

## A. STATEMENT OF TECHNICAL RATIONALE AND JUSTIFICATION

### 1. INTRODUCTION

Motorcycle brake regulations have not kept pace with the advancement of modern technologies. With the improvement of disc brake systems and the recent introduction of new technologies such as anti-lock brake systems (ABS) and combined brake systems (CBS), modern motorcycles can be equipped with very sophisticated and effective braking systems. In addition, the motorcycle manufacturing and testing certification industry has become a global industry, serving a global market.

Together, the Contracting Parties to the 1998 Agreement and the motorcycle industry, have determined that work should be undertaken to address the braking performance of motorcycles as a means of improving road safety in their countries. The development of a global technical regulations (gtr) on motorcycle brake systems is intended to reduce the injuries and fatalities associated with motorcycle accidents. The Working Party on Brakes and Running Gear (GRRF) believes that it is time to update current national standards by implementing a harmonized regulation, based on the best practices within existing Contracting Party<sup>1</sup> national regulations, while taking into account modern brake system technologies.

### 2. BACKGROUND

During the one-hundred-and-twenty-sixth session of the World Forum for Harmonization of Vehicle Regulations (WP.29) in March 2002, the Executive Committee AC.3 of the 1998 Global Agreement adopted the 1998 Global Agreement Programme of Work, which included the development of a gtr on motorcycle brake systems. Subsequently, Canada offered to sponsor the gtr on motorcycle braking requirements at the fifty-second session of GRRF, in September 2002. To proceed with the development of the gtr, AC.3 endorsed Canada's request to establish and chair an informal group on motorcycle brakes, at the one-hundred-and-thirtieth session of WP.29 in June 2003.

Following approval of WP.29, Canada initiated and chaired five meetings of the informal group. The meetings were open to all interested parties. Due to the time schedule and nature of the task, discussions on the content of the gtr and research necessary to develop the gtr began on 25 October 2002, prior to the establishment of the informal group. A total of seven meetings concerning the development of a gtr on motorcycle brake systems were held, including two before the informal group was established, as noted below:

- 25 October 2002, in Montreal, Canada
- 6 February 2003, in Geneva, Switzerland
- 16-17 July 2003, in Pisa, Italy. First official meeting by the informal group concerning the gtr on motorcycle brake systems
- 26-28 April 2004, in Brussels, Belgium. Second meeting by the informal group concerning the gtr on motorcycle brake systems
- 08-10 November 2004, in Montreal, Canada. Third meeting by the informal group

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<sup>1</sup> As defined in UN/ECE document ECE/TRANS/132 entitled "Agreement concerning the establishing of global technical regulations for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles".

- concerning the gtr on motorcycle brake systems
- 27-29 June 2005, in Munich, Germany. Fourth meeting by the informal group concerning the gtr on motorcycle brake systems
- 17-19 October 2005, in Brussels, Belgium. Fifth meeting by the informal group concerning the gtr on motorcycle brake systems

The attendees for the informal group included representatives of:

- Canada (Transport Canada)
- United States of America (National Highway Traffic Safety Administration)
- Italy
- United Kingdom
- Japan (JASIC (Japan Automobile Standards Internationalization Center))
- India (by correspondence)
- IMMA (International Motorcycle Manufacturers Association)
- FEMA (Federation of European Motorcyclists' Associations)
- AMA (American Motorcyclist Association)
- JAMA (Japan Automobile Manufacturers Association, Inc.)

Early work on a motorcycle brake system gtr was initiated by the International Motorcycle Manufacturer's Association (IMMA). They initiated a programme of work at the forty-sixth session of GRRF in September of 2002 with the intention of completing a proposal for a gtr for motorcycle brake systems. In an effort to select the most stringent performance requirements for a gtr, the IMMA conducted an analysis of the relative stringency of three national motorcycle brake system regulations in which the UNECE Regulation No. 78, the United States Federal Motor Vehicle Safety Standard FMVSS No. 122 and the Japanese Safety Standard JSS 12-61 were compared. The subsequent reports, along with proposed provisions of a gtr, were presented at the fifty-first GRRF as informal document No. 15, and at the fifty-third GRRF session as informal document No. 26.

The United States of America, in a joint project with Canada, conducted a similar study comparing the stringency of the same three national regulations. This report was made available at the fifty-fifth session of GRRF. Despite using different methodologies, the results were very similar to that of the IMMA work. The results of this report were also discussed at a second informal group meeting, held in Brussels. A preliminary consensus was reached among all participants, on an outline of the performance requirements of a gtr on motorcycle brake systems.

The United States and Canada conducted a further performance evaluation study, in which selected motorcycles equipped with anti-lock brake systems were compared to like models without ABS. This report was presented at the third informal group meeting in Montreal.

The studies completed by the United States and Canada and the IMMA, as well as work completed by the JASIC, provided the basis for the development of the technical requirements of the gtr.

The first formal proposal for a gtr concerning motorcycle brake systems was presented during the fifty-eighth GRRF session in September 2005, documents TRANS/WP.29/GRRF/18 and TRANS/WP.29/GRRF/18/Add.1. A more detailed report on the technical details, deliberations and conclusions, which led to the proposed gtr, was provided separately as informal report No. 16.

This final report and appended gtr technical requirements are in response to Article 6 of the 1998 Agreement concerning the Establishment of Global Technical Regulations for Wheeled Vehicles, Equipment and Parts Which Can be Fitted and/or Used on Wheeled Vehicles, known as the 1998 Global Agreement. This final report has been prepared after a thoughtful review by GRRF of the proposal submitted by Canada.

### 3. EXISTING REGULATIONS, DIRECTIVES, AND INTERNATIONAL VOLUNTARY STANDARDS

While there were no regulations contained in the Compendium of Candidates, the following regulations and standards were reviewed and used as the basis for the development of the gtr:

UNECE Regulation No. 78 - Uniform provisions concerning the approval of vehicles of category L vehicles with regard to braking.

U.S. Code of Federal Regulations (CFR) Title 49: Transportation; Part 571.122: Motorcycle brake systems.

Canada Motor Vehicle Safety Regulation No. 122 - Motorcycle brake systems.

European Union Directive 93/14/EEC, braking for category L vehicles (in effect, the same as UNECE Regulation No. 78).

Japan Safety Standard J12-61.

Australian Design Rule 33/00 - Brake systems for motorcycles and mopeds.

ISO 8710:1995, Motorcycles - Brakes and braking devices - tests and measurement methods.

ISO 12364:2001, Two-wheeled motorcycles - Antilock braking systems (ABS) - tests and measurement methods.

ISO 8709:1995, Mopeds - Brakes and braking devices - tests and measurement methods.

ISO 12366:2001, Two-wheeled mopeds - Antilock braking systems (ABS) - tests and measurement methods.

Most of these regulations and standards have been in existence for many years and the methods of measurement sometimes vary significantly. The technical experts were familiar with these requirements and held detailed discussions over them in their working sessions.

#### 4. DISCUSSION OF ISSUES ADDRESSED BY THE gtr

The gtr was developed so that it would be:

- applicable to all Category 3 vehicles (i.e. mopeds, motorcycles and three-wheelers);
- representative of world-wide on-road motorcycle operation;
- able to provide the highest possible level of efficiency in controlling motorcycle braking;
- representative of state-of-the-art testing and measurement technology, and;
- applicable in practice to existing and foreseeable future braking technologies.

The informal group reviewed each of the listed regulations and standards and compared the requirements in each during the development of the gtr. These regulations and standards, in conjunction with the research and analysis, were used to develop a draft table of regulatory requirements. This draft table of requirements was continually updated as the technical issues were raised, discussed and resolved. This table was presented and discussed at the fifty-seventh GRRF session in February 2005, and discussed further at the fifty-eighth GRRF session in September 2005 in conjunction with a first draft of the proposed gtr. The informal group used the feedback from the GRRF presentations to assist with the completion of the proposed gtr, a copy of which is included in Part B of this document.

Where national regulations or standards address the same subject, e.g. dry stop or heat fade performance requirements, the informal group reviewed comparative data on the relative stringency of the requirements from the research and studies and included the most severe options. In many cases, individual members of the informal group were tasked with completing additional testing to confirm or refine the testing and performance requirements. Qualitative issues, such as which wet brake test to include, were discussed on the basis of the original rationales and the appropriateness of the tests to modern conditions and technologies.

In each of these steps, specific technical issues were raised, discussed, and resolved. The technical rationale provided in the section below describes this information.

#### 5. TECHNICAL RATIONALE

##### 5.1 General

The proposed gtr on motorcycle brake systems consists of a compilation of the most stringent and relevant test procedures and performance requirements from current standards and regulations. The informal group reviewed existing standards and regulations on various levels, including estimating the relative stringency of the requirements, as well as considering the original rationales for the tests and their appropriateness to modern conditions and technologies.

As a result of the comparison process, the selected performance requirements of the gtr are mainly drawn from the UN/ECE Regulation No. 78 (ECE R78), the United States Federal Motor Vehicle Safety Standard FMVSS 122 (FMVSS 122) and the Japanese Safety Standard JSS 12-61 (JSS 12-61).

The selected format for the gtr text is based on the alternative formats section located in the UN/ECE document entitled *Format of Global Technical Regulations (gtr)*, TRANS/WP.29/883, and was chosen to facilitate quick reference and understanding of the requirements. While developing the gtr, the informal group endeavoured to clarify the selected test procedures and

performance requirements to ensure a better understanding of the referenced tests and to improve consistency in the way in which the respective tests are conducted.

The gtr is comprised of several fundamental tests, each with their respective test procedures and performance requirements. These tests are listed below, in no particular order, along with the national regulation on which they are based:

1. dry stop test with each brake control operated separately (ECE R78 / JSS 12-61)
2. dry stop test with all braking systems activated simultaneously (FMVSS 122)
3. high speed test (JSS 12-61)
4. wet brake test (ECE R78 / JSS 12-61)
5. heat fade test (ECE R78 / JSS 12-61)
6. parking brake test (ECE R78 / JSS 12-61)
7. ABS tests (ECE R78 / JSS 12-61)
8. partial failure test – split service brake systems (FMVSS 122)
9. servo failure test.

Certain general requirements were omitted from the gtr, such as the ECE R78 requirement that brake friction material shall not contain asbestos. In this instance, the national regulation does not include a referenced standardized test method with which to make that determination, and none was proposed for that purpose. Also, depending on the Contracting Parties, the handling of asbestos and other substances known as “hazardous materials” may be addressed by other sections of government that deal with public health or environmental issues. In light of the above, it was decided to omit restrictions on the content of the brake friction material, and leave this issue for resolution at the national level.

#### 5.1.1 gtr Test Parameters

To maintain the integrity of a referenced test, the parameters for each test are almost entirely as specified in the respective national regulation on which the test was based. Although the national regulations share many similarities, the terminology and their respective meanings sometimes varied.

In order to streamline the text of the gtr, common terminology and definitions were based on the UN/ECE document entitled “*Special Resolution No. 1 concerning the common definitions of vehicle categories, masses and dimensions (S.R.1)*”, TRANS/WP.29/2005/21, developed for the purposes of the gtrs. Alternate sources were referenced for more specific terms unique to this gtr, including from existing national standards and from publications by organizations recognized within the industry, such as the International Organization for Standardization (ISO) and the Society of Automotive Engineers (SAE).

Definitions were revised or updated when necessary, such as the terms used to describe antilock brake system (ABS), vehicle maximum speed (Vmax) and peak friction coefficient (PFC). New terminology was also introduced to bridge common definitions. For example, the terminology “lightly-loaded vehicle weight” (FMVSS 135), “unladen vehicle” (ECE R78) and “unloaded” (JSS 12-61) essentially share the same meaning, for defining the motorcycle test mass. In an effort to streamline the gtr, the Contracting Parties agreed to use the term “lightly-loaded”, as this does not conflict with existing definitions in S.R.1, nor with the definitions in other publications.

### 5.1.2 Measurement of Deceleration and Stopping Distance

The ECE R78 and JSS 12-61 test methods allow brake performance to be measured through the use of either deceleration or stopping distance, whereas FMVSS 122 evaluates performance through stopping distance only.

ECE R78 and JSS 12-61 measure deceleration slightly differently. ECE R78 utilizes the mean fully developed deceleration (MFDD), which is the vehicle deceleration calculated between 10 and 80 percent of the vehicle initial speed. JSS 12-61 uses the vehicle mean saturated deceleration (MSD), which can be obtained in several ways depending on the instrumentation employed. Both methods measure a steady state deceleration rate, by excluding the transient period during the initial stage of the brake application and the very end of the braking manoeuvre. Nevertheless, the different methods can provide different results. In order to maintain consistency in the results, the MFDD was adopted to measure braking deceleration performance.

The FMVSS 122 stopping distance requirement is based on an average deceleration rate for the entire stopping manoeuvre, from the moment a force is applied to the brake control to the moment the vehicle comes to a complete stop. The ECE R78 and JSS 12-61 stopping distance requirements are based on the MFDD (or MSD) and also include a factor for the brake system reaction time.

To maintain the integrity of the referenced test, the performance requirements are almost entirely as specified in the respective national regulation on which the test was based.

### 5.1.3 Vehicle Test Speed and Corrected Stopping Distance

Deceleration or stopping distance performance requirements are set for a specified initial test speed. While professional test riders can approach this initial test speed, it is unlikely that the test will be started at the exact speed specified, affecting the stopping distance measurement.

A method for correcting the measured stopping distance is specified in JSS 12-61, to compensate for the difference between the specified test speed and the actual speed where the brakes were applied. Although not specified in their regulations, the National Highway Traffic Safety Administration (NHTSA) and Transport Canada also apply a correction factor to test data, using the method specified in SAE J299 – *Stopping Distance Test Procedure*. The above noted stopping distance correction methods, and the one specified in ISO 8710:1995, *Motorcycles – Brakes and braking devices - tests and measurement methods*, were evaluated.

SAE J299 offers the most basic method for estimating the corrected distance, and as a result the method is applicable to a speed tolerance of  $\pm 3.2$  km/h ( $\pm 2$  mph). The ISO 8710 and JSS 12-61 methods are based on the same principles, but also take into consideration the brake system reaction time. These methods are applicable to a wider speed tolerance of  $\pm 5$  km/h. However, a small error in handling the system reaction time is apparent in the ISO 8710 equation, which results in higher than expected corrected values.

Based on this analysis, the informal group agreed that the stopping distance correction method specified in JSS 12-61 is the most appropriate for the gtr. Therefore, as with the existing

Japanese standard, the specified test speed will include a general tolerance of  $\pm 5$  km/h, and the JSS stopping distance correction method can be used to normalize the measured test results.

#### 5.1.4 Test Surface – Peak Friction Coefficient

Peak Friction Coefficient (PFC) is a measure of the coefficient of friction of the test surface and is an important parameter for assessing the brake performance of a vehicle. FMVSS 122 currently requires that the road tests be conducted on an 8-foot-wide level roadway with a skid number of 81. The road test surface conditions specified do not apply to the burnish procedure. For parking brake system tests, the test surface must be clean, dry, smooth Portland concrete cement. With the exception of the surface friction requirements for the ABS tests, the ECE R78 and JSS 12-61 do not specify the coefficient of friction for the test surface but describe that the test surface must be level, dry, and affording good adhesion. The test lane width is also specified, as 2.5 m (8 feet).

For the non-ABS tests, ECE R78 and JSS 12-61 rely on a subjective description of the test surface coefficient of friction. Under the self-certification system currently used by Contracting Parties such as the United States and Canada, the test surface is defined, objectively, to reduce variability of the results when testing motorcycle brake systems for compliance to their national standard. Given that the test surface coefficient of friction affects the attainable braking performance limit of a vehicle, specifying a value for the coefficient in the gtr will prevent unreasonable variability in the test results, thus provide a better and more repeatable measure of the motorcycle's actual braking ability.

The Contracting Parties agreed to define the test surface using a PFC instead of a skid number as currently specified in FMVSS 122. The PFC is a measure of tire-to-road surface friction based on the maximum deceleration of a rolling tire, whereas skid number is a measure of the tire-to-road surface friction based on a skidding tire. Therefore, a PFC is a more relevant surface friction measurement for non-locked-wheel tests, as those included in this gtr. The Contracting Parties agreed that a nominal PFC of 0.9 is an appropriate and objective value for the dry test surface used for the motorcycle brake system tests.

The United States Federal motor vehicle safety standards that currently use a PFC specify that the road test surface must have a PFC of 0.9 when measured using the American Society for Testing and Materials (ASTM) E1136 standard reference test tire, in accordance with ASTM Method E1337-90, at a speed of 40 mph without water delivery. However, since the ASTM test method is not widely used outside of North America and there is no common test method used in Europe or Japan, the Contracting Parties agreed to specify the PFC for the test surface, but to leave it to the national regulation to determine the test method that should be used to measure the PFC.

#### 5.1.5 Test Sequence

There is no specified test order in the ECE R78. Similarly, JSS 12-61 indicates that tests can be done in any order, with the exception that the fade test be conducted last. FMVSS 122 requires that all tests be conducted in a specific sequence, ending with the wet brake test. The purpose here is to minimize the variability of test results through consistency in both the condition of the brakes throughout the tests and in the way in which the brakes are evaluated.

The need for a testing sequence and whether this may have any effect on braking performance was discussed. In order to eliminate this possibility, the informal group agreed to adopt a

specific sequence in which the tests are conducted. The proposed sequence was selected based on increasing severity of the test on the motorcycle and its brake components, in order to preserve the condition of the brakes.

There was general agreement among the Contracting Parties that the fade test would have the greatest effect on the condition of the motorcycle brakes, which could affect brake performance in subsequent tests. For this reason, FMVSS 122 requires that a re-burnishing be conducted after the fade test, to refresh the brake components. In order to eliminate the need for re-burnishing, the informal group agreed that the fade test be the last of the motorcycle brake system performance tests, consistent with the existing practice in JSS 12-61.

The ABS test would be the next most severe test, which will result in braking at or near the limits of friction and the possibility of locked wheel braking and flat spotting the motorcycle tires. Thus for motorcycles so equipped, the ABS test would precede the fade test. The remaining tests are not as severe on the braking system, and were selected based on increasing test speed for the dry stop performance tests, followed by the wet brake performance test.

The proposed test sequence is as follows:

1. Dry stop test - single brake control activated;
2. Dry stop test - all service brake controls activated;
3. High speed test;
4. Wet brake test;
5. If fitted:
  - a. Parking brake test;
  - b. ABS test;
  - c. Partial failure, for split service brake systems test;
  - d. Servo failure test.
6. Heat fade test.

Proposed alternatives to the testing sequence were assessed, including selecting a test sequence based on the loading of the motorcycle in order to save time, and relocating the wet brake test to second-last, before the final fade test. Either option would place the more severe brake tests earlier in the test sequence, which could affect braking performance in subsequent tests. It was therefore agreed to keep the test sequence as noted above.

#### 5.1.6 Brake Controls - Force Application Location

Controls for the application of the brakes can include hand and foot operated control levers.

The national standards and regulations have slightly different brake control input force limits, and in the case of a hand operated control lever, there is also a discrepancy as to the location of application of the input force. One consistent element is the location and direction of application of the input force to the foot operated lever (i.e. pedal). The respective input forces are noted in the following table:



## Brake Actuation Forces

Regulation	Foot Control, $F_P$ (N)	Hand Control, $F_L$ (N)
FMVSS 122	$25 < F_P < 400$	$10 < F_L < 245$
ECE R78 / JSS 12-61	$F_P < 350$	$F_L < 200$

In the gtr, the specified input force remains as per the respective national regulation on which the individual test is based. In an effort to minimize confusion, the respective figures are listed for each test within the gtr.

With respect to the location of the input force on the hand-controlled lever, ECE R78 and JSS 12-61 place the input force 50 mm from the end of the lever, while FMVSS 122 locates the input force 30 mm from the of end of the handle bar grip. On most models (but not all), the control lever typically extends slightly beyond the handle bar grip, such that the control forces are almost at the same location regardless of the method followed. Depending on the regulation, however, it is not entirely clear whether this measurement should be taken along the length of the control lever or parallel to the handle bar grip; or, how to measure with a curved or angled control lever. Some interpretation is required.

The informal group agreed that none of the three national regulations is clear enough with respect to measuring the location of the input force on the hand-controlled lever. In an effort to define a common practice, a revised description for the location of the input force on the control lever and its direction of application was included in the gtr, based on ISO 8710.

### 5.1.7 Brake Temperature Measurement

Test procedures typically require the measurement of the initial brake temperature. FMVSS 122 includes a specification for plug type thermocouples, including detailed schematics addressing their installation on disc or drum type brakes. Although ECE R78 and JSS 12-61 also require brake temperature measurement, neither makes reference to specific measurement equipment or installation methods. In informal meetings, the International Motorcycle Manufacturers Association (IMMA) and the Japan Automobile Standards Internationalization Center (JASIC) requested that rubbing thermocouples should also be considered.

The plug type thermocouples required by the NHTSA and Transport Canada are imbedded in the brake friction material, 0.04 inches (1 mm) below the contact surface, between the friction material and the disc or drum. Issues raised with this method include the effects of different friction material composition (i.e. different heat transfer rates) on temperature readings and the thermocouple installation that requires a modification of the actual brake component.

Rubbing thermocouples, also referenced as contact thermocouples, are in direct contact with the disc or drum surface, and thus do not require the dismantling or modifying of any of the brake system components. The thermocouple is spring loaded to maintain good contact with the surface whose temperature is being measured. Although this type of thermocouple can provide a quicker response to temperature change, there are limitations. Being spring loaded, the thermocouple has self-heating characteristics while rubbing against the measured surface, up to 15°C at 50 km/h per the ISO publicly available specification, ISO/PAS 12158:2002 *Road vehicles – Braking systems – Temperature measuring methods*. Also, such thermocouples cannot be used or cannot be properly located on certain discs with ventilation characteristics (whether groves or cross-drilled holes).

After several discussions, including one with type approval experts from the technical service company TUV SUD Group, the informal group agreed to list both methods for measuring brake temperature. However, because of their unique characteristics, the informal group agreed that these methods would be listed in the gtr with the qualification that Contracting Parties may specify which temperature measurement method would be accepted.

With respect to the actual brake temperature values required for testing purposes, each of the national regulations on which the gtr performance requirements are based specifies a value for the initial brake temperature (IBT), prior to conducting a test. For most tests, the ECE R78 and JSS 12-61 specify that the IBT must be less than or equal to 100°C (212°F), whereas FMVSS 122 specifies an IBT between 55°C and 65°C (130°F and 150°F).

The Contracting Parties agreed that a narrow IBT range could improve the repeatability of the performance tests. However, test data indicated that the narrow range required by the FMVSS 122 might not be achievable for those motorcycles equipped with a combined braking system. Therefore, the Contracting Parties agreed to specify an IBT between 55°C and 100°C in order to encompass all brake systems.

#### 5.1.8 Burnishing

The burnishing procedure serves as a conditioning of the foundation brake components to permit the braking system to achieve its full capability. Burnishing typically matches the friction components to one-another and results in more stable and repeatable stops during testing. FMVSS 122 includes a burnishing procedure, whereas ECE R78 and JSS 12-61 do not include any burnishing procedure. Under the ECE and the JSS regulations, the motorcycle is generally presented for type approval compliance testing in a burnished condition, using a procedure determined by the motorcycle manufacturer.

All Federal motor vehicle safety standards for brake systems (FMVSS 105, 121, 122 and 135) currently include a burnishing procedure. The burnishing procedure of FMVSS 122 requires 200 stops with both brakes applied, simultaneously, decelerating from a speed of 30 mph at 12 fps<sup>2</sup> with an initial brake temperature (IBT) between 55°C and 65°C (130°F and 150°F).

The Contracting Parties agreed to specify in the proposed motorcycle brake systems gtr a burnishing procedure that may be performed by the manufacturer. The procedure is based on FMVSS 122, but also includes some aspects of procedures currently used by motorcycle manufacturers in preparation for ECE R78/ JSS 12-61 type approval testing. For example, the initial speed proposed for the procedure has been changed to 50 km/h to round-off the metric equivalent, which is a slight increase from 30 mph (48 km/h) as required by FMVSS 122. Instead of making complete stops, the proposal also includes braking the motorcycle at the specified deceleration down to a speed between 5 km/h and 10 km/h, after which the motorcycle may be accelerated to the initial test speed for the next stop in the burnishing procedure. The primary reason for not braking the motorcycle to a complete stop is to expedite the burnishing procedure. The increased motorcycle kinetic energy resulting from the small initial speed increase of 2 km/h is likely to offset any reduction in kinetic energy resulting from not braking the motorcycle until a complete stop is reached.

The Contracting Parties agreed to propose burnishing the brakes separately since this would result in a more complete burnish for both front and rear brakes, as compared with the current

FMVSS method of using both brakes simultaneously. Hence, the proposed gtr requires each brake to be burnished for 100 decelerations.

Finally, the Contracting Parties agreed to propose a change in the IBT, from the range of 55°C to 65°C currently specified in FMVSS 122, to an IBT less than or equal to 100°C. The primary reasons for proposing a change in the IBT are to accommodate the higher operational temperatures of motorcycles equipped with disc brakes and to reduce the cooling times between stops. The Contracting Parties agreed that although a narrow IBT range is important to achieve good repeatability of the performance tests, the IBT range is not as critical for the burnishing procedure.

## 5.2 Specific Performance Tests

### 5.2.1 Dry Stop Test – Single brake control activated

The purpose of a dry stop test is to ensure a minimum level of motorcycle braking performance on a dry road surface. Each of the major national motorcycle brake regulations, ECE R78, FMVSS 122, and JSS 12-61, includes such a test in its requirements.

The ECE R78 and the JSS 12-61 test procedures and performance requirements are similar. The ECE R78/JSS 12-61 regulations require that the braking performance be evaluated separately for each brake control, with the motorcycle in the laden condition and at test speeds of 40 km/h or 60 km/h depending on the vehicle category. The only exception is for vehicle category 3-4, whereby it is specified that the brakes at all wheels must be actuated via a single foot operated control.

The main FMVSS performance requirements are quite different, tested in the lightly-loaded condition and with all brake controls applied simultaneously. The FMVSS also requires testing from 30 mph (48.3 km/h), 60 mph (96.6 km/h) and 80 mph (128.8 km/h). Consistent with being tested in the lightly-loaded condition and with both brakes applied together, the FMVSS 122 deceleration requirements are higher than in the ECE R78/JSS 12-61. The FMVSS 122 and the ECE R78/JSS 12-61 tests are conducted with the engine disconnected, which means that only the foundation brake performance is measured and engine braking is not a factor. Although the FMVSS 122 also requires that independent service brake systems be evaluated separately, it is conducted with the brakes in the pre-burnished condition, hence, requiring a lower level of performance.

In independent studies of the relative severity of the tests as they apply to category 3-3 motorcycles, the IMMA concluded that the ECE R78/JSS 12-61 test was marginally more stringent, whereas the NHTSA/TC findings indicated that the FMVSS 122 test was marginally more stringent. Despite this inconsistency, neither study demonstrated a significant difference in stringency between these national regulations.

The primary advantage of the ECE R78/JSS 12-61 requirement is that each brake control is tested separately, which ensures that each independent brake system meets specific performance criteria. In the main FMVSS 122 dry stop test with both brake controls applied simultaneously, the test rider must judge how to apportion the force applied to the front and rear brakes. This may give unrepeatable test results, or may allow the test rider to compensate for a “weak” brake. Therefore, the informal group decided to develop the dry stop test with single brake control based on ECE R78/JSS 12-61 requirements, for the purposes of the gtr. As per present ECE/JSS

national standards, the performance requirement can be met through measurement of either the stopping distance or the MFDD.

In the event the performance requirements cannot be achieved due to limited adhesion, the ECE R78 includes an alternate test with the vehicle laden, using both braking devices together, for vehicle categories 3-2 and 3-3. As noted earlier, the dry stop test in ECE R78/JSS 12-61 does not specify a value for the surface coefficient of friction, other than to say that the surface must afford good adhesion. Given that the gtr includes a requirement that the test surface must have a nominal PFC of 0.9, it was agreed that this alternative test be omitted from the gtr.

#### 5.2.2 Dry Stop Test – all service brake controls activated

The purpose of the dry stop test with all service brake controls activated is to evaluate the full braking performance of the motorcycle from a speed of 100 km/h with both front and rear brakes applied simultaneously.

The current requirements of FMVSS 122 include a stopping distance test from 60 mph (96 km/h) with all brake controls applied simultaneously and with the motorcycle in the lightly-loaded condition. The stopping distance requirement from this speed is 185 feet (56.4 meters), which is equivalent to an average deceleration of  $6.4 \text{ m/s}^2$  over the entire stop. The current requirements of ECE R78 and JSS 12-61 do not include a performance test from such a speed.

The Contracting Parties agreed to include in the proposed gtr a requirement based on the FMVSS 122 test noted above. These test parameters are relevant since they represent the typical operating conditions of a motorcycle with a single rider travelling at highway speeds. In addition, testing in the lightly loaded condition with a full brake application helps to evaluate vehicle stability during braking. Under the proposed gtr, this test would apply to vehicle categories 3-3, 3-4 and 3-5, but not to vehicle categories 3-1 and 3-2. The latter are vehicles with a maximum speed less than 50 km/h. Given this speed restriction, vehicle categories 3-1 and 3-2 will use a test speed based on 90%  $V_{\text{max}}$ , or almost at the same exact speed as the 40 km/h test speed for the dry stop test – single brake control activated. As the level of stringency was deemed comparable for both dry stop tests, the Contracting Parties agreed that it would be redundant to require in the proposed gtr that these vehicles undergo a dry stop test with all the service brake controls activated.

The brake application force specified in the gtr is less than or equal to 245 N for hand levers and less than or equal to 400 N for foot pedals. Since this proposed requirement is being adopted from FMVSS 122, with a slight increase in speed to 100 km/h from 96 km/h, the Contracting Parties agreed to retain the corresponding control lever/pedal force parameters to maintain the stringency of the original test. If this dry stop requirement were adopted with the force parameters from ECE R78 and JSS 12-61 Standards (200N/350N for the hand lever/foot pedal controls, respectively), it would increase the stringency of the requirement since it would effectively be proposing that the current FMVSS requirements be met with lower application forces.

The stopping distance requirement from a speed of 100 km/h is 198.5 feet (60.5 meters). In keeping with the original requirements on which this test is based, the Contracting Parties agreed to maintain the performance requirement for this dry stop test in terms of stopping distance only, thus excluding any reference to MFDD.

### 5.2.3 High Speed Test

The purpose of the high speed test is to evaluate the full braking performance of the motorcycle from a high speed and with both front and rear brakes applied simultaneously. Each of the major national motorcycle brake regulations, ECE R78, FMVSS 122, and JSS 12-61, includes a high speed test in its requirements.

The ECE R78 and the JSS 12-61 tests are similar and are performed from a speed of 160 km/h or 0.8 of the vehicle's maximum speed ( $V_{\max}$ ), whichever is less. The ECE R78 test requires that vehicle braking performance and behaviour be recorded, however, it does not have specific performance requirements. The performance required by JSS 12-61 includes achieving a mean fully developed deceleration (MFDD) of at least  $5.8 \text{ m/s}^2$  or coming to a stop prior to the equivalent braking distance. The high speed effectiveness test of FMVSS 122 is conducted from a test speed that is based on the speed capability of the motorcycle, not exceeding 193.2 km/h (120 mph). When tested at the maximum speed of 120 mph, the required stopping distance is 861 feet (262.5 meters), equivalent to an average deceleration of  $5.5 \text{ m/s}^2$ . Based on these figures, the FMVSS 122 test appears to be more stringent due to the higher test speed, whereas the JSS 12-61 appears to be more stringent based on a deceleration requirement.

The test conditions for the FMVSS 122 and the ECE R78/JSS 12-61 high speed tests are quite similar, including the motorcycle test mass and the simultaneous application of both brakes. The main difference between test parameters, besides the difference in the vehicle test speeds, is that the FMVSS 122 test is conducted with the engine disconnected (clutch disengaged), whereas the ECE R78/JSS 12-61 test is conducted with the engine connected (clutch engaged). It is understood that with a connected engine, the subsequent engine braking can assist in the deceleration of the motorcycle. This effect is reduced to a minimum by placing the transmission in the highest gear during the braking manoeuvre. The benefit of having the engine connected is the effect of stabilizing the motorcycle while braking from such a high speed.

Based on the Transport Canada Test Report "Review of Motorcycle Brake Standards", the Contracting Parties believe that 100 mph (160 km/h) or 0.8  $V_{\max}$  is adequate for a high speed effectiveness test since the benefits of testing from higher speeds do not warrant the potential hazard to which the rider is exposed. The Contracting Parties agree that the test speed should be limited to 160 km/h to address test facility limitations and safety concerns.

The FMVSS 122 and JSS 12-61 performance requirements are very similar from a maximum speed of 160 km/h. The equivalent average deceleration in FMVSS 122 is  $5.5 \text{ m/s}^2$  from 100 mph, compared to the JSS 12-61 MFDD of  $5.8 \text{ m/s}^2$  from 160 km/h. In actual testing, the performance differences for the high speed tests were too small to clearly identify one testing procedure as being more stringent than the other.

Finally, the Contracting Parties also agreed to require that the high speed test be conducted with the motorcycle engine connected and the transmission in the highest gear, per JSS 12-61, which has the effect of enhancing vehicle stability during braking from test speeds of 160 km/h.

### 5.2.4 Wet Brake Test

The purpose of the Wet Brake Test is to ensure a minimum level of braking performance when the motorcycle is ridden in heavy rain conditions. Each of the major national motorcycle brake

regulations, ECE R78, FMVSS 122, and JSS 12-61, includes a wet brake test, but different philosophies are found in them.

The ECE R78 and the JSS 12-61 test procedures and performance requirements are similar, but are different from the FMVSS 122 test. The ECE R78 regulation was developed 20 years ago in the United Kingdom in order to deal with problems in the field where the braking performance of motorcycles with exposed disc brakes was significantly reduced when ridden in heavy rain. This coincided with the large scale introduction of disc brakes on motorcycles. Therefore, in order to simulate heavy rain conditions, the ECE R78 test requires a brake performance test with a wetted brake. This is achieved by spraying water directly onto the brakes during the test.

The ECE R78 wet brake performance evaluation begins with a baseline test where each brake is tested separately and is required to decelerate a laden motorcycle at a specified rate, using the conditions of the Dry Stop Test – single brake control activated. For comparison, the same test is then repeated, but with a constant spray of water to wet the brakes. The difference in performance is evaluated immediately after the application of the respective brake, to assure a minimum rise in deceleration performance with wet brakes. In addition, a drying brake can sometimes result in an excessively high pad friction leading to vehicle instability and wheel lock, therefore a check for this “over recovery” is also included.

As with the ECE R78/JSS 12-61 requirement, the FMVSS 122 requires an evaluation of wet brake performance by comparison of a baseline dry stop test with performance after wetting. However, the philosophy behind the test is quite different, as the test is based on brake performance recovery following the motorcycle crossing an area of standing water. As such, the wetting procedure consists of immersing the front and rear brakes in water, separately, for two minutes each. Performance is evaluated with all brakes applied simultaneously and the wet brake recovery performance is based on the fifth stop after having immersed the brakes. The motorcycle is also tested in the lightly loaded condition. Practical problems can occur when carrying out the brake immersion requirement, due to low exhaust systems and other mechanical system locations, which may affect the motorcycle engine/transmission.

The respective brake regulations address minimum performance requirements for wet brakes, albeit under different conditions. In terms of the overall performance requirements, the stringency comparison studies by IMMA and the NHTSA/TC both concluded that the ECE R78/JSS 12-61 performance requirements are more stringent. The Contracting Parties agreed that the ECE R78/JSS 12-61 procedure akin to braking while riding in the rain is a more common operating condition than crossing an area covered with water.

Therefore, the Contracting Parties decided to propose a wet brake test based on the contents of the ECE R78/JSS 12-61 test, and to make it applicable to all vehicle categories. At present, the ECE R78/JSS 12-61 procedure excludes brakes that are fully enclosed because water is prevented from reaching the braking surface. For the purposes of the gtr, however, there was general agreement that the scope be expanded to include testing of enclosed disc brakes or drum brakes that have ventilation or inspection holes, as these include potential entry points for water spray.

#### 5.2.5 Heat Fade Test

The heat fade test will assure that a minimum level of braking performance is maintained, after numerous consecutive brake applications. In terms of real world conditions, this could be akin

to frequent braking while driving in a busy suburban area or on a downhill gradient. Each of the national regulations includes a test to evaluate the brake for heat fade and any change in brake performance.

As with the wet brake test, the ECE R78 and JSS 12-61 share the same test procedure and performance requirements. Each require that the brakes be tested separately, with the motorcycle loaded to its maximum mass capacity. The FMVSS 122 test parameters are different in that all brakes are applied simultaneously and the motorcycle test mass is set at 200 pounds (90.7 kg) above the unloaded motorcycle mass (i.e. the 200 pounds includes the mass of the test rider and test equipment).

Each test begins with a baseline test with an IBT between 55°C and 100°C, which provides the benchmark for performance comparison and evaluation of the heated brakes. This is followed by 10 consecutive fade stops with the purpose of building heat within the brakes. The similarities between national regulations end here. In the ECE R78/JSS 12-61, the final performance test occurs with one stop immediately following the 10 fade stops. FMVSS 122 requires an additional five recovery stops, and the performance in the fifth stop is compared to the baseline performance. The respective regulation test parameters include additional differences such as initial test speeds, brake lever and pedal control forces, deceleration rates, and the transmission gear selection (engine connected / disconnected).

Finally, to evaluate brake fade performance, the FMVSS 122 procedure compares the brake pedal and lever actuation forces necessary to maintain the same deceleration as in the baseline test, whereas the ECE R78/JSS 12-61 procedures compare deceleration (or stopping distance) for the same brake pedal and lever actuation forces as used in the baseline test.

Although the national regulations have distinct differences, they share the common goal of evaluating the effect of heat on braking performance. The stringency of the respective tests was evaluated separately by the IMMA and in a joint study by TC/NHTSA. The results from both studies indicated that the ECE R78/JSS 12-61 fade test was more stringent, thus providing the basis for the requirements of the gtr.

Minor adjustments were made to the referenced national test procedure. In addition to narrowing the range for the initial brake temperature, the text was revised to use the average brake control force from the baseline test, calculated from the measured values between 80 percent and 10 percent of the specified vehicle test speed.

The proposed gtr fade test is applicable to vehicle categories 3-3, 3-4 and 3-5, as is presently the case in the ECE R78, JSS 12-61 and FMVSS 122. Only Canada's national regulation requires a fade test for vehicles with an engine size less than 50cc and a top speed less than 50 km/h (i.e. vehicle categories 3-1 and 3-2). However, none of the participants in the informal group could substantiate the need to include the fade test for those vehicle categories. There was no negative experience reported due to the absence of a fade test for these smaller motorcycles, and therefore it was agreed that such motorcycles would not require the heat fade test.

#### 5.2.6 Parking Brake Test

The purpose of the parking brake 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.

FMVSS 122 requires that the parking brake system be capable of holding the motorcycle stationary for 5 minutes when tested in the lightly-loaded condition on a 30% grade, in the forward and reverse directions. In addition, FMVSS 122 requires that the parking brake be of a friction type with solely mechanical means to retain engagement. The parking brake requirement in ECE R78 and JSS 12-61 are equivalent, and require that the brake must be capable of holding the motorcycle stationary on an 18% grade in the laden condition (i.e., the maximum weight limit specified by the manufacturer), in the forward and reverse directions. No time limit is specified in either the ECE or JSS regulation.

The Contracting Parties agreed to use the ECE R78/JSS 12-61 parking brake test as a basis for the proposed motorcycle brake system gtr, even though the level of stringency appears to be similar to that in FMVSS 122, given the ECE R78's laden condition on an 18% grade versus the FMVSS 122's lightly loaded condition on a 30% grade. The Contracting Parties agreed that the laden condition is the worse case loading condition and test facilities around the world are more likely to have an 18% grade than a 30% grade available for testing.

The proposed gtr includes a requirement that the motorcycle remain stationary for 5 minutes, which was adopted from FMVSS 122. In addition, the Contracting Parties agreed that the proposed gtr retain the common requirement that the parking brake be designed to retain engagement solely by mechanical means, but not include the FMVSS 122 requirement that the parking brake be of a friction type. This removes a design restriction and allows a manufacturer to use any parking brake design that retains engagement by mechanical means.

#### 5.2.7 ABS Performance

The purpose of the antilock brake system (ABS) requirements is to assess the stability and stopping performance of a motorcycle with the ABS functioning. The proposed gtr does not require that a motorcycle be equipped with ABS, but establishes minimum performance requirements for motorcycles so equipped.

ECE R78 and JSS 12-61 include ABS specific performance requirements but do not require that ABS be fitted on motorcycles. Common to both national regulations are wheel lock tests on high friction and low-friction surfaces and ABS failed systems performance test. In addition, the ECE R78 performance requirements include an ABS adhesion utilization (i.e efficiency) tests on high-friction and low-friction surfaces, a high-friction surface to low-friction surface transition stop and a low-friction surface to high-friction surface transition stop. FMVSS No. 122 does not include any ABS-specific performance requirements.

The Contracting Parties reviewed each of the ABS performance tests and their corresponding requirements to assess their appropriateness for the proposed motorcycle brake system gtr. With the exception of the ABS adhesion utilization test and the low-friction surface to high-friction surface transition stop, the Contracting Parties agreed to adopt, with selected revisions and clarifications, the remaining ABS test procedures and performance requirements. Possible alternatives for those tests in which a basic agreement was not achieved are discussed further below.



Of the agreed tests, in the case of the wheel lock test on a low-friction surface, the present ECE R78 regulation states that for a road surface with a  $PFC \leq 0.35$ , the specified initial test speed of 80 km/h may be reduced for safety reasons, but does not specify by how much. In order to assure consistency in the way the vehicles are evaluated and to maintain the objective of rider safety, the proposed gtr text specifies that the test speed shall be the lesser of  $0.8V_{max}$  or 60 km/h for the low-friction surface test.

In regard to the low-friction to high-friction surface transition test, a clarification was brought to better assure a sudden transition between the two surfaces. In order to obtain a sufficiently low PFC, the motorcycle may initially be braked on a wetted surface, and then transition onto a dry, high friction surface. This is not a sudden transition as the motorcycle tire is still wet and there may also be some water over the two surfaces at the transition point. In an effort better assure a sudden transition between test surfaces, the proposed gtr makes the further precision that the low friction surface must be followed by a wet high friction surface with a PFC exceeding 0.8.

Finally, when evaluating the performance of ABS, it is required that the ABS be cycling during the respective tests. The test rider must therefore apply a specific force to the brake control, which may be increased to assure that the ABS is fully cycling. Depending on the ABS, some brake feedback may be felt through the brake control, such that it is not possible to maintain the specified control force. Based on test data, it was agreed that the test rider should be able to maintain the specified force within a 20 percent margin for the entire stop.

#### 5.2.7.1 ABS Performance – Stopping Performance Requirement

The adhesion utilization test is required by the ECE standard only, and compares the separate performance of the front and rear ABS brakes to the separate maximum braking performance of the front and rear brakes with the ABS disabled. It is evaluated on two road surfaces, a high-friction surface and a low-friction surface.

Several discussions were had on the issues of test repeatability and variability of the results. The ECE test has a high potential for producing non-repeatable results because it is a test of the maximum motorcycle braking performance as achieved by the rider of the motorcycle. Numerous factors come into play when attempting to achieve maximum performance, including rider skill, the condition of the test equipment and site (tires, brakes and track surface), and the weather conditions. For example, the performance of ABS may be favourable when tested by a mediocre rider; however, the efficiency of ABS can diminish significantly when tested by an expert rider.

In conducting such tests, some ABS efficiency results were noted to exceed 100% (i.e. improved deceleration compared to non-ABS braking performance), which is only possible when the test rider is not able to achieve the maximum available deceleration rate. In addition to rider influence, the ECE R78 procedure is slightly flawed in that it prescribes a constant control force for the entire stop. Research has shown that the available surface friction (i.e. PFC) increases as the vehicle speed decreases, and therefore the ABS system will have the advantage of higher deceleration rates at lower speeds. Therefore, to obtain the maximum deceleration capability without ABS, the rider would have to increase the braking control force as the motorcycle is being decelerated.

Safety and logistical issues were also noted with the ECE R78 adhesion utilization test:

- Rider safety. The test requires that the rider achieve an impending locked-wheel braking condition with the ABS disabled, to obtain maximum deceleration data with which to evaluate ABS in later tests. This impending locked-wheel braking condition is at the beginning of loss-of-control of the vehicle, which could result in a crash. Even with protective outriggers in place, it is a hazardous condition that is asked of the test rider.
- Logistical. The test requires modifying the braking system to disable the ABS. This may not be a simple task, or may not be possible depending on the complexity of the motorcycle braking system. Furthermore, the standard requires that maximum deceleration be recorded with an altered braking system (i.e. to disable ABS), hence possibly outside the manufacturer's design parameters.

In light of these issues, an alternate ABS test was developed at the fourth informal group meeting in June 2005, based on the ECE R78 national regulation. The tests consisted of braking on both high and low friction surfaces with ABS cycling, but with emphasis placed on maintaining vehicle stability rather than actual stopping performance. Nevertheless, stopping performance was also specified for the high friction test only, based on the minimum performance requirements for the general ECE R78 dry stop test. No stopping distance performance requirement was specified for the low friction surface test, as there was no baseline test in ECE R78 with which to compare. The proposed tests do not require the braking system to be altered, nor the rider to attempt to obtain the maximum attainable deceleration rate, thereby addressing the safety and logistical issues.

The proposed alternate test was presented at the fifty-eighth GRRF in September 2005. While there was no issue raised with regard to the test procedure, the relative stringency of the stopping performance requirements was thought to be too low compared to the existing ECE R78 ABS requirement, which could result in unnecessarily long stopping distances when ABS is cycling.

As a result, the informal group revisited this ABS test during the fifth informal meeting in October 2005 and are presenting the following options for the purposes of this gtr:

- a) Exclude the ECE R78 ABS adhesion utilization test;
- b) Include the ECE R78 adhesion utilization test with a sunset clause;
- c) Adopt a modular approach to include the ECE R78 adhesion utilization test. Interested Contracting Parties would then register their commitment to that module; and,
- d) Stop the gtr and develop a new test with ABS stopping performance requirements.

In the first option, the gtr would simply include all tests to which the Contracting Parties can agree. In this case, most of the ECE R78 ABS tests would be included with the exception of the adhesion utilization test. In option b), the gtr would also include the ECE R78 ABS adhesion utilization test but with a statement indicating that the adhesion utilization test would no longer be applicable after a specified date (i.e. include a sunset clause). In option c), a modular approach would be adopted in which the disputed tests are placed, and interested Contracting Parties could then register their commitment to that module. Finally in option d), the gtr is stopped until a new and acceptable test with ABS stopping performance requirements are developed.

#### 5.2.7.2 ABS Performance – Low-Friction to High-Friction Surface Transition Stop

This is an existing test in ECE R78, with the performance requirement that the motorcycle does not deviate from its initial course and that its deceleration must rise to an “appropriate” value. To make the test more objective and acceptable to all Contracting Parties, an actual performance number would have to be added to define what is appropriate.

At the fifth informal meeting in October 2005, Japan presented some preliminary test data that revealed a wide range of ABS performance responses to the sudden change in surface friction. Thus, at that time, it was not possible to determine a specific value with which to improve the objectivity of the ECE performance requirements.

In summary, there is no issue with the ECE R78 test procedure, or with the requirement that the motorcycle does not deviate from its initial course. Only the deceleration requirement needs to be addressed. As a result, the following options are proposed for the purposes of this gtr:

- a) Exclude the deceleration requirement from this specific test;
- b) Include the deceleration requirement with a sunset clause;
- c) Adopt a modular approach to include the controversial requirement, to which interested Contracting Parties would register their commitment; and,
- d) Stop the gtr and undertake further efforts to determine an objective value to which motorcycle deceleration must rise.

In the first option, the deceleration requirement may simply be removed for the purposes of the gtr. In option b), the gtr would include the deceleration requirement but with a statement indicating that it will no longer be applicable after a specified date (i.e. include a sunset clause). In an effort to establish such a value, it was proposed that data be recorded in future testing in order to assist with making an amendment to the gtr at a future date.

In option c), a modular approach would be adopted in which the disputed requirements are placed, and interested Contracting Parties could then register their commitment to that module. Finally in option d), the gtr is stopped until a new and acceptable performance requirement is established.

#### 5.2.8 Partial Failure Test – Split service brake system

The split service brake system is based on the passenger car braking system and its use on motorcycles is unique to vehicles in Canada and the United States. The purpose of this test is to assure that, in the event of a pressure component leakage failure in one of the hydraulic subsystems, a minimum level of braking performance is still available in the remaining hydraulic subsystem to allow the rider to bring the motorcycle to a stop.

Only the FMVSS 122 addresses a failure test for motorcycles equipped with a split service brake system. The test requirements are not applicable to vehicle categories 3-1 and 3-2. The Contracting Parties agreed that the performance requirements of FMVSS 122 are sufficient for the purposes of this gtr.

#### 5.2.9 Power-Assisted Brake System Failure Test

An outline including all of the proposed test procedures for the gtr was presented during the 57<sup>th</sup> GRRF, for the purposes of soliciting initial comments. One such comment concerned the absence, and requested the addition, of a power-assisted brake system failure test. None of the referenced motorcycle brake regulations or standards include such a requirement, most likely because the application of power-assisted brake systems on motorcycles is relatively new.

It is recognized that some motorcycles are presently equipped with power-assisted brake systems, and that the use of such systems could expand in the future. Existing standards are limited to motor vehicles where this technology has been in use for many years, such as on passenger cars. At present, however, there is no known performance requirement in the event of the failure of a power-assisted brake system on a motorcycle.

The informal group therefore proposes a test to assure that, in the event of a power-assisted brake system failure, a minimum level of braking performance is still available to allow the rider to bring the motorcycle to a stop. The test is not required if the motorcycle is equipped with another separate service brake system.

In summary, the proposed test is based on the Dry Stop Test – single brake control activated (section 4.3), whereby the minimum performance requirement was initially set to that required of the secondary brake for vehicles equipped with CBS. This performance requirement was believed to be too low. For the revised proposal, in the case of separate service brake systems, each brake control must be tested separately and capable to meet the minimum brake performance for the single rear brake system. In the case of vehicles equipped with CBS or SSBS, each brake control must be tested separately and the minimum performance requirements are those for the secondary brake.

### 6. REGULATORY IMPACT AND ECONOMIC EFFECTIVENESS

Many global motorcycle brake regulations have not kept pace with the advancement of modern technologies. With the improvement of disc brake systems and the recent introduction of new technologies such as anti-lock brake systems (ABS) and combined brake system (CBS), modern motorcycles can be equipped with very sophisticated and effective braking systems.

Statistics compiled to date indicate that improved motorcycle brake systems would be beneficial in reducing motorcycle accidents. Fatal motorcycle accidents have been on the rise in North America since 1997. Of particular concern is the rise in motorcycle accident fatalities for the age group of 40 and above, by 8.2 per cent in Canada from 1994 to 2000, and 24.7 per cent in the United States from 1994 to 1999. In addition, statistics from the United States of America for the period of 1991 to 1999 inclusively indicate that about 13 per cent of the yearly average of 1,055 fatal single vehicle motorcycle crashes were related to braking manoeuvres. A request for additional motorcycle traffic accident data was made at the fifty-second GRRF session, to all nations, in an effort to prepare for the cost effectiveness study for the purposes of the gtr. No responses were received following this request.

The informal group reviewed the benefits of developing a gtr. The group concluded that there are many benefits to the consumer, Contracting Parties and for manufacturers. The following highlights some of the significant benefits raised during the discussions:

- The gtr includes technical requirements to access recently developed technologies, such as combined brake systems (CBS) and anti-lock brakes (ABS). Most regulatory requirements of the Contracting Parties do not include such current requirements.
- A gtr enables motorcycle manufacturers to test their models to just one regulation/series of tests to sell globally. Currently, tests have to be carried out to many different regulations e.g. FMVSS No. 122 in the USA, UNECE Regulation No. 78 in Europe, JSS 12-61 in Japan, ADR in Australia, CMVSS No. 122 in Canada, etc.
- Carrying out just one set of tests is particularly beneficial to new manufacturers and manufacturers from the emerging nations. Apart from the benefits outlined above, manufacturers' test departments need only become familiar with the gtr tests.
- It has been many years since current regulations were reviewed for their relevance. In order to compare current regulations, members of the informal gtr group (NHTSA, Transport Canada, and IMMA) carried out many vehicle tests and analyses that effectively checked the suitability of current regulations, with modifications being incorporated as required.
- The informal group gave many individuals and organizations the opportunity to come together to directly influence and participate in the development and content of the gtr. This has, in fact, been the case where a broad cross-section of motorcycle manufacturers, authorities of several countries, and the motorcycle riders' group have all participated.
- The gtr combines the better and more stringent procedures from current USA, UNECE, and Japan regulations. This will result in an enhanced gtr that will benefit all motorcycle users in terms of brake performance, brake durability, and potential safety.
- Motorcycles sold in the USA and Canada will benefit from the following:
  - a wet brake test that simulates in service conditions by spraying water onto the disc;
  - a more stringent dry brake test;
  - a more stringent heat fade test;
  - a more stringent high speed test;
  - an additional test to evaluate ABS performance.
- Motorcycles sold in Europe will benefit from the following:
  - a specified burnishing procedure for government conformity testing;
  - an additional test from 100 km/h with both brakes applied;
  - a more stringent high speed test;
  - additional general requirements e.g. warning lamp specification, brake system inspection;
  - a specified test sequence.
- Motorcycles sold in Japan will benefit from the following:
  - a specified burnishing procedure for government conformity testing;
  - an additional test from 100 km/h with both brakes applied;
  - additional general requirements e.g. warning lamp specification, brake system inspection;
  - a specified test sequence.

In addition, the text of the gtr will provide clear, straightforward instructions on test procedures and requirements that should be easy to follow for the tester. Additional documentation on interpretation (which is used currently) should not be necessary. This will provide a benefit to all Contracting Parties, manufacturers and testing facilities.

Motorcycles are vehicles, which are prepared for the world market. To the extent that manufacturers are preparing substantially different models in order to meet different braking regulations, testing costs and other production values are increased. It would be more economically efficient to have manufacturers using the same test procedure and meeting the same performance requirements worldwide. This will be achieved by this gtr and thus reduce the amount of resources utilized to test motorcycles. These savings will accrue not only to the manufacturer, but also more importantly, to the consumer as well.

In summary, as the gtr has been prepared on the basis of the most stringent current requirements, there will be an increase in safety in all countries; since no one country has a monopoly on the most stringent requirement for the common test procedures. In addition, the gtr provides testing requirements applicable to new technologies such as ABS and CBS that will benefit all road users."

#### B. TEXT OF REGULATION

(Insert proposed gtr text here)