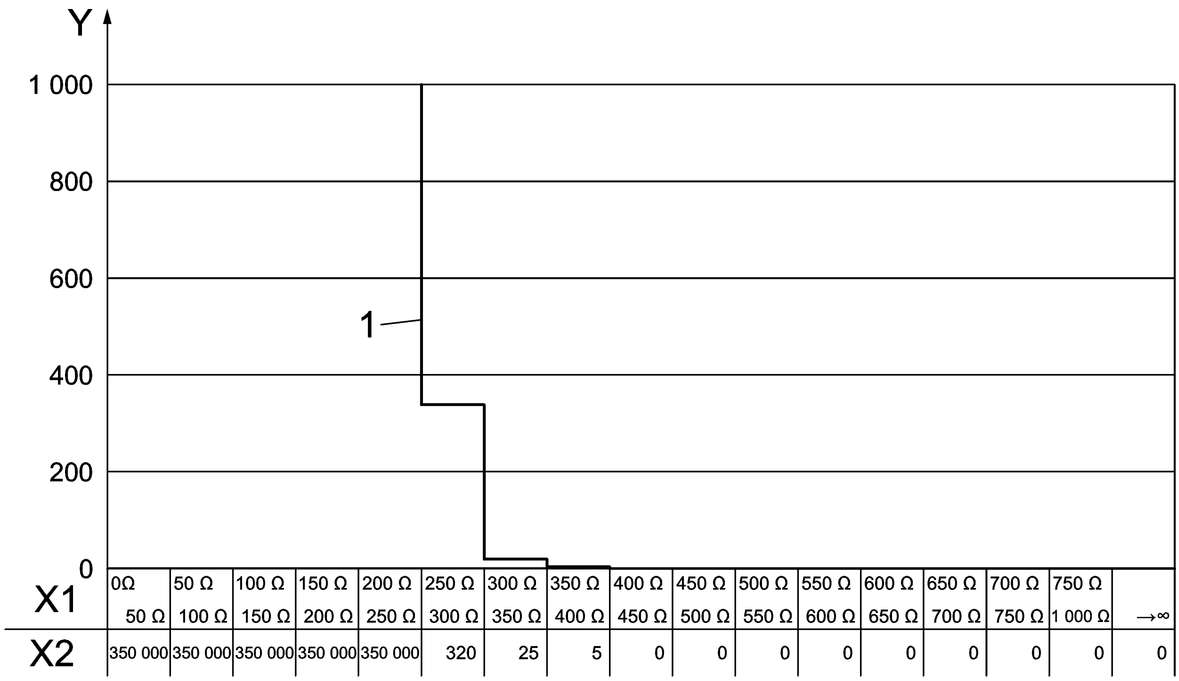
X2 limit values of frequency distribution of resistance per class

Y frequency distribution of resistance per class

Figure O.5 — Limit value for cleaned disc

Pass/fail criteria for assessment of brake block:

The test results with contaminated disc shall be lower than limit value defined below.



Key

1 limit curve

X1 resistance classes

X2 limit values of frequency distribution of resistance per class

Y frequency distribution of resistance per class

Figure O.6 — Limit values for contaminated disc

Annex P
(informative)

Vehicle test to demonstrate the compatibility with track circuits

P.1 General

This annex describes the test method and proof of compatibility with the track circuits of the European rail networks for composite brake blocks L used on coaches.

Reference standards: EN 50238, *Railway applications - Compatibility between rolling stock and train location systems*.

Compliance should be with CCS TSI, Annex A, Table A.2, index 77.

Safety, availability and reliability requirements: Proof of compatibility of a composite brake block with the track circuits shall show that a coach braked with composite brake blocks is always ensured to be located by track circuits, irrespective of their type.

Functional and technical requirements: The proof of compatibility of a composite block type is determined by the residual voltage which is determined on passage of a coach braked with this type of block. This value is measured in the area of the track circuit UM71 classic at the secondary winding of the input transformer on the receiver side (measurement of U_{R1R2} voltage).

P.2 Test conditions

For a coach, the test shall be conducted on a coach with two bogies with a tare weight of circa 40 t and a nominal wheel diameter of between 760 mm and 950 mm (L blocks).

The coach shall be fitted with the composite brake block to be tested (bedded in to at least 80 % contact on the friction surface of the block). The test coach shall be empty and ready for operation.

The tests take place on the Paris-Brest line between the stations Plouaret and Plounérin on a level, stabilized section with continuous welded rails and low traffic (<20 scheduled trains per day, except test trains).

The tests are performed with a motive power unit with insulated wheelsets.

The measurements are performed on sections at least 650 m long with GSK type UM71 Classic (432E, 432F, 432G) and a UR1R2 voltage of around 250 mV.

The measurements are performed as follows:

— stopped in last quarter of a GSK on receiver side;

— travel at 30 km/h, 60 km/h and 90 km/h;

— service brake and rapid brake applications.

Only the measurements performed according to conditions are taken into account, i.e.

— dry rail surface;

— relative humidity between 70 % and 95 %.

As the acceptance conditions are based on calculations of the mean times of exceeding the individual limit values to obtain a representative test, 40 to 45 measurements shall be present with at least 3 test drives for each configuration above.

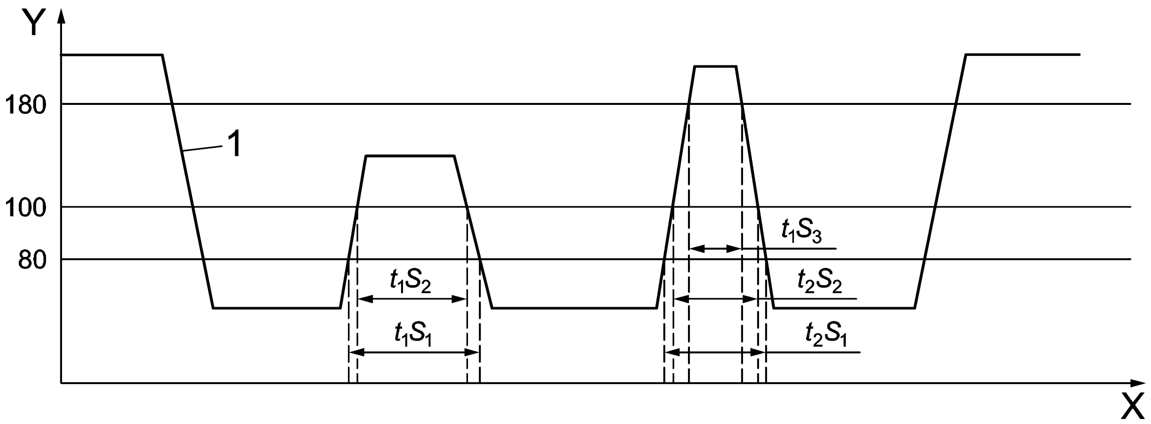
P.3 Assessment of results

A special computer program calculates, for each measurement, the maximum value of the residual voltage and the three cumulative times of exceeding each of the three predefined limit values:

— S_1: 80 mV;

— S_2: 100 mV;

— S_3: 180 mV.



Key

1 curve of cumulative exceeding time

X cumulative exceeding time, in s

Y residual voltage, in mV

Figure P.1 — Preliminary evaluation

Cumulative exceeding time S_1: $t_iS_1 = t_1S_1 + t_2S_1$,

Cumulative exceeding time S_2: $t_iS_2 = t_1S_2 + t_2S_2$,

Cumulative exceeding time S_3: $t_iS_3 = t_1S_3$.

The analysis method is as follows:

1) Determination of maximum value of residual voltage when stopped;

2) Determination of absolute maximum of residual voltage;

3) Calculation of cumulative time of exceeding each limit value, for all measurements:

   — total time for exceeding limit value S_1: $t_{total}S_1 = \Sigma t_1S_1$;

— total time for exceeding limit value S_2: $t_{total}S_2 = \Sigma t_1 S_2$;

— total time for exceeding limit value S_3: $t_{total}S_3 = \Sigma t_1 S_3$;

4) Calculation of mean of cumulative time of exceeding each limit value, per measurement:

— mean time for exceeding limit value S_1: $t_{mean}S_1 = t_{total}S_1/N$;

— mean time for exceeding limit value S_2: $t_{mean}S_2 = t_{total}S_2/N$;

— mean time for exceeding limit value S_3: $t_{mean}S_3 = t_{total}S_3/N$.

N (total number of measurements) = 3 n, where n corresponds to the number of runs and 3 is the number of monitored TC for the run.

P.4 Pass/fail criteria

When used on a coach, a composite brake block is considered shunt-compatible with TC if the following conditions are observed:

— maximum residual voltage when stopped ≤ 30 mV;

— all measured residual voltage values ≤ 180 mV;

— the mean of cumulative times with residual voltage values for 100 mV < 0,5 s;

— the mean of cumulative times with residual voltage values for 80 mV < 2 s.

These conditions are depicted graphically in the following diagram.

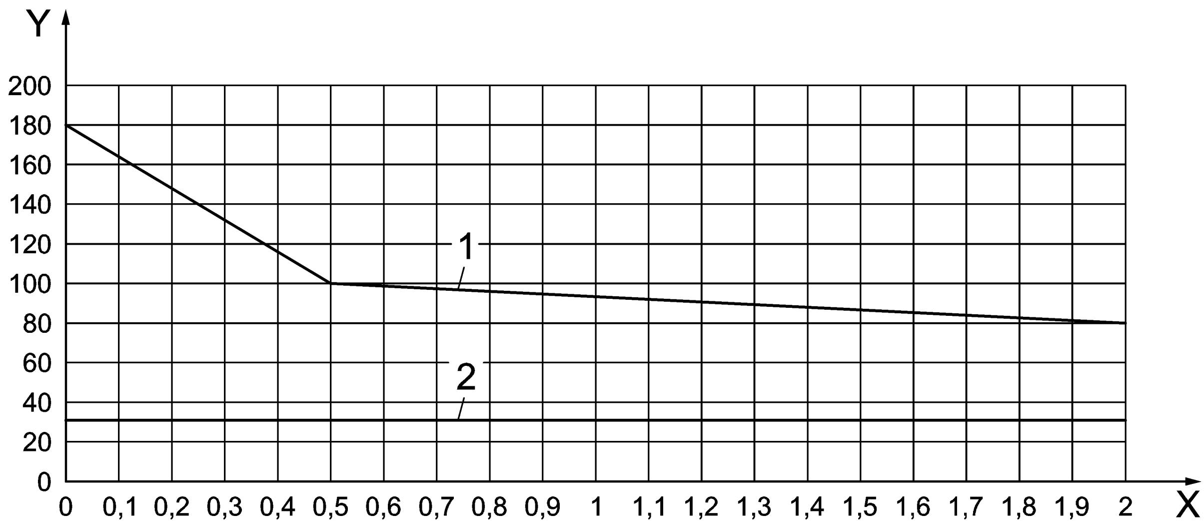
The limit curve for acceptance is defined by the following points:

— ordinates with origin 180 mV;

— mean of time of exceeding limit value 100 mV: 0,5 s;

— mean of time of exceeding limit value 80 mV: 2 s.

The limit curve for acceptance when stopped is defined by the equation y = 30 mV.



Key

1 upper limit curve during the run

2 upper limit curve when stopped

X residual voltage duration (s)

Y residual voltage value (mV)

Figure P.2 — Pass/fail criteria

Annex Q
(informative)

Dynamometer test program – Determination of static friction coefficient

Q.1 Test program for freight wagons with brake blocks type K and LL

Conditions for Table Q.1

Brake block configuration:	2Bgu [4 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel. 2Bg [2 brake blocks of 320 × 80 $\binom{+1}{-2}$ mm] per wheel. 1Bgu [2 brake blocks of 250 × 80 $\binom{+1}{-2}$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\binom{+5}{-0}$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	9,0 t

Table Q.1 — Test program for brake blocks type K or LL in conformity with performance tests Annex C or Annex D

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
R.1 - R.X	100	24 (K) 60 (LL)	20 to100	9,0	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to a contact pattern of 100 % is reached
1 to 5	-	5	< 30	-	-
6 to 10		14			
11 to 15		30			
16 to 20		40			

Q.2 Test program for EMU – DMU and Locomotive with brake blocks type K

Conditions for Table Q.2

Brake block configuration:	1Bgu [2 brake blocks of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	870 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	7,5 t

Table Q.2 — Test program for brake blocks type K in conformity with performance test Annex H

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
R.1 - R.X	100	23	20 to100	7,5	Brake applications to rest under dry conditions to allow bedding of the brake blocks up to a contact pattern of 100 % is reached
1 to 5	-	5	< 30	-	-
6 to 10		14			
11 to 15		30			
16 to 20		40			

Q.3 Test program for High speed train with brake blocks type K

Conditions for Table Q.3

Brake block configuration:	1Bg [1 brake block of 320 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel.
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	850 $\left(^{+5}_{-0}\right)$ mm (new wheel 920 mm). The accurate diameter shall be given in the test report.
To be braked mass per wheel:	4,0 t

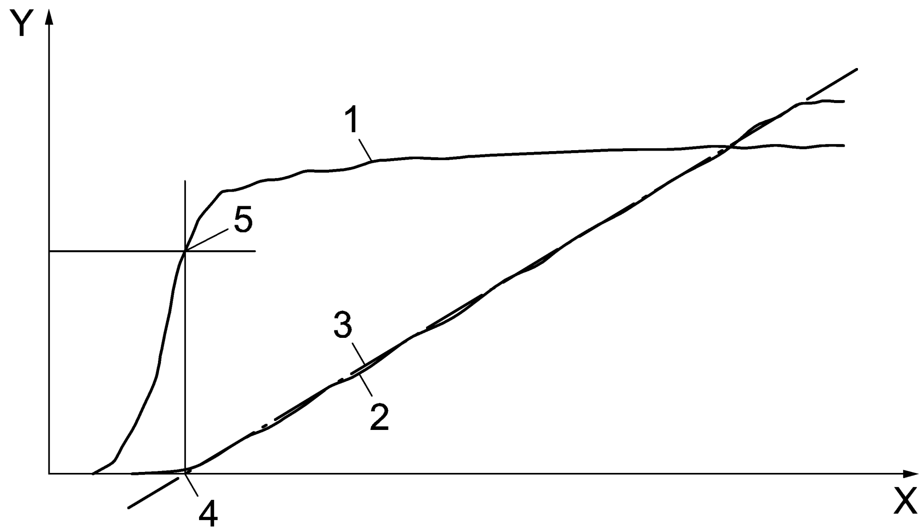
Table Q.3 — Test program for brake blocks type K in conformity with performance test Annex I

No. of brake application	Initial speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	F_B	θ_0	m	
	km/h	kN	°C	t	
R.1 - R.X	100	23	20 to100	4,0	Brake applications to rest under dry conditions to allow bedding of the brake block up to a contact pattern of 100 % is reached
1 to 5	-	5	< 30	-	-
6 to 10		14			
11 to 15		30			

Q.4 Specific Requirements for conducting dynamometer test programmes Q.1 to Q.3

Q.4.1 Definition of the static friction coefficient

Value of the instantaneous friction coefficient at the time corresponding to the commencement of sliding (mean value calculated from the measurement records for the intersection between the linearized characteristic line of the rotation angle and the time axis).



Key

1 example of friction coefficient curve

2 rotation angle of wheel

3 straight regression line

4 intersection between straight regression line and time axis

5 value of static coefficient

X time axis

Y friction coefficient (μ) / rotation angle of wheel

Figure Q.1 — Principle for determination of static coefficient

Q.4.2 Measurements to be recorded

During the test, following measurements shall be carried out and their results shall be continuously registered for each test:

— time;

— rotating torque;

— swing angle of the wheel being tested in relation to the brake blocks;

— brake blocks force;

— instantaneous friction coefficient (calculated).

Q.4.3 Further conditions

— The wheel tread hollow wear at the start of the test shall not exceed 1 mm;

— the state of the surface of the wheel tread shall be registered and noted in writing in the test report;

— the application of the rotating torque shall be constant and the force shall continuously increase. The start of the rotation shall occur between 0,3 s and 2,0 s after the beginning of the build-up of the rotating torque;

— the measuring accuracy of rotation of the wheel shall make it possible to measure the milliradian with an accuracy of approximately 30 mrad;

— the mounting clearances shall be minimized, they shall appear according to the displacements;

— the system for measuring the displacement of the wheel should be fixed to the brake block or to the fixation system of the brake cylinder in order to measure the relative displacement between the brake blocks and the wheel.

Annex R
(informative)

Dynamometer test program – Simulation of service conditions for freight wagons

R.1 Simulation freight wagon with brake block type K 2Bgu

R.1.1 Test program

The test consists of ten consecutively repeated basic cycles defined as follow:

Conditions for Table R.1

Brake block configuration:	2 × Bgu [4 brake block of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	Between 920 mm and 870 mm (new wheel 920 mm). The accurate diameter shall be given in the test report
To be braked mass per wheel:	3,5 t, 6,5 t and 10,0 t

Table R.1 — Basis cycle of the simulation program for brake block type K for freight wagons (v_{max} = 120 km/h) in configuration 2Bgu and wheel diameter 920 mm

Number and type of braking		Initial speed	Final speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
		v	v_3	F_B	θ_0	m	
		km/h	km/h	kN	°C	t	
22	Stop	30	0	3,5	80 – 90	3,5	Empty
1	Stop	75	0	9			
1	Stop	90	0	3,5			
1	Slow	75	45	7			
13	Slow	90	50	3,5			
1	Slow	100	30	7			
3	Slow	120	40	3,5			
2 times: 15 slowing braking + 1 brake to rest, spaced 180 s (“*Saw-tooth” simulation*)							
15	Slow	75	45	3,5	50 – 60[a]		
1	Stop	75	0	3,5			

<table>
<tr><th colspan="2" rowspan="3">Number and type of braking</th><th>Initial speed</th><th>Final speed</th><th>Total F_B per wheel</th><th>Initial temperature</th><th>Mass to brake per wheel</th><th rowspan="3">Remarks</th></tr>
<tr><th>v</th><th>v_3</th><th>F_B</th><th>θ_0</th><th>m</th></tr>
<tr><th>km/h</th><th>km/h</th><th>kN</th><th>°C</th><th>t</th></tr>
<tr><td>30</td><td>Stop</td><td>30</td><td>0</td><td>5,5</td><td rowspan="4">80 – 90</td><td rowspan="4">6,5</td><td rowspan="4">Partially loaded</td></tr>
<tr><td>1</td><td>Stop</td><td>30</td><td>0</td><td>7</td></tr>
<tr><td>1</td><td>Stop</td><td>100</td><td>0</td><td>5,5</td></tr>
<tr><td>29</td><td>Slow</td><td>90</td><td>50</td><td>6</td></tr>
<tr><td>2</td><td>Slow</td><td>120</td><td>75</td><td>5,2</td><td>80 – 90</td><td rowspan="4">6,5</td><td rowspan="4">Partially loaded</td></tr>
<tr><td colspan="6">7 times: 15 slowing braking + 1 brake to rest, spaced 180 s (“Saw-tooth” simulation)</td></tr>
<tr><td>15</td><td>Slow</td><td>75</td><td>45</td><td>6</td><td rowspan="2">50 – 60[a]</td></tr>
<tr><td>1</td><td>Stop</td><td>75</td><td>0</td><td>6</td></tr>
<tr><td>50</td><td>Stop</td><td>30</td><td>0</td><td>3,5</td><td rowspan="12">80 - 90</td><td rowspan="24">10,0</td><td rowspan="24">Loaded</td></tr>
<tr><td>13</td><td>Stop</td><td>30</td><td>0</td><td>8,5</td></tr>
<tr><td>1</td><td>Stop</td><td>30</td><td>0</td><td>1,6</td></tr>
<tr><td>1</td><td>Stop</td><td>75</td><td>0</td><td>2,6</td></tr>
<tr><td>1</td><td>Stop</td><td>100</td><td>0</td><td>5</td></tr>
<tr><td>1</td><td>Stop</td><td>100</td><td>0</td><td>8,5</td></tr>
<tr><td>15</td><td>Slow</td><td>90</td><td>60</td><td>5</td></tr>
<tr><td>13</td><td>Slow</td><td>90</td><td>50</td><td>9</td></tr>
<tr><td>1</td><td>Slow</td><td>80</td><td>20</td><td>1,7</td></tr>
<tr><td>1</td><td>Slow</td><td>120</td><td>70</td><td>4</td></tr>
<tr><td>1</td><td>Slow</td><td>120</td><td>60</td><td>8,5</td></tr>
<tr><td>1</td><td>Slow</td><td>120</td><td>20</td><td>1,9</td></tr>
<tr><td colspan="6">5 times: 14 slowing braking + 1 brake to rest, spaced 180 s (“Saw-tooth” simulation)</td></tr>
<tr><td>14</td><td>Slow</td><td>75</td><td>45</td><td>5</td><td rowspan="2">50 – 60[a]</td></tr>
<tr><td>1</td><td>Stop</td><td>75</td><td>0</td><td>5</td></tr>
<tr><td colspan="6">3 times: 16 slowing braking + 1 brake to rest, spaced 180 s (“Saw-tooth” simulation)</td></tr>
<tr><td>16</td><td>Slow</td><td>75</td><td>45</td><td>9</td><td rowspan="2">50 – 60[a]</td></tr>
<tr><td>1</td><td>Stop</td><td>75</td><td>0</td><td>9</td></tr>
<tr><td colspan="6">1 time: 11 slowing braking + 1 brake to rest, spaced 180 s (“Saw-tooth” simulation)</td></tr>
<tr><td>11</td><td>Slow</td><td>75</td><td>45</td><td>1,5</td><td rowspan="2">50 – 60[a]</td></tr>
<tr><td>1</td><td>Stop</td><td>75</td><td>0</td><td>1,5</td></tr>
</table>

Number and type of braking	Initial speed	Final speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
	v	v_3	F_B	θ_0	m	
	km/h	km/h	kN	°C	t	

[a] Initial temperature is referring only for the first slowing braking of the “saw-thooth” simulation.

Stop = Stopping braking

Slow = Slowing braking

R.1.2 Specific requirements for conducting test program

The test consists of 10 consecutively repeated basic cycles.

The sequence of braking of a basic cycle, “saw-tooth” simulation, is obtained by random selection of brake mass. “Saw-tooth” braking simulations are then inserted at regular interval in the basic cycle.

If the dynamometer is not able to simulate different brake masses without modification of the inertia of the dynamometer, it is permitted to conduct test as 3 separate tests in the empty, part laden and laden conditions separately.

The time to reach 95 % of the demand F_B should be 7 s ± 0,5 s.

Rotation and ventilation conditions:

— the direction of rotation of the test bench shall be alternate after each “saw-tooth” simulation;

— the speed of the test bench between braking shall be 60 km/h;

— the speed of the cooling air between braking shall be 30 km/h.

Particular measurements to be carried out before the test then after each basic cycle:

— transverse wheel profile;

— weight and thickness of the brake block.

R.2 Simulation freight wagon with brake block type LL 2Bgu

R.2.1 Test program

Conditions for Table R.2

Brake block configuration:	2 × Bgu [4 brake block of 250 × 80 $\left(^{+1}_{-2}\right)$ mm] per wheel
Wheel type:	In conformity with EN 13979–1
Wheel diameter:	Between 920 mm and 870 mm (new wheel 920 mm). The accurate diameter shall be given in the test report

To be braked mass per wheel:	3,5 t, 6,5 t and 10,0 t

Table R.2 — Simulation program for brake blocks of type LL for freight wagons (v_{max} = 120 km/h) in configuration 2Bgu and wheel diameter 920 mm

Number and type of braking		Initial speed	Final speed	Total F_B per wheel	Initial temperature	Mass to brake per wheel	Remarks
		v	v_3	F_B	θ_0	m	
		km/h	km/h	kN	°C	[t]	
22	Stop	30	0	6	80 – 90	3,5	Empty
1	Stop	75	0	16			
1	Stop	90	0	6			
1	Slow	75	45	12,5			
13	Slow	90	50	6			
1	Slow	100	30	12,5			
3	Slow	120	40	6			
2 times: 15 slowing braking + 1 brake to rest, spaced 180 s (“*Saw-tooth” simulation*)							
15	Slow	75	45	6	50 – 60[a]		
1	Stop	75	0	6			
30	Stop	30	0	12	80 – 90	6,5	Partially loaded
1	Stop	30	0	15			
1	Stop	100	0	12			
29	Slow	90	50	13			
2	Slow	120	75	11			
7 times: 15 slowing braking + 1 brake to rest, spaced 180 s (“*Saw-tooth” simulation*)							
15	Slow	75	45	13	50 – 60[a]		
1	Stop	75	0	13			
50	Stop	30	0	8,5	80 - 90	10,0	Loaded
13	Stop	30	0	20,5			
1	Stop	30	0	39			
1	Stop	75	0	63			
1	Stop	100	0	12			
1	Stop	100	0	20,5			
15	Slow	90	60	12			
13	Slow	90	50	22			

1	Slow	80	20	41			
1	Slow	120	70	10			
1	Slow	120	60	20,5			
1	Slow	120	20	46			
5 times: 14 slowing braking + 1 brake to rest, spaced 180 s (“*Saw-tooth” simulation*)							
14	Slow	75	45	12	50 – 60[a]		
1	Stop	75	0	12			
3 times: 16 slowing braking + 1 brake to rest, spaced 180 s (“*Saw-tooth” simulation*)							
16	Slow	75	45	22	50 – 60[a]		
1	Stop	75	0	22			
1 time: 12 slowing braking + 1 brake to rest, spaced 180 s (“*Saw-tooth” simulation*)							
11	Slow	75	45	36	50 – 60[a]		
1	Stop	75	0	36			

[a] Initial temperature is referring only for the first slowing braking of the “saw-thooth” simulation.

Stop = Stopping braking

Slow = Slowing braking

R.2.2 Specific requirements for conducting test program

The test consists of 10 consecutively repeated basic cycles.

The sequence of braking of a basic cycle, “saw-tooth” simulation, is obtained by random selection. “Saw-tooth” braking simulations are then inserted at regular interval in the basic cycle.

If the dynamometer is not able to simulate all conditions, it is permitted to conduct tests in the empty, part laden and laden conditions separately.

The time to reach 95 % of the demand F_B should be 7 s ± 0,5 s.

Rotation and ventilation conditions:

— the direction of rotation of the test bench shall be alternate after each “saw-tooth” simulation;

— the speed of the test bench between braking shall be 60 km/h;

— the speed of the cooling air between braking shall be 30 km/h.

Particular measurements to be carried out before the test then after each basic cycle:

— transverse wheel profile;

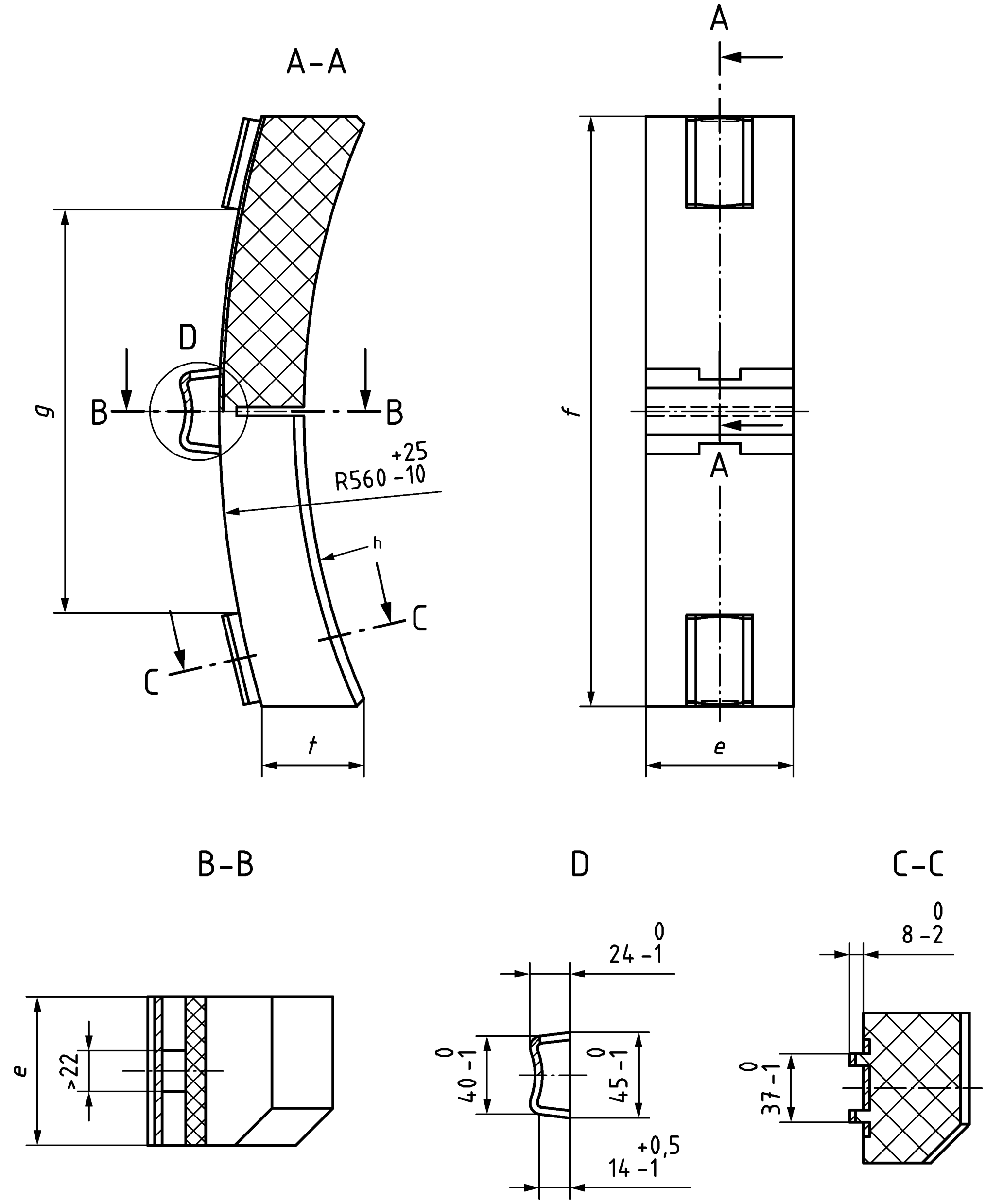
— weight and thickness of the brake blocks.

Annex S
(normative)

Interchangeability, rejection lugs and critical dimensions

Design dimensions and tolerances for brake block used in EU-D Rolling stock and rejection lugs to prevent interchangeability between brake block of different friction characteristics are defined below.

Dimensions in mm



Key

e preferential dimension = 80 mm

f = 250 mm for brake block of 250 mmm (typically used for Bgu configuration)
= 320 mm for brake block of 320 mmm (typically used for Bg configuration)

g = 182 mm for brake block of 250 mmm (typically used for Bgu configuration)
= 220 mm for brake block of 320 mmm (typically used for Bg configuration)

h contact surface between brake block and wheel tread. Except where specifically agreed, the profile of the friction surface shall be compatible with the wheel profile S1002 of EN 13715

t preferential dimension = 60 mm

Figure S.1 — Brake block design for brake block type K, L and LL with a length of 250 mm and 320 mm

Dimensions in mm

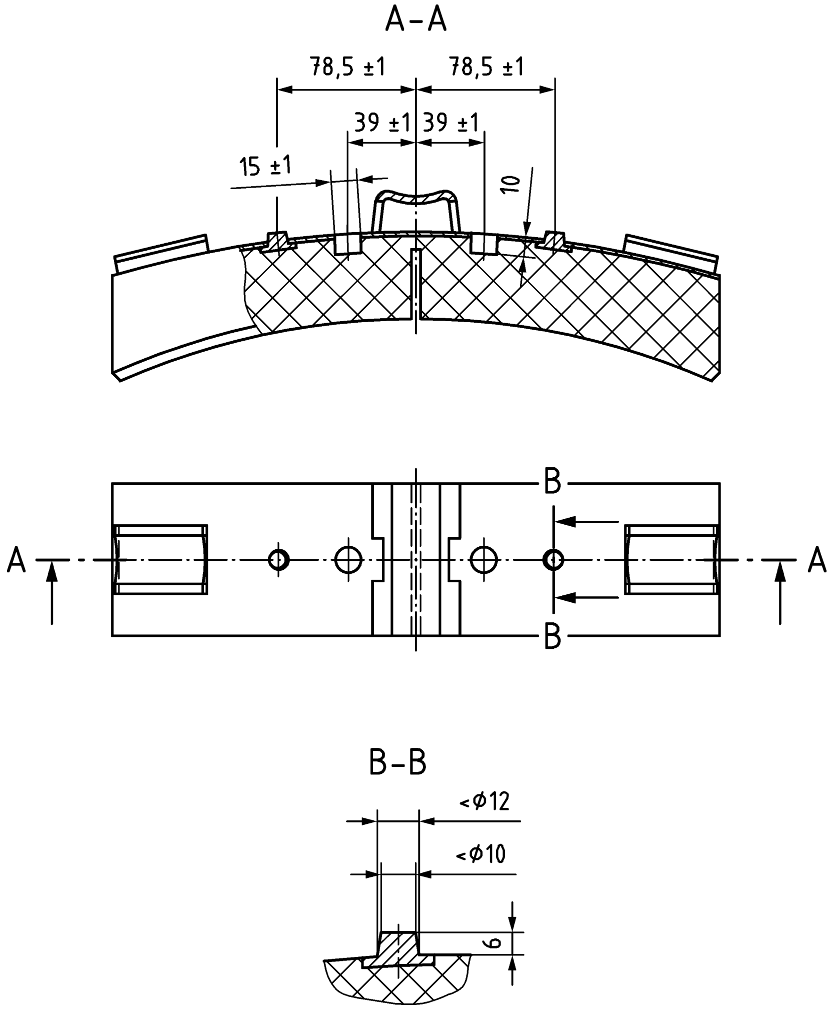


Figure S.2 — Non interchangeability design for brake block type K

Annex T
(normative)

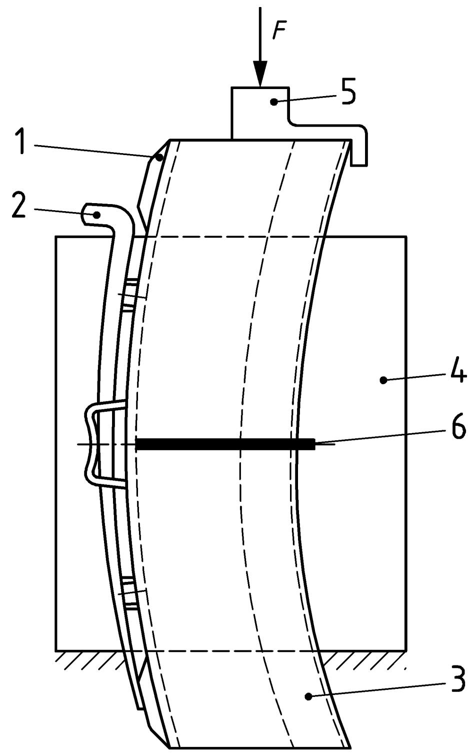
Brake block shear and flexural strength tests

T.1 General

The mechanical characteristics of the assembly between back plate and friction material of brake block shall be tested according the test procedures below.

T.2 Shear strength test

T.2.1 Principe of mounting for test



Key

1 brake block back plate

2 brake block fixing key

3 friction material

4 side panel

5 force application fixing

6 brake block groove filling device

F force (15 kN)

Figure T.1 — Shear strength test mounting arrangement

T.2.2 Test procedure

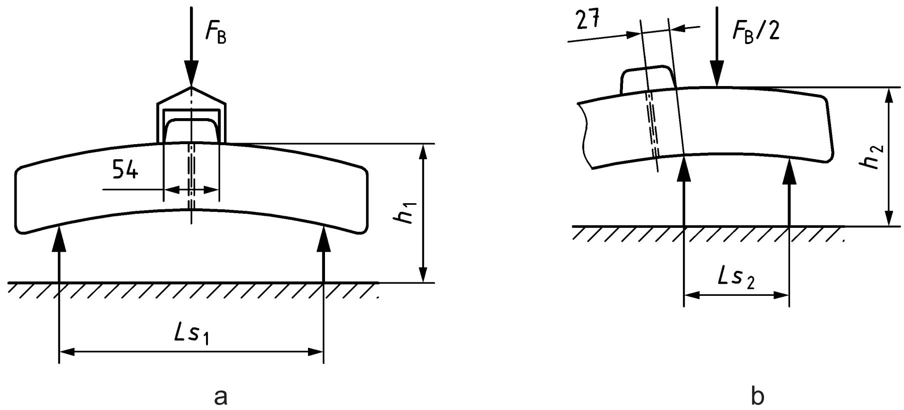
The test can be performed with the mounting shown above. It shall be carried out with a brake block. In the case of a brake block in two parts or a mono-bloc brake block with a central groove, a wedge shall be placed in the central groove as shown.

The force "F" of 15 kN shall be applied, in the direction of the tangential force applied during the brake application, in a regular and progressive way up to the maximum value within 4 s and shall be kept constant for a period of 2 min.

T.3 Flexural strength test

T.3.1 Principe of mounting for test

Dimensions in mm



Key

a mounting for performing test n°1

b mounting for performing test n°2

Figure T.2 — Flexural strength test mounting arrangement

T.3.2 Test procedure

The tests shall be performed with the mountings 1 and 2 shown above, the end of the supports shall have a radius of 5 mm.

Test 1 and test 2 are performed on 2 new brake blocks. The load shall be applied five times on each brake block for both test types.

The force shall be applied up to the maximum indicated value in the direction shown such that that it reaches the maximum value in 4 s. It shall then be kept constant for a period of 2 min.

Maximum force F_B:

— F_B K = 19 kN (brake block K, 250 mm or 320 mm);

— F_B LL = 28 kN (brake block LL, 250 mm);

— F_B LL = 33 kN (brake block LL, 320 mm).

Distance *Ls*:

— L_{s1} = 200 mm (brake block 250 mm);

— L_{s1} = 270 mm (brake block 320 mm);

— L_{s2} = 75 mm (brake block 250 mm);

— L_{s2} = 110 mm (brake block 320 mm).

Arrow Δh:

— Δh_1 = 2 mm;

— Δh_2 = 1 mm.

Annex U
(normative)

Limitation of permissible mechanical damage of brake block

U.1 General

Figures U.1 to Figure U.6 show damage that can happen to brake blocks like radial cracks in friction material (Figure U.1), crumbling of the friction material (Figure U.2), metal pick-up (Figure U.3), detachment from back plate (Figure U.4), cracks in the direction of wheel circumference (Figure U.5) and detachment of the friction material (Figure U.6).

Mechanical damage experienced by the brake block as shown below during dynamometer tests (except for test “locked brakes” in 7.5) and in service assessment is not permitted.

If such damage occurs, during the in service assessment, further investigations should be carried out to confirm if the friction material is the root cause of the problem.

U.2 Cracked through to back-plate

Radial crack in friction material from the rubbing surface to the back-plate

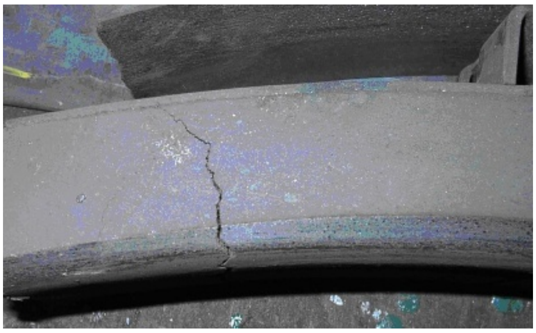


Figure U.1 — Cracked through to back-plate

U.3 Crumbling of the friction material

Crumbling of the friction material along more than ¼ of the length of the brake block (correlates to total length > 63 mm for 250 mm brake blocks or total length > 80 mm for 320 mm brake blocks)

Figure U.2 — Crumbling of the friction material

U.4 Metal pick-up

Metal pick-up more than 5 % of the total brake block rubbing surface.

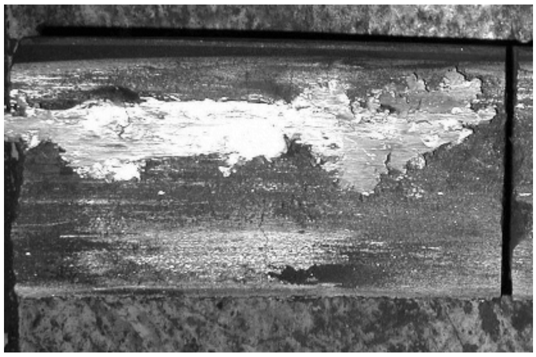


Figure U.3 — Metal pick-up

U.5 Detachment from back-plate

Detachment from back-plate more than 25 mm

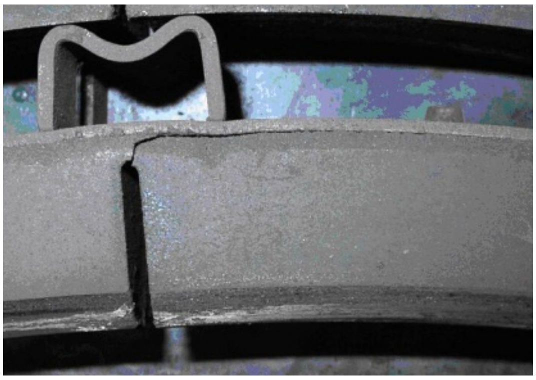


Figure U.4 — Detachment from back-plate

U.6 Cracks in the direction of wheel circumference

Cracks in the direction of wheel circumference more than 25 mm

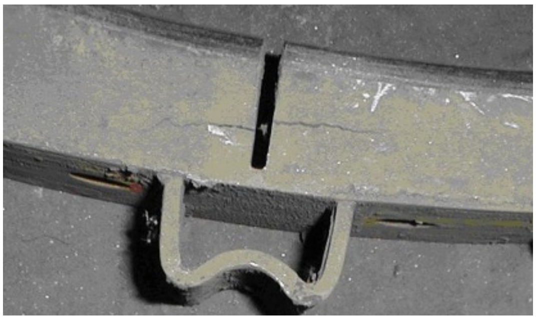


Figure U.5 — Cracks in the direction of wheel circumference

U.7 Detachment of the friction material

Detachment of the friction material more than 10 % of the total brake block rubbing surface.

Figure U.6 — Detachment of the friction material

U.8 Interface with the brake block holder

The brake block back-plate shall not be damaged or worn so as to induce the following:

— brake block overhang of the wheel rim. A brake block is considered to be overhanging when its outer edge reaches the outer edge of the wheel rim;

— mechanical failure of the back plate resulting in loss of the brake block from the block holder.

Annex V
(normative)

In service assessment of brake block

V.1 General

Service trials shall be carried out to demonstrate that the composition brake block type concerned is suitable for use in the application for which certification has been granted, damage to wheels or blocks does not occur, and that it does not result in any operational problems during use.

The in-service assessment for the brake block shall be performed as prescribed below. The evaluation of wheel profile shall be compared with a reference (see definition in V.7)

V.2 Freight wagon

V.2.1 Introduction

The in-service assessment shall be performed on at least five (5) freight wagons per brake block configuration and braking regime (S/SS-braked) and under various weather conditions, for 12 months without interruption and for a minimum of 60 000 km for each vehicle.

If a brake block type has only passed the simulation of a downhill brake application with 40 kW of braking power (see 7.2.7.1, Annex C and Annex D) a service test in trains running regularly on tracks with heavy slopes shall be performed with this type of block.

V.2.2 Monitoring regime

The following monitoring shall take place:

Table V.1 — Areas to monitor

Monitoring operation	Initial	After 1/3 of test time	After 2/3 of test time	Final
S1	All	-	All	All
S2	All	All	All	All
R1	All	-	2 freight wagons	All
R2	All	All	All	All
R3	All	-	All	All
R4	All	All	-	2 freight wagons

Description of monitoring operation and additional measures see V.7.

V.3 Coach

V.3.1 Introduction

The in-service assessment shall be performed on at least four coaches and under various weather conditions, for 12 months without interruption and for a minimum of 120 000 km for each vehicle.

V.3.2 Monitoring regime

The following monitoring shall take place:

Table V.2 — Areas to monitor

Monitoring operation	Initial	After 30 000 km	After 6 month	Final
S1	All	-	All	All
S2	All	All	All	All
R1	All	-	2 coach	All
R2	All	All	All	All
R3	All	-	All	All
R4	All	All	-	2 coach

Description of monitoring operation and additional measures see V.7.

V.4 Locomotive

V.4.1 Introduction

The in-service assessment shall be performed on at least five locomotives under various weather conditions, for 12 months without interruption and for a minimum of 120 000 km for each one.

V.4.2 Monitoring regime

The following monitoring shall take place:

Table V.3 — Areas to monitor

Monitoring operation	Initial	After 1/3 of test time or km	After 2/3 of test time or km	Final
S1	All	All	All	All
S2	All	All	All	All
R1	All	-	2 locomotives	All
R2	All	All	All	All
R3	All	-	All	All

Description of monitoring operation and additional measures see V.7.

V.5 EMU-DMU

V.5.1 Introduction

The in-service assessment shall be performed on at least ten bogies distributed within at least five EMU/DMU cars under various weather conditions, for 12 months without interruption and for a minimum of 120 000 km for each vehicle.

V.5.2 Monitoring regime

The following monitoring shall take place:

Table V.4 — Areas to monitor

Monitoring operation	Initial	After 1/3 of test time or km	After 2/3 of test time or km	Final
S1	All	All	All	All
S2	All	All	All	All
R1	All	-	4 Boogies	All
R2	All	All	All	All
R3	All	-	All	All

Description of monitoring operation and additional measures see V.7.

V.6 High speed train

V.6.1 Introduction

The in-service assessment shall be performed on at least ten bogies distributed within at least five high speed trains under various weather conditions, for 12 months without interruption and for a minimum of 250 000 km for each vehicle.

V.6.2 Monitoring regime

The following monitoring operations shall take place:

Table V.5 — Areas to monitor

Monitoring operation	Initial	After 1/3 of test time	After 2/3 of test time	Final
S1	All	All	All	All
S2	All	All	All	All
R1	All	-	4 bogies	All
R2	All	All	All	All
R3	All	-	All	All

Description of monitoring operation and additional measures see V.7.

V.7 Description of areas to be monitored and additional measures

The description of the areas to be monitored and additional measures are shown below.

Table V.6 — Description of areas to be monitored

Monitoring operation	Description
S1	Status of bedding in (percentage of friction surface in contact with the tread) and block thickness measurement (three values to be determined, the thickness at each extremity and the thickness in the centre. Thickness is measured at the edge of the block opposite the wheel flange)
S2	Visual inspection of block condition (damage, etc.) the mechanical damage shall be assessed in accordance with the requirements of Annex U
R1	Wheel tread profile measurement
R2	Visual inspections of the wheel tread (thermal cracks, etc.) according to EN 15313
R3	Visual inspection of wheel condition according to EN 15313
R4	Wheel tread measurement of out-of-roundness (Circularity defects of tread wheel – the shape and amplitude are to be determined and, *inter alia*, presented in the form of a graph)

The wheel tread profile measurement (R1) should be obtained to quantify the variations of wheel parameters defined below in comparison with a “reference”.

The reference wheel tread profile shall be obtained after use with a brake block (composite or cast iron) frequently used:

— for the same or similar type of vehicle;

— for the same or similar conditions of service;

List of parameters to be evaluated:

— determination of variation of diameter of wheel (d);

— determination of variation of flange thickness (e);

— determination of variation of flange height per (h);

— determination of variation of distance between flange angle (qR);

— determination of falls flange (profile of wheel tread);

— determination of variation of back-to-back distance between wheels (a_1).

The profile of the wheel tread, wheel diameter d and a_1 distance shall be used for determination of the variation of equivalent conicity calculated with a theoretical rail standard profile of 1/20 and 1/40.

V.8 Pass/fail criteria

For the all vehicles the results arising from V.7 above shall not exceed that permitted by the maintenance criteria in EN 15313 for the vehicle concerned or that provided in Annex U.

The maximum lateral displacement of the rim measured in conformity with prescriptions of EN 13979-1 shall not exceed +1,5/-0,5 mm.

Annex W
(informative)

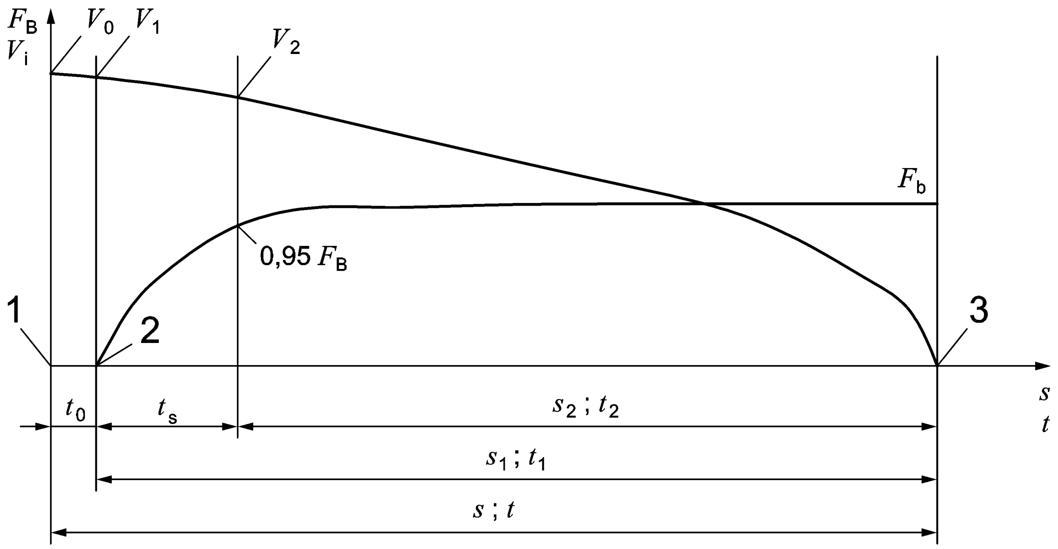
Complementary definitions and abbreviations

Clause 4 contains the abbreviations used in the draft. Complementary abbreviations and definitions defined below can be used for the tests reports.

Table W.1 — Description of areas to be monitored

Symbol	Unit	Definition
a	[m/s²]	Instantaneous deceleration
$a_m = \frac{v_0^2}{2_s}$	[m/s²]	Mean deceleration calculated from v_0 and s
F_{bm}	[kN]	Integrated mean application force on s_2
F_{tR}	[kN]	Instantaneous tangential force in relation to the wheel radius
F_{umR}	[kN]	Mean tangential force (integrated over s_2) in relation to the wheel
P	[kW]	Total nominal braking power per wheel during the drag brake applications (v and F_{tR} = continuous setting)
P_c	[bar]	Brake cylinder air pressure
P_m	[kW]	Mean braking power (integrated over s_2)
s	[m]	Total stopping distance from brake application initiation to rest
s_1	[m]	Stopping distance from the beginning of the build-up of F_B to rest
s_2	[m]	Stopping distance from the moment on when $F_b = 0{,}95 \cdot F_B$ to rest
t	[s]	Total time for the stop to rest
t_0	[s]	Dead time registered between the brake application initiation and start of the build-up of F_B
t_1	[s]	Stopping duration corresponding to s_1
t_2	[s]	Braking duration corresponding to s_2
t_s	[s]	Application time measured from 0 % to 95 % of the force F_B
v_0	[km/h]	Actual speed, at the brake application initiation
v_1	[km/h]	Speed at the beginning of the build-up of F_b
v_2	[km/h]	Speed at the moment when $F_b = 0{,}95 \cdot F_B$
θ_m	[°C]	Maximum temperature obtained by the instantaneous average of the temperatures

Symbol	Unit	Definition
θ_i	[°C]	Instantaneous temperature
θ_{max}	[°C]	Maximum temperature
$\Delta\theta_{max}$	[°C]	Maximum temperature difference between two measurements
K	[-]	Coefficient for the speed correction



Key

1 brake demand

2 force rise of F_B

3 stop

Figure W.1 — Complementary abbreviations

Annex X
(informative)

Brake block characterization test

Test X is required once only and is to be conducted on one brake blocks used during the evaluation period and Test Y is required for every batch of brake shoe inserts used during the evaluation period. Table X.1 specifies test to be performed depending on material organic/sinter.

Table X.1 — Assignments of test to materials organic/sinter

	Organic Material	Sinter Material
Chemical analysis [a]	X	X
Macrographic structure		X
Hardness	Y	Y
Friction coefficient (reduced scale)	Y	Y
Density	Y	Y
High temperature stability		X

[a] Results for chemical analysis are confidential. They are not included in the evaluation test report. They will be retained for future comparison and have to be retained by the brake block manufacturer for a period of 10 years.

The test results shall be attached to the evaluation report.

For each property, the test method and the tolerance band are to be defined by the manufacturer in accordance with the product itself and the manufacturing process.

The test method and the tolerance band for each property shall be defined in accordance with the product itself and the production process.

Annex ZA
(informative)

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

This European Standard has been prepared under a mandate 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 [1)].

Once this standard is cited in the Official Journal of the European Union 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 HS Rolling Stock, Table ZA.2 for CR Freight Wagons and Table ZA.3 for CR Locomotives and Passenger Rolling Stock 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.

Table ZA.1 – Correspondence between this European Standard, the HS TSI RST published in the OJEU dated 26 March 2008 and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard applies	4. Characterization of the subsystem 4.2 Functional and technical specification of the subsystem 4.2.4 Braking	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.5 1.2. Reliability and availability 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.2 Reliability and availability 2.4.3 Technical compatibility §3	The full compliance with the TSI requirements depends on the way the product is integrated into the rolling stock.

1) 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.2 – Correspondence between this European Standard, the CR TSI RST Freight Wagon dated July 2006, published in the OJEU on 8 December 2006 and its intermediate revision published in the OJEU on 14 February 2009 and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard applies	4.Characterization of the subsystem 4.2. Functional and technical specifications of the subsystem, 4.2.4 Braking §4.2.4.1.2.3 Braking performance, Functional and technical specification, Mechanical components 5. Interoperability constituents 5.3 List of constituents §5.3.3.10 Braking, brake blocks 5.4 Constituents performances and specifications §5.4.3.11 Braking, brake blocks 6. Assessment of conformity and/or suitability for the use of the constituents and verification of the subsystem 6.2 Subsystem conventional rail rolling stock freight wagons §6.2.3.3.2 Specification for assessment of the subsystem, Braking, Minimum brake system testing Annex I Interfaces of braking interoperability constituents §I.10 Brake block Annex P Braking performance, assessment of interoperability constituents §P1.10 Design assessment,	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.5 1.2. Reliability and availability 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §3 2.4.3 Technical compatibility §3	The brake block is cited as an Interoperability Constituent in the TSI. The specifications for brake block in TSI is an open point.

	Brake block §P2.10 Product assessment, Brake block Annex Q Assessment procedures, Interoperability constituents Annex S Braking - Braking Performance		

Table ZA.3 - Correspondence between this European Standard, the CR LOC and PASS RST TSI published in the OJEU dated 26 May 2011and Directive 2008/57/EC

Clause/ subclauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard applies	4.Characterization of the Rolling stock subsystem 4.2 Functional and technical specifications of the subsystem. 4.2.4 Braking	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.5 1.2. Reliability and availability 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.2 Reliability and availability 2.4.3 Technical compatibility §3	The full compliance with the TSI requirements depends on the way the product is integrated into the rolling stock

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

Bibliography

[1] UIC 510-5, *Technical approval of monobloc wheels*

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

[3] UIC 541-4, *Brakes — Brakes with composite brake blocks — General conditions for certification of composite brake blocks*

[4] B 169/RP33, *The influence of composite braking material on shuntage — Physico-chemical and electrical characterisation of composite brake blocks in laboratory shuntage line tests*

[5] B 169/RP39, *Influence des matériaux de freinage composite sur le shuntage en ligne. Caractérisation électrique des semelles de frein en matériau composite vis-à-vis du shuntage en ligne — Essais de reproductibilité de bancs de freinage à échelle réduite*

[6] B 126/DT408, *Dynanometer ventilating conditions*

[7] B 126/RP 18, *Dynamometers for international approval of friction materials — requirements*

[8] B 126/RP37, *Dynamometer test simulation of extreme winter conditions for freight applications*

[9] IN 2725, *Spécification d'Admission du Matériel — SAM S004 — Aptitude au shuntage des matériels roulants et des semelles*

[10] EN 50238, *Railway applications — Compatibility between rolling stock and train detection systems*

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.

...making excellence a habit.™