INTERNATIONAL STANDARD

**ISO 26865**

First edition
2009-03-15

# 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
ISO 26865:2009(E)



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Published in Switzerland

 

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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) | $m/s^2$ |
| $I$ | Test inertia | $kg \cdot m^2$ |
| $m$ | 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 ± 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 [a] | Axle load kg | $r_{dyn}$ m | Test inertia kg·m$^2$ | 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 | — |

[a] 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):

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

where $V_I$ 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 [1)] brake pressure.

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 [a] | $V_I$ 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 | $T_R$ | — | — |
| **Green performance** | | | | | | | | | |
| 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 | — | — |
| **Performance after bedding** | | | | | | | | | |
| 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 | — | — |
| **1st fading** | | | | | | | | | |
| 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 [b] | — | 60 |
| 17. | 252 to 252 | Hot stop | 1 | Average of 229 to 231 | 60 | 0,5 | [c] | | |
| 18. | 253 to 272 | Recovery | 20 | 0,2 | 60 | 20 | 150 | — | — |

**Table 3** (*continued*)

| Step | Brake applications | Section | Number of applications | Brake pressure MPa [a] | $V_I$ km/h | $V_E$ km/h | $T_I$ °C | $T_E$ °C | $\Delta_t$ s |
|---|---|---|---|---|---|---|---|---|---|
| **Performance 100 °C** | | | | | | | | | |
| 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 | — |
| **Performance 300 °C** | | | | | | | | | |
| 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 | — | — |
| **Performance control 100 °C** | | | | | | | | | |
| 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 [a] | $V_I$ km/h | $V_E$ km/h | $T_I$ °C | $T_E$ °C | $\Delta_t$ s |
|---|---|---|---|---|---|---|---|---|---|
| **2nd fading** | | | | | | | | | |
| 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 [d] | — | 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 | — |
| **Performance 500 °C** | | | | | | | | | |
| 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 [a] | $V_I$ km/h | $V_E$ km/h | $T_I$ °C | $T_E$ °C | $\Delta_t$ s |
|---|---|---|---|---|---|---|---|---|---|
| **Temperature effect 650 °C** | | | | | | | | | |
| 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 | — | — |
| **Performance control 100 °C** | | | | | | | | | |
| 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 | — | — |
| **Performance control 100 °C** | | | | | | | | | |
| 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<br>Measure at least six points equally distributed over the pad working surface<br>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 [a] | $V_I$ 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 | $T_R$ | — | — |
| **Green performance** | | | | | | | | | |
| 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 | — | — |
| **Performance after bedding** | | | | | | | | | |
| 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 | — | — |
| **1st fading** | | | | | | | | | |
| 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 [b] | — | 60 |
| 17. | 352 to 352 | Hot stop | 1 | Average of 329 to 331 | 60 | 0,5 | [c] | | |
| 18. | 353 to 372 | Recovery | 20 | 0,2 | 60 | 20 | 150 | — | — |

**Table 4** (*continued*)

| Step | Brake applications | Section | Number of applications | Brake pressure MPa [a] | $V_I$ km/h | $V_E$ km/h | $T_I$ °C | $T_E$ °C | $\Delta_t$ s |
|---|---|---|---|---|---|---|---|---|---|
| **Performance 100 °C** | | | | | | | | | |
| 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 | — |
| **Performance 225 °C** | | | | | | | | | |
| 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 | — | — |
| **Performance control 100 °C** | | | | | | | | | |
| 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 [a] | $V_I$ km/h | $V_E$ km/h | $T_I$ °C | $T_E$ °C | $\Delta_t$ s |
|---|---|---|---|---|---|---|---|---|---|
| **2nd fading** | | | | | | | | | |
| 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 [d] | — | 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 | — |
| **Performance 350 °C** | | | | | | | | | |
| 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 [a] | $V_I$ km/h | $V_E$ km/h | $T_I$ °C | $T_E$ °C | $\Delta_t$ s |
|---|---|---|---|---|---|---|---|---|---|
| **Temperature effect 450 °C** | | | | | | | | | |
| 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 | — | — |
| **Performance control 100 °C** | | | | | | | | | |
| 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 | — | — |
| **Performance control 100 °C** | | | | | | | | | |
| 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<br>Measure at least six points equally distributed over the lining working surface<br>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 [a] kN·m | Prototyping - samples Prototype results | | Specification/validation Production transfer results | | Series monitoring 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 | | | | | | |

[a] During performance versus pressure steps, report brake torque at 0,6 MPa (6,0 bar) of input pressure.

**ICS 43.040.40**

Price based on 14 pages