

6 December 2012

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## Agreement

**Concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions\***

(Revision 2, including the amendments which entered into force on 16 October 1995)

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## Addendum 89: Regulation No. 90

### Revision 3 – Amendment 1

Supplement 1 to the 02 series of amendments - Date of entry into force: 18 November 2012

**Uniform provisions concerning the approval of replacement brake lining assemblies, drum-brake linings and discs and drums for power-driven vehicles and their trailers**



UNITED NATIONS

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\* Former title of the Agreement: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

Paragraph 1.1, insert a new footnote 1 and renumber footnote 1 as footnote 2, to read:

"1.1. This Regulation applies to the basic braking function of the following replacement parts<sup>1,2</sup>:

<sup>1</sup> In this Regulation, references to Regulations Nos. 13, 13-H or 78 shall be deemed also to refer to any other international rule such as 71/320/EEC, that applies the same technical requirements as Regulations Nos. 13, 13-H or 78. References to specific sections of the Regulations shall be interpreted accordingly. "

Footnotes 2 to 5, shall be renumbered as footnotes 3 to 6.

Paragraph 3.4.3.1., the table, amend to read:

"

Item No.	Check / Test	Sample*						Remarks
		1	2	3	4	5	6	
1	Geometric check Paragraphs 5.3.3.1., 5.3.4.1.	x	x	x	x	x	x	
2	Material check Paragraphs 5.3.3.2., 5.3.4.2.	x	x					
3	Balancing provisions check Paragraph 5.3.7.2.			x	x	x	x	
4	Wear condition marking check Paragraph 5.3.7.3.			x	x	x	x	
5	Integrity test - thermal fatigue Paragraphs 4.1.1., 4.2.1. of Annex 11, 4.1.1., 4.2.1. of Annex 12				x	x		
6	Integrity test - high load test Paragraphs 4.1.2., 4.2.2. of Annex 11, and paragraphs 4.1.2., 4.2.2. of Annex 12			x			x	
7	Service brake vehicle performance test Paragraph 2.2. of Annex 11, Paragraph 2.2. of Annex 12						Pair of discs	either front or rear axle
8	Parking brake vehicle performance test Paragraph 2.3. of Annex 11, Paragraph 2.3. of Annex 12						Pair of discs	if applicable
9	Service brake dyno. performance test Paragraph 3.3. of Annex 11, paragraph 3.3. of Annex 12						x	alternative to vehicle test

\* For interchangeable parts it is not necessary to use sample 3; for equivalent parts it is not necessary to use sample 6."

Paragraph 5.3.6.2.2.1., amend to read:

"5.3.6.2.2.1. Test group relating to the tests stipulated in paragraphs 1. to 4. of Annex 11 or Annex 12.

Brake drums may be grouped together as test groups on the basis that each permitted test group range is from the smallest inside diameter to the smallest inside diameter +10 per cent and by no more than 40mm on the shoe width of the drum."

Paragraph 6.2.1., amend to read:

"6.2.1. Every unit sold shall be provided with at least the following information:"

Insert a new paragraph 6.2.2.3., to read:

"6.2.2.3. Part number"

Paragraphs 6.2.2.3. and 6.2.2.4. (former), renumber as paragraphs 6.2.2.4. and 6.2.2.5.

Annex 11,

Paragraph 1., amend to read:

"1. Test overview

The tests required in paragraph 5.3. of this Regulation are detailed as follows according to the vehicle category:

Table A11/1A

**Vehicles of categories M<sub>1</sub>, N<sub>1</sub>**

	<i>Vehicle test</i>	<i>Alternative dynamometer test</i>
Performance tests according to Regulations No. 13/13-H	2.2.1. Type 0, engine disconnected	Type 0 (simulation engine disconnected)
	2.2.2. Type 0, engine connected	Brake tests simulation Type 0, engine connected Speed and load analog to item 2.2.2.
	2.2.3. Type I	Type I
	2.3. Parking braking system (if applicable)	
Comparison test with original part	2.4. Testing the dynamic frictional properties (comparison test conducted on the individual axles)	Testing the dynamic frictional properties (comparison test conducted on the individual wheel brake)
Integrity tests	No vehicle test - use dynamometer test	Brake discs Brake disc thermal fatigue test Brake disc high load test Brake drums Brake drum thermal fatigue test Brake drum high load test

For each disc and drum type at least one test group (see definition in paragraph 5.3.6. of this Regulation) requires the Type 0 and Type I tests to be carried out on a vehicle (not applicable for identical and equivalent parts).

Table A11/1B ...."

Paragraph 3.2.1.2., insert a new subparagraph (c) to read:

"(c) When testing brake discs and drums for vehicles with more than 2 axles:

$$m = 0,55 m_{axle} \quad m_{axle}: \text{max. permitted mass of the axle}"$$

Paragraph 3.3., amend to read:

"3.3. Alternative dynamometer performance test

Table A11/3.3.

1a.	In the case of vehicles of categories M <sub>1</sub> , M <sub>2</sub> , N <sub>1</sub> See bedding-in (burnishing) procedure as described in Annex 3, paragraph 2.2.2.3.
1b.	In the case of vehicles of categories M <sub>3</sub> , N <sub>2</sub> , N <sub>3</sub> Bedding-in (burnishing): 100 (disc) or 200 (drum) brake applications T <sub>i</sub> = 150°C (disc) or 100°C (drum) v <sub>i</sub> = 60 km/h d <sub>m</sub> = 1 and 2 m/s <sup>2</sup> alternating
2.	Dynamic friction properties, see paragraph 3.5.1. of this annex
3.	Brake test Type 0 (simulation engine disconnected), see paragraph 3.4.1. of this annex
4.	Brake test Type I, see paragraph 3.4.2. of this annex
5.	Re-burnishing: 10 (disc) or 20 (drum) brake applications T <sub>i</sub> = 150 °C (disc) or 100 °C (drum) v <sub>i</sub> = 60 km/h, d <sub>m</sub> = 1 and 2 m/s <sup>2</sup> alternating
6.	Brake test Type 0 (simulation engine disconnected), see paragraph 3.4.1. of this annex
7.	Brake test Type 0 (simulation engine connected), see paragraph 3.4.4. of this annex
8.	Re-burnishing: (like No. 5.)
9.	Dynamic friction properties, see paragraph 3.5.1. of this annex
10.	Brake test Type II (if applicable), see paragraph 3.4.3. of this annex
11.	Re-burnishing: (like No. 5.)
	Steps 12 to 19 are optional (if activation is not sufficient)
12.	Brake test Type 0, see paragraph 3.4.1. of this annex
13.	Brake test Type I, see paragraph 3.4.2. of this annex
14.	Re-burnishing: (like item 5.)
15.	Dynamic friction properties see paragraph 3.5.1. of this annex
16.	Brake tests Type 0 (simulation engine connected), see paragraph 3.4.4. of this annex
17.	Re-burnishing: (like item 5.)
18.	Dynamic friction properties see paragraph 3.5.1. of this annex
19.	Re-burnishing: (like item 5.)

Paragraphs 3.4. to 3.4.4., amend to read:

"3.4. Service braking system

3.4.1. Brake test Type-0 test (simulation engine disconnected)

From the initial rotational speed equivalent to 100 km/h (M<sub>1</sub>/N<sub>1</sub>), or 60 km/h (M<sub>2</sub>/M<sub>3</sub>/N<sub>2</sub>/N<sub>3</sub>) and at a brake temperature ≤ 100 °C at the start of each application, perform three brake applications at the same brake actuating pressure such that a mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a mean brake torque based on the braking distance equivalent to the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) of at least 6.43 m/s<sup>2</sup> for vehicles of categories M<sub>1</sub>/N<sub>1</sub> or 5 m/s<sup>2</sup> for vehicles of categories M<sub>2</sub>/M<sub>3</sub>/N<sub>2</sub>/N<sub>3</sub> is achieved.

In the case of pneumatic braking systems the brake actuator pressure shall not exceed the pressure that is permanently guaranteed by the braking system of the vehicle type(s) (e.g. cut in pressure of the compressor), and the brake input torque (C) shall not exceed the maximum permissible brake input torque ( $C_{max}$ ) by using the smallest brake chamber of the vehicle type(s).

The average of the three results shall be taken as the cold performance.

3.4.1.1. Rolling resistance

The rolling resistance is taken to equate to a deceleration of  $0.1 \text{ m/s}^2$ .

3.4.2. Brake test Type I

3.4.2.1. Heating procedure

3.4.2.1.1. According to the vehicle category make consecutive snub applications of the brake in accordance with the conditions laid down in the following table. Every brake application shall be conducted in that way that a constant deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a constant brake torque equivalent to the deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) of  $3 \text{ m/s}^2$  will be achieved.

The first brake application shall commence at a brake temperature of  $\leq 100 \text{ }^\circ\text{C}$ .

Vehicle Category	$v_1$ [km/h]	$v_2$ [km/h]	$\Delta t$ [sec]	N
$M_1$	$80\% v_{max} \leq 120 \text{ km/h}$	$0.5 v_1$	45	15
$M_2$	$80\% v_{max} \leq 100 \text{ km/h}$	$0.5 v_1$	55	15
$N_1$	$80\% v_{max} \leq 120 \text{ km/h}$	$0.5 v_1$	45	15
$M_3/N_2/N_3$	$80\% v_{max} \leq 60 \text{ km/h}$	$0.5 v_1$	60	20

where:

$v_1$  = initial speed, at beginning of braking

$v_2$  = speed at end of braking

$v_{max}$  = maximum speed of vehicle

n = number of brake applications

$\Delta t$  = duration of a braking cycle: time elapsing between the initiation of one brake application and the initiation of the next.

3.4.2.1.2. In the case of brakes equipped with automatic brake adjustment devices, the adjustment of the brakes shall, prior to the Type I test above, be set according to the following procedures as appropriate:

3.4.2.1.2.1. In the case of air operated brakes, the adjustment of the brakes shall be such as to enable the automatic brake adjustment device to function. For this purpose the actuator stroke shall be adjusted to:

$$S_0 \geq 1.1 \cdot S_{re-adjust}$$

(the upper limit shall not exceed a value recommended by the manufacturer)

where:

$S_{re-adjust}$  is the readjustment stroke according to the specification of the manufacturer of the automatic brake adjustment device, i.e. the stroke, where it starts to readjust the running clearance of the brake with an actuator pressure of 15 per cent of the brake system operating pressure but not less than 100 kPa.

Where, by agreement with the Technical Service, it is impractical to measure the actuator stroke, the initial setting shall be agreed with the Technical Service.

From the above condition the brake shall be operated with an actuator pressure of 30 per cent of the brake system operating pressure but not less than 200 kPa 50 times in succession. This shall be followed by a single brake application with an actuator pressure of  $\geq 650$  kPa.

3.4.2.1.2.2. In the case of hydraulically operated disc brakes, no setting requirements are deemed necessary.

3.4.2.1.2.3. In the case of hydraulically operated drum brakes, the adjustment of the brakes shall be as specified by the manufacturer.

3.4.2.2. Hot performance

Not later than 60 seconds after completion of the heating procedure the hot performance shall be measured under the conditions of speed and pressure applied in the Type 0 test.

For vehicles of category  $M_1$  and  $N_1$  the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a mean brake torque based on the braking distance equivalent to the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) must not be less than 75 per cent of the value achieved with the cold brake in the Type 0 test nor less than  $4.8 \text{ m/s}^2$ .

For vehicles of category  $M_2$ ,  $M_3$ ,  $N_2$  and  $N_3$  the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a mean brake torque based on the braking distance equivalent to the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) must not be less than 60 per cent of the value achieved with the cold brake in the Type 0 test nor less than  $4 \text{ m/s}^2$ .

3.4.2.3. Free running test

In the case of brakes equipped with automatic brake adjustment devices, after completing the tests defined in paragraph 3.4.2.2. above the brake shall be allowed to cool to a temperature representative of a cold brake (i.e.  $\leq 100$  °C) and it shall be verified that the brake is capable of free running by fulfilling one of the following conditions:

- (a) The disc or drum is running freely (i.e. may be rotated by hand);
- (b) When the disc or drum is rotated at a rotational speed equivalent to a constant speed of  $v = 60$  km/h with the brake released the asymptotic temperatures shall not exceed a drum/disc temperature increase of 80 °C.

- 3.4.3. Brake test Type II
- 3.4.3.1. Heating procedure
- 3.4.3.1.1. The brakes shall be heated from an initial temperature of  $\leq 100$  °C by dragging the brake at a constant rotational speed equivalent to 30 km/h with a constant braking torque corresponding to a deceleration, excluding rolling resistance, of  $0.15 \text{ m/s}^2$  for a period of 12 minutes.
- 3.4.3.1.2. In the case of brakes equipped with automatic brake adjustment devices the adjustment of the brake shall, prior to the Type II test above, be set according to the procedure as laid down in paragraph 3.4.2.1.2. of this annex.
- 3.4.3.2. Hot performance
- Not later than 60 seconds after completion of the heating procedure the hot performance shall be measured under the conditions of speed and brake actuating pressure applied in the Type 0 test.
- With the heated brake the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or the mean brake torque based on the braking distance equivalent the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) must not be less than  $3.75 \text{ m/s}^2$ .
- 3.4.3.3. Free running test
- See paragraph 3.4.2.3. of this annex
- 3.4.4. Brake test Type-0 test (simulation engine connected)
- Instead of the Type 0 test with engine connected, for the purpose of this Regulation it is acceptable to carry out a test simulating for the laden condition (see paragraph 3.2. of this annex).

Vehicle Category	Initial Speed - $v_1$ (km/h)
M <sub>1</sub>	80% $v_{\text{max}} \leq 160$ km/h
M <sub>2</sub>	100 km/h
M <sub>3</sub>	90 km/h
N <sub>1</sub>	80% $v_{\text{max}} \leq 160$ km/h
N <sub>2</sub>	100 km/h
N <sub>3</sub>	90 km/h

where:

$v_1$  = initial speed, at beginning of braking

$v_{\text{max}}$  = maximum speed of vehicle

From an initial rotational speed equivalent to the vehicle speeds in the table above and at a brake temperature of  $\leq 100$  °C at the start of each application make three brake applications at the same brake actuating pressure such that a mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a mean brake torque based on the braking distance equivalent to the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) of at least  $5.76 \text{ m/s}^2$ , for vehicles of categories M<sub>1</sub> and N<sub>1</sub> or  $4 \text{ m/s}^2$ , for vehicles of categories M<sub>2</sub>, M<sub>3</sub>, N<sub>2</sub> and N<sub>3</sub> is achieved.

The average of the three results shall be taken as the cold performance."

Paragraph 4.1.1.1.2., amend to read:

"4.1.1.1.2. Test program (brake disc thermal fatigue test)

The new brake linings and the new disc shall be fitted to the relevant brakes and bedded (burnished) according to the procedure of Annex 3, paragraph 2.2.2.3. If any new brake linings are required in order to complete the test, they shall be bedded (burnished) according to the same procedure:

Table A11/4.1.1.1.2.

Test provision	Thermal fatigue test
Vehicle categories	$M_1 / N_1$
Type of braking	Sequential brake applications
Braking interval (= $t_{total}$ )	70 s
Number of brake applications per cycle	2
Brake torque set to produce a deceleration of	5.0 m/s <sup>2</sup>
Total number of braking cycles	100 or 150 (see 4.1.1.1.3.)
Brake applications from to	$v_{max}$ 20 km/h
Initial temperature of the 1st brake application in each cycle	≤ 100 °C

where:

$v_{max}$  the  $v_{max}$  to be used to test the replacement part is that corresponding to the vehicle which has the highest ratio of kinetic energy to disc mass

$t_{bra}$  actual braking period during the application

$t_{acc}$  minimum acceleration time in accordance with the accelerating power of the respective vehicle

$t_{rest}$  rest period

$t_{total}$  Braking interval ( $t_{bra} + t_{acc} + t_{rest}$ )"

Paragraph 4.1.2., amend to read:

"4.1.2. Brake disc high load test

In the case of interchangeable parts the high load test shall be conducted on a new brake disc or on the same brake disc which has been used for the alternative dynamometer test (see paragraph 3.3. of this annex).

In the case of equivalent parts the high load test shall be conducted using a new disc, an original brake caliper of the vehicle(s) concerned and new brake lining assemblies of the vehicle(s) concerned which have been type approved according to Regulations Nos. 13, 13-H or 90 (in the condition as mounted on the vehicle, e.g. protective grease removed).

Worn brake linings may be replaced during the test if necessary."

Paragraph 4.1.2.1.2., amend to read:

"4.1.2.1.2. Test program (brake disc high load test)

The new brake linings and the new disc shall be fitted to the relevant brakes and bedded (burnished) according to the procedure of Annex 3,



paragraph 2.2.2.3. If any new brake linings are required in order to complete the test, they shall be bedded (burnished) according to the same procedure:

Table A11/4.1.2.1.2.

<i>Test provision</i>	<i>High load test</i>
Vehicle categories	$M_1 / N_1$
Type of braking	Single brake applications
Number of brake applications	70
Initial temperature at the beginning of braking	$\leq 100 \text{ }^\circ\text{C}$
Brake torque set to produce a deceleration of	10.0 m/s <sup>2</sup> with a pressure $\leq 16,000$ kPa or $p = 16,000$ kPa ( $< 10.0$ m/s <sup>2</sup> )
Brake applications from to	$v_{\max}$ 10 km/h

Where the  $v_{\max}$  to be used to test the replacement part is that corresponding to the vehicle which has the highest ratio of kinetic energy to disc mass"

Paragraph 4.1.2.2.2., amend to read:

"4.1.2.2.2. Test program (brake disc high load test)

Bedding in accordance with table A11/4.1.1.2.2.

500 brake applications are carried out from a speed of 50 km/h to 10 km/h with a brake torque of 90 per cent of the maximum brake torque applicable to the relevant brake caliper.

Initial temperature:  $\leq 200 \text{ }^\circ\text{C}$ "

Paragraph 4.1.2.2.3., amend to read:

"4.1.2.2.3. Test result (brake disc high load test)

The test is regarded as having been passed if the brake disc does not exhibit any signs of fracture after 500 brake applications. The test shall be considered valid provided the required maximum torque is achieved for at least 90 per cent of the brake applications under the condition that for the other 10 per cent the maximum pressure is applied.

Damage in this context means:

- (a) Radial cracks on the friction surface which are longer than 2/3 of the radial height of the friction surface;
- (b) Cracks on the friction surface which reach the inner or outer diameter of the friction surface;
- (c) Through-cracking of any friction ring;
- (d) Any type of structural damage or cracks in any area outside the friction surface."

Table A11/4.2.1.2.2., amend to read:

"

<i>Test provision</i>	<i>Thermal fatigue test</i>
"Bedding in" procedure	200 brake applications Initial speed: 60 km/h Final speed: 5 km/h $d_m$ alternating between 1 m/s <sup>2</sup> and 2 m/s <sup>2</sup> Initial temperature : ≤ 200 °C (beginning at room temperature) Alternatively bedding may be omitted if the applicant for approval does not consider it to be necessary
Type of braking	Sequential brake applications
Number of brake applications	250 or 300 (whichever is applicable) – see paragraph 4.2.1.2.3. NB: The test is interrupted when a through crack appears.
Brake torque set to produce a deceleration of	3.0 m/s <sup>2</sup>
Brake applications from to	130 80 km/h
Initial temperature of each brake application	≤ 50 °C
Cooling pursuant to paragraph 3.2.3.	Permitted

"

Paragraph 4.2.1.2.3., the heading, amend to read:

"4.2.1.2.3. Test result (brake drum thermal fatigue test)"

Paragraph 4.2.2., amend to read:

"4.2.2. Brake drum high load test

In the case of interchangeable parts the high load test shall be conducted on a new brake drum or on the same brake drum which has been used for the alternative dynamometer test (see paragraph 3.3. of this annex.).

In the case of equivalent parts the high load test shall be conducted using a new drum, an original brake of the vehicle(s) concerned and new brake lining assemblies of the vehicle(s) concerned which have been type approved according to Regulations Nos. 13, 13-H or 90 (in the condition as mounted on the vehicle, e.g. protective grease removed).

Worn brake linings may be replaced during the test if necessary."

Paragraph 4.2.2.1.2., amend to read:

"4.2.2.1.2. Test program (brake drum high load test)

This test covers also the requirements of the thermal fatigue test (see paragraph 4.2.1.1.2.)

The test has to be carried out according to the following table:"

Table A11/4.2.2.1.2., amend to read:

"

"Bedding in" procedure	Make 100 consecutive snub applications with $v_1 = 80$ km/h and $v_2 = 10$ km/h and an initial temperature of $\leq 100$ °C. The deceleration of the first application shall be constant $1.5$ m/s <sup>2</sup> . From the second up to the last application the pressure shall be constant and equivalent to the average of the first application. The bedding should be continued until a minimum of 80 per cent lining to drum contact is achieved.
Test provision	Brake drum high load test
Type of braking	Single brake applications
Number of brake applications	100
Initial temperature at the beginning of braking	$\leq 100$ °C
Brake torque set to produce a deceleration of	$10.0$ m/s <sup>2</sup> with a pressure $\leq 16,000$ kPa or $p = 16,000$ kPa ( $< 10.0$ m/s <sup>2</sup> )
Brake applications from to	$v_{max}$ 10 km/h

Where the  $v_{max}$  to be used to test the replacement part is that corresponding to the vehicle which has the highest ratio of kinetic energy to disc mass"

Paragraph 4.2.2.2.2., amend to read:

"4.2.2.2.2. Test program (brake drum high load test)

Table A11/4.2.2.2.2.,

<i>Test provision</i>	<i>High load test</i>
"Bedding in" procedure	200 brake applications Initial speed: 60 km/h Final speed: 5 km/h dm alternating between $1$ m/s <sup>2</sup> and $2$ m/s <sup>2</sup> Initial temperature: $\leq 200$ °C (beginning at room temperature) Alternatively bedding may be omitted if the applicant for approval does not consider it to be necessary
Total number of brake applications	150
Initial brake drum temperature at each brake application	$\leq 100$ °C
Brake applications from to	60 km/h $\leq 5$ km/h
Brake torque set to produce a deceleration of	$6$ m/s <sup>2</sup>
Cooling (also deviating from paragraph 3.2.3. of this annex)	Permitted

"

*Paragraph 4.2.2.2.3.*, amend to read:

"4.2.2.2.3. Test result (brake drum high load test)

The test result is positive provided the brake drum does not fracture.

The test shall be considered valid provided the required maximum torque is achieved for at least 90 per cent of the brake applications under the condition that for the other 10 per cent the maximum pressure is applied.

Damage in this context means:

- (a) Radial cracks on the friction surface which are longer than 2/3 of the radial height of the friction surface;
- (b) Cracks on the friction surface which reach the inner or outer diameter of the friction surface;
- (c) Through-cracking of any friction ring;
- (d) Any type of structural damage or cracks in any area outside the friction surface."

*Annex 12*

*Paragraph 3.2.1.2.*, amend to read:

"3.2.1.2. Test mass

The test mass for calculating the inertia mass shall be as follows:

$$m = 0,55 m_{\text{axle}} \quad m_{\text{axle}}: \text{max. permitted mass of the axle}"$$

"

*Paragraphs 3.4. to 3.5.3.*, amend to read:

"3.4. Service braking system

3.4.1. Brake test Type 0, vehicle laden

With a brake temperature  $\leq 100$  °C at the start of each application and from the initial rotational speed equivalent to 40 km/h before Type I or 60 km/h before Type III, perform three brake applications at the same brake actuating pressure such that a mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a mean brake torque based on the braking distance equivalent to the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) of at least  $5 \text{ m/s}^2$  is achieved.

The brake actuating pressure must not exceed 650 kPa.

The average of the three results shall be taken as the cold performance.

3.4.1.1. Rolling resistance

The rolling resistance is taken to equate to a deceleration of  $0.1 \text{ m/s}^2$ .

3.4.2. Brake test Type-I (Downhill test)

3.4.2.1. Heating procedure

The brake shall be heated from an initial temperature of  $\leq 100$  °C by dragging the brake at a constant rotational speed equivalent to 40 km/h at a constant braking torque corresponding to a deceleration, including rolling resistance (see paragraph 3.4.1.1. of this annex) of  $0.7 \text{ m/s}^2$  for a period of 153 sec.

3.4.2.1.4. In the case of brakes equipped with automatic brake adjustment devices the adjustment of the brakes shall, prior to the Type I test above, be set according to the procedure as laid down in paragraph 3.4.3.1.2. of this annex.

3.4.2.2. Hot performance

3.4.2.2.1. Not later than 60 seconds after completion of the heating procedure the hot performance shall be measured at 40 km/h using the same brake actuation pressure that was used for the Type 0 test at 40km/h.

The mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a mean brake torque based on the braking distance equivalent to the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) must not be less than 60 per cent of the value achieved with the cold brake in the Type 0 test nor less than  $3.6 \text{ m/s}^2$ .

3.4.2.3. Free running test

In the case of brakes equipped with automatic brake adjustment devices, after completing the tests defined in paragraph 3.4.2.2. the brake shall be allowed to cool to a temperature representative of a cold brake (i.e.  $\leq 100 \text{ }^\circ\text{C}$ ) and it shall be verified that the brake is capable of free running by fulfilling one of the following conditions:

- (a) The disc or drum is running freely (i.e. may be rotated by hand);
- (b) When the disc or drum is rotated without any cooling at a rotational speed equivalent to a constant speed of  $v = 60 \text{ km/h}$  with the brake released the asymptotic temperatures shall not exceed a drum/disc temperature increase of  $80 \text{ }^\circ\text{C}$ .

3.4.3. Type-III test (fade test for vehicles of category  $O_4$ )

3.4.3.1. Heating procedure

3.4.3.1.1. Make consecutive snub applications of the brake in accordance with the conditions laid down in the table. The first brake application should commence at a brake temperature of  $\leq 100 \text{ }^\circ\text{C}$  and be conducted in such a way that a constant deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a constant brake torque equivalent to the deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) of  $3 \text{ m/s}^2$  will be achieved. The mean value of brake actuating pressure used for the first brake application should be maintained for all succeeding brake applications for the remainder of the test.

Category of vehicles	Conditions			
	$v1 \text{ [km/h]}$	$v2 \text{ [km/h]}$	$\Delta t \text{ [sec]}$	$n$
$O_4$	60	$1/2 v_1$	60	20

where:

- $v_1$  = initial speed, at beginning of braking
- $v_2$  = speed at end of braking
- $n$  = number of brake applications
- $\Delta t$  = duration of a braking cycle: time elapsing between the initiation of one brake application and the initiation of the next

- 3.4.3.1.2. In the case of brakes equipped with automatic brake adjustment devices the adjustment of the brakes shall, prior to the Type III test above, be set according to the following procedures as appropriate:
- 3.4.3.1.2.1. In the case of air operated brakes the adjustment of the brakes shall be such as to enable the automatic brake adjustment device to function. For this purpose the actuator stroke shall be adjusted to  $s_0 \geq 1.1 \times s_{\text{re-adjust}}$  (the upper limit shall not exceed a value recommended by the manufacturer):
- where:
- $s_{\text{re-adjust}}$  is the readjustment stroke according to the specification of the manufacturer of the automatic brake adjustment device, i.e. the stroke, where it starts to re-adjust the running clearance of the brake with an actuator pressure of 100 kPa
- Where, by agreement with the Technical Service, it is impractical to measure the actuator stroke, the initial setting shall be agreed with the Technical Service.
- From the above condition, the brake shall be operated with an actuator pressure of 200 kPa, 50 times in succession. This shall be followed by a single brake application with an actuator pressure of  $\geq 650$  kPa.
- 3.4.3.1.2.2. In the case of hydraulically operated disc brakes, no setting requirements are deemed necessary.
- 3.4.3.1.2.3. In the case of hydraulically operated drum brakes, the adjustment of the brakes shall be as specified by the manufacturer.
- 3.4.3.2. Hot performance
- Not later than 60 seconds after completion of the heating procedure, the hot performance shall be measured at a rotational speed equivalent to 60 km/h using the same brake actuation pressure that was used for the Type 0 test at 60 km/h.
- The mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) or a mean brake torque based on the braking distance equivalent to the mean fully developed deceleration, including the rolling resistance (see paragraph 3.4.1.1. of this annex) must not be less than 60 per cent of the value achieved with the cold brake in the Type 0 test nor less than  $4.0 \text{ m/s}^2$ .
- 3.4.3.3. Free running test
- See paragraph 3.4.2.3.
- 3.5. Testing the dynamic frictional properties (comparison test conducted on the individual wheel brake)
- 3.5.1. The test shall be carried out in accordance of Regulation No. 13, Annex 19, paragraphs 4.4.3.1. to 4.4.3.4.
- 3.5.2. The brake test described in paragraph 3.5.1. also shall be carried out using the original brake disc/drum.
- 3.5.3. The dynamic frictional properties at step 2 of the procedure of the replacement brake disc/drum can be regarded as similar to those of the original brake disc/drum, provided the values attained in relation to the mean fully developed deceleration at the same operating pressures or control forces

in the region of the upper 2/3 of the curve generated do not deviate by more than  $\pm 8$  per cent or  $\pm 0.4 \text{ m/s}^2$  from those of the original brake disc/drum."

Paragraph 4.1.1.1.2., amend to read:

"4.1.1.1.2. Test program (brake disc thermal fatigue test)

Table A12/4.1.1.1.2.,

<i>Test provision</i>	<i>Thermal fatigue test</i>
Vehicle categories	O <sub>1</sub> / O <sub>2</sub>
"Bedding in" procedure	100 brake applications Initial speed: 60 km/h Final speed: 30 km/h d <sub>m</sub> alternating between 1 m/s <sup>2</sup> and 2 m/s <sup>2</sup> Initial temperature : $\leq 300 \text{ }^\circ\text{C}$ (beginning at room temperature)
Type of braking	Sequential brake applications
Braking interval (= t <sub>total</sub> )	70 s
Number of brake applications per cycle	2
Brake torque set to produce a deceleration of	5.0 m/s <sup>2</sup>
Total number of braking cycles	100 or 150 (see paragraph 4.1.1.1.3.)
Brake applications from to	80 km/h 20 km/h
Initial temperature of the 1st brake application in each cycle	$\leq 100 \text{ }^\circ\text{C}$

where:

- v<sub>max</sub> = maximum design speed (as per its range of use)
- t<sub>bra</sub> = actual braking period during the application
- t<sub>acc</sub> = minimum acceleration time in accordance with the accelerating power of the respective vehicle
- t<sub>rest</sub> = rest period
- t<sub>total</sub> = Braking interval (t<sub>bra</sub> + t<sub>acc</sub> + t<sub>rest</sub>)"

Paragraph 4.1.2., amend to read:

"4.1.2. Brake disc high load test

In the case of interchangeable parts, the high load test shall be conducted on a new brake disc or on the same brake disc which has been used for the alternative dynamometer test (see paragraph 3.3. of this annex.).

In the case of equivalent parts, the high load test shall be conducted using a new disc, an original brake caliper of the vehicle(s) concerned and new brake lining assemblies of the vehicle(s) concerned which have been type approved according to Regulations Nos. 13 or 90 (in the condition as mounted on the vehicle, e.g. protective grease removed).

Worn brake linings may be replaced during the test if necessary."

Paragraph 4.1.2.1., amend to read:

"4.1.2.1. Vehicles of categories O<sub>1</sub> and O<sub>2</sub>

The new brake linings and the new disc shall be fitted to the relevant brakes and bedded (burnished) according to the procedure of Annex 3,

paragraph 2.2.2.3. If any new brake linings are required in order to complete the test, they shall be bedded (burnished) according to the same procedure. "

*Insert new paragraphs 4.1.2.1.1. to 4.1.2.1.3., to read:*

"4.1.2.1.1. Test conditions (brake disc high load test)

See paragraph 4.1.1.1.1. above.

4.1.2.1.2. Test program (brake disc high load test)

The test has to be carried out according to the following table:

Table A12/4.1.2.1.2.

<i>Test provision</i>	<i>High load test</i>
Vehicle categories	O <sub>1</sub> /O <sub>2</sub>
Type of braking	Single brake applications
Number of brake applications	70
Initial temperature at the beginning of braking	≤ 100 °C
Brake torque set to produce a deceleration of	10.0 m/s <sup>2</sup> with a pressure ≤ 16,000 kPa or p = 16,000 kPa (< 10.0 m/s <sup>2</sup> )
Brake applications from to	80 10 km/h

4.1.2.1.3. Test result (brake disc high load test)

The test is regarded as having been passed if 70 or more brake applications are completed without damage or failure.

If less than 70 brake applications are completed before damage or failure, then a test should be conducted on the original part and the results compared. If the damage or failure point is no worse than the number of cycles of the original part -10 per cent then the test is regarded as having been passed.

Damage in this context means:

- (a) Radial cracks on the friction surfaces which are longer than two thirds of the radial height of the friction surface;
- (b) Cracks on the friction surface which reach the inner or outer diameter of the friction surface;
- (c) Through-cracking of any friction ring;
- (d) Any type of structural damage or cracks in any area outside the friction surface."

*Paragraph 4.1.2.2.2., amend to read:*

"4.1.2.2.2. Test program (brake disc high load test)

Bedding in accordance with table A12/4.1.1.2.2.

500 brake applications are carried out from a speed of 50 km/h to 10 km/h with a brake torque of 90 per cent of the maximum brake torque applicable to the relevant brake caliper.

Initial temperature: ≤ 200 °C"



Paragraph 4.1.2.2.3., amend to read:

"4.1.2.2.3. Test result (brake disc high load test)

The test is regarded as having been passed if the brake disc does not exhibit any signs of fracture after 500 brake applications. The test shall be considered valid provided the required maximum torque is achieved for at least 90 per cent of the brake applications under the condition that for the other 10 per cent the maximum pressure is applied.

Damage in this context means:

- (a) Radial cracks on the friction surface which are longer than 2/3 of the radial height of the friction surface;
- (b) Cracks on the friction surface which reach the inner or outer diameter of the friction surface;
- (c) Through-cracking of any friction ring;
- (d) Any type of structural damage or cracks in any area outside the friction surface;"

Table A12/4.2.1.1.2.,

<i>Test provision</i>	<i>Thermal fatigue test</i>
"Bedding in" procedure	200 brake applications Initial speed: 60 km/h Final speed: 5 km/h $d_m$ alternating between 1 m/s <sup>2</sup> and 2 m/s <sup>2</sup> Initial temperature : ≤ 200 °C (beginning at room temperature) Alternatively bedding may be omitted if the applicant for approval does not consider it to be necessary
Type of braking	Sequential brake applications
Number of brake applications	250 or 300 (whichever is applicable) – see paragraph 4.2.1.1.3. NB: The test is interrupted when a through crack appears.
Brake torque set to produce a deceleration of	3.0 m/s <sup>2</sup>
Brake applications from to	130 80 km/h
Initial temperature of each brake application	≤ 50 °C
Cooling pursuant to paragraph 3.2.3.	Permitted

Paragraph 4.2.1.1.3., amend to read:

"4.2.1.1.3. Test result (brake drum thermal fatigue test)

The test is regarded as having been passed if 300 or more brake applications are completed without damage or failure.

If less than 300 brake applications but more than 250 brake applications are completed without damage or failure then the Technical Service must repeat the test on a new replacement part. Under these circumstances both tests must complete more than 250 brake applications without damage or failure for the part to have passed the test.

If less than 250 brake applications are completed before damage or failure then a test should be conducted on the original part and the results compared. If the damage or failure point is no worse than the original part then the test is regarded as having been passed.

Damage in this context means:

- (a) Cracks on the friction surface which are longer than two-thirds of the axial width of the friction surface;
- (b) Cracks on the friction surface which reach the axial outer end of the drum;
- (c) Through-cracking of the drum;
- (d) Any type of structural damage or cracks in any area outside the friction surface."

*Paragraph 4.2.2.*, amend to read:

"4.2.2. Brake drum high load test

In the case of interchangeable parts, the high load test shall be conducted on a new brake drum or on the same brake drum which has been used for the alternative dynamometer test (see paragraph 3.3. of this annex.). In either case, the brake lining assemblies used for the test should be approved according to Regulations No. 13 or 90 and bedded to the drum in accordance with the procedure specified in paragraph 4.2.2.2.2. of this annex. Alternatively bedding may be omitted if the applicant for approval does not consider this to be necessary

In the case of equivalent parts, the high load test shall be conducted using a new drum, an original brake of the vehicle(s) concerned and new brake lining assemblies of the vehicle(s) concerned which have been type approved according to Regulations Nos. 13 or 90 (in the condition as mounted on the vehicle, e.g. protective grease removed). Bedding should be in accordance with the procedure specified in paragraph 4.2.2.2.2. of this annex. Alternatively bedding may be omitted if the applicant for approval does not consider this to be necessary

Worn brake linings may be replaced during the test if necessary."

*Paragraph 4.2.2.1.1.*, amend to read:

"4.2.2.1.1. Test conditions (brake drum high load test)

The inertia mass of the inertia dynamometer shall be determined in accordance with the requirements laid down in paragraphs 3.2.1., 3.2.1.1. and 3.2.1.2. of Annex 12.

The rotational speed of the dynamometer shall correspond to the linear test speed of the vehicle based on the mean of the largest and smallest dynamic rolling radius of the tyres authorized for that vehicle."

Paragraph 4.2.2.2.2., amend to read:

"4.2.2.2.2. Test program (brake drum high load test)

Table A12/4.2.2.2.2.

<i>Test provision</i>	<i>High load test</i>
"Bedding in" procedure	200 brake applications Initial speed: 60 km/h Final speed: 5 km/h $d_m$ alternating between 1 m/s <sup>2</sup> and 2 m/s <sup>2</sup> Initial temperature : $\leq 200$ °C (beginning at room temperature) Alternatively bedding may be omitted if the applicant for approval does not consider it to be necessary
Type of braking	Braking to less than 5 km/h
Total number of brake applications	150
Initial brake drum temperature at each brake application	$\leq 100$ °C
Brake applications from to	60 km/h 0 km/h
Brake torque set to produce a deceleration of	6 m/s <sup>2</sup>
Cooling (also deviating from paragraph 3.2.3. of this annex	Permitted

Paragraph 4.2.2.2.3., amend to read:

"4.2.2.2.3. Test result (brake drum high load test)

The test result is positive provided the brake drum does not fracture.

The test shall be considered valid provided the required maximum torque is achieved for at least 90 per cent of the brake applications under the condition that for the other 10 per cent the maximum pressure is applied.

Damage in this context means:

- (a) Radial cracks on the friction surface which are longer than 2/3 of the radial height of the friction surface;
- (b) Cracks on the friction surface which reach the inner or outer diameter of the friction surface;
- (c) Through-cracking of any friction ring;
- (d) Any type of structural damage or cracks in any area outside the friction surface."

Annex 13

Paragraph 1.6., amend to read:

"1.6. Marking:

	Identification	Location of marking	Method of marking
Manufacturer name or trade name:			
Approval number	E2-90R02 Cxxxx/yyyy xxxx => Type No. yyyy => Variant No.		
Part number			
Indication for traceability			
Minimum thickness (disc) / maximum inside diameter (drum) <sup>1</sup>			

"

Paragraph 3.1.1.12.2., amend to read:

"3.1.1.12.2. Brake caliper / brake drum mechanism<sup>1</sup>, amend to read:

Manufacturer: .....  
Type: .....  
Variant: .....  
Part number: .....  
Method of construction: .....  
piston / wheel cylinder diameter<sup>2</sup>: .....  
Maximum technically permissible torque  $C_{max,e}$  at  
The brake lever (pneumatic) / line pressure ( $p_{max,e}$ ) (hydraulic)<sup>1</sup>: .....  
Threshold torque  $C_{0,e}$  (pneumatic) / line pressure (hydraulic)<sup>1</sup>: .....  
Ratio  $l_e / e_e$  (pneumatic) / piston diameter (hydraulic)<sup>1</sup>: ..... / .....  
Maximum brake torque: ....."

Insert new paragraphs 3.2.2. to 3.2.2.1., to read:

"3.2.2. Test bench data: ....."

3.2.2.1. Location: ....."

Paragraph 4.5.1.1., amend to read

"4.5.1.1. Service brake performance in the case of categories  $M_1$ ,  $M_2, M_3$ ,  $N_1$  and  $N_2$  with hydraulic braking systems<sup>2</sup>:"

Insert new paragraphs 4.5.1.1.1. and 4.5.1.1.2., to read:

"4.5.1.1.1. Vehicle test results:

<i>Test Type:</i>		<i>0 disconnected</i>	<i>0 connected</i>	<i>I</i>	<i>Parking brake<sup>2</sup></i>
Annex 11, paragraph:		2.2.1.	2.2.2.	2.2.3.	2.3.
Load condition:		laden	unladen	laden	laden
Test speed					
Initial:	km/h				
Final:	km/h	0	0		
Pressure:	kPa				
Deceleration:	m/s <sup>2</sup>				
Number of applications:	-	-	-		
Duration of one brake cycle:	s	-	-		

Free running test passed: yes / no<sup>1</sup>

4.5.1.1.2. Inertia dynamometer test results:

<i>Test Type:</i>		<i>0 disconnected</i>	<i>0 simulation connected</i>	<i>I simulation</i>
Annex 11, paragraph:		3.4.1.	3.4.4.	3.4.2.
Load condition				
Test speed				
Initial:	km/h			
Final:	km/h	0	0	
Pressure:	kPa			
Deceleration:	m/s <sup>2</sup>			
Number of applications:	-	-		
Duration of one brake cycle:	s	-		

Free running test passed: yes / no<sup>1"</sup>

Paragraph 4.5.1.2., amend to read

"4.5.1.2. Service brake performance in the case of categories M<sub>2</sub>, M<sub>3</sub>, N<sub>2</sub>, N<sub>3</sub> with pneumatic braking systems<sup>2"</sup>

Insert new paragraphs 4.5.1.2.1. and 4.5.1.2.2., to read:

"4.5.1.2.1. Vehicle test results:

<i>Test Type:</i>		<i>0 disconnected</i>	<i>0 connected</i>	<i>I</i>	<i>Parking brake<sup>2</sup></i>
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Annex 11, paragraph:		2.2.1.	2.2.3.		2.2.4.	2.3.
Load condition:		Laden	unladen	laden	laden	laden
Test speed						
Initial:	km/h					
Final:	km/h	0	0	0		
Brake chamber pressure $p_e$ :	kPa					
Deceleration:	$m/s^2$					
Number of applications:	-					
Duration of one brake cycle:	s					
Brake force $0.5 \cdot T_e$ :	daN					
Braking ratio $0.5 \cdot T_e / 9.81 \cdot m$ ( $m$ := Test mass).	-					
Brake chamber stroke $s_c$ :	Mm					
Threshold torque at the brake lever						
$C_e$ :	Nm					
$C_{0,e}$ :	Nm					

Free running test passed: yes / no<sup>1</sup>

4.5.1.2.2. Inertia dynamometer test results:

<i>Test Type:</i>		<i>0</i>	<i>I</i>	<i>II</i>
Annex 11, paragraph:		3.4.1.	3.4.2.	3.4.3.
Test speed				
Initial:	km/h			
Final:	km/h			
Brake chamber pressure $p_e$ :	kPa			
Deceleration:	$m/s^2$			
Number of applications:	-			
Duration of one brake cycle:	s			
Brake force $0.5 \cdot T_e$ :	daN			
Braking ratio $0.5 \cdot T_e / 9.81 \cdot m$ ( $m$ := Test mass)	-			
Brake chamber stroke $s_c$ :	mm			
Threshold torque at the brake lever				
$C_e$ :	Nm			
$C_{0,e}$ :	Nm			

Free running test passed: yes / no<sup>1a</sup>

Paragraph 4.5.1.3., amend to read

"4.5.1.3. Service brake performance in the case of categories O<sub>1</sub>, O<sub>2</sub> and O<sub>3</sub> with pneumatic braking system"

Insert new paragraphs 4.5.1.3.1. and 4.5.1.3.2., to read:

"4.5.1.3.1. Vehicle test results:

<i>Test Type:</i>		<i>0</i>	<i>I</i>	<i>Parking brake<sup>2</sup></i>
Annex 12, paragraph:		2.2.1.	2.2.2.	2.3.
Load condition:		laden	laden	laden
Test speed				
Initial:	km/h			

Final:	km/h			
Brake chamber pressure $p_e$ :	kPa			
Deceleration:	$m/s^2$			
Number of applications:	-			
Duration of one brake cycle:	s			
Brake force $0.5 \cdot T_e$ :	daN			
Braking ratio $0.5 \cdot T_e / 9.81 \cdot m$ (m:= Test mass):	-			
Brake chamber stroke $s_e$ :	mm			
Threshold torque at the brake lever $C_e$ : $C_{0,e}$ :	Nm Nm			

Free running test passed: yes / no<sup>1</sup>

4.5.1.3.2. Inertia dynamometer test results:

Test Type:		0	I
Annex 12, paragraph:		3.4.1.	3.4.2.
Test speed			
Initial:	km/h		
Final:	km/h		
Brake chamber pressure $p_e$ :	kPa		
Deceleration:	$m/s^2$		
Number of applications:	-		
Duration of one brake cycle:	s		
Brake force $0.5 \cdot T_e$ :	daN		
Braking ratio $0.5 \cdot T_e / 9.81 \cdot m$ (m:= Test mass):	-		
Brake chamber stroke $s_e$ :	mm		
Threshold torque at the brake lever $C_e$ : $C_{0,e}$ :	Nm Nm		

Free running test passed: yes / no<sup>1a</sup>

Paragraph 4.5.1.4., amend to read

"4.5.1.4. Service brake performance in the case of categories O<sub>4</sub><sup>2</sup>

Test Type:	0	III	
No. Sample			
Annex 12, paragraph:	2.2.1. / 3.4.1. <sup>1</sup>	2.2.3. / 3.4.3. <sup>1</sup>	
Test speed			
Initial:	km/h		
Final:	km/h		
Brake chamber pressure p <sub>e</sub> :	kPa		
Number of applications:	-		
Duration of one brake cycle:	s		
Brake force 0.5T <sub>e</sub> :	daN		
Braking ratio 0.5T <sub>e</sub> / 9.81 · m (m:= Test mass):	-		
Brake chamber stroke s <sub>e</sub> :	mm		
Threshold torque at the brake lever			
C <sub>e</sub> :	Nm		
C <sub>0,e</sub> :	Nm		

Free running test passed: yes / no<sup>1</sup>"

Paragraph 4.5.1.5., should be deleted

Paragraph 4.5.1.6., should be renumbered as paragraph 4.5.1.5.

Paragraph 4.6.2., amend to read:

"4.6.2. High load test:

Sample No.	Cycles without damage in accordance with Annex 11: paragraphs 4.1.2.1.3. / 4.1.2.2.3. / 4.2.2.1.3. / 4.2.2.2.3. Annex 12: paragraphs 4.1.2.1.3. / 4.1.2.2.3. / 4.2.2.1.3. / 4.2.2.2.3. <sup>1</sup>
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Paragraph 7., amend to read:

"7. Date(s) of test:"

Insert new paragraphs 7.1. and 7.2., to read:

"7.1. Date(s) of vehicle test<sup>2</sup>: .....

7.2. Date(s) of Inertia dynamometer test: ....."