MOTORCYCLE BRAKES GTR – 5th DRAFT – Prepared **2005-3-1**

This Draft does not include any outstanding actions or comments.
These are included in document - "MOTORCYCLE BRAKES GTR – ACTION LIST".
Areas of text where there is outstanding work or agreement has not been reached are in red.

1. SCOPE

This GTR specifies requirements for service brake and, where applicable, associated parking brake systems.
Its purpose is to ensure safe braking performance under normal and emergency riding conditions.
The GTR applies to power driven vehicles with 2 and 3 wheels as summarised in the following table:

CATEGORY		DESCRIPTION
***Proposed**: (from TRANS/ WP29/2004/25)*	*ECE R78 Reference:*	
3-1	L_1	2 wheels, engine < 50cc and max speed < 50 km/h
3-2	L_2	3 wheels, engine < 50cc and max speed < 50 km/h
3-3	L_3	2 wheels, engine > 50 cc or max speed > 50 km/h
3-4	L_4	3 wheels – asymmetric, engine > 50 cc or max speed > 50 km/h (motorcycle + sidecar)
3-5	L_5	3 wheels – symmetrical, engine > 50 cc or max speed >50 km/h .

Notes:
- the categories include vehicles with electric power.
- the categories do not include:
  - vehicles with a V max. of < 25 km/h
  - vehicles equipped for invalid drivers

2. DEFINITIONS

(Provisionally listed in a table as Attachment 1)

3. GENERAL REQUIREMENTS

3.1 **Brake system requirements**

3.1.1 - 2 wheeled vehicles (category 3-1 and 3-3) shall be equipped with 2 separate service brake systems, or a split service brake system, with at least 1 brake operating on the front wheel and at least 1 brake operating on the rear wheel.

3.1.2 - Category 3-4 vehicles shall have the same brake system requirements as outlined in 3.1.1 above. A brake on the sidecar wheel is not required providing the vehicle meets the prescribed performance requirements outlined in section 4 of this GTR.

3.1.3 – 3 wheeled vehicles of category 3-2 and 3-5 shall be equipped with a parking brake system plus one of the following service brake systems:

a. 2 separate service brake systems which, when applied together, actuate the brakes on all wheels, or

b. a service brake system that operates on all wheels and a secondary brake system which may be the parking brake, or

c. a split braking system which actuates the brakes on all wheels, actuated through a single control.

3.1.4 – Where 2 separate service brake systems are installed, there may be a common brake provided failure in 1 system does not affect the performance in the other.

3.1.5 – For vehicles with a hydraulic transmission, the master cylinder shall have a separate reservoir for each brake system, with its own cover. The fluid level shall be easily visible for checking without removal of the cover.

3.1.6 – Vehicles that are equipped with a split service brake system shall be fitted with a red warning lamp, which is clearly visible to the rider and which shall be activated:
- if there is a hydraulic failure when a 90 N. max control force is applied
- without activation of a brake control, when the brake fluid level in the master cylinder reservoir falls below the level specified by the manufacturer or to ≤ 0.5 of the fluid reservoir capacity, whichever is the greater.
For function checking, the warning lamp shall be turned on briefly by the activation of the ignition switch.
The warning lamp shall remain on whilst a failure condition exists.

3.1.7 – Vehicles that are equipped with an ABS system shall be fitted with an amber warning lamp which is clearly visible to the rider. The lamp shall be activated
when there is a break in the supply of electricity in the system.
For function checking, the warning lamp shall be turned on briefly by the activation of the ignition switch.
The warning lamp shall remain on whilst a failure condition exists.

3.1.8 – Brake friction material shall not contain asbestos.

3.2 **Brake system, general operation**

3.2.1 Service brake system
The service brake system shall progressively reduce the speed of the moving vehicle, bring it to a halt, and keep it stationary. The rider shall achieve this whilst seated in the normal driving position and with both hands on the steering control.

3.2.2 Secondary brake system
Where a secondary brake system is fitted, it shall progressively reduce the speed of the moving vehicle to a halt in the event of a failure of the service brake system.
The rider shall achieve this whilst seated in the normal driving position and with at least 1 hand on the steering control.

3.2.3 Parking brake system
Where a parking brake system is fitted, it must hold the vehicle stationary on the prescribed slope.
The brake shall have a control which is separate from the service brake controls and shall be held in the locked position by solely mechanical means.
The rider shall be able to operate the parking brake whilst seated in the normal driving position.

3.3 **Durability**

3.3.1 - The brake system shall take account of friction material wear automatically or by manual means.

3.3.2 - The friction material thickness shall be visible without disassembly, but for drum brakes, where the friction material is not visible, wear shall be assessed by observing the relative position of a pointer device designed for that purpose.

3.3.3 - During the tests and on their completion, there shall be no lining detachment and no leakage of brake fluid.

3.4 Measurement of Dynamic performance

The method utilized to measure performance shall be as specified in the respective tests in Section 4. There are 3 ways in which the brake performance may be measured:

3.4.1: MFDD (Mean Fully Developed Deceleration)

MFDD can only be applied to the following test types: Dry Stop, Heat Fade Base line, Heat Fade Recovery, and High Speed.

Calculation of MFDD :

$$d_m = \frac{V_b^2 - v_e^2}{25.92\ (S_e - S_b)} \quad m/s^2$$

Where :
d_m = mean fully developed deceleration
V_1 = vehicle speed when rider actuates control
V_b = vehicle speed at 0.8 V_1 in km/h
V_e = vehicle speed at 0.1 V_1 in km/h
S_b = distance traveled between V_1 and V_b in metres
S_e = distance traveled between V_1 and V_e in metres

3.4.2: Stopping distance:

Stopping distance data can only be applied to the following test types: Dry Stop, Heat Fade Base line, Heat Fade Recovery, and High Speed.

Based on the basic equations of motion:
$S = 0.1\ V + (X)\ V^2$

Where:
S = stopping distance in metres
V = vehicle speed in km/h
X = a variable based on the requirement for each test

3.4.3 Continuous Deceleration Readout:

For tests such as the Wet Brake and ABS surface transition tests, there shall be a continuous readout of the vehicle deceleration from the point where the brake control is applied until the end of the test.

4. TEST CONDITIONS, PROCEDURES AND PERFORMANCE REQUIREMENTS.

4.1 **General**

4.1.1 Test surfaces:

4.1.1.1 Dynamic brake tests (excluding low friction ABS tests)
The test area shall have a clean, dry and level surface, with a gradient ≤ 1%
The surface shall have a peak friction coefficient (PFC) of ≥0.85.

4.1.1.2 Dynamic ABS tests
Vehicles with ABS shall be tested on two surfaces with the following peak friction coefficients:
- High = ≥0.8
- Low = ≤ 0.45

4.1.1.3 Parking brake tests
The test area shall have a clean, dry and solid surface with the specified slope.

4.1.1.4 Lane width
For a 2 wheeled vehicles (category 3-1 and 3-3) the lane width shall be 2.5 m.
For a 3 wheeled vehicles (category 3-2, 3-4 and 3-5) the lane width shall be 2.5 m + the vehicle width.

4.1.2 Ambient temperature:
The ambient temperature shall be between 4° C and 38° C.

4.1.3 Wind speed:
The wind speed shall be not more than 5 m/s

4.1.4 Test speed:
Unless otherwise stated, vehicles shall be tested at the specified test speed or [0.8] Vmax, whichever is the lower.

4.1.5 Automatic transmission
Vehicles with automatic transmissions shall complete all tests whether they are for “engine connected” or “engine disconnected”.
If an automatic transmission has a neutral position, the neutral position shall be selected for tests where “engine disconnected” is specified.

4.1.6 Vehicle position and wheel lock
- The vehicle shall be positioned in the centre of the test lane for the beginning of each stop.
- Stops shall be made without the vehicle wheels passing outside the test lane and without wheel lock. For ABS equipped vehicles, wheel lock is permitted below a speed of 10 km/h.

4.1.7 Test sequence

TEST ORDER	SECTION
1. Dry Stop - single brake control activated	4.3
2. Dry Stop – all service brake controls activated	4.4
3. High Speed	4.5
4. Wet Brake	4.6
5. Heat Fade (1)	4.7
6. If fitted:	
6.1 Parking Brake	4.8
6.2 ABS	4.9
6.3 Partial failure test, for a split brake system	4.10

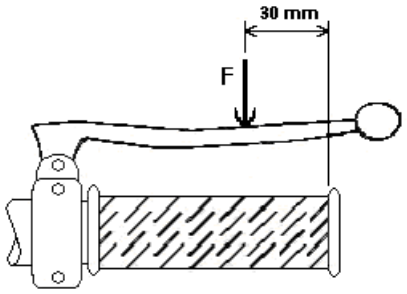
Note (1): the heat fade test shall always be the last test carried out

4.2 Preparation

4.2.1 Engine idle speed:
Engine idle speed shall be set to the manufacturer's specification.

4.2.2 Tyre pressures:
Tyres shall be inflated to the manufacturer's specification for the vehicle loading condition.

4.2.3 Control lever application points:
For the hand control lever, the input force (F) shall be applied at a point [30] mm from the outer end of the end of the handle grip (see figure below). The direction of the input force shall be perpendicular to the handle grip.



For the foot control pedal, the input force shall be applied to the centre of the pedal and at right angles to the pedal.

4.2.4 Brake temperature measurement:
The brake temperature shall be measured on the approximate centre of the braking path of the disc or drum. (*Schematics are needed)*

4.2.5 Burnishing procedure:
(Final text to include an explanation that manufacturers will burnish before certification testing and that administrations will use this method when conducting CoP/Audit testing)

- Vehicle unladen.

- Engine disconnected

- Test speed:
  Initial speed ≥50 km/h
  Final speed 5 to 10 km/h

- Brake application:
  Each brake control applied separately.

- Vehicle deceleration:
Front wheel braking only = 3.0-3.5 m/s^2
Rear wheel braking only = 1.5-2.0 m/s^2
Combined Brake System = 3.5-4.0 m/s^2

- Number of decelerations: 100 per brake system

- Initial brake temperature before each manoeuvre ≤100° C.

- Accelerate to the initial test speed after each manoeuvre and maintain that speed until the brake temperature falls to the specified initial value. When these conditions are met, initiate the braking manoeuvre by decelerating at the specified rate, to a final speed of 5 to 10 km/h. Repeat for the number of specified decelerations.

4.3 **Dry Stop Test – single brake control activated**

4.3.1 Vehicle condition.

- Laden
  For vehicles fitted with CBS: also unladen

- Engine disconnected

4.3.2 Test conditions and procedure

- Initial brake temperature: ≤ 100° C

- Test speed **:**
  Category 3-1 & 3-2 vehicles: 40 km/h
  Category 3-3, 3-4 & 3-5 vehicles: 60 km/h

- Brake application:
  Each brake control separately.

- Brake actuation force:
  Hand control ≤200N
  Foot control ≤350N for 3-1, 3-2, 3-3, 3-4 vehicles
  ≤500N for 3-5 vehicles

- Number of stops : until the vehicle meets the performance requirements, with a maximum of 6 tests

- For each stop, accelerate the vehicle to the test speed and then activate the brake control under the conditions specified above

4.3.3 Performance requirements

When the brakes have been tested in accordance with test procedure 4.3.2, the stopping distance shall be as specified in column 2 or the MFDD shall be as specified in column 4 of the following table:

Category	STOPPING DISTANCE (S) (Where V is the test speed in km/h and S is in metres)	**OR**	MFDD
For single front brakes only:			
3-1	$S = \leq 0.1\ V + V^2/90$		$\geq 3.4 m/s^2$
3-2	$S = \leq 0.1\ V + V^2/70$		$\geq 2.7 m/s^2$
3-3	$S = \leq 0.1\ V + V^2/115$		$\geq 4.4 m/s^2$
3-4	$S = \leq 0.1\ V + V^2/95$		$\geq 3.6 m/s^2$
3-5	Not applicable		
For single rear brakes only			
3-1	$S = \leq 0.1\ V + V^2/70$		$\geq 2.7\ m/s^2$
3-2	$S = \leq 0.1\ V + V^2/70$		$\geq 2.7 m/s^2$
3-3	$S = \leq 0.1\ V + V^2/75$		$\geq 2.9 m/s^2$
3-4	$S = \leq 0.1\ V + V^2/95$		$\geq 3.6 m/s^2$
3-5	Not applicable		
For CBS, both laden and unladen			
3-1 + 3-2	$S = \leq 0.1\ V + V^2/115$		$\geq 4.4 m/s^2$
3-3	$S = \leq 0.1\ V + V^2/132$		$\geq 5.1 m/s^2$
3-4	$S = \leq 0.1\ V + V^2/140$		$\geq 5.4 m/s^2$
3-5	$S = \leq 0.1\ V + V^2/130$		$\geq 5.0 m/s^2$
For vehicles with CBS – secondary brake only:			
ALL	$S = \leq 0.1\ .\ v + v^2 / 65$		$\geq 2.5\ m/s^2$

4.4 **Dry Stop Test – all service brake controls activated**

4.4.1 Vehicle condition.

- Unladen
- Engine disconnected

4.4.2 Test conditions and procedure

- Initial brake temperature = ≤ 100° C
- Test speed**:** 100 km/h or 0.8 V max, whichever is the lower.
- Minimum test speed = 45 km/h
- Brake application:
  Simultaneous application of both brake controls, if so equipped, or of the single brake control in the case of a service brake system that operates on all wheels.
- Brake actuation force:
  Hand control ≤ 250N
  Foot control ≤ 400N
  ≤500N for 3-5 vehicles
- Number of stops : until the vehicle passes, with a maximum of 6 tests
- For each stop, accelerate the vehicle to the test speed and then apply the brakes under the conditions specified above

4.4.3 Performance requirements

When the brakes have been tested in accordance with the test procedure in 4.4.2, the stopping distance (S) shall be ≤ $0.1\ V + 0.0051V^2$
[where V is the test speed in km/h and S is in metres]
or the MFDD shall be ≥ $7.6 m/s^2$

4.5 **High Speed Test**

4.5.1 Vehicle condition

- Test is applicable to vehicle categories 3-3, 3-4, 3-5
- Unladen
- Engine connected

4.5.2 Test conditions and procedure

- Initial brake temperature ≤ 100° C

- Test speed: 160 km/h or 0.8 V max, whichever is the lower.

- Minimum test speed = 100 km/h

- Brake application:
  Both brake controls shall be activated at the same moment

- Brake actuation force:
  Hand control ≤ 200N
  Foot control ≤ 350N for 3-3, 3-4 vehicles
  ≤ 500N for 3-5 vehicles

- Number of stops : until the vehicle passes, with a maximum of 4 tests

- For each stop, accelerate the vehicle to the test speed and then activate the brake control under the conditions specified above

4.5.3 Performance requirements

When the brakes have been tested in accordance with the test procedure in 4.5.2:

- Stopping distance (S) shall be $\leq 0.1\ V + V^2\ /149$
[where V is the test speed in km/h and S is in metres]
or the MFDD shall be $\geq 5.8 m/s^2$

4.6 **Wet Brake Test**

4.6.1 General information:

- The test comprises two parts that shall be carried out consecutively:
  a. A **baseline** test based on the Dry Stop Test - with single brake control activated.
  b. A single **wet brake** stop using the same test parameters as in a. above but with the brake(s) being continuously sprayed with water in order to assess the effect of riding in wet conditions.

- Test is applicable to vehicle categories 3-1, 3-2, 3-3, 3-4, 3.5

- All brake types must be tested

- The test is not applicable to parking brakes

- This test requires the vehicle to be fitted with instrumentation that gives a continuous read out of vehicle deceleration. The MFDD and the stopping distance alternative are not appropriate in this case.

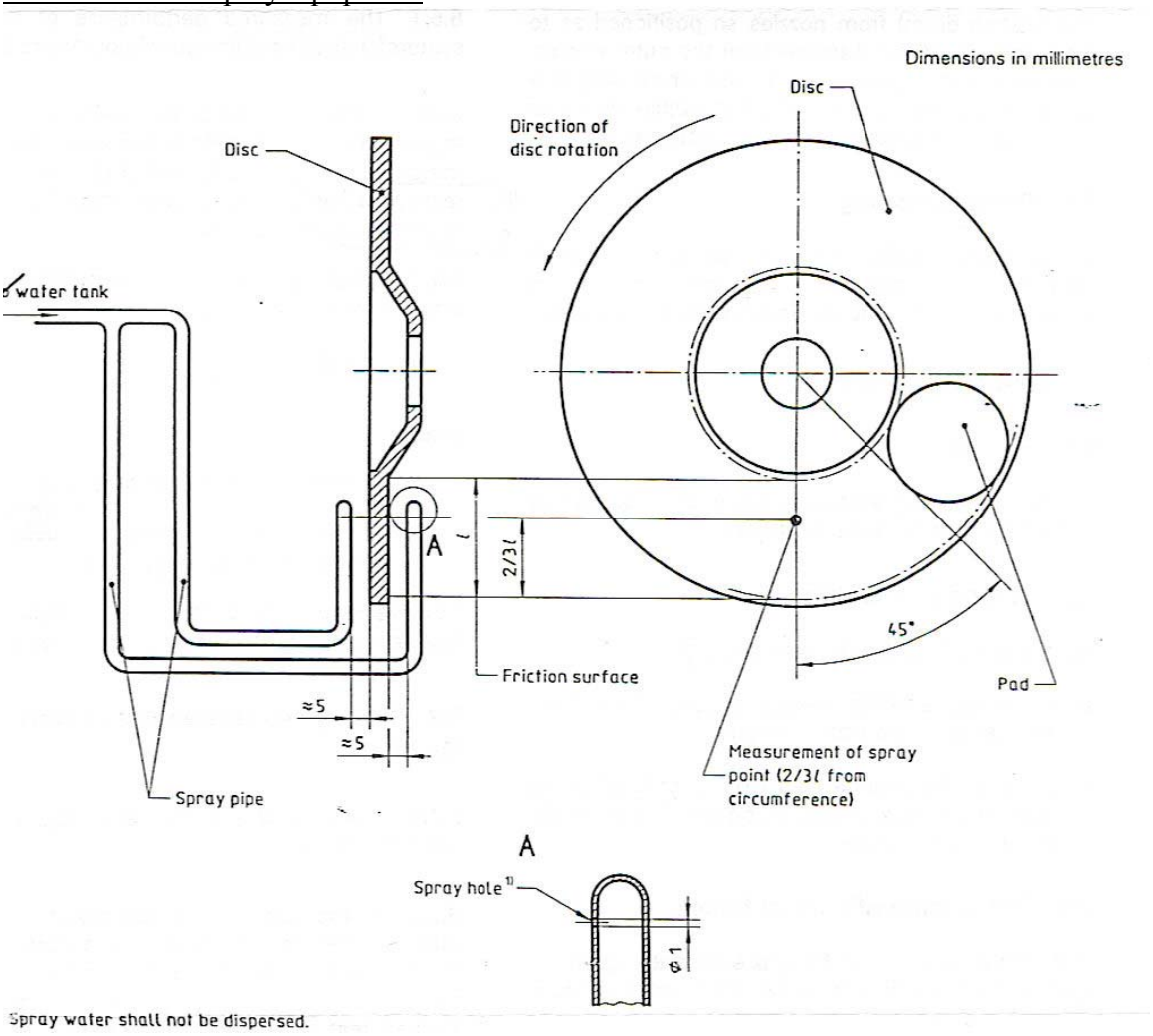
4.6.2 Vehicle condition.

- Laden
  For vehicles fitted with CBS : also unladen

- Engine disconnected

- Each brake shall be fitted with water spray equipment – see sketch.

Sketch of water spray equipment:



Notes on the installation of the water spray equipment:

- Water shall be sprayed onto each brake with a flow rate of 15 l/hr. For disc brakes, the water shall be equally distributed on each side of the rotor.
- If the surface of the rotor has any shielding, the spray shall be applied 45° prior to the shield.
- If it is not feasible to position the spray at 45° as shown on the sketch, or if the spray coincides with a brake ventilation hole or similar, the spray may be moved 90° max prior to this position.

4.6.3 Baseline Test:

- Carry out test number 4.3 (Dry Stop Test - with single brake control activated) for each braking system and measure the brake control force that will produce an average vehicle deceleration of 2.5 m/s^{2}.

4.6.4 Wet Brake Stop:

4.6.4.1 Test conditions and procedure

a. The vehicle shall be ridden at the test speed used in the Baseline test 4.6.3 with the water spray equipment (sketch X) operating on the brake(s) to be tested and with no activation of the brake system.
b. After a distance of ≥500 m., apply the control for the brake system being tested with the same input force as derived in Baseline Test 4.6.3

4.6.5. Performance requirements

When tested in accordance with 4.6.4.1, the wet brake performance shall be:

≥ 60% of the Dry Brake performance recorded in the Base line test in 4.6.3. in the period 0.5 to 1.0 seconds after brake control application.

≤ 120% of the Dry Brake performance recorded in the Base line test in 4.6.3. for the complete stop.

4.7 **Heat Fade Test**

4.7.1 General information:

- The test comprises three parts that shall be carried out consecutively for each brake system:
  a. A **baseline** test based on the Dry Stop Test - single brake control activated (4.3).
  b A **heating procedure** which includes a series of repeated stops in order to heat the brake(s)
  c. A **recovery** stop based on the Dry Stop Test - single brake control activated (4.3), to measure the recovery of the brake's performance after the heating procedure.

- Test is applicable to vehicle categories 3-1, 3-2, 3-3, 3-4, 3-5.

- Test is not applicable to parking brakes or secondary brakes.

- All stops with vehicle laden

- The heating procedure requires the vehicle to be fitted with instrumentation that gives a continuous read out of vehicle deceleration. The baseline and recovery stops require the measurement of either MFDD or the stopping distance.

4.7.2 Baseline Test:

4.7.2.1 Vehicle condition.

- Engine disconnected

4.7.2.2 Test conditions and procedure

- Initial brake temperature = ≤ 100° C
- Test speed **:** 60 km/h
- Brake application:
  Each brake control separately.
- Brake actuation force:
  Hand control ≤200N
  Foot control ≤350N for 3-3 & 3-4 vehicles
  ≤500N for 3-5 vehicles
- For each stop, accelerate the vehicle to the test speed, activate the brake control under the conditions specified above, and record the control force necessary to achieve the required performance.

4.7.3 Heating Procedure

4.7.3.1 Test conditions and procedure

- Initial brake temperature prior to first stop only = ≤ 100 ^{0} C.
- Test speed:
  Front brakes(s): 100 km/h or 0.7 V max, whichever is the lower.
  Rear brake(s): 80 km/h or 0.7 V max, whichever is the lower.
  CBS: 100 km/h or 0.7 V max, whichever is the lower.
- Brake application:
  Each brake control separately.
- Brake actuation force:
  A constant control force that achieves an average vehicle deceleration rate of 3 m/s^{2} for the duration of the first stop.
  The control input force used for the first stop shall be repeated for each of the remaining stops.
- Number of stops: 10
- Interval between stops: 1000 m.

- Engine transmission:
  a. From the test speed to 50% test speed: connected, with the highest gear selected.
  b. From 50% test speed to standstill : disconnected.

- Carry out a stop to the conditions specified above and then immediately use maximum acceleration to reach the test speed and maintain that speed until the next stop is made.

4.7.4 Recovery Stop:

4.7.4.1 Test conditions and procedure

- Perform a single stop following the conditions used in the baseline test (4.7.2) for the brake system that has been heated during test 4.7.3. This stop shall be carried out within one minute of the completion of test 4.7.3 with a mean brake actuation force ≤ the mean force used in 4.7.2.

4.7.5 Performance Requirements

When the brakes have been tested in accordance with 4.7.4.1, performance shall be:

If based on MFDD, ≥ 60% of the average vehicle deceleration recorded in test 4.7.2.

If based on stopping distance, $S_2 \leq 1.67\ S_1 - 0.67 \times 0.1\ V$

Where:
S_1 = average stopping distance in metres achieved in baseline test 4.7.2
S_2 = stopping distance in metres achieved in test 4.7.4.1
V = test speed in km/h.

4.8 **Parking Brake Test – for vehicles equipped with parking brakes**

4.8.1 Vehicle condition.

- Laden
- Engine disconnected

4.8.2 Test conditions and procedure

- Initial brake temperature ≤ 100 ^{0} C.

- Test surface gradient = 18%

- Brake actuation force:
  Hand control ≤ 400 N.
  Foot control ≤ 500 N.

- For the first part of the test, park the vehicle on the test surface gradient facing up the slope by activating the brake system under the conditions specified above. If the vehicle remains stationary, start the measurement of time.

- On completion of the test with vehicle facing up, repeat the same test procedure with the vehicle facing down the gradient.

4.8.3 Performance requirements
When tested in accordance with test procedure 4.8.2, the parking brake system shall hold the vehicle stationary for 5 minutes in both a forward and reverse direction on the gradient.

4.9 **ABS Tests**

4.9.1 General information:

- The tests are only applicable to the brake systems of categories 3-1 and 3-3 vehicles that are equipped with an Anti lock Brake System (ABS)

- The test series comprises the following separate tests, which may be carried out in any order:

ABS TESTS	SECTION
a. Stops on a high friction surface (≥0.8)	4.9.3
b. Stops on a low friction surface (≤0.45)	4.9.4
c. Wheel lock checks on high and low friction surfaces.	4.9.5
d. Wheel lock check - high to low friction surface transition.	4.9.6
e. Wheel lock check - low to high friction surface transition.	4.9.7
f. Stops with an ABS electrical failure.	4.9.8

- The performance of the ABS system shall not be affected by electro magnetic fields. It shall comply with ECE R10 or relevant data shall be provided by the vehicle manufacture.

4.9.2 Vehicle condition

- Unladen

- Engine disconnected

4.9.3 Stops on a high friction surface:

4.9.3.1 Test conditions and procedure

- Initial brake temperature = ≤ 100°C.

- Test speed: 60 km/h or 0.8 V max, whichever is lower.

- Brake application:

a. Each brake control separately.
b. Where ABS is fitted to both brake systems, both controls shall also be activated at the same moment.

- Brake actuation force:
  Hand control = 200N
  Foot control = 350N
  These forces may be increased in order to promote ABS cycling.

- Number of stops: ≥1

- For each stop, accelerate the vehicle to the test speed and then activate the brake control under the conditions specified above.

- Record the stopping distance, or MFDD.

4.9.3.2 Performance requirements

When the vehicle has been tested in accordance with the test procedures in 4.9.3.1, there shall be no wheel lock and the stopping distance / MFDD requirement shall be as follows:

4.9.4 Stops on a low friction surface:

Repeat section 4.9.3 but using a low friction surface instead of a high friction one and without measuring stopping distance or MFDD.

4.9.5 Wheel lock checks on high and low friction surfaces.

4.9.5.1 Test conditions and procedure

- Test surfaces:
  a. High friction
  b. Low friction

- Initial brake temperature = ≤ 100°C.
- Test speed: 80 km/h or 0.8 V max, whichever is lower.

- Brake application:
  a. Each brake control separately.
  b. Where ABS is fitted to both brake systems, both controls shall also be activated at the same moment.

- Brake actuation force:
  Hand control = 200N
  Foot control = 350N
  These forces may be increased in order to promote ABS cycling.

- Brake application rate:
  The brake actuation force shall be applied in 0.2 – 0.5 seconds

- Number of stops: ≥1

- For each stop, accelerate the vehicle to the test speed and then activate the brake control under the conditions specified above. The brake control may be released and the test concluded when the vehicle speed has reduced by [20 km/h] ?.

- Record wheel lock rotation.

4.9.5.2 Performance requirements

When the vehicle has been tested in accordance with the test procedures in 4.9.5.1, there shall be no wheel lock.

4.9.6 Wheel lock check - high to low friction surface transition.

4.9.6.1 Test conditions and procedure

- Test surfaces:
  A length of high friction surface immediately followed by a length of low friction surface.

- Initial brake temperature = ≤ 100°C.

- Test speed:
  The speed that will result in 50 km/h at the point where the vehicle passes from the high friction to the low friction surface.

- Brake application:
  a. Each brake control separately.
  b. Where ABS is fitted to both brake systems, both controls shall also be activated at the same moment.

- Brake actuation force:
  Hand control = 200N
  Foot control = 350N
  These forces may be increased in order to promote ABS cycling.

- Number of stops: ≥1

- For each stop, accelerate the vehicle to the test speed and then activate the brake control under the conditions specified above. The brake control may be released and the test concluded when the vehicle speed has reduced by [20] km/hr after crossing the surface transition point.

- Record wheel rotation.

4.9.6.2 Performance requirements

When the vehicle has been tested in accordance with the test procedures in 4.9.6.1, there shall be no wheel lock.

4.9.7 Wheel lock check - low to high friction surface transition.

4.9.7.1 Test conditions and procedure

- Test surfaces:
  A length of low friction surface immediately followed by a length of high friction surface.

- Initial brake temperature = ≤ 100°C.

- Test speed:
  The speed that will result in 50 km/h at the point where the vehicle passes from the low friction to the high friction surface.

- Brake application:
  a. Each brake control separately.
  b. Where ABS is fitted to both brake systems, both controls shall also be activated at the same moment.

- Brake actuation force:
  Hand control = 200N
  Foot control = 350N
  These forces may be increased in order to promote ABS cycling.

- Number of stops: ≥1

- For each stop, accelerate the vehicle to the test speed and then activate the brake control under the conditions specified above.

- Record any wheel lock, and the vehicle's continuous deceleration.

4.9.7.2 Performance requirements

- When the vehicle has been tested in accordance with the test procedures in 4.9.7.1, there shall be no wheel lock.

- After passing over the transition point between low and high friction on the test surface, the vehicle deceleration shall rise to [at least the minimum performance requirements for MFDD as specified in the appropriate section of the table in section 4.3.3., in X secs.]

4.9.8 Stops with an ABS electrical failure.

4.9.8.1 Test conditions and procedure

- Carry out test 4.3 (Dry stop test – with single brake control activated) applying the conditions relevant to the brake system and vehicle being tested.

4.9.8.2 Performance requirements

When the brakes have been tested in accordance with test procedure 4.9.8.1, the minimum requirements for stopping distance or MFDD shall be as specified in the **single rear brakes only** section of the table in 4.3.3.

4.10 **Partial failure test – for split service brake systems**

4.10.1 General information:

- Test is only applicable to vehicles that are equipped with split service brake systems.

- Test is to confirm the performance of the remaining sub system in the event of a hydraulic system leakage failure.

4.10.2 Test conditions and procedure

- Initial brake temperature: ≤ 100°C

- Test speeds: 50 km/h and 100 km/h [or 0.8 V max, whichever is lower.]

- Minimum test speed = 24 km/h

- Brake actuation force:
  Hand control ≤ 250N
  Foot control ≤ 400N

- Number of stops: until the vehicle passes, with a maximum of 6 tests.

- The service brake system must be altered to induce a complete loss of braking in any one subsystem. Then, for each stop, accelerate the vehicle to the test speed and then apply the brakes under the conditions specified above. Repeat for each subsystem.

4.10.3 Performance requirements

When the brakes have been tested in accordance with test procedure 4.10.2, the stopping distance or MFDD shall be as specified below.

If based on deceleration, MFDD ≥ 3.3 m/s²
If based on stopping distance, $S \leq 0.1V + V^2/85$
Where: S = stopping distance in meters; V = test speed in km/h

ATTACHMENT 1

PROVISIONAL LIST OF DEFINITIONS

Alphabetical

TERM	DEFINITION	SOURCE
ABS (Anti Lock Brake system)	A system which automatically modulates the pressure producing the braking forces at the wheel(s) to limit the degree of wheel slip.	ISO 611:2003
Baseline Test	A series of stops [minimum = 3, maximum = 6] carried out in order to confirm the performance of the brake prior to subjecting it to a further test e.g. Heating procedure or Wet brake stop.	JC
Brake	Parts in which the forces opposing the movement of the vehicle are developed.	ISO 1710:1995
Brake system	Combination of parts (excluding the engine) whose function is progressively to reduce the speed of a moving vehicle or bring it to a halt, or keep it stationary if already halted. The system consists of the Control, the Transmission, and the Brake.	ISO 12364
CBS (Combined Brake System)	2 wheeled vehicles: a brake system where at least two brakes on different axles are actuated by the operation of a single control. Category 3.2 & 3.5: a brake system where the brakes on all axles are actuated by the operation of a single control. Category 3.4: a brake system where the brakes on at least the front and rear axles are actuated by the operation of a single control. (Where the rear wheel and sidecar wheel are braked simultaneously, this is regarded as the rear brake.)	ECE R78
Control	Part actuated directly by the rider in order to supply the energy to the transmission required for braking the vehicle.	ISO 12364
Controller	Component designed to evaluate and operate on data transmitted by a sensor and transmit signals to the modulator	ISO 12364
Engine Disconnected	When the engine is no longer connected to the driving wheels.	NR
Initial Brake Temperature	Temperature of the hottest brake 0.32 km. before any brake application.	FMVSS 135
Gross Vehicle Mass (Laden)	Maximum mass of the fully laden vehicle based on its construction and design performances, as declared by the manufacture.	SR1
Modulator	Component designed to vary braking force in	ISO 12364

	accordance with the signal received from the controller	
Peak Friction Coefficient (PFC)	Ratio between the maximum value of a standard test tyre's braking force occurring prior to wheel lock and the simultaneous vertical force, as the braking torque is increased, and measured in accordance with the procedure in ASTM E1337-90.	ISO 611:2003? ASTM E1337-90
Sensor	Component designed to identify and transmit to the controller conditions of rotation of the wheels or other dynamic conditions of the vehicle.	ISO 12364
Single brake system	A brake system which acts on only one axle	IMMA
Split service brake system	A brake system consisting of two or more subsystems actuated by a single control designed so that a single failure in any subsystem (such as a leakage type failure of a hydraulic subsystem) does not impair the operation of any other subsystem.	FMVSS 135
Stopping distance	Distance travelled by the vehicle from the point of application of the control to the point at which the vehicle reaches a full stop.	FMVSS 135
Test speed	Vehicle speed measured at the moment the rider begins to actuate brake system control(s)	ISO 12364
Transmission	Combination of components which provide the functional link between the control and the brake.	ISO 1710:1995
Mass in running order (Unladen)	Sum of the nominal mass of the complete vehicle (as determined by SR1) and the driver's mass.	SR1
V max	Means the highest speed attainable by accelerating at a maximum rate from a standing start for a distance of 3.2 km on a level surface, with the vehicle at its lightly loaded vehicle weight.	FMVSS 135
Wheel lock	The condition that occurs when there is a slip ratio of 1.00. Note: In practice, wheel lock is judged to have occurred when the vehicle speed exceeds 15 km/h while the wheel speed falls below 5 km/h.	ISO 12364
Average Deceleration		