BS EN 14535-3:2015

BSI Standards Publication

Railway applications — Brake discs for railway rolling stock

Part 3: Brake discs, performance of the disc and the friction couple, classification

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National foreword

This British Standard is the UK implementation of EN 14535-3:2015.

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**
2	1
3	1
5	3
10	5
15	10
20	10
30	20
40	25
50	30
60	40
80	50
100	60
120	75
140	90
150	95
160	100
170	105
180	110
190	120
200	125
220	135
225	140
230	145
250	155
280	175
300	190
320	200
350	220
360	225

The UK participation in its preparation was entrusted by 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.

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EUROPEAN STANDARD

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

Applications ferroviaires - Disques de frein pour matériel roulant ferroviaire - Partie 3: Disques de frein, performances du disque et du couple de friction, classification

Bahnanwendungen - Bremsscheiben für Schienenfahrzeuge - Teil 3: Bremsscheiben, Leistung Bremsscheibe und der Reibpaarung, Klassifikation

This European Standard was approved by CEN on 10 July 2015.

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

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European foreword

This document (EN 14535-3:2015) 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 June 2016 and conflicting national standards shall be withdrawn at the latest by June 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(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

EN 14535, *Railway applications — Brake discs for railway rolling stock*, is currently composed of the following parts:

— *Part 1: Brake discs pressed or shrunk onto the axle or drive shaft, dimensions and quality requirements*;

— *Part 2: Brake discs mounted onto the wheel, dimensions and quality requirements*;

— *Part 3: Brake discs, performance of the disc and the friction couple, classification*.

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

This European Standard gives the requirements and classification to be met for the design, dimensions, performance, and testing of the brake disc and "pad and brake disc friction couple". These requirements need to be proven in sufficient detail by dynamometer tests. Quality of design, workmanship and construction need to ensure accordance with good engineering practice and manufacture.

The classification according to this standard is the subject of a brake disc classification certificate (Annex A).

1 Scope

This European Standard applies to brake discs designed to be fitted to railway vehicles.

This European Standard comprises a type test of brake disc performance. The brake disc is tested for energy conversion and dissipation, ventilation characteristics as well as mechanical integrity.

The classification qualifies a brake disc in conjunction with the defined brake pad by dynamometer tests which simulates up to one year in service when operating in the defined application class. It does not define the application and the brake performance in specific trains.

NOTE For this purpose, additional tests may be necessary.

For the application of brake discs on railway vehicles it is not mandatory to use classified brake discs.

Classified brake discs can be validated for the use on railway vehicles for higher performance applications with additional tests.

This standard describes the type test procedure for brake disc classification as specified in EN 14535-1 and EN 14535-2.

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

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

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

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

3 Terms and definitions

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

3.1
axle mounted brake disc
component attached to the axle shaft, drive shaft or any shaft directly coupled to the wheel, and rotating with the wheel

Note 1 to entry: See EN 14535-1.

3.2
wheel mounted brake disc
component attached to the wheel rim, wheel web or wheel hub, and rotating with the wheel

Note 1 to entry: See EN 14535-2.

3.3
friction face
radially and circumferentially extending planar surface of the brake disc available for frictional engagement of the brake pad(s)

3.4
brake ring
portion of the brake disc having the friction face(s)

3.5
brake disc temperature
arithmetic average of the temperature values measured by the six temperature sensors installed on the brake disc

3.6
brake disc classification certificate
document which declares the class fulfilled by the tested product by the classification table

Note 1 to entry: See Clause 5.

Note 2 to entry: It includes the references of the tested specimen and of all the documents produced to obtain the classification.

Note 3 to entry: See Annex A.

3.7
technical datasheet of the product
document in which are described the technical characteristics of the product and the maintenance criteria

4 Symbols and units

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

Table 1 — Symbols and units

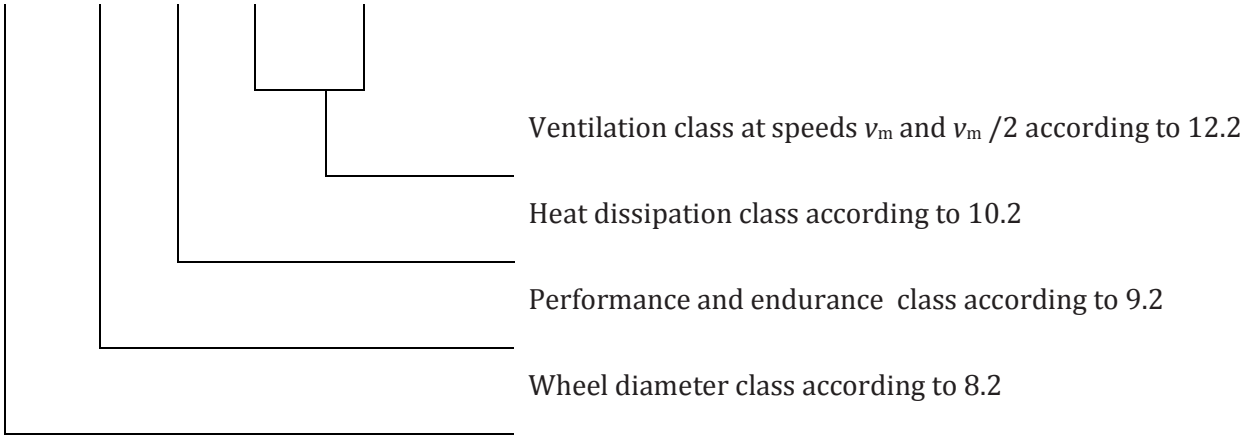
Symbol	Description	Unit
P_C	Nominal power per brake disc in a dragging brake	kW
v	Speed	km/h
U	Imbalance	g·m
a_m	Deceleration	m/s^2
m	Braked mass per brake disc	t
v_m	Class speed	km/h
t	Application duration	min
P_m	Maximum power of the class	kW
W_b	Maximum energy of the class	MJ
P_{vmin}	Minimum ventilation power of the class	kW
P_{vmax}	Maximum ventilation power of the class	kW
Θ_0	Initial temperature	°C

5 Classification

The classification of the brake disc is described by use of a performance class, which is a set of the values of brake energy, brake power and brake torque, related to the major diameter, width and type of the brake disc, at which it is type tested to demonstrate its capability to withstand these conditions without exceeding the defined limits of structural degradation.

The classification of the brake disc is summarized in as follows and recorded in the classification certificate (see Annex A):

W3- C1- H3- V03/ V01



NOTE The designation and marking are in accordance with EN 14535-1 and EN 14535-2.

6 Information to be supplied

The following information shall be fully documented. For compliance with the standard both the common requirements specified throughout the standard and the following documented items shall be satisfied:

— definition and identification of the brake pads (7.2);

— drawing of the wheel (In case of wheel mounted brake disc);

— wheel class (8.2) and wheel diameter if the wheel class is W0;

— method for preliminary and final verifications (8.3);

— performance and endurance target class (9.2);

— heat dissipation target class (10.2);

— ventilation target class (12.2);

— method for the verification of pass and fail criteria (9.4, 10.4, 11.4, 12.4);

— imbalance class according to EN 14535-1 and EN 14535-2 and value of imbalance if it isn't defined;

— maximum values for corrugation, swashing and buckling (9.4, 10.4).

NOTE Usually these items of information are supplied by the manufacturer.

7 Tested properties for brake disc classification

7.1 General requirements

Brake disc and pad materials used for the performance tests shall be in accordance with the specifications of this standard.

The brake disc and pad interaction couple, which is used as a reference, shall be defined.

Should the classification be required with more than one reference pad, then only the performance, endurance and heat dissipation tests, are required to be repeated with the further pad type.

If brake disc dimensions are changed by no more than ± 1 % from existing models, this brake disc shall be included in the same performance class of the existing brake disc without re-testing.

In case of wheel mounted brake discs, all the tests shall be performed with the brake disc assembled on a wheel.

Details for the execution of the tests are described in the following clauses.

The operators shall monitor the product installed during the trial test according to their specific evaluation criteria.

7.2 Test specimens

Three specimens shall be provided for a classification. The specimens shall be produced under serial conditions and the raw materials shall come from the same casting or forging batch. The production data shall be confirmed by certificates.

Dimensional and material controls: Specimen 1.

The classification tests shall be carried out in the following order using the reference specimens:

— performance and endurance test: Specimen 2;

— centrifugal test: Specimen 2;

— ventilation test: Specimen 3;

— heat dissipation test: Specimen 3.

The pad type shall be defined and used for all the classification test. The pads used for each test shall be identified.

7.3 Preliminary and final verification sequences

Before starting the tests and after any test that may influence or change the physical integrity of the tested brake disc the verifications that are listed in Table 3 shall be executed.

7.4 Pass and fail criteria

The pass and fail criteria for every test are mentioned after each test to which they apply.

8 Preconditions

8.1 Dynamometers

The tests shall be carried out on calibrated dynamometers.

All test devices shall be calibrated according to the relevant clauses of EN ISO/IEC 17025.

The brake ring shall be equipped with six temperature sensors positioned 1 mm below the friction surface, 3 on each face. For each face one sensor is positioned on the middle radius of the friction face of brake ring and the other two are positioned on the middle radius ± 40 mm, circumferentially positioned at an angle of 120° to each other.

This shall be applied except when the brake disc geometry does not allow it. In this case sliding thermocouples may be used.

8.2 Wheel diameter

Depending on the application of the brake disc, different wheel diameters shall be used as a parameter for the test to be done. The diameter closer to the application required shall be considered. The following wheel diameters, as set out in Table 2, shall be used and specified in the classification table.

Table 2 — Wheel diameters

Wheel class	Test Wheel diameter	Wheel diameter range
	mm	mm
W0	Half worn wheel diameter	≤ 550
W1	625	550 < d ≤ 760
W2	890	760 < d ≤ 980
W3	1 200	> 980

8.3 Preliminary and final verification sequences

Before starting the tests and after any test that may influence or change the physical integrity of the tested brake disc, the verifications that are listed in the Table 3 shall be carried out.

Table 3 — Preliminary and final verifications

Brake disc number = > Tests and verifications	Specimen 1	Specimen 2	Specimen 3
Preliminaries verifications			
Chemical characteristics Verified against manufacturer's specification (y/n)	X		
Hardness Verified against manufacturer's specification (y/n)	X		
Tensile testing Verified against manufacturer's specification (y/n)	X		
Charpy impact test Verified against manufacturer's specification (y/n)	X[a]		
Physical characteristics Verified against manufacturer's specification (y/n)	X		
Geometrical characteristics Verified against manufacturer's specification (y/n)	X	X	X
Examination by non-destructive testing Magnetic Particle Inspection	X	X	X
Residual imbalance	X	X	X
Final verifications			
Geometrical characteristics according to EN 14535-1 and EN 14535-2		X	X
Examination by non-destructive testing Magnetic Particle Inspection		X	X
Residual imbalance according to EN 14535-1 and EN 14535-2		X	X
[a] Only applicable for steel brake discs.			

9 Performance and Endurance Test

9.1 Scope

The scope of the Performance and Endurance test is to check the performance of the friction couple according to the Class in which the brake disc is proposed, in terms of both maximum and endurance characteristics.

For this test specimen no. 2 shall be used.

9.2 Classification test parameters

Included in Table 4 are the parameters that shall be used for the Classification test.

Table 4 — Classification test parameters

Classification test parameters:						
Class	**Maximum Energy of the class**	**Maximum Power of the class**	**Class speed**	**Braked mass**	**Initial brake disc temperature**	**Deceleration rate**
	W_b MJ	P_m kW	v_m km/h	m t	Θ_0 °C	a_m m/s²
A1	4,6	400	120	10	50 – 60	1,2
B1	7,9	427	160	8	50 – 60	1,2
B2	9,9	533	160	10	50 – 60	1,2
C1	12,3	533	200	8	50 – 60	1,2
C2	15,4	667	200	10	50 – 60	1,2
D1	20,5	472	250	8,5	50 – 60	0,8
E1	27,8	533	300	8	50 – 60	0,8
F1	23,6	389	350	5	50 – 60	0,8
F2	28,4	467	350	6	50 – 60	0,8
F3	33,1	544	350	7	50 – 60	0,8
G1	37	533	400	6	50 – 60	0,8

NOTE The classes are nominated by a capital letter for the speed and an Arabic figures for the braked mass. These nominations apply to the highest power the brake disc can dissipate at the given speed.

The classes in Table 4 may be extended in future to cover further applications.

9.3 Test procedure

The performance and endurance test is composed of 1 000 brake applications, performed in order to stress the brake disc mechanically, and to take into account fatigue and wear.

The test program is composed by slowing brake applications, in order to accelerate the crack generation and emergency braking that check the maximum brake performances of the brake disc. The final speed for each class is shown in Table 5.

Table 5 — Slowing brake applications parameters

Class	Initial speed		Final speed		Energy dissipated in one slowing brake application	
	km/h		km/h		MJ	
	Brake application number		Brake application number		Brake application number	
	1 ÷ 10	11 ÷ 20	1 ÷ 10	11 ÷ 20	1 ÷ 10	11 ÷ 20
A1	120	80	100	65	1,7	0,8
B1	160	110	140	95	1,9	0,9
B2	160	110	140	95	2,3	1,2
C1	200	135	170	115	3,4	1,5
C2	200	135	170	115	4,3	1,9
D1	250	170	215	140	5,3	3,0
E1	300	200	260	170	6,9	3,4
F1	350	235	300	200	6,3	2,9
F2	350	235	300	200	7,5	3,5
F3	350	235	300	200	8,8	4,1
G1	400	270	345	230	9,5	4,6

The test program is composed of 10 repetitions of the programme cycle, as defined in Table 6.

Table 6 — Performance and endurance test program cycle

Brake application number	Initial speed	Final speed	Deceleration rate	Initial brake disc temperature	braked mass per brake disc	Remarks
	km/h	km/h	m/s^2	°C	t	
b1 to bx	120	0	1,0	20–100	6,0	X brake applications to bed-in up to at least 85 % of pad surface in contact with the brake disc.
1	[a]	[a]	4/5 a_m	Θ_0	m	Slowing brake application
2 to 5	[a]	[a]	4/5 a_m	[b]	m	
6	[a]	[a]	2/5 a_m	2 x Θ_0	m	
7 to 10	[a]	[a]	2/5 a_m	[b]	m	
11	[a]	[a]	4/5 a_m	2 x Θ_0	m	
12 to 15	[a]	[a]	4/5 a_m	[b]	m	
16	[a]	[a]	2/5 a_m	2 x Θ_0	m	
17 to 20	[a]	[a]	2/5 a_m	[b]	m	
21	v_m	0	a_m	Θ_0	m	Emergency braking
22 to 35	2/3 v_m	0	1/2 a_m	Θ_0	m	14 Service braking
36	v_m	0	a_m	Θ_0	m	Emergency braking
37 to 50	2/3 v_m	0	1/2 a_m	Θ_0	m	14 Service braking
51	v_m	0	a_m	Θ_0	m	Emergency braking
52 to 65	2/3 v_m	0	1/2 a_m	Θ_0	m	14 Service braking
66	v_m	0	a_m	Θ_0	m	Emergency braking
67 to 80	2/3 v_m	0	1/2 a_m	Θ_0	m	14 Service braking
81	v_m	0	a_m	Θ_0	m	Emergency braking
82 to 95	2/3 v_m	0	1/2 a_m	Θ_0	m	14 Service braking
96 to 97	v_m	0	a_m	[c]	m	Consecutive Emergency braking
98 to 100	2/3 v_m	0	1/2 a_m	Θ_0	m	Service braking

[a] For the reference values, see Table 5.

[b] The brake disc shall be accelerated immediately after the end of the previous brake application with train acceleration of 0,7 m/s^2. The time between the end of brake force application and beginning of next braking shall be 60 s.

[c] After the brake application n. 96, a stop time of 60 s shall be done. After this period the brake disc shall be accelerated with train acceleration of 0,3 m/s^2.

The value of the parameters a_m, m, v_m and Θ_0 are defined in Table 4.

Wheel diameter shall be in accordance with 8.2. The brake application shall ensure that the deceleration stated in column 4 is achieved by control of the braking torque. The brake force build-up time shall be 4 s ± 0,2 s. Test interruption is only permitted at the end of brake applications n. 20, 95, 97, 100 for each repetition. If pad wear during the test exceeds the limit of the pad, exchange of pads is permitted. In this case the bedding-in shall be repeated.

During the performance and endurance test the ventilation conditions are defined in Table 7.

Table 7 — Ventilation conditions

	Simulated speed km/h	**Speed of the cooling air** km/h
During brake at		
$v \leq 200$ km/h	v	$v/2$
$v > 200$ km/h	v	100
Between the brake applications	100	80

The ventilation of dynamometer used for conducting the heat dissipation test should be suitable for carrying out this test in the correct manner.

NOTE Existing documents that define the requirements of dynamometers for ventilation at the time of writing this standard include UIC document: ERRI - B126/DT 408. This one could be used as reference document.

9.4 Pass and fail criteria

After the completion of the test program, the following degradation criteria shall be met:

— The imbalance value of the axle mounted brake disc shall not exceed 1,2 times that measured before the performance test.

— The imbalance value of the wheel mounted brake disc shall not exceed 1,2 times that measured before the performance test with the brake disc assembled to the wheel.

— The brake disc shall be checked according to the criteria contained in the technical datasheet of the product. The results of this check shall be reported in detail.

In the case of a brake disc with a monobloc non-ventilated brake ring produced from forged steel it will be necessary to have additional destructive verification after the centrifugal test.

10 Heat Dissipation Test

10.1 Scope

The Heat Dissipation test scope is to qualify the thermal dissipation performance of the brake disc with the selected pad type to one of the classes listed in Table 8.

For this test specimen no. 3 shall be used after having carried out the Ventilation Test.

10.2 Test parameters

Test parameters are defined according to the chosen class.

Table 8 — Heat Dissipation parameters

Heat dissipation class	Power	Speed	Initial brake disc temperature	Application duration
	P_C kW	v km/h	Θ_0 °C	t min
H1	20	80	50 – 60	30
H2	30	80	50 – 60	30
H3	40	80	50 – 60	30
H4	50	80	50 – 60	30
H5	60	80	50 – 60	30

NOTE The heat dissipation classes are nominated by a capital letter and a figure for the dissipated power. These nominations apply to the highest power the brake disc can dissipate at the given speed.

10.3 Test procedure

The heat dissipation test consists of 10 drag brake applications according to the parameters of the class in which the brake disc shall be classified as described in the following Table 9.

Table 9 — Heat dissipation test program

No. of braking	Initial speed	Deceleration rate	Initial brake disc temperature	Braked mass per brake disc	Application duration	Remarks
	km/h	m/s^2	°C	t	min	
b1 to bx	120	1	20–100	6	—	x brake applications to bed-in up to at least 85 % of pad surface is in contact with the brake disc. Parameters taken from Table 6
1 to 10	80	—	Θ_0	—	t	Drag brake applications of P_C kW. Parameters taken from Table 8.

The brake force build-up time shall be 4s ± 0,2 s.

If pad wear during the test exceeds the limit of the pad, exchange of pads is permitted. In this case the bedding-in shall be repeated.

During the heat dissipation test the ventilation conditions are defined in Table 10.

Table 10 — Ventilation conditions

	Simulated speed km/h	**Speed of the cooling air** km/h
During brake at		
$v \leq 200$ km/h	v	$v/2$
$v > 200$ km/h	v	100
Between the brake applications	100	80

The ventilation of dynamometer used for conducting the heat dissipation test should be suitable for carrying out this test in the correct manner.

NOTE Existing documents that define the requirements of dynamometers for ventilation at the time of writing this standard include UIC document: ERRI – B126/DT 408. This document could be used as reference document.

10.4 Pass and fail criteria

After the completion of the test program, the following degradation criteria shall be met:

— The imbalance value of the axle mounted brake disc shall not exceed 1,2 times that measured before the heat dissipation test.

— The imbalance value of the wheel mounted brake disc shall not exceed 1,2 times that measured before the heat dissipation test with the brake disc assembled to the wheel.

— The brake disc shall be checked according to the criteria contained in the technical datasheet of the product. The results of this check shall be reported in details.

In the case of a brake disc with a monobloc non-ventilated brake ring produced from forged steel, after having made one cut (see Figure 1) in radial direction completely passing through the thickness of the ring with a tool with width S (from 4 mm to 6 mm), the remaining gap measured on the average diameter of the ring shall not exceed the value S ± 3 mm.

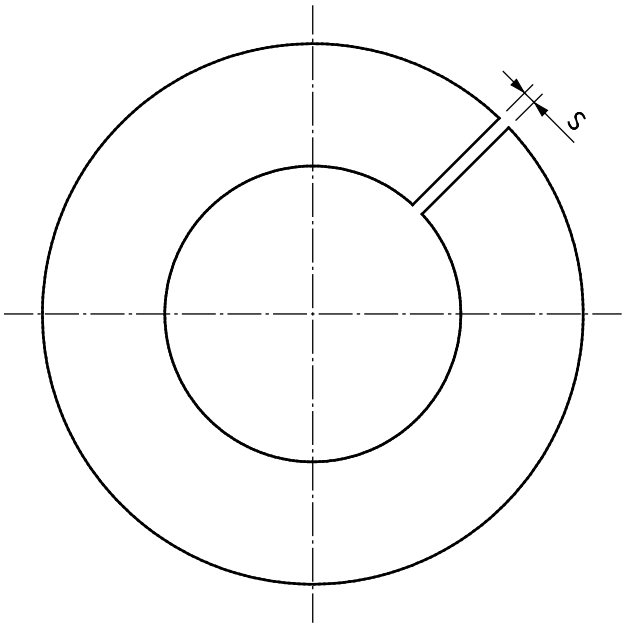


Figure 1 — Monobloc non-ventilated brake ring with radial cut

11 Centrifugal test

11.1 Scope

The centrifugal test scope is to verify the resistance of the brake disc against the centrifugal force applied on the brake disc after passing the performance and endurance test.

11.2 Test parameters

The maximum speed to refer to is the speed related to the class of the brake disc, given in Table 4. According to the chosen wheel class, the specific wheel diameter for the centrifugal test shall be used as specified in Table 11.

Table 11 — Wheel diameter to be used for the centrifugal test

Wheel class	Test wheel diameter	Wheel diameter range	Specific wheel diameter for centrifugal test
	mm	mm	mm
W0	Half worn wheel diameter	≤ 550	Worn wheel diameter
W1	625	550 < d ≤ 760	550
W2	890	760 < d ≤ 980	760
W3	1 200	> 980	980

For this test specimen no. 2 shall be used after the completion of performance and endurance test.

11.3 Test procedure

The brake disc shall be spun up to 1,2 times of the maximum rotating speed. The wheel mounted brake disc shall be assembled to the wheel with the original fixing devices. The prepared brake disc is assembled to a spinning rig or a dynamometer and accelerated to 1,2 times of the speed v_m. The speed is maintained for 3 min. Then the brake disc shall be decelerated until standstill. Braking with the brake disc is not permitted. Ventilation is not required.

11.4 Pass and fail criteria

The brake disc shall be checked according to the maintenance criteria contained in the technical datasheet of the product. The results of this check shall be reported in details. Special attention shall be taken for the following points:

a) brake ring integrity;

b) hub integrity (Axle Mounted Disc);

c) fixing device integrity.

In the case of a brake disc with a monobloc non-ventilated brake ring produced from forged steel, after having made one cut (see Figure 1) in radial direction completely passing through the thickness of the ring with a tool with width S (from 4 mm to 6 mm), the remaining gap measured on the average diameter of the ring shall not exceed the measure S ± 3 mm.

This control shall be done after the centrifugal test.

12 Ventilation Test

12.1 Scope

The scope of the ventilation test is to evaluate and classify for v_m and v_m /2 the ventilation losses generated by the brake disc during its rotation. For this test specimen no. 3 shall be used.

12.2 Test parameters

A specific class referring to the following Table 12 shall be given to the brake disc for each speed v_m and v_m /2.

Table 12 — Parameters for the power ventilation class

Ventilation class	Minimum Ventilation Power of the class	Maximum Ventilation Power of the class
	P_{vmin} kW	P_{vmax} kW
V01	0	0,5
V02	> 0,5	1,0
V03	> 1,0	1,5
V04	> 1,5	2,0
V05	> 2,0	2,5
V06	> 2,5	3,0
V07	> 3,0	3,5
V08	> 3,5	4,0
V09	> 4,0	4,5
V10	> 4,5	5,0

12.3 Test procedure

The power which is necessary to keep the brake disc rotating at constant speed against the retarding effect of the ventilation air flow shall be measured. The brake disc to be measured is assembled to a test rig.

The test rig may be a special device or a dynamometer. If existing, the ventilation of the test rig shall not be activated. The ventilation losses shall be measured at the 100 % and 50 % of the class speed v_m (Table 4).

During the test the brake disc is accelerated to the defined speed. The speed shall be maintained until a steady-state of power consumption is reached for 10 min. The result shall be taken as a mean value of the last five minutes of the constant speed period.

12.4 Pass and fail criteria

The result shall not exceed the specific class limit (see Clause 6).

13 Noise generation

The noise generation test is performed in order to ensure that a brake disc under rotation doesn't produce a noise over the acceptance limit.

A noise generation test is not declared as a type test.

If a noise generation test is made, an example of procedure is in Annex B.

Annex A
(informative)

Brake Disc Classification Certificate according to EN 14535-3

Certified Brake Disc:

Additional information is in accordance with EN 14535-1 and EN 14535-2.

IDENTIFICATION CODE OF THE BRAKE DISC (IN ACCORDANCE WITH EN 14535-1 AND EN 14535-2, § DESIGNATION)

IDENTIFICATION CODE OF THE PAD

Results of the Verification Sequences:

FOCUS	REFERENCE TO TEST DOCUMENTATION
Result of the preliminary verification of the brake disc specimen (EN 14535-3:2015, 7.3)	
Results of the final verification of the brake disc specimen (EN 14535-3:2015, 7.3)	

Achieved Classification and Document references

	WHEEL CLASS	POWER CLASS	HEAT DISSIPATION CLASS	VENTILATION CLASS V	VENTILATION CLASS V/2
Passed Classes:					
Reference to test documentation					

Testing Laboratory

TESTING LABORATORY	
Date of Certificate issue	
Signature of person responsible	

Annex B
(informative)

Noise generation test

The noise (sound pressure level in dB(A)) generated by the rotation of the brake disc should be measured at the speed v_m as defined in Clause 9, Table 4 with a microphone. The microphone should be positioned at 1 m distance from the friction face of the tested brake disc in the direction of the dynamometer axle and at the level of it. The measuring microphone should be directed towards the brake disc and no obstacle should be within the acoustic propagation between the microphone and the brake disc. The brake disc to be measured is assembled to a test bench. The test bench may be a special device or a dynamometer without additional external ventilation. During the test the brake disc speed should be accelerated and maintained at the speed v_m until a steady-state of speed is reached. The noise should be recorded for 2 min. The result should be taken as the maximum dB(A) of the second half of the measurement.

The evaluation of the results should be done by comparison with existing brake discs proven in service.

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 mandates given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the Directive 2008/57/EC.

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 freight wagons and Table ZA.2 for locomotive and passenger RST, 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 Commission Regulation of 13 March 2013 concerning the technical specification for interoperability relating to the subsystem 'rolling stock – freight wagons' of the rail system in the European Union and repealing Decision 2006/861/EC (published in the *Official Journal L 104, 12.4.2013, p.1*) and Directive 2008/57/EC

Clause/subclauses of this European Standard	Chapter/§/annexes of the Technical Specification for Interoperability (TSI)	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable	4.Characterization of the subsystem 4.2. Functional and technical specifications of the subsystem 4.2.4. Brake 4.2.4.3.Functional and technical requirements 4.2.4.3.3. Thermal capacity 6. Conformity assessment and EC verification 6.2. Subsystem 6.2.2. EC verification procedures 6.2.2.6. Thermal capacity	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2, 1.1.3 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §3	This standard makes possible the acceptance assessment of discs according to EN 14535-1 and EN 14535-2. The clauses of TSIs are relevant to the braking system as a whole; the standard defines characteristics of the brake discs that may be taken into account to demonstrate compliance of the brake system to the TSI.

Table ZA.2 — Correspondence between this European Standard, the TSI Locomotive and Passenger Rolling Stock (approved by the RISC68 on 24 October 2013), and Directive 2008/57/EC

Clause/subclauses of this European Standard	Chapter/§/annexes of the technical specification for interoperability (TSI)	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable	4 Characterization of the Rolling stock subsystem 4.2 Functional and technical specifications of the subsystem 4.2.4 Braking 4.2.4.5 Braking performance § 4.2.4.5.4 Calculations relating to thermal capacity	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2, 1.1.3 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §3	This standard makes possible the acceptance assessment of discs according to EN 14535-1 and EN 14535-2. The clauses of TSIs are relevant to the braking system as a whole; the standard defines characteristics of the brake discs that may be taken into account to demonstrate compliance of the brake system to the TSI.

Bibliography

[1] ERRI – B126/DT 408 – *Braking – Ventilation of friction test benches*

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