

**Road vehicles —  
Brake lining friction  
materials — Standard  
performance test  
procedure for  
commercial vehicles  
with air brakes**

ICS 43.040.40,

## National foreword

This British Standard is the UK implementation of ISO 26865:2009.

The UK participation in its preparation was entrusted to Technical Committee AUE/11, Braking systems.

A list of organizations represented on this committee 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.

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**26865**

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## **Road vehicles — Brake lining friction materials — Standard performance test procedure for commercial vehicles with air brakes**

*Véhicules routiers — Matériaux de friction pour garnitures de freins —  
Mode opératoire d'essai des performances normalisées pour les  
véhicules utilitaires munis de freins à air comprimé*



Reference number  
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## **Foreword**

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 26865 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Braking systems and equipment*.

## **Introduction**

The standardization of performance testing friction for commercial vehicle application is a major challenge for technical groups around the world in their efforts to harmonize procedures.

The diverse conditions under which the friction material is tested and evaluated ensure a wide spectrum of data, which is critical during the various phases of product life (i.e. product and manufacturing process development; production validation; quality control; product auditing; field issues evaluation).

This International Standard has been developed as part of the friction material global harmonization programme outlined in ISO 15484 and is the product of a close collaboration between major car manufacturers, brake system and component manufacturers, leading testing services and standards development organizations [e.g. SAE and JSAE (Japanese Society of Automotive Engineers)].

The introduction by various truck and trailer manufacturers of a wide range of performance tests has proven time-consuming and has led to multiple evaluations of the same friction material for the same application. The test results thus provided do not necessarily correspond with one another because the test procedures and test conditions are not the same.





# Road vehicles — Brake lining friction materials — Standard performance test procedure for commercial vehicles with air brakes

## 1 Scope

This International Standard applies to commercial vehicles of the categories M2, M3, N2, N3, O3 and O4, as defined in UNECE R.E.3, which are equipped with air brakes.

This International Standard applies during product development, product prototypes, product specification or validation, and ongoing series production, as defined in ISO 15484.

When used in conjunction with other applicable standards or test procedures, this International Standard is intended to provide a complete assessment of a friction material's adequacy for use in a certain application, market or vehicle platform.

**NOTE** Applicable standards and test procedures include ISO, JIS/JASO (Japanese Industrial Standard/Japanese Automotive Standards Organization), SAE (Society of Automotive Engineers), Federal Codes or regulations, and other project or company-specific testing programmes.

This International Standard does not include performance requirements related to stopping distance or braking force distribution, under different vehicle conditions of speed, temperature, tyre-to-road adhesion, loads and operating conditions of the braking system, as indicated in Federal Codes or Regulations.

This International Standard specifies a single-ended inertia-dynamometer performance procedure, which is intended to standardize the various procedures for commercial vehicles equipped with air brakes into one unique procedure covering all performance requirements of interest.

The test sequence includes performance evaluation for the following conditions:

- performance test before and after bedding;
- brake fade after bedding and after moderate temperature;
- sensitivity to temperature, speed and pressure influence;
- downhill simulation;
- brake recovery.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 611:2003, *Road vehicles — Braking of automotive vehicles and their trailers — Vocabulary*

ISO 1176, *Road vehicles — Masses — Vocabulary and codes*

ISO 3833, *Road vehicles — Types — Terms and definitions*

ISO 11157:2005, *Road vehicles — Brake lining assemblies — Inertia dynamometer test method*

ISO 15484:2008, *Road vehicles — Brake lining friction materials — Product definition and quality assurance*

UNECE R.E.3 (1999), *Consolidated Resolution on the Construction of Vehicles*

### **3 Terms and definitions**

For the purposes of this document, the terms and definitions given in UNECE R.E.3, ISO 611, ISO 1176, ISO 3833, ISO 15484 and the following apply.

#### **3.1 air brake system**

braking system in which control and energy are transmitted from the point of application to the foundation brakes by air/pneumatic transmission devices

#### **3.2 axle load**

technically feasible maximum design total mass specified by the vehicle or axle manufacturer and acknowledged by the Technical Services

NOTE This mass can exceed the “maximum authorized total mass” permitted by national regulations. Unless otherwise specified by the test requestor, the axle loads indicated in Table 2 are used to determine the test inertia.

#### **3.3 brake type**

brake sizes determined by the nominal rim diameter code in accordance with Table 2

NOTE The same nominal rim diameter can have different tyre dynamic rolling radius. Information pertaining to other nominal rim sizes or tyre dynamic radius can be obtained from the test requestor.

#### **3.4 brake temperature**

temperature measured on the disc or drum at the centre of the path followed by the lining

#### **3.5 test inertia**

part of the total inertia of the vehicle braked by the wheel under consideration, in accordance with Table 2

NOTE For other loads or tyre sizes, see ISO 11157.

#### **3.6 wheel load**

half of the **axle load** (3.2)

## 4 Symbols

Table 1 — Symbols

Symbol	Description	Unit
$d_m$	Mean fully developed deceleration (MFDD)	m/s <sup>2</sup>
$I$	Test inertia	kg·m <sup>2</sup>
$m$	Mass acting on the ground for the wheel(s) under consideration	kg
$M_d$	Brake measured torque	N·m
$p_B$	Brake actuating pressure	bar
$r_{dyn}$	Tyre dynamic rolling radius	m
$T_R$	Room temperature	°C
$T_E$	Temperature at end of braking	°C
$T_I$	Initial temperature at beginning of braking	°C
$V_{air}$	Velocity of the cooling air	km/h
$V_B$	Pad or lining wear	mm, g
$V_E$	Speed at the end of braking	km/h
$V_I$	Initial speed at beginning of braking	km/h
$V_s$	Rotor or drum wear	mm, g
$\Delta_{fade}$	Percent difference between initial and minimum MFDD values during electrical and computer engineering (ECE) fading steps	%
$\Delta_t$	Duration of a braking cycle: time elapsing between the initiation of one brake application and the initiation of the next	s

## 5 Sampling

Unless otherwise specified by the test requestor, sampling shall be conducted in accordance with ISO 15484:2008, 5.3.

## 6 Test method

### 6.1 Principle

This International Standard uses a single-ended brake inertia-dynamometer to conduct the test. The inertia-dynamometer provides a computer-controlled method to perform the test sequence, controlling the different parameters to ensure the accurate and repeatable evaluation of the different tests. The control system of the inertia-dynamometer also records the in-stop values that allow the subsequent generation of a complete test report to the requestor.

### 6.2 Test equipment and parts

**6.2.1** An inertia-dynamometer having the characteristics specified in 6.2.2 to 6.2.4 shall be used for the test.

**6.2.2** The inertia-dynamometer shall be capable of generating as close as possible, with a tolerance of  $\pm 5\%$ , the inertia specified in 6.3.1 or the test inertia indicated by the test requestor.

**6.2.3** The brake fitted shall be identical to the intended use type and oriented as close as possible to the vehicle mounting position. Inconsequential changes to the lining configuration are permitted (i.e. chamfers, slots, wear indicators, noise shims, etc.)

**6.2.4** The instrumentation for the test shall be capable of providing at least the following data:

- a) continuous recording of disc or drum rotational speed;
- b) number of revolutions completed during a brake application;
- c) stopping time;
- d) continuous recording of the temperature on the disc and pads or the drum and lining;
- e) continuous recording of control line pressure or force during a brake application;
- f) continuous recording of brake output torque.

### 6.3 Test conditions

**6.3.1** Test inertia and tyre dynamic rolling radius shall be in accordance with Table 2.

**Table 2 — Test conditions**

Brake manufacturer	Brake type <sup>a</sup>	Axle load kg	$r_{dyn}$ m	Test inertia kg·m <sup>2</sup>	Remarks
All	22,5"	10 000	0,527	1 389	—
All	19,5"	9 000	0,518	1 267	Trailers
All	19,5"	9 000	0,446	895	Trucks
All	17,5"	6 600	0,407	547	—

<sup>a</sup> The brake chamber shall be selected in coordination with the brake manufacturer.

**6.3.2** The initial rotational speed of the inertia-dynamometer shall correspond to the test speeds as specified in Table 3 and shall be based on the tyre dynamic rolling radius.

**6.3.3** Cooling air at ambient temperature may be used, directly perpendicular to the axis of rotation of the brake. The velocity of the cooling air over the brake,  $V_{air}$ , expressed in km/h, shall be as calculated in Equation (1):

$$V_{air} = 0,33 \times V_1 \quad (1)$$

where  $V_1$  is the initial speed at the beginning of braking, in km/h.

**6.3.4** When required, heat up the brake to the required temperature by performing brake applications from 60 km/h to 20 km/h at 0,3 MPa <sup>1)</sup> brake pressure.

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1) 1 bar = 0,1 MPa.

## 6.4 Test procedure for disc brake systems

Table 3 specifies the test procedure for disc brake systems.

**Table 3 — Test procedure for disc brakes**

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
1.	—	Parts measurement	—	—	—	—	—	—	—
2.	—	Initial adjustment to 2,0 mm clearance	—	—	—	—	—	—	—
3.	1 to 50	Stroke adjustment	50	0,2	0	0	$T_R$	—	—
4.	51 to 51	Stroke measurement	1	0,9	0	0	$T_R$	—	—
<b>Green performance</b>									
5.	52 to 57	Performance versus pressure	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
6.	58 to 157	Bedding	100	0,3	60	20	150	—	—
<b>Performance after bedding</b>									
7.	158 to 163	Performance versus pressure 40 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	40	0,5	100	—	—
8.	164 to 164	Stroke measurement	1	0,9	0	0	100	—	—
9.	165 to 170	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
10.	171 to 176	Performance versus pressure 80 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	80	0,5	100	—	—
11.	177 to 182	Performance versus pressure 100 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	100	50	100	—	—
12.	183 to 202	Auto-adjuster check	20	0,2	0	0	100	—	—
13.	203 to 208	Performance versus pressure 120 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	120	60	100	—	—
14.	209 to 228	Recovery	20	0,2	60	20	150	—	—
<b>1st fading</b>									
15.	229 to 231	Type 0 (average)	3	For 60 % deceleration	60	0,5	100	—	—
16.	232 to 251	ECE fading	20	First at 30 % deceleration; maintain same pressure for remaining 19	60	30	100 <sup>b</sup>	—	60
17.	252 to 252	Hot stop	1	Average of 229 to 231	60	0,5	<sup>c</sup>		
18.	253 to 272	Recovery	20	0,2	60	20	150	—	—

Table 3 (continued)

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
<b>Performance 100 °C</b>									
19.	273 to 278	Performance versus pressure 40 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	40	0,5	100	—	—
20.	279 to 279	Stroke measurement	1	0,9	0	0	100	—	—
21.	280 to 285	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
22.	286 to 291	Performance versus pressure 80 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	80	0,5	100	—	—
23.	292 to 297	Performance versus pressure 100 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	100	50	100	—	—
24.	298 to 317	Auto-adjuster check	20	0,2	0	0	100	—	—
25.	318 to 323	Performance versus pressure 120 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	120	60	100	—	—
26.	324 to 343	Recovery	20	0,2	60	20	150	—	—
27.	344 to 344	Heat-up to 350 °C by intermittent braking	as needed	0,3	60	20	—	350	—
<b>Performance 300 °C</b>									
28.	345 to 350	Performance versus pressure 40 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	40	0,5	300	—	—
29.	351 to 351	Stroke measurement	1	0,9	0	0	300	—	—
30.	352 to 357	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	300	—	—
31.	358 to 363	Performance versus pressure 80 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	80	0,5	300	—	—
32.	364 to 369	Performance versus pressure 100 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	100	50	300	—	—
33.	370 to 389	Auto-adjuster check	20	0,2	0	0	300	—	—
34.	390 to 392	Performance versus pressure 120 km/h	one at each pressure	0,3; 0,6; 0,9	120	60	300	—	—
35.	393 to 412	Recovery	20	0,2	60	20	150	—	—
36.	413 to 413	Stroke measurement	1	0,9	0	0	100	—	—
<b>Performance control 100 °C</b>									
37.	414 to 419	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—

Table 3 (continued)

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
<b>2nd fading</b>									
38.	420 to 422	Type 0 (average)	3	For 60 % deceleration	60	0,5	100	—	—
39.	423 to 442	ECE fading	20	First at 30 % deceleration; maintain same pressure for remaining 19	60	30	100 <sup>d</sup>	—	60
40.	443 to 443	Hot stop	1	Average of 420 to 422	60	0,5	e		
41.	444 to 463	Recovery	20	0,2	60	20	150	—	—
42.	464 to 464	Stroke measurement	1	0,9	0	0	100	—	—
43.	465 to 470	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
44.	471 to 471	Heat-up to 550 °C by intermittent braking	as needed	0,3	60	20	—	550	—
<b>Performance 500 °C</b>									
45.	472 to 474	Performance versus pressure 40 km/h	one at each pressure	0,3; 0,6; 0,9	40	0,5	500	—	—
46.	475 to 475	Stroke measurement	1	0,9	0	0	500	—	—
47.	476 to 478	Performance versus pressure 60 km/h	one at each pressure	0,3; 0,6; 0,9	60	0,5	500	—	—
48.	479 to 481	Performance versus pressure 80 km/h	one at each pressure	0,3; 0,6; 0,9	80	0,5	500	—	—
49.	482 to 484	Performance versus pressure 100 km/h	one at each pressure	0,3; 0,6; 0,9	100	50	500	—	—
50.	485 to 504	Auto-adjuster check	20	0,2	0	0	f	—	—
51.	505 to 507	Performance versus pressure 120 km/h	one at each pressure	0,3; 0,6; 0,9	120	60	500	—	—
52.	508 to 527	Recovery	20	0,2	60	20	150	—	—
53.	528 to 533	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
54.	534 to 534	Heat-up to 700 °C by intermittent braking	as needed	0,3	60	20	—	700	—

**Table 3 (continued)**

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
<b>Temperature effect 650 °C</b>									
55.	535 to 584	Temperature effect	50	0,3	60	50	650		
56.	585 to 585	Hot stop	1	0,6	60	0,5	g		
57.	586 to 586	Stroke measurement	1	0,9	0	0	h	—	—
58.	587 to 587	Stroke measurement	1	0,9	0	0	100		
59.	588 to 588	Cold stop	1	0,6	0	0	100		
60.	589 to 618	Auto-adjuster check	30	0,2	0	0	100		
61.	619 to 619	Stroke measurement	1	0,9	0	0	100	—	—
<b>Performance control 100 °C</b>									
62.	620 to 625	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
63.	626 to 688	Recovery	63	Alternate 0,2; 0,4 and 0,8 every 20 stops	60	0,5	150	—	—
64.	689 to 689	Stroke measurement	1	0,9	0	0	100	—	—
<b>Performance control 100 °C</b>									
65.	690 to 695	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
66.	Measurement and inspection of test parts and brake components Measure at least six points equally distributed over the pad working surface Measure disc wear in grams								
a	1 bar = 0,1 MPa.								
b	For 232.								
c	45 s after 251.								
d	For 423.								
e	45 s after 442.								
f	$T_E$ after 484.								
g	45 s after 584.								
h	$T_E$ after 585.								



## 6.5 Test procedure for drum brake systems

Table 4 — Test procedure for drum brakes

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
1.	—	Parts measurement	—	—	—	—	—	—	—
2.	—	Initial adjustment to 50 mm stroke	—	—	—	—	—	—	—
3.	1 to 50	Stroke adjustment	50	0,2	0	0	$T_R$	—	—
4.	51 to 51	Stroke measurement	1	0,9	0	0	$T_R$	—	—
<b>Green performance</b>									
5.	52 to 57	Performance versus pressure	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
6.	58 to 257	Bedding	200	0,3	60	20	100	—	—
<b>Performance after bedding</b>									
7.	258 to 263	Performance versus pressure 40 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	40	0,5	100	—	—
8.	264	Stroke measurement	1	0,9	0	0	100	—	—
9.	265 to 270	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
10.	271 to 276	Performance versus pressure 80 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	80	0,5	100	—	—
11.	277 to 282	Performance versus pressure 100 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	100	50	100	—	—
12.	283 to 302	Auto-adjuster check	20	0,2	0	0	100	—	—
13.	303 to 308	Performance versus pressure 120 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	120	60	100	—	—
14.	309 to 328	Recovery	20	0,2	60	20	150	—	—
<b>1st fading</b>									
15.	329 to 331	Type 0 (average)	3	For 60 % deceleration	60	0,5	100	—	—
16.	332 to 351	ECE fading	20	First at 30 % deceleration; maintain same pressure for remaining 19	60	30	100 <sup>b</sup>	—	60
17.	352 to 352	Hot stop	1	Average of 329 to 331	60	0,5	<sup>c</sup>		
18.	353 to 372	Recovery	20	0,2	60	20	150	—	—

Table 4 (continued)

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
<b>Performance 100 °C</b>									
19.	373 to 378	Performance versus pressure 40 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	40	0,5	100	—	—
20.	379 to 379	Stroke measurement	1	0,9	0	0	100	—	—
21.	380 to 385	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
22.	386 to 391	Performance versus pressure 80 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	80	0,5	100	—	—
23.	392 to 397	Performance versus pressure 100 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	100	50	100	—	—
24.	398 to 417	Auto-adjuster check	20	0,2	0	0	100	—	—
25.	418 to 423	Performance versus pressure 120 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	120	60	100	—	—
26.	424 to 443	Recovery	20	0,2	60	20	150	—	—
27.	444 to 444	Heat-up to 275 °C by intermittent braking	as needed	0,3	60	20	—	275	—
<b>Performance 225 °C</b>									
28.	445 to 450	Performance versus pressure 40 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	40	0,5	225	—	—
29.	451 to 451	Stroke measurement	1	0,9	0	0	225	—	—
30.	452 to 457	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	225	—	—
31.	458 to 463	Performance versus pressure 80 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	80	0,5	225	—	—
32.	464 to 469	Performance versus pressure 100 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	100	50	225	—	—
33.	470 to 489	Auto-adjuster check	20	0,2	0	0	225	—	—
34.	490 to 492	Performance versus pressure 120 km/h	one at each pressure	0,3; 0,6; 0,9	120	60	225	—	—
35.	493 to 512	Recovery	20	0,2	60	20	150	—	—
36.	513 to 513	Stroke measurement	1	0,9	0	0	100	—	—
<b>Performance control 100 °C</b>									
37.	514 to 519	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—

Table 4 (continued)

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
<b>2nd fading</b>									
38.	520 to 522	Type 0 (average)	3	For 60 % deceleration	60	0,5	100	—	—
39.	523 to 542	ECE fading	20	First at 30 % deceleration; maintain same pressure for remaining 19	60	30	100 <sup>d</sup>	—	60
40.	543 to 543	Hot stop	1	Average of 420 to 422	60	0,5	e		
41.	544 to 563	Recovery	20	0,2	60	20	150	—	—
42.	564 to 564	Stroke measurement	1	0,9	0	0	100	—	—
43.	565 to 570	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
44.	571 to 571	Heat-up to 400 °C by intermittent braking	as needed	0,3	60	20	—	400	—
<b>Performance 350 °C</b>									
45.	572 to 574	Performance versus pressure 40 km/h	one at each pressure	0,3; 0,6; 0,9	40	0,5	350	—	—
46.	575 to 575	Stroke measurement	1	0,9	0	0	350	—	—
47.	576 to 578	Performance versus pressure 60 km/h	one at each pressure	0,3; 0,6; 0,9	60	0,5	350	—	—
48.	579 to 581	Performance versus pressure 80 km/h	one at each pressure	0,3; 0,6; 0,9	80	0,5	350	—	—
49.	582 to 584	Performance versus pressure 100 km/h	one at each pressure	0,3; 0,6; 0,9	100	50	350	—	—
50.	585 to 604	Auto-adjuster check	20	0,2	0	0	f	—	—
51.	605 to 607	Performance versus pressure 120 km/h	one at each pressure	0,3; 0,6; 0,9	120	60	350	—	—
52.	608 to 627	Recovery	20	0,2	60	20	150	—	—
53.	628 to 633	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
54.	634 to 634	Heat-up to 500 °C by intermittent braking	as needed	0,3	60	20	—	500	—

Table 4 (continued)

Step	Brake applications	Section	Number of applications	Brake pressure MPa <sup>a</sup>	$V_I$ km/h	$V_E$ km/h	$T_I$ °C	$T_E$ °C	$\Delta_t$ s
<b>Temperature effect 450 °C</b>									
55.	635 to 684	Temperature effect	50	0,3	60	50	450		
56.	685 to 685	Hot stop	1	0,6	60	0,5	g		
57.	686 to 686	Stroke measurement	1	0,9	0	0	h	—	—
58.	687 to 687	Stroke measurement	1	0,9	0	0	100		
59.	688 to 688	Cold stop	1	0,6	0	0	100		
60.	689 to 718	Auto-adjuster check	30	0,2	0	0	100		
61.	719 to 719	Stroke measurement	1	0,9	0	0	100	—	—
<b>Performance control 100 °C</b>									
62.	720 to 725	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
63.	726 to 788	Recovery	63	Alternate 0,2; 0,4 and 0,8 every 20 stops	60	0,5	150	—	—
64.	789 to 789	Stroke measurement	1	0,9	0	0	100	—	—
<b>Performance control 100 °C</b>									
65.	790 to 795	Performance versus pressure 60 km/h	one at each pressure	0,15; 0,3; 0,45; 0,6; 0,75; 0,9	60	0,5	100	—	—
66.	Measurement and inspection of test parts and brake components Measure at least six points equally distributed over the lining working surface Measure drum wear in grams								
a	1 bar = 0,1 MPa.								
b	For 332.								
c	45 s after 351.								
d	For 523.								
e	45 s after 542.								
f	$T_E$ after 584.								
g	45 s after 684.								
h	$T_E$ after 685.								

## 6.6 Expression of results

Mean fully developed deceleration (MFDD) shall be indicated in accordance with ISO 611:2003, Annex B, and ISO 11157:2005, Annexes A and B.

## **7 Test report**

### **7.1 Tabular report**

Unless otherwise indicated by the test requestor, test results for each brake application shall be presented in tabular format, indicating at least the following:

- a) initial and end speeds;
- b) initial and end brake temperatures;
- c) average by distance pressure;
- d) average by distance torque;
- e) MFDD when applicable;
- f) time elapsed between brake applications for stops controlled by time.

### **7.2 Summary of results**

Unless otherwise specified by the test requestor, a summary of the test results shall be provided, indicating:

- a) disc and pads, or drum and lining wear;
- b) results from final test parts and brake components inspection.

### **7.3 Lining data sheet**

Test results shall be reported in a lining data sheet in accordance with Table 5.

**Table 5 — Summary lining data sheet**

Step number	Brake torque <sup>a</sup> kN·m	Prototyping - samples		Specification/validation		Series monitoring	
		Prototype results		Production transfer results		Series production results	
		minimum	maximum	minimum	maximum	minimum	maximum
9	After bedding 60 km/h; 100 °C						
11	After bedding 100 km/h; 100 °C						
17	1st fading $\Delta_{fade}$						
21	After 1st fading 60 km/h; 100 °C						
23	After 1st fading 100 km/h; 100 °C						
30	60 km/h; 300 °C disc; 225 °C drum						
32	100 km/h; 300 °C disc; 225 °C drum						
39	2nd fading $\Delta_{fade}$						
47	60 km/h; 500 °C disc; 350 °C drum						
49	100 km/h; 500 °C disc; 350 °C drum						
53	60 km/h; 100 °C						
62	60 km/h; 100 °C						
65	60 km/h; 100 °C						

<sup>a</sup> During performance versus pressure steps, report brake torque at 0,6 MPa (6,0 bar) of input pressure.









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