Transmitted by the expert from Italy

Informal document **GRRF-76-44**
(76th GRRF, 17 – 21 February 2014,
agenda item 5(a))

Proposal for amendments to Global Technical Regulation No. 3 (Motorcycle brake systems)

Submitted by the expert from Italy

The text reproduced below was prepared by the experts from the International Motorcycles Manufacturers Association (IMMA) to introduce amendments clarifying the current text on the use of Combined Braking Systems (CBS) and some general text of the GTR. This document contains ECE/TRANS/WP.29/GRRF/2014/3, ECE/TRANS/WP.29/GRRF/2014/4, GRRF-76-35-Rev 1 and updated by the comments raised at the seventy-sixth GRRF session.

The modifications to the current text of the Regulation are marked in bold for new or strikethrough for deleted characters.

Statement of Technical Rationale and justification

I. Objective

1. The objective of this proposal is to recommend the adoption of an amendment to the current Global Technical Regulation (GTR) on motorcycle brake systems. At the June 2013 session of the Executive Committee (AC.3), Contracting Parties to the 1998 Global Agreement, under the World Forum for Harmonization of Vehicle Regulations (WP.29), gave their consent to amend UN GTR No. 3.

II. Introduction

2. One of the main purposes of UN 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.

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

4. The objective of this proposal is to clarify the current text of UN GTR No. 3 on motorcycle brake systems on concerns raised about the possible confusion of the GTR text caused by the interpretation of the terms "inoperative" and "disconnected".

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

6. The current provision in UN 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.

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

8. Not all CBS architectures were however existing at the time the original CBS requirements were drafted (in the 1980s) and it is therefore understood that GRRF did not consider such systems when introducing this requirement.

9. In order to ensure that, in case of a failure in 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. Italy is of the opinion that such a failure test requirement should ensure the acceptance of such a CBS in terms of demonstrated robustness and guaranteed minimum braking performance.

III. Justification of changes

10. The terms "inoperative" and "disconnected": for the disconnected-method the brake-line pressure is the maximum braking pressure just before wheel-locking (higher pressure than ABS operating start) where as for the inoperative-method the brake-line pressure is lower than ABS operating start, so braking pressure during K-measurement can be adjusted only lower range than ABS operating.

11. This amendment clarifies the term "inoperative" by clearly stating that it refers to when the ABS function is disabled.

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

13. The clarification of "Fully cycling" ensures that 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 ~~cycle fully~~ **be fully cycling** throughout each stop, down to 10 km/h."

14. This amendment updates the use of SI units and change in decimal points.

15. It has been noticed during testing that 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.

16. 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 4.8.2., could be misunderstood as the parking brake test also being relevant to categories 3-1 and 3-3.

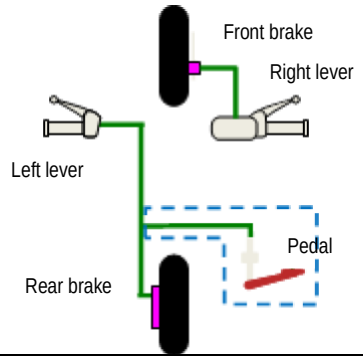
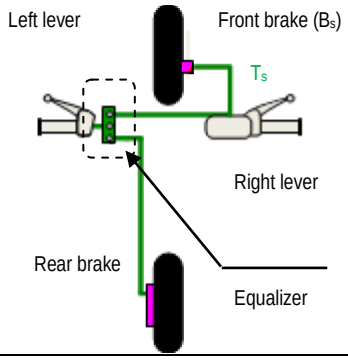
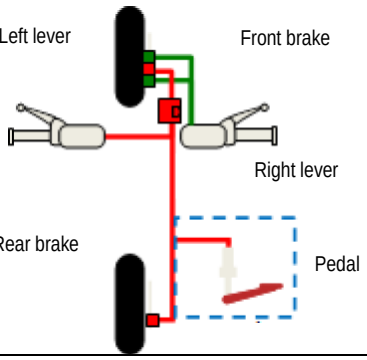
17. The K-method (alternative method for determining the PBC (peak brake coefficient)) text has been introduced as paragraph 5 rather than being referenced to allow for clarity and ease of reference especially if the K-method was updated.

18. The current provision in UN GTR No. 3 (para. 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 Combined Brake Systems (CBS).

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

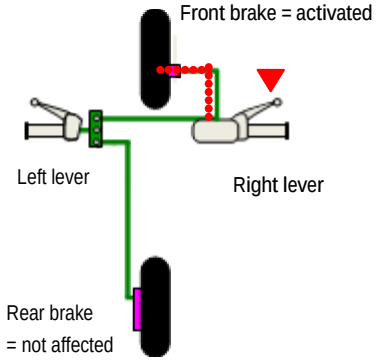
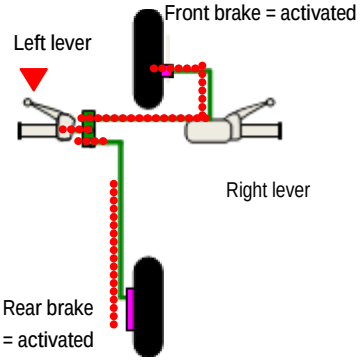
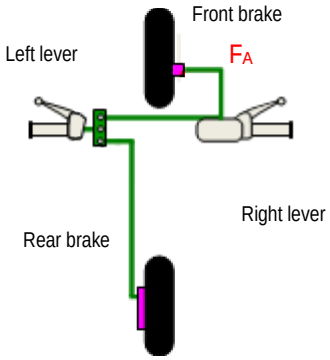
20. Not all CBS architectures were however existing at the time the original CBS requirements were drafted (in the 1980s) and it is therefore understood that GRRF did not consider such systems when introducing this requirement.

21. Architecture B is an example of a CBS that shares a transmission (T_s) and a brake (B_s).

Conventional Brake System	*Combined Brake System (CBS)*	
Architecture A	***Architecture B***	***Architecture C***
		
▪ Left lever (pedal) operates rear brake only ▪ Right lever operates front brake only	▪ Left lever operates CBS ▪ Right lever operates front brake only	▪ Left lever (pedal) operates CBS ▪ Right lever operates front brake only

CBS Architecture B

22. While a failure in e.g. the "front system" (F_A) may affect the performance of the CBS, the rear system (operated by the left lever) will continue to be operational.

Normal operating conditions		*Fail conditions*
Right lever operation	***Left lever operation (CBS)***	***Failure A (FA)***
		
	Front brake	Defect
	Rear brake	Operational by left lever

23. In order to ensure that, in case of a failure in 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. Italy is of the opinion that such a failure test requirement should ensure the acceptance of such a CBS in terms of demonstrated robustness and guaranteed minimum braking performance.

Other CBS architectures such as Architecture C

24. A failure test is not necessary for this type of CBS architecture because there are no shared components with the exception of a brake cylinder which is one of the components that are regarded to not be liable to breakage.

IV. Justifications for the proposed amendments

A. Justification 1

Paragraph 3.1.4. Parking brake system:

Paragraph 4.1.1.4. Parking brake system tests:

(a) Currently in paragraph 3.1.4 Parking brake system following is described.

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

And in "paragraph 4.8 in Annex 3"

"4.8. Parking brake system test – for vehicles equipped with parking brake

4.8.1. Vehicle condition:

(a) The test is applicable to vehicle categories 3-2. 3-4 and 3-5;

(b) Laden;

(c) Engine disconnected.

4.8.2. Test conditions and procedure:

(a) ----------

(b) ----------"

As "in paragraph 4.8.2" is referred to paragraph 3.1.4., there is a concern that users may miss the intervening requirements if they move from paragraph 3.1.4. to paragraph 4.8.2.

In this case the objective category described in paragraph 4.8.1. for parking brake test can be ignored, and it can be possible to misunderstand that categories 3-1 and 3-3 are also subject to parking brake test.

This proposal prevents this misunderstanding.

In paragraph 5.2.6., the Parking brake system test in the section "Statement of technical rationale and justification" of UN GTR No. 3, is described as follows.

"5.2.6. Parking brake system test

The purpose of the parking brake system requirement in the motorcycle brake systems gtr is to ensure that 3-wheeled motorcycles can remain stationary without rolling away when parked on an incline."

(b) The slope prescription in paragraph 4.1.1.4. is not enough for gradient.

B. Justification 2

Paragraph 4.1.1.3. Measurement of Peak Braking Coefficient (PBC)

(a) Currently in 1.1.General in paragraph 4.1.1.3. the following is described.

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

The terms "for the vehicle type" infers that the vehicle used for PBC test should only be the vehicle used for type approval. The PBC test in this instance is not for the vehicle but for the test surface. Method (a) (ASTM method) specifies that the same specification tire should always be used but from the point of view for control of test surface, using same vehicle, which means the same specification tire, means the PBC test is more appropriate.

(b) In some instances just before the wheel-locking condition for all-wheels during the PBC test, the following may happen to the vehicle for type approval:

"(a) rear wheel lift due to maximum braking may cause difficulties in undertaking the PBC test.

(b) vehicle not getting into the wheel lock, because of reduction in brake performance (brake lever stroke reaches full stroke before wheel locking).

(c) For 3-wheeled motorcycles (3-2, 3-4, 3-5), the PBC test is not described and it may understood that the PBC test is not possible for these vehicle types for type approvals."

The K-method in Regulation No. 78 (02 series of amendments) was designed around the ABS test. Specifically, for those motorcycles equipped with ABS, the motorcycle had to brake with more than 70 per cent efficiency with the ABS fully cycling, relative to the maximum adhesion obtained with that same motorcycle tested without ABS (i.e. by way of the K-method). This was only applicable to vehicles of categories L1 and L3 equipped with ABS. Finally, for all other brake performance evaluations, the Regulation No. 78 (02 series of amendments) specification was for a test surface "affording good adhesion"

C. Justification 3

Paragraph 4.9. ABS tests

(a) The clarification of the term "Fully cycling" ensures that brake force modulates repeatedly or continuously during ABS braking. This allows for a wider range of modulations, which are not limited to the traditional ABS cycles.

(b) For consistency the term "cycle fully" has been replaced by "fully cycling" which is defined in paragraph 4.9.1. The clarification allows a wider range of modulations and is not limited to the traditional ABS cycles.

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

D. Justification 4

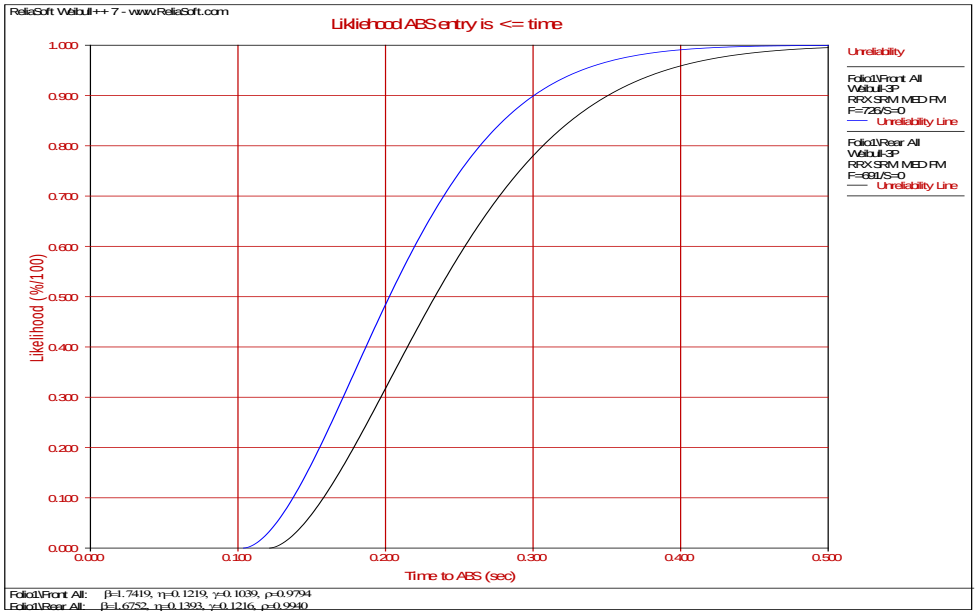
Paragraph 4.9. ABS tests

"4.9.5. …

(f) Brake application rate:

The brake control actuation force is applied in ~~0.2~~ **0.1** – 0.5 seconds."

It has been noticed in testing that the brake application rate specified in paragraph 4.9.5.1 can result in a large number of test failures. If can be seen in the chart below that the 0.2 second lower limit shows a failure rate is between 30 per cent and 50 per cent of the time.



By reducing the lower limit to 0.1 seconds the test failure rate reduces to practically zero. 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.

Proposed amendments

In the text of the regulation (part B)

Contents page, add to the end of the current contents list:

"**5. ALTERNATIVE METHOD FOR THE DETERMINATION OF PEAK BRAKING COEFFICIENT (PBC)**"

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**.

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.

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

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~~ **a common transmission, or both** 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 using either:

(a) ~~the American Society for Testing and Materials~~ **An ASTM International** (ASTM) E1136-93 (Re-approved 2003) standard reference test tyre, in accordance with ASTM Method E1337-90 (Re-approved ~~2002~~ **2008)**, at a speed of 40 mph; or

(b) the method specified in ~~Appendix 1 to Annex 3 of UNECE Regulation No. 78,{ Supplement 1 to the 03 Series of amendments].~~ **paragraph 5.**

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."

Paragraphs 4.4.2 (c), 4.5.2 (c), and 4.9.3.1 (c), amend to read:

"(c) Brake application:

Simultaneous actuation of both ~~service~~ brake ~~system~~ controls~~, if so equipped,~~ **in the case of a vehicle with two service brake systems** or **actuation** of the single ~~service~~ brake ~~system~~ control in the case of a **vehicle with one** service brake system ~~that operates on all wheels~~."

Paragraph 4.9.1., amend to read:

"4.9.1. General:

…

(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 ~~0.2~~ **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 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 a common hydraulic or common mechanical transmission;

(b) The test is to confirm the performance of the service brake systems in the event of a transmission failure. This can be demonstrated by a common hydraulic hose or mechanical cable failure.

4.12.2. Test conditions and procedure:

(a) Alter the brake system to produce a failure causing a complete loss of braking in the portion of the system which is shared.

(b) Perform the dry stop test specified in section 4.3. in the laden condition. Other conditions to be observed are 4.3.1. (c) and 4.3.2. (a), (b), (d), (e) and (f). Instead of the provisions in section 4.3.2. (c), only apply the control for the brake not affected by the simulated failure."

4.12.3. Performance requirements

When the brakes are tested in accordance with the test procedure set out in paragraph 4.12.2., 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	**$S \leq 0.1\,V + 0.0111\,V^2$**	**≥ 3.4 m/s^2**
3-2	**$S \leq 0.1\,V + 0.0143\,V^2$**	**≥ 2.7 m/s^2**
3-3	**$S \leq 0.1\,V + 0.0087\,V^2$**	**≥ 4.4 m/s^2**
3-4	**$S \leq 0.1\,V + 0.0105\,V^2$**	**≥ 3.6 m/s^2**
3-5	**$S \leq 0.1\,V + 0.0117\,V^2$**	**≥ 3.3 m/s^2**
Rear wheel(s) braking only		
3-1	**$S \leq 0.1\,V + 0.0143\,V^2$**	**≥ 2.7 m/s^2**
3-2	**$S \leq 0.1\,V + 0.0143\,V^2$**	**≥ 2.7 m/s^2**
3-3	**$S \leq 0.1\,V + 0.0133\,V^2$**	**≥ 2.9 m/s^2**
3-4	**$S \leq 0.1\,V + 0.0105\,V^2$**	**≥ 3.6 m/s^2**
3-5	**$S \leq 0.1\,V + 0.0117\,V^2$**	**≥ 3.3 m/s^2**

Insert new Paragraph 5., to read:

"**5. ALTERNATIVE METHOD FOR THE DETERMINATION OF PEAK BRAKING COEFFICIENT (PBC)**

5.1. General

(a) The test is to establish a 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) The Peak Braking Coefficient (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 V_{max} to (0.8 V_{max} - 20), where V_{max} 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, if fitted, shall be either disconnected or inoperative (ABS function disabled), 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 6.5.1. (c).

The application of the control force must 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."