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

Véhicules routiers — Matériaux de friction pour garnitures de freins — Méthode normale d'essai d'usure pour véhicules industriels équipés de systèmes de freinage pneumatiques

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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 26866 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 2, *Braking systems and equipment*.

Introduction

The huge variety of wear tests introduced by different truck and trailer manufacturers is highly time-consuming and leads to multiple evaluations of the same pad material on the same application. In view of the fact that test procedures are different, results do not correspond with each other.

Wear testing in general is very time-consuming and hence very costly. This International Standard has been developed in an effort to characterize friction materials that are used for a wide array of applications. Being a block wear schedule that comprises different energy and temperature levels, it provides a good general characterization of the wear behaviour of a friction material.

This International Standard standardizes all different procedures into one single procedure that covers all wear requirements of interest whilst having a minimum testing duration.

In the process of harmonizing commercial vehicle applications, the standardization of performance testing friction materials is a top priority.

The varied conditions under which the friction material is tested and evaluated ensures a wide spectrum of data, which is critical during the various phases of product life, such as product and manufacturing process development, production validation, quality control, product auditing and field issues evaluation.

This International Standard is intended to be used in conjunction with other applicable standards or test procedures (ISO, SAE, JIS/JASO, Federal Codes or Regulations, and other project or company-specific testing programmes) to fully assess the adequacy of a friction material for use in a certain application, market or vehicle platform. 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 has been developed as part of the friction material global harmonization programme outlined in ISO 15484, and results from close collaboration with major car manufacturers, brake system and component manufacturers, leading testing services, and standards development organizations such as SAE and JIS/JASO.

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

1 Scope

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

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

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.

UNECE R.E.3, *Consolidated resolution on the construction of vehicles*

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*

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 authorised total mass” permitted by national regulations. Unless otherwise specified by the test requestor, the axle loads indicated in Table 1 are used to determine the test inertia.

3.3
brake type
brake sizes determined by the nominal rim diameter code, in accordance with Table 1

NOTE The same nominal rim diameter can have different tyre dynamic rolling radiuses. For other nominal rim sizes or tyre dynamic radiuses, refer to the test requestor.

3.4
brake temperature
temperature measured on the disc or drum at the centre of the path followed by the lining

NOTE The brake temperature is measured using embedded thermocouples, located in the centre of the friction area about (0,5 ± 0,1) mm below the disc/drum surface.

3.5
test inertia
part of the total inertia of the vehicle braked by the wheel under consideration, in accordance with Table 1

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

3.6
wheel load
half of the **axle load** (3.2)

3.7
total wear
average of all measurement locations per pad or lining, added to the value of all pads and linings per brake

NOTE Standardized wear rate is based on a total number of 250 stops per step.

4 Symbols

Symbol	Definition	Unit
T_R	Room temperature	°C
T_{start}	Initial temperature at beginning of braking	°C
V_{end}	Speed at end of braking	km/h
V_{start}	Initial speed at beginning of braking	km/h

5 Sampling

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

6 Test method

6.1 Principle

This International Standard uses a single- or double-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 in order 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) the number of revolutions completed during a brake application;

c) the 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 1.

Table 1 — Test conditions

Brake manufacturer	Brake type[a]	Axle load kg	Tyre dynamic rolling radius m	Test inertia $kg \cdot m^2$	Remarks
All	22,5”	10 000	0,527	1 389	—
All	19,5”	9 000	0,518	1 207	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 6.5, 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. Use the maximum cooling air speed of the system to reduce testing time. Make sure that the initial braking temperature is achieved properly. Record and report the cooling air conditions, ambient temperature and humidity (absolute or relative) values during the test.

6.3.4 When the rotor or drum temperature is below the initial temperature required for the brake application, drag the brake at the braking speed of the intended brake event without exceeding 80 km/h at 0,2 g equivalent torque until the initial temperature plus 50 °C is reached. Alternatively, brake applications from 60 km/h to 20 km/h at 0,3 MPa (3 bar)[1)] brake pressure might be used.

1) 1 bar = 0,1 MPa.

6.3.5 The initial rotational speed of the inertia-dynamometer shall correspond to the test speeds as specified in 6.5, and shall be based on the tyre dynamic rolling radius.

6.4 Wear measurement methods

6.4.1 Measurement of pad wear and mass

6.4.1.1 Use at least six locations equally spread for the measurement; if a centre groove is present, then use eight locations. The distance from edges and corners should be approximately 12 mm. In case of chamfers, reduce this distance to 6 mm.

6.4.1.2 The measurement locations shall be permanently marked; the surface shall be specially prepared if necessary. In the case of surface brakeouts or edge crumbling, the affected measurement location shall not be considered for further evaluation.

6.4.1.3 Measure and report the overall thickness of the friction material, including the backing plate.

6.4.1.4 For the determination of mass, ensure that the pads are always in the same assembly condition. The pads shall be cleaned from debris.

6.4.1.5 The required accuracy for the thickness is ±0,01 mm; the required accuracy for the mass is ±0,1 g.

6.4.1.6 Record and document the values for each cycle.

6.4.2 Measurement of lining wear and mass

6.4.2.1 Turn the linings to match the drum diameter as close as possible, following the instructions provided by the requestor.

6.4.2.2 Make drill-points in either the lining or the shoe at each measurement location. The drill-points in the lining shall be as small as possible, but large enough to allow access for the measurement device.

6.4.2.3 Use at least six locations per segment equally distributed for the measurement. Avoid positions in the projected tracks of the rivets.

6.4.2.4 In the case of surface breakouts or edge crumbling, do not consider the affected measurement location for further measurements.

6.4.2.5 For the determination of mass, ensure that the linings are always in the same assembly condition. The linings shall be cleaned from debris.

6.4.2.6 The required accuracy for the thickness is ±0,01 mm; the required accuracy for the mass is ±0,1 g.

6.4.2.7 Record and document the values for each cycle.

6.4.3 Disc measurement

6.4.3.1 Use a minimum of eight positions at the inner and outer diameter (the distance to the edges being between 6 mm and 12 mm) equally distributed over 90° sections and mark them permanently at the outer face of the disc.

6.4.3.2 In order to take the mass value, the disc shall be cleaned and in the same assembly condition at any time.

6.4.3.3 The required accuracy for the thickness is ±0,01 mm; the required accuracy for the mass is ±0,1 g.

6.4.3.4 Record and document the values before and after the test.

6.4.4 Drum measurement

6.4.4.1 The wear measurement of a drum is very inaccurate and therefore not recommended.

6.4.4.2 In order to take the mass value, clean the drum mass in the same assembly condition every time.

6.4.4.3 The required accuracy for the drum mass is ±1 g.

6.4.4.4 Record and document the values before and after the test.

6.5 Test procedure for disc brake systems

The test procedure for disc brake systems shall be in accordance with Table 2.

Table 2 — Test procedure for disc brakes

Step	Brake applications From – to	Section	Number of applications	Deceleration m/s^2	Brake pressure MPa	V_{start} km/h	V_{end} km/h	T_{start} °C
1.	–	Weigh/measure pads and disc	–	–	–	–	–	T_R
Green performance and bedding								
2.	1 – 6	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
3.	7 – 206	Bedding	200	–	0,30	60	10	150
4.	207 – 212	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 1								
5.	–	Weigh/measure pads	–	–	–	–	–	T_R
6.	213 – 712	Wear applications	500	1,5	–	60	10	100
7.	–	Weigh/measure pads	–	–	–	–	–	T_R
8.	713 – 962	Wear applications	250	1,5	–	100	50	100
9.	963 – 968	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 2								
10.	–	Weigh/measure pads	–	–	–	–	–	T_R
11.	969 – 1 468	Wear applications	500	1,5	–	60	10	200
12.	–	Weigh/measure pads	–	–	–	–	–	T_R
13.	1 469 – 1 718	Wear applications	250	1,5	–	100	50	200
14.	1 719 – 1 724	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 3								
15.	–	Weigh/measure pads	–	–	–	–	–	T_R
16.	1 725 – 1 974	Wear applications	250	1,5	–	60	10	300
17.	–	Weigh/measure pads	–	–	–	–	–	T_R
18.	1 975 – 2 224	Wear applications	250	1,5	–	100	50	300
19.	2 225 – 2 230	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100

Table 2 (*continued*)

Step	Brake applications From – to	Section	Number of applications	Deceleration m/s²	Brake pressure MPa	V_{start} km/h	V_{end} km/h	T_{start} °C
Wear cycle 4								
20.	–	Weigh/measure pads	–	–	–	–	–	T_R
21.	2 231 – 2 480	Wear applications	250	1,5	–	60	10	400
22.	–	Weigh/measure pads	–	–	–	–	–	T_R
23.	2 481 – 2 730	Wear applications	250	1,5	–	100	50	400
24.	2 731 – 2 736	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 5								
25.	–	Weigh/measure pads	–	–	–	–	–	T_R
26.	2 737 – 2 986	Wear applications	250	1,5	–	60	10	500
27.	–	Weigh/measure pads	–	–	–	–	–	T_R
28.	2 987 – 3 086	Wear applications	100	1,5	–	100	50	500
29.	3 087 – 3 092	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
30.	–	Weigh/measure pads and disc	–	–	–	–	–	T_R

6.6 Test procedure for drum brake systems

The test procedure for drum brake systems shall be in accordance with Table 3.

Table 3 — Test procedure for drum brakes

Step	Brake applications From – to	Section	Number of applications	Deceleration m/s²	Brake pressure MPa	V_{start} km/h	V_{end} km/h	T_{start} °C
1.	–	Weigh/measure linings and drum	–	–	–	–	–	T_R
Green performance and bedding								
2.	1 – 6	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
3.	7 – 206	Bedding	200	–	0,30	60	10	180
4.	207 – 212	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 1								
5.	–	Weigh/measure linings	–	–	–	–	–	T_R
6.	213 – 712	Wear applications	500	1,5	–	60	10	120
7.	–	Weigh/measure linings	–	–	–	–	–	T_R
8.	713 – 962	Wear applications	250	1,5	–	100	50	120
9.	963 – 968	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 2								
10.	–	Weigh/measure linings	–	–	–	–	–	T_R
11.	969 – 1 468	Wear applications	500	1,5	–	60	10	180
12.	–	Weigh/measure linings	–	–	–	–	–	T_R
13.	1 469 – 1 718	Wear applications	250	1,5	–	100	50	180
14.	1 719 – 1 724	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100

Table 3 (*continued*)

Step	Brake applications From – to	Section	Number of applications	Deceleration m/s²	Brake pressure MPa	V_{start} km/h	V_{end} km/h	T_{start} °C
Wear cycle 3								
15.	–	Weigh/measure linings	–	–	–	–	–	T_R
16.	1 725 – 1 974	Wear applications	250	1,5	–	60	10	230
17.	–	Weigh/measure linings	–	–	–	–	–	T_R
18.	1 975 – 2 224	Wear applications	250	1,5	–	100	50	230
19.	2 225 – 2 230	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 4								
20.	–	Weigh/measure linings	–	–	–	–	–	T_R
21.	2 231 – 2 480	Wear applications	250	1,5	–	60	10	290
22.	–	Weigh/measure linings	–	–	–	–	–	T_R
23.	2 481 – 2 730	Wear applications	250	1,5	–	100	50	290
24.	2 731 – 2 736	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
Wear cycle 5								
25.	–	Weigh/measure linings	–	–	–	–	–	T_R
26.	2 737 – 2 986	Wear applications	250	1,5	–	60	10	340
27.	–	Weigh/measure linings	–	–	–	–	–	T_R
28.	2 987 – 3 086	Wear applications	100	1,5	–	100	50	340
29.	3 087 – 3 092	Performance versus pressure	one at each pressure	–	0,15; 0,30; 0,45; 0,60; 0,75; 0,90	60	10	100
30.	–	Weigh/measure linings and drum	–	–	–	–	–	T_R

6.7 Expression of results

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

7 Test report

7.1 Report for disc brakes

Unless otherwise indicated by the test requestor, present the results in accordance with the examples in Figures 1 and 2.

7.2 Report for drum brakes

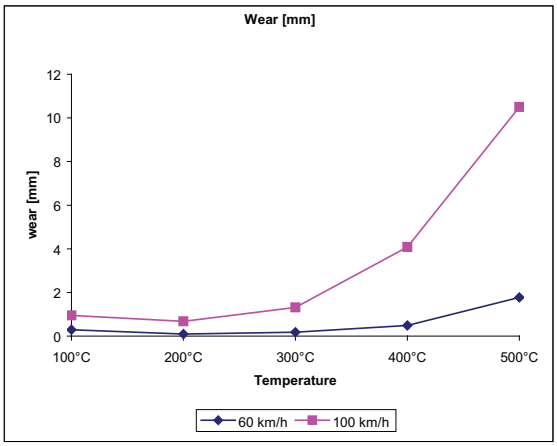
Unless otherwise indicated by the test requestor, present the results in accordance with the examples in Figures 3 and 4.

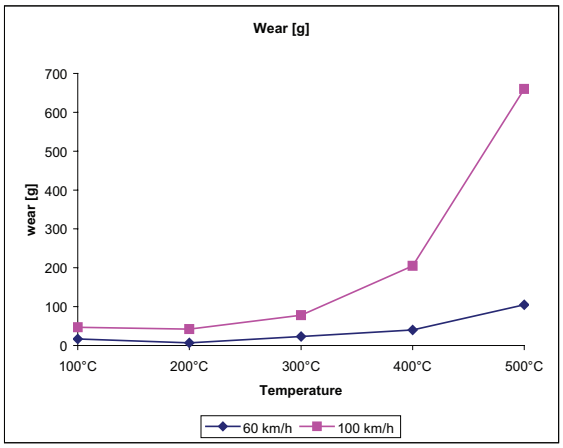
Test No.:		Brake / No.:	
Proj.-No.:		Actuator / No.:	
Part No.:		Maximum actuator stroke [mm]:	
Material:		Dynamometer:	
Friction batch:		Date:	
Compressibility:		Test Program No.:	
Disc / Batch:		Brake Torque [Nm]:	
Remarks:		Inertia [kgm²]:	**1389**
		Wheel Radius [mm]:	**527**
		Final Speed [km/h]:	**5**

Measured Values

Test cycle				Pad wear [mm]			Pad wear [g]			Pad Wear [mm/GJ]	Disc wear	
Temp.	Speed		Stops	Inner	Outer	Total	Inner	Outer	Total		[mm]	[g]
100°C	60	1	500	0,29	0,30	**0,59**	15,0	19,0	**34,0**	**0,86 mm/GJ**	0,10	
100°C	100	2	250	0,55	0,40	**0,95**	28,0	19,0	**47,0**	**0,99 mm/GJ**	0,01	
200°C	60	3	500	0,10	0,08	**0,18**	7,0	7,0	**14,0**	**0,26 mm/GJ**	0,00	
200°C	100	4	250	0,34	0,34	**0,68**	21,0	21,0	**42,0**	**0,71 mm/GJ**	0,00	
300°C	60	5	250	0,09	0,09	**0,18**	13,0	10,0	**23,0**	**0,52 mm/GJ**	0,00	
300°C	100	6	250	0,69	0,62	**1,31**	41,0	37,0	**78,0**	**1,36 mm/GJ**	0,00	
400°C	60	7	250	0,24	0,25	**0,49**	20,0	20,0	**40,0**	**1,42 mm/GJ**	0,00	
400°C	100	8	250	1,98	2,10	**4,08**	100,0	105,0	**205,0**	**4,24 mm/GJ**	0,00	
500°C	60	9	250	1,04	0,73	**1,77**	60,0	45,0	**105,0**	**5,13 mm/GJ**	0,01	
500°C	100	10	100	2,06	2,14	**4,20**	123,0	141,0	**264,0**	**10,91 mm/GJ**	0,01	
	Total			7,38	7,05	**14,43**	564,5	424,0	**988,5**		**0,13**	**300,0**

standardized to 250 stops for each section





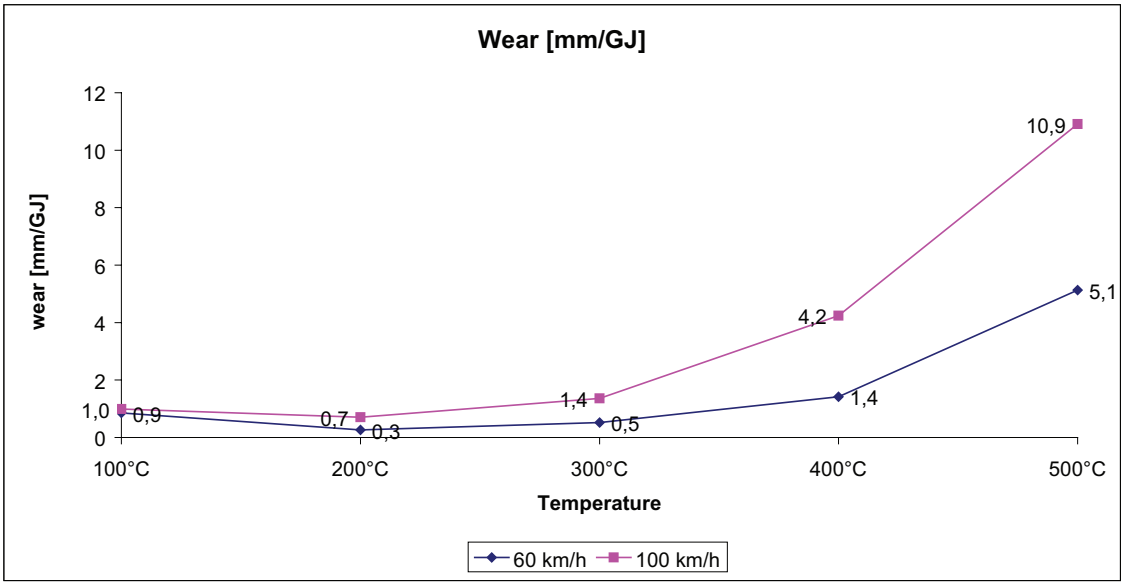


Figure 1 — Test report for disc brakes — wear measurements

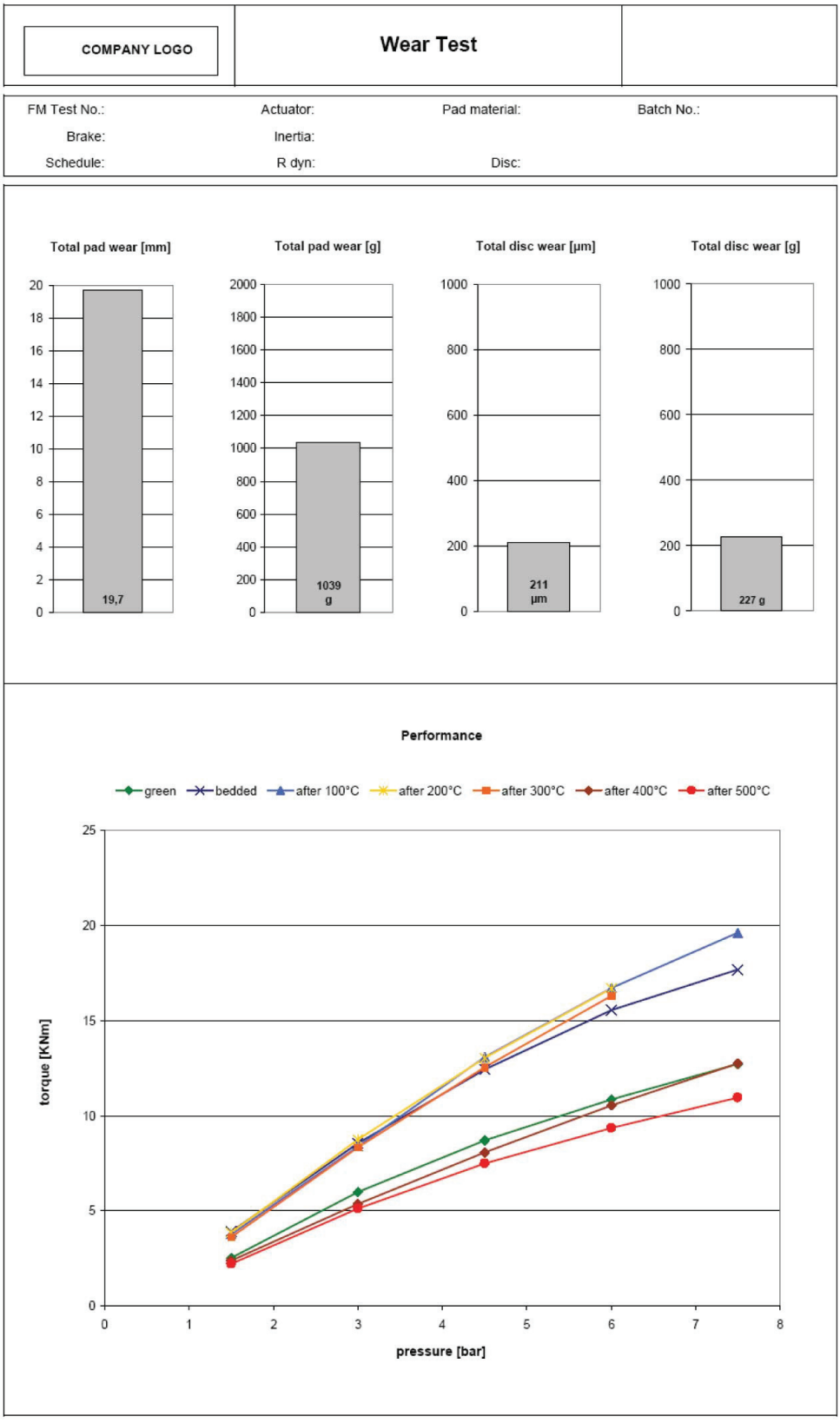


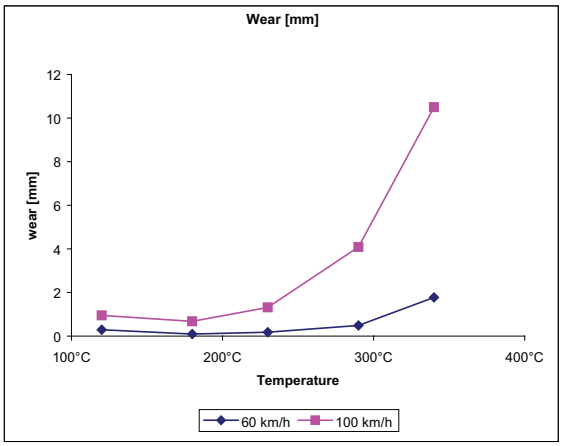
Figure 2 — Test report for disc brakes — thickness and mass loss

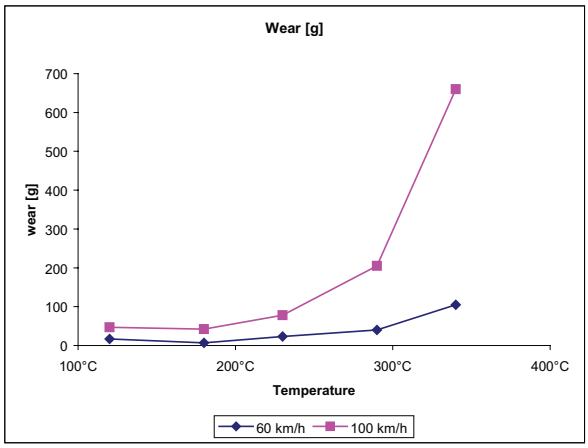
Test No.:		Brake / No.:	
Proj.-No.:		Actuator / No.:	
Part No.:		Maximum actuator stroke [mm]:	
Material:		Dynamometer:	
Friction batch:		Date:	
Compressibility:		Test Program No.:	
Disc / Batch:		Brake Torque [Nm]:	
Remarks:		Inertia [kgm²]:	1389
		Wheel Radius [mm]:	527
		Final Speed [km/h]:	5

Measured Values

Test cycle				Lining wear [mm]			Lining wear [g]			Lining Wear [mm/GJ]	Drum wear	
Temp.	Speed		Stops	Leading	Trailing	Total	Leading	Trailing	Total		[mm]	[g]
120°C	60	1	500	0,29	0,30	**0,59**	15,0	19,0	**34,0**	**0,86 mm/GJ**	0,10	
120°C	100	2	250	0,55	0,40	**0,95**	28,0	19,0	**47,0**	**0,99 mm/GJ**	0,01	
180°C	60	3	500	0,10	0,08	**0,18**	7,0	7,0	**14,0**	**0,26 mm/GJ**	0,00	
180°C	100	4	250	0,34	0,34	**0,68**	21,0	21,0	**42,0**	**0,71 mm/GJ**	0,00	
230°C	60	5	250	0,09	0,09	**0,18**	13,0	10,0	**23,0**	**0,52 mm/GJ**	0,00	
230°C	100	6	250	0,69	0,62	**1,31**	41,0	37,0	**78,0**	**1,36 mm/GJ**	0,00	
290°C	60	7	250	0,24	0,25	**0,49**	20,0	20,0	**40,0**	**1,42 mm/GJ**	0,00	
290°C	100	8	250	1,98	2,10	**4,08**	100,0	105,0	**205,0**	**4,24 mm/GJ**	0,00	
340°C	60	9	250	1,04	0,73	**1,77**	60,0	45,0	**105,0**	**5,13 mm/GJ**	0,01	
340°C	100	10	100	2,06	2,14	**4,20**	123,0	141,0	**264,0**	**10,91 mm/GJ**	0,01	
	Total			7,38	7,05	**14,43**	564,5	424,0	**988,5**		**0,13**	**300,0**

standardized to 250 stops for each section





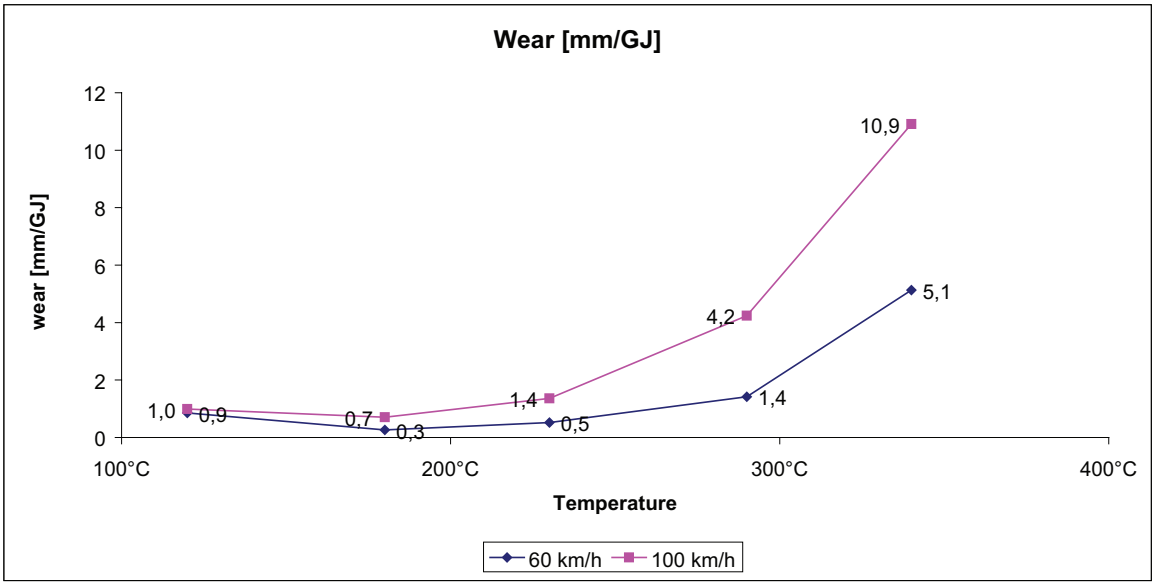
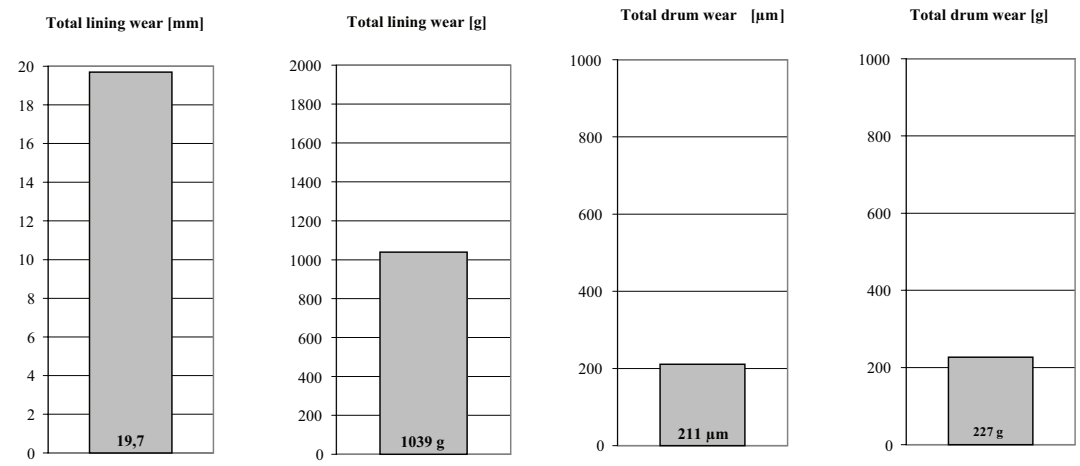


Figure 3 — Test report for drum brakes — wear measurements

COMPANY LOGO	Wear Test	

FM Test No.:	Actuator:	Lining material:	Batch No.:
Brake:	Inertia:		
Schedule:	R dyn:	Drum:	



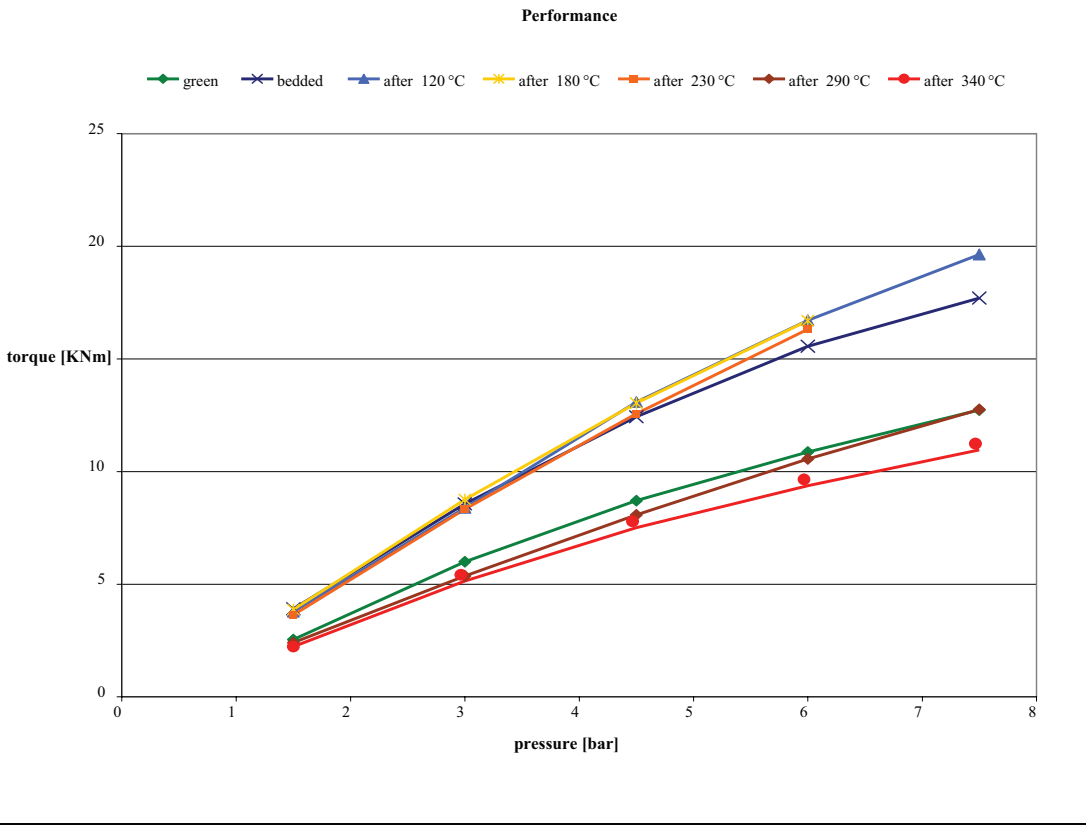


Figure 4 — Test report for drum brakes — thickness and mass loss

7.3 Lining data sheet

Report the test results on a lining data sheet in accordance with Table 4.

Table 4 — Summary lining data sheet

Step number	**Pad/lining wear** mm/g	**Prototyping — samples** Prototype results		**Specification/Validation** Production transfer results		**Series monitoring** Series production results	
		min.	max.	min.	max.	min.	max.
5	After bedding						
7	After cycle 1; 60 km/h to 10 km/h						
10	After cycle 1; 100 km/h to 50 km/h						
12	After cycle 2; 60 km/h to 10 km/h						
15	After cycle 2; 100 km/h to 50 km/h						
17	After cycle 3; 60 km/h to 10 km/h						
20	After cycle 3; 100 km/h to 50 km/h						
22	After cycle 4; 60 km/h to 10 km/h						
25	After cycle 4; 100 km/h to 50 km/h						
27	After cycle 5; 60 km/h to 10 km/h						
30	After cycle 5; 100 km/h to 50 km/h						

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