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Working Party on Brakes and Running Gear (GRRF)
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PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION No. 90

(Replacement brake linings)

Transmitted by the Expert from the Russian Federation

Note: The text reproduced below was prepared by the expert from the Russian Federation in order to make equivalent the inertia dynamometer test with the road test. The document is based on the English translation of a Russian document distributed without a symbol during the one-hundred-and-twenty-eighth session of WP.29 (informal document No. 8) that WP.29 agreed to transmit to GRRF for consideration.

Note: This document is distributed to the experts on Brakes and Running Gear only.

A. PROPOSAL

Paragraph 5.2.1., amend to read:

"5.2.1. Replacement brake linings for the vehicles of categories M₁, M₂ and N₁ shall be tested according to the prescriptions of annex 3 using one of two methods described in paragraphs 1. and 2. and must satisfy the requirements of this annex."

Annex 3, amend to read:

"Annex 3

REQUIREMENTS FOR REPLACEMENT BRAKE LINING ASSEMBLIES FOR VEHICLES OF CATEGORIES M₁, M₂ AND N₁

1. Vehicle test

1.1. Test vehicle

A vehicle which is representative of the type(s) for which the replacement brake lining assembly approval is required shall be equipped with the replacement brake lining assemblies of the type for which approval is requested and instrumented for brake testing as required by Regulation No. 13.

Brake linings submitted for test shall be fitted to the relevant brakes and, until a fixed burnishing procedure is established, shall be burnished to the manufacturer's instructions in agreement with the technical service.

1.2. Tests and requirements

1.2.1. Conformance with Regulation No. 13

1.2.1.1. The braking system of the vehicle shall be tested according to the requirements for the vehicle category in question (M₁, M₂ or N₁) in Regulation No. 13, annex 4, paragraphs 1. and 2. The applicable requirements of tests are:

1.2.1.1.1. Service braking system

1.2.1.1.1.1. Type-0 test with engine disconnected, vehicle laden

1.2.1.1.1.2. Type-0 test with engine connected, vehicle unladen and laden, according to Regulation No. 13, annex 4, paragraphs 1.4.3.1. (stability test) and 1.4.3.2. (only the test with initial speed $V = 0.8 V_{max}$)

1.2.1.1.1.3. Type-I test

- 1.2.1.1.2. Secondary braking system
- 1.2.1.1.2.1. Type-0 test with engine disconnected, vehicle laden (this test may be omitted in cases where it is obvious that the requirements are met, e.g. diagonal split braking system)
- 1.2.1.1.3. Parking braking system
(Only applicable if the brakes for which lining approval is sought are used for parking).
- 1.2.1.1.3.1. Downhill test at 18 per cent gradient, vehicle laden
- 1.2.1.2. The vehicle must satisfy all the relevant requirements stated in Regulation No. 13, annex 4, paragraph 2. for that category of vehicles
- 1.2.2. Additional requirements (split axle test)

For this test the vehicle shall be fully laden and all brake applications made with engine disconnected on a level road.

The vehicle service brake control system shall be equipped with a means of isolating front and rear axle brakes so that either may be used independently of the other.

Where brake lining assembly approval is required for front axle brakes the rear axle brakes shall remain inoperative throughout the test.

Where brake lining assembly approval is required for rear axle brakes the front axle brakes shall remain inoperative throughout the test.

- 1.2.2.1. Cold performance equivalence test

A comparison of the cold performance of the replacement brake lining assembly shall be made by comparing the results of testing to the following method.

- 1.2.2.1.1. Make a minimum of six brake applications at spaced increments of pedal effort or line pressure up to wheel lock or, alternatively, up to a mean fully developed deceleration of 6 m/s^2 or up to the allowed maximum pedal force for the category of vehicle in question from an initial speed as given in the table below:

Vehicle category	Test speed in km/h	
	front axle	rear axle
M ₁	70	45
M ₂	50	40
N ₁	65	50

The initial brake temperature at the start of each application shall be ≤ 100 °C.

1.2.2.1.2. Note and plot pedal force or line pressure and mean fully developed deceleration for each application, and determine the pedal force or line pressure required to achieve (if possible) a mean fully developed deceleration of 5 m/s^2 for front axle brakes and 3 m/s^2 for rear axle brakes. If these values cannot be achieved with the maximum allowed pedal force determine alternatively the pedal force or line pressure required to achieve maximum deceleration.

1.2.2.1.3. The replacement brake lining assembly shall be considered to show similar performance characteristics to the original brake lining assembly if the achieved mean fully developed decelerations at the same control force or line pressure in the upper two thirds of the generated curve are within 15 per cent of those obtained with the original brake lining assembly.

1.2.2.2. Speed sensitivity test

1.2.2.2.1. Using the pedal force derived from paragraph 1.2.2.1.2. of this annex and with initial brake temperature ≤ 100 °C, make three brake applications from each of the following speeds:

Front axle 65, 100 km/h and 135 km/h where v_{max} exceeds 150 km/h.

Rear axle 45, 65 km/h and 90 km/h where v_{max} exceeds 150 km/h.

1.2.2.2.2. Average the results for each group of three applications and plot speed against corresponding mean fully developed deceleration.

1.2.2.2.3. Mean fully developed decelerations recorded for the higher speeds shall lie within 15 per cent of that recorded for the lowest speed.

2. Inertia dynamometer test

2.1. Test equipment

For the tests an inertia dynamometer shall be equipped with the vehicle brake in question. The dynamometer shall be instrumented for continuous recording of rotational speed, brake torque, pressure in the brake line, number of rotations after brake application, braking time and brake rotor temperature.

2.1.1. Test conditions

2.1.1.1. The rotational mass of the dynamometer shall correspond to half the axle portion of the maximum vehicle mass as listed in the table below and to the rolling radius of the largest tyre that is authorized for that vehicle type(s).

Vehicle category	Axle portion of maximum vehicle mass	
	front	rear
M ₁	0.77	0.32
M ₂	0.69	0.44
N ₁	0.66	0.39

2.1.1.2. The initial dynamometer rotational speed shall correspond to the linear vehicle speed as stated in paragraphs 2.2.1.1. and 2.2.1.3. of this annex and shall be based on the dynamic rolling radius of the tyre.

2.1.1.3. Brake linings submitted for test shall be fitted to the relevant brakes and, until a fixed burnishing procedure is established, shall be burnished to the manufacturer's instructions in agreement with the technical service.

2.1.1.4. If cooling air is used, the speed of the airflow at the brake shall be not more than 10 km/h

2.2. Tests and requirements

2.2.1. Tests based on Regulation No. 13

2.2.1.1. Type-0 test

From the initial speed of 80 km/h for M₁ and N₁ and 60 km/h for M₂ and with brake temperature ≤ 100 °C at the start of each application make a minimum of six brake applications at spaced intervals of line pressure up to a mean fully developed deceleration of 6 m/s².

2.2.1.2. Note and plot line pressure and mean fully developed deceleration for each application, and determine line pressure required to achieve 5 m/s².

2.2.1.3. The replacement brake lining assembly shall be considered to show similar performance characteristics to the original brake lining assembly if the achieved mean fully developed decelerations at the same control force or line pressure in the upper two-thirds of the generated curve are within 15 per cent of those obtained with the original brake lining assembly.

2.2.1.2. Type-I test

2.2.1.2.1. Heating procedure

The brake pedal shall be successively and abruptly applied and released 15 times at speeds V₁ = 120 km/h and V₂ = 60 km/h for M₁, and N₁ category of vehicles, at speeds V₁ = 100 km/h and V₂ = 50 km/h for M₂ category of vehicles within

45-second braking cycle for M₁ category of vehicles and within 55-second braking cycle for M₂ and N1 category of vehicles with initial brake temperature ≤ 100 °C before first brake pedal application. The line pressure shall correspond to a deceleration of 3 m/s² at the first brake application, and shall remain constant throughout the succeeding brake applications.

2.2.1.2.2. Hot performance

At the end of the heating procedure the hot performance shall be measured under the conditions of paragraph 2.2.1.1. above, using the guaranteed line pressure as defined in paragraph 2.2.1.2. (the temperature conditions may be different). The mean fully developed deceleration with the heated brake must be not less than 60 per cent of the value achieved with the cold brake or 4 m/s².

2.2.1.2.3. Recovery

Starting 120 s after the hot performance brake application make 5 full stops with the line pressure used in paragraph 2.2.1.2. above and with intervals of at least 2 minutes from the initial speed of 80 km/h. At the beginning of the fifth application the brake temperature shall be ≤ 100 °C and the mean fully developed deceleration achieved shall be within 10 per cent of that calculated from the relation line pressure/deceleration of the Type-0 test at 80 km/h.

2.2.1.3. Speed sensitivity test

2.2.1.3.1. Using the line pressure derived from paragraph 2.2.1.2. and with initial brake temperature ≤ 100 °C make three brake applications from rotational speeds corresponding to vehicle linear speeds of:

75, 120 km/h and 160 km/h where V_{max} exceeds 150 km/h

2.2.1.3.2. Average the results for each group of three applications and plot speed against corresponding mean fully developed deceleration.

2.2.1.3.3. Mean fully developed decelerations recorded for the higher speeds shall lie within 15 per cent of that recorded for the lowest speed."

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B. JUSTIFICATION

According to the practice, there are two types of brake lining tests, which allow adequate comparison of parts intended for after-sale maintenance with those installed on a vehicle at the time of granting the type approval: road tests and inertia dynamometer tests.

The road tests require a vehicle, for which the replacement brake linings are intended. Meeting that requirement may be difficult with regard to availability of a vehicle of a particular type and expensive. Besides that, achievement of completely comparable results may not be possible since

the test conditions cannot be exactly identical (weather, road and vehicle conditions, driver's performance, etc.).

The inertia dynamometer tests allow to collect more and reliable data; they are simpler and cheaper, as only the brake mechanism of the vehicle to be equipped with the tested brake linings is required. The test results are more comparable, as they are carried out in stationary laboratory conditions and input parameters are not operator dependent.

At the present time, the official type approval of brake linings with respect to their mechanical properties is based on the requirements specified in Regulations Nos. 13 (Annex 15) and 90.

In Regulation No. 13, which is the basic document for vehicle braking performance evaluation, the test results of replacement brake linings achieved on the test vehicle and on the inertia dynamometer are considered equivalent.

Regulation No. 90 stipulates different status of inertia dynamometer tests depending on the category of a vehicle: for M_1 , M_2 and N_1 those are considered auxiliary (annex 3); for M_3 , N_2 and N_3 they are equivalent to the road tests (annex 4), although the brake linings for the M_3 , N_2 and N_3 category vehicles are not less loaded, and instability of those frictional characteristics cannot be compensated without increased braking force applied to the control pedal, once the braking force is restricted by the upper limit of the pressure in the air braking system, which such vehicles are normally equipped with.

Taking into account the above-mentioned, it is considered expedient to specify the similar approach to the tests on a vehicle and on a dynamometer bench, when the results achieved on both types of tests will be considered legally equivalent for the purpose of certification with respect to Regulation No. 90.
