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Progress on the development of new UN Global Technical Regulation (UN GTRs) and of amendments to established UN Global Technical Regulation (UN GTRs) - Gtr No. 3 (Motorcycle braking)

Authorization to develop amendments to gtr No. 3 (Motorcycle brake systems)

Submitted by the Government of Italy*

This document was prepared by the representative of Italy, as technical sponsor, requesting authorization for amending gtr No. 3. It is based on ECE/TRANS/WP.29/2013/128 considered at the 161st session of the World Forum (ECE/TRANS/WP.29/1106, para. 96). It is distributed to the World Forum and to the Executive Committee of the 1998 Agreement (AC.3) for consideration and to the Working Party on Brakes and Running Gear (GRRF) for its development. In accordance with the provisions of paras. 6.3.4.2, 6.3.7 and 6.4 of the 1998 Agreement, this document shall be appended to the amended gtr once adopted.

* In accordance with the programme of work of the Inland Transport Committee for 2012–2016 (ECE/TRANS/224, para. 94 and ECE/TRANS/2012/12, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Introduction

1. One of the main purposes of global technical regulation (gtr) No. 3 is to reduce the injuries and fatalities associated with motorcycle accidents by addressing the braking performance of motorcycles as a means of improving road safety.

2. Gtr No. 3 provides clear and objective test procedures and requirements that can be easily followed and also addresses the development of current Combined Braking Systems (CBS) and Anti-lock Braking System (ABS) technologies.

3. The objective of this proposal is to clarify the text of gtr No. 3 on motorcycle brake systems concerning the possible confusion in the interpretation of the terms "inoperative" and "disconnected".

4. The proposal also develops requirements for CBS to cover recent developments in structures of the braking systems.

5. The proposal introduces the text of the "K-method" into the gtr.

6. The proposal introduces the concept of a representative vehicle based on the provisions of Regulation No. 13-H.

II. Justification of the amendments

7. Concern had been raised on the interpretation of the terms "inoperative" and "disconnected". For the disconnected-method the brake-line pressure is the maximum braking pressure just before wheel-locking (higher than the ABS operating start pressure) where as for the inoperative-method the brake-line pressure is lower than the ABS operating start pressure, so the braking pressure during the K-measurement can be adjusted to a lower range than the ABS operating range. This amendment clarifies the situation by deleting both terms and using the term "inoperable". The dictionary definition for "inoperable" is "incapable of being implemented or operated; unworkable".

8. Clarification of cross-references to ensure that the correct test is used for the right category of vehicles.

9. Clarification is given on what should be considered as a representative vehicle.

10. The clarification of "fully cycling" ensures that the brake force modulates repeatedly or continuously during ABS braking. This allows for a wider range of modulations, not limited to the traditional ABS cycles. The term "cycle fully" has been replaced by "fully cycling" in the text for sake of consistency.

> "The force applied is that which is necessary to ensure that the ABS will be fully cycling throughout each stop, down to 10 km/h."

11. This amendment updates the use of International System (SI) units and change in decimal points.

12. During testing, the brake application rate specified in paragraph 4.9.5.1 can result in a large number of test failures. Allowing the reduction tends to make the regulation more stringent by including a greater number of brake force application rates and eliminates restrictive test requirements.

13. The amendment to paragraph 3.1.4 clarifies the cross-reference and refers to the category of vehicles to prevent any misunderstanding that may have been created by the current cross-reference as to which category of vehicles were subject to the parking brake

test; the current cross-reference to the slope in paragraph 4.8.2 could be misunderstood as the parking brake test is also relevant to categories 3-1 and 3-3.

14. The K-method (alternative method for determining the peak brake coefficient (PBC)) text has been introduced as paragraph 5 rather than being referenced to allow for clarity and ease of reference especially if the K-method is updated.

15. The use of a representative vehicle with the specified tyres is being proposed when the vehicle being used for type approval makes it difficult to undertake the PBC test due to possible rear-wheel lift during maximum braking or not getting into the wheel lock, because of brake performance (brake lever stroke reaches full stroke before wheel locking).

16. The K-method PBC test is not for vehicles but for the test surface whereas the same specification tyre should always be used according to the American Society for Testing and Materials (ASTM) method. So from the point of view of test surface control, using same vehicle which means the same specification tyre for PBC test is more appropriate.

17. Tests undertaken during the initial gtr development have shown a correlation between K-method and ASTM method which supports the use of an alternative vehicle with the specified tyres.

18. The current provision in gtr No. 3 (paragraph 3.1.9), requiring that "two separate brake systems may only share a common brake if a failure in one system does not affect the performance of the other" limits the application of CBS.

19. Not all CBS architectures can meet this requirement although they will outperform conventional brake systems.

20. However, not all CBS architectures were considered at the time when the original CBS requirements were drafted (in the 1980s) and, therefore, it is understood that the Working Party on Brakes and Running Gear (GRRF) did not intentionally exclude such systems by introducing this requirement.

21. In order to ensure that, in case of a failure of one system, the performance of the other system still equals that of a conventional system, it is proposed to allow that two separate brake systems share a brake and/or a transmission, provided that the other system meets the single brake system performance requirements in case of a failure of such shared components(s). To that end, a failure test is proposed for CBS brake systems of architecture B. The International Motorcycle Manufacturers Association (IMMA) is of the opinion that such a failure test requirement should ensure the acceptance of a CBS in terms of demonstrated robustness and guaranteed minimum braking performance.

22. This proposal will further contribute to the expansion of CBS, allowing even inexperienced riders to brake safer and achieve higher decelerations than with conventional brake systems, while ensuring that, in the case of a failure in one of the systems, at least the front or the rear brake can be actuated with a performance not less than that of a conventional system.

III. Proposed amendments

In the text of the regulation (part B)

Contents page:

Add at the end of the current contents list, the following references to paragraph 5, to read:

"**5. Alternative Method for the determination of Peak Braking Coefficient**"

Paragraph 3.1.4., amend to read:

"3.1.4. Parking brake system:

If a parking brake system is fitted, it shall hold the vehicle stationary on the slope prescribed in paragraph ~~4.8.2~~ **4.1.1.4**.

For 3-2, 3-4 and 3-5, the parking brake system shall be tested in accordance with paragraph 4.8.

The parking brake system shall:

(a) Have a control which is separate from the service brake system controls; and

(b) Be held in the locked position by solely mechanical means.

Vehicles shall have configurations that enable a rider to be able to actuate the parking brake system while seated in the normal driving position."

Paragraph 3.1.9., amend to read:

"3.1.9. In cases where two separate service brake systems are installed, the systems may share a common brake~~, if a failure in one system does not affect the performance of the other~~ **and a common transmission**, **if the requirements of paragraph 4.12. are met.**"

Paragraphs 4.1.1.3. and 4.1.1.4., amend to read:

"4.1.1.3 Measurement of PBC

The PBC is measured ~~as specified in national or regional legislation determined by the approval authority~~ using either:

(a) The American Society for Testing and Materials (ASTM) E1136 standard reference test tyre, in accordance with ASTM Method E1337-90, at a speed of 40 mph without water delivery; or

(b) The method specified in ~~the appendix to Annex 4~~ **paragraph 5.** ~~of UNECE Regulation No. 78, 01 series of amendments~~

***Note*: An alternative vehicle may be acceptable for PBC measurement by method (b) if that vehicle has shown the same nominal PBC on both high μ and low μ as previously determined by method (a)**.

PBC measurement of the surface shall be carried out at least once a year. PBC measurement shall be completed prior to testing if any major maintenance or alterations that may significantly modify the PBC have occurred since the last measurement.

4.1.1.4. Parking brake system tests:

The specified test slope ~~has~~ **shall have a test surface gradient of 18 per cent and shall have** a clean and dry surface that does not deform under the weight of the vehicle."

Paragraph 4.9.1., amend to read:

"4.9.1. General:

(a) The tests are only applicable to the ABS fitted on vehicle categories 3-1 and 3-3.

(b) The tests are to confirm the performance of brake systems equipped with ABS and their performance in the event of ABS electrical failure.

(c) "Fully cycling" means that the anti-lock system is repeatedly **or continuously** modulating the brake force to prevent the directly controlled wheels from locking."

Paragraph 4.9.3.1., amend to read:

"4.9.3.1. Test conditions and procedure:

…

(d) Brake actuation force:

The force applied is that which is necessary to ensure that the ABS will ~~cycle fully~~ **be fully cycling** throughout each stop, down to 10 km/h."

Paragraph 4.9.5.1., amend to read:

"4.9.5.1. Test conditions and procedure:

…

(e) Brake actuation force:

The force applied is that which is necessary to ensure that the ABS will ~~cycle fully~~ **be fully cycling** throughout each stop, down to 10 km/h.

(f) Brake application rate:

The brake control actuation force is applied in **0.1** – 0.5 seconds."

Paragraph 4.9.6.1., amend to read:

"4.9.6.1. Test conditions and procedure:

…

(e) Brake actuation force:

The force applied is that which is necessary to ensure that the ABS will ~~cycle fully~~ **be fully cycling** throughout each stop, down to 10 km/h."

Paragraph 4.9.7.1., amend to read:

"4.9.7.1. Test conditions and procedure:

…

(e) Brake actuation force:

The force applied is that which is necessary to ensure that the ABS will ~~cycle fully~~ **be fully cycling** throughout each stop, down to 10 km/h."

Insert a new paragraph 4.12., to read:

"**4.12. CBS failure test**

4.12.1. General information:

(a) This test will only apply to vehicles fitted with CBS of which the separate service brake systems share components;

(b) The test is to confirm the performance of the service brake systems in the event of failure of one of the common components. Certain parts, such as the brake itself, the brake cylinders and their pistons (except the seals) the push rods, the cam assemblies and the master cylinders (except the seals), shall not be regarded as liable to breakage if they are amply dimensioned, are readily accessible for maintenance, and exhibit sufficient safety features and therefore shall be exempted from a failure test.

4.12.2. Test conditions and procedure:

(a) In case a vehicle is fitted with CBS of which the separate service brake systems share components, carry out the test set out in paragraph 3. of this annex, (dry stop test – single brake control actuated) with a simulated failure of the common component.

(b) Laden.

4.12.3. Performance requirements

When the brakes are tested in accordance with the test procedure set out in paragraph 12.2., the stopping distance shall be as specified in column 2 or the MFDD shall be as specified in column 3 of the following table:

Column 1	*Column 2*	*Column 3*
Vehicle Category	*STOPPING DISTANCE (S) (Where V is the specified test speed in km/h and S is the required stopping distance in metres)*	*MFDD*
Front wheel(s) braking only		
3-1	$S \leq 0.1\,V + 0.0111\,V^2$	$\geq$ **3.4 m/s²**
3-2	$S \leq 0.1\,V + 0.0143\,V^2$	$\geq$ **2.7 m/s²**
3-3	$S \leq 0.1\,V + 0.0087\,V^2$	$\geq$ **4.4 m/s²**
3-4	$S \leq 0.1\,V + 0.0105\,V^2$	$\geq$ **3.6 m/s²**
3-5	$S \leq 0.1\,V + 0.0117\,V^2$	$\geq$ **3.3 m/s²**
Rear wheel(s) braking only		
3-1	$S \leq 0.1\,V + 0.0143\,V^2$	$\geq$ **2.7 m/s²**
3-2	$S \leq 0.1\,V + 0.0143\,V^2$	$\geq$ **2.7 m/s²**
3-3	$S \leq 0.1\,V + 0.0133\,V^2$	$\geq$ **2.9 m/s²**
3-4	$S \leq 0.1\,V + 0.0105\,V^2$	$\geq$ **3.6 m/s²**
3-5	$S \leq 0.1\,V + 0.0117\,V^2$	$\geq$ **3.3 m/s²**

"

Insert new paragraphs 5. to 5.3., to read:

"**5. Alternative Method for the determination of Peak Braking Coefficient**

5.1. General

(a) The test is to establish a Peak Braking Coefficient (PBC) for the vehicle when being braked on the test surfaces described in paragraphs 4.1.1.1. and 4.1.1.2.

(b) The test comprises a number of stops with varying brake control forces. Both wheels shall be braked simultaneously up to the point reached before wheel lock, in order to achieve the maximum vehicle deceleration rate on the given test surface.

(c) The maximum vehicle deceleration rate is the highest value recorded during all the test stops.

(d) PBC is calculated from the test stop that generates the maximum vehicle deceleration rate, as follows:

$$PBC = \frac{0.566}{t}$$

where:

t = time taken for the vehicle speed to reduce from 40 km/h to 20 km/h in seconds.

Note: **For vehicles unable to achieve a test speed of 50 km/h, PBC shall be measured as follows:**

$$PBC = \frac{0.566}{t}$$

where:

t = time taken, in seconds, for the speed of the vehicle to reduce from 0.8 Vmax to (0.8 Vmax - 20), where Vmax is measured in km/h.

(e) The value of PBC shall be rounded to two decimal places.

5.2. Vehicle condition

(a) The test is applicable to vehicle categories 3-1 and 3-3.

(b) The anti-lock system shall be inoperable between 40 km/h and 20 km/h.

(c) Lightly loaded.

(d) Engine disconnected.

5.3. Test conditions and procedure

(a) Initial brake temperature: ≥ 55 °C and ≤ 100 °C.

(b) Test speed: 60 km/h or 0.9 V_{max}, whichever is lower.

(c) Brake application:

Simultaneous actuation of both service brake system controls, if so equipped, or of the single service brake system control in the case of a service brake system that operates on all wheels.

For vehicles equipped with a single service brake system control, it may be necessary to modify the brake system if one of the wheels is not approaching maximum deceleration.

(d) Brake actuation force:

The control force that achieves the maximum vehicle deceleration rate as defined in paragraph 6.1.(c).

The application of the control force shall be constant during braking.

(e) Number of stops: until the vehicle meets its maximum deceleration rate.

(f) For each stop, accelerate the vehicle to the test speed and then actuate the brake control(s) under the conditions specified in this paragraph."