Global Technical Regulation on motorcycle braking: report to 51/GRRF.

1. Introduction

Following the establishment of the Global Agreement, IMMA outlined a programme of work at 46/GRRF which it would complete in order to prepare a proposal for a Global Technical Regulation (GTR) for brakes on L-category vehicles.

The main part of the programme was the analysis of the relative severity of the existing regulations, because no contracting party would be able to accept a level of performance which was lower than it's current requirements. The comparison was made between the ECE R78, Japan's Safety Standard 12-61 and the US FMVSS 122 requirements, because these two regulations represent the test procedures in all the other regulations and standards from around the world. In certain cases, e.g. the high speed test, IMMA found that the Japanese regulation provided the most suitable version of the basic test procedure.

Comparative assessments were made on the four tests, (i.e. dry, wet, heat-fade and high speed,) and presentations have been made to 48/, 49/ and 50/GRRF. This report summarises these previous presentations and sets out IMMA's proposal for a GTR.

The results of the comparative work are presented in tabular form (Annex 1), with the basic data contained in an Appendix.

The IMMA proposal is also presented in tabular form (Annex 2). It is IMMA's experience that it is easier to keep the technical issues clear if the points are discussed on the basis of a table, before turning the final, agreed version of the table into a text. The text will be drafted in line with any guidelines agreed by WP29: these are currently under discussion.

2. The results of the comparative assessments

The table in Annex 1 itemises the different requirements in the regulations and then summarises the content of FMVSS 122, ECE R78 and Japan's SS 12-61 in separate columns. The next column summarises the results of the severity comparison. The final column contains additional comments and, for convenience, a brief reference to the relevant parallel sections in the car regulation R13H/FMVSS 135.

The results have already been presented to GRRF but in summary:

- for the dry stop test, ECE R78 was the most severe
- for the high speed test, the Japanese test was the most severe
- for the heat-fade test, ECE R78 was the most severe
- for the wet-test, ECE R78 was the most severe, with the case of drum brakes needing further discussion (see below).

3. The IMMA proposal

The proposal is based on the results of the severity test and adopts the ECE testing philosophy.

The table in Annex 2 starts with a copy of the column containing the results of the severity test from Annex 1. The next column contains the IMMA proposal and the last column contains comments and appropriate references to R13H/FMVSS 135.

Where the requirements of the regulations are not measurable, IMMA has followed the logic of taking the most demanding requirement. Where the reasoning behind these decisions is not self-evident, it is included in the comment column.

4. Items requiring further discussion

The items which require further discussion are:

1. whether or not to include quadricycles, which depends on the vehicle categorisation decisions in the GRSG Common Tasks Group
2. which kind of wet brake test to use for drum brakes
   (Note: the ECE test is a good test for disc brakes and for most situations with drum brakes. There have been no reports of problems with drum brakes in service but there is a potential problem when fording rivers or when the roadway is inundated. IMMA seeks GRRF's views on the need for a specific water recovery test for drum brakes. If GRRF considers it necessary IMMA will continue to work on this issue.)
3. modifying the wet-test for modern CBS systems, for which the current brake control forces are too low to obtain reliable results
4. control layouts, in the light of new control technologies, i.e. brake by wire
5. whether there is a need for minimum actuation forces
6. whether there is a need for partial failure testing
7. the language for master-cylinder labelling, if any labelling is required

Dr NM Rogers

ECE/FMVSS/Japan Severity Comparison Test by IMMA

1.Summary of the data for Dry Test

(1) Test Method

* Conduct FMVSS/ECE dry brake tests using large and small motorcycles
* Method of comparing stringency

Test I: Compare the braking force necessary to obtain the minimum decelerations prescribed by FMVSS and ECE..

Test II : Compare the decelerations obtained with the same braking force.

(2) Test condition

Items	Reg.	FMVSS 122	ECE R78
Pattern		Simultaneous front/rear service brake operation from vehicle speed of 30mph	Separate front/rear service brake operaion from vehicle speed of 60km/h
Weight		unladen	Laden
Braking Force	Test I	The force measured at the time of deceleration reaching the 6.85 m/s^2 limit	The force measured at the time of deceleration reaching the 4.4(F) and 2.9(R) m/s^2 limit
	Test II	Same braking force as Test I	Same braking force as FMVSS

(3)Test vehicle 6 motorcycle models Large displacement: A =1500, B =1300, C =750 cc
Small displacement : D= 225, E= 125, F=125 cc

(4)Test results

Test I: Braking force necessary for compliance (N)

Test vehicle	Reg.	FMVSS 122	ECE R78	Date/Test place
A	Front	123	142	2000.12.15
	Rear	154	148	/ Japan
B	Front	62	56	2001.1.10
	Rear	52	95	/Japan
C	Front	39	42	2000.12.20
	Rear	74	185	/Japan
D	Front	97	88	2001.1.10
	Rear	77	150	/Japan
E	Front	91	108	2000.12.15
	Rear	97	121	/Japan
F	Front	72	75	2000.12.20
	Rear	98	255	/Japan

Test II : Deceleration G by same braking force as Test I of FMVSS (m/s^2)

Test vehicle	Reg.	FMVSS 122	(Required)	ECE R78	(Required)	Date/Place
A	Front			4	(4.4)	2000.12.15/Japan
	Rear			2.8	(2.9)	
	F+R	6.8	(6.85)	6.8	*(7.3)	
E	Front			3.8	(4.4)	2000.12.15/Japan
	Rear			2.3	(2.9)	
	F+R	6.9	(6.85)	6.1	*(7.3)	

* = (Calculated)

(5) Conclusion

1.FMVSS and ECE requirements are equally stringent with respect to the front service brake.

2.ECE requirement is more stringent than the FMVSS requirement with respect to the rear service brake.

3.The lowest necessary braking force for satisfying the FMVSS requirement is not sufficient to obtain the minimum deceleration required by the ECE.

Therefore for the dry stop test, ECE R78 (=Japan) is the most severe.

ECE/FMVSS/Japan Severity Comparison Test by IMMA

2 .Summary of the data for Heat Fade Test

(1) Test Metod

* Conduct FMVSS/ECE heat fade tests using a middle sized motorcycle
* Method of comparing stringency

Measure the temperature of brake pad during the ten stops required by each regulation.

Compare the resulting temperature levels between FMVSS & ECE.

(2) Test condition

Items Reg.	FMVSS 122	ECE R78
Pattern	Simultaneous front/rear service brake operation from vehicle speed of 60 mph (96 km/h)	Separate front/rear service brake operation from vehicle speed of 100km/h(front)& 80km/h(rear)
Weight	unladen (291kg)	laden (380kg)
Number of stops	10 stops	10 stops
Braking interval	640 m	1000 m

(3)Test vehicle

motorcycle model a middle sized displacement: A = 600 cc

Brake system: Front; Disc (Dual)

Rear: Disc (Single)

(4)Test results

Date: 1999.11.30 Test place: JARI (Japan)

Test data	Reg.	FMVSS 122	ECE R78	Reference
Deceleration		6.6m/s^2	3m/s^2	(10 stops average)
Braking Force				
	Front	38N	30N	(10 stops average)
	Rear	106N	184N	(10 stops average)
Temperature	(Front brake pad)			
	Start	40°C	58°C	
After 10	stops	138°C	226°C	
Peak	(Max.)	177°C	266°C	
Temperature	(Rear brake pad)			
	Start	45°C	50°C	
After 10	stops	165°C	373°C	
Peak	(Max.)	222°C	465°C	

(5) Conclusion

1.During the heat fade procedure, the ECE test temperature is higher than that of the FMVSS, for both front and rear service brakes.
2.The condition for the ECE Heat Fade test are clearly stricter than for the FMVSS test. Therefore the ECE requires a higher recovery performance than FMVSS for compliance.

For the heat fade test , ECE R78 (=Japan) is the most severe.

ECE/FMVSS/Japan Severity Comparison Test by IMMA

3. Summary of the data for High Speed Test

(1) Test Metod

* Conduct FMVSS/Japan high speed tests using large size motorcycle
* Method of comparing stringency

Compare the average braking forces needed satisfy each regulation.
The higher the force,the more severe.

(2) Test condition

Items Reg.	FMVSS 122	ECE R78
Pattern	Simultaneous front/rear service brake operation from vehicle speed of 192 km/h (160 mph)	Simultaneous front/rear service brake operation from vehicle speed of 160 km/h
Weight	unladen	unladen
Engine	disconnected	connected
Deceleration	5.4 m/s^2	5.8 m/s^2

(3)Test vehicles

4 motorcycle models — large size displacement: A,B,D = 1000 cc C: = 900 cc
Brake system: Front; Disc (Dual)
Rear: Disc (Single)

(4)Test results

Braking force necessary for compliance (N)

Test vehicle	Reg.	FMVSS 122 (kph/G)	(N)	Japan (kph/G)	(N)	Date/Test place
A	Front	(193/5.5)	21	(162/5.9)	26	2001.8.9
	Rear		52		55	/Japan
B	Front	(194/5.5)	20	(158/5.9)	20	2001.8.24
	Rear		60		70	/Japan
C	Front	(192/5.4)	33	(161/5.8)	35	2001.8.25
	Rear		68		69	/Japan
D	Front	(193/5.6)	26	(161/5.9)	35	2001.9.3
	Rear		53		63	/Japan

(5) Conclusion

1.The Japanese test needs higher braking forces for compliance than the FMVSS test.

2.ECE has no requirement for deceleration.

Therefore for the high speed test the Japanese test is more severe than the FMVSS test.

Comparison of the wet test in ECE Regulation 78 and FMVSS 122

Vehicle: L3, 2 disc brakes, 4 caliper pistons per disc, sintered metal pads

	Unladen		Laden	
	ECE	FMVSS	ECE	FMVSS
Baseline force (F) N	31N	36	34	39.5
Deceleration (d):				
Specified	2.5 m/s^2		2.5 m/s^2	
Obtained	2.28 m/s2		2.14 m/s2	
dwet/ddry	91.20%		85.60%	
F needed per stop:				
1		45		48.5
2		41.5		44.5
3		39.5		41.5
4		38		40.5
5		37		40.2
% recovery at 5th stop (Fdry/Fwet)		97.30%		98.26%

At the 5th FMVSS stop the brake is effectively dry. In the ECE test the brake remains wet

BRAKE PAD WATER ABSORPTION & RETENTION TESTING

SIX PAD AVERAGE

DATE: 19/01/2001
AVERAGE OF 6 SAMPLES
DRY WEIGHT : 157.98 WITH TC & WIRE - AVERAGE OF (6) SIX PADS
CHAMBER TEMP : 160 ºF

PRETEST CONDITIONS (PAD HAD A 5 MINUTE SOAK AT CHAMBER TEMPERATURE PRIOR TO STARTING TEST)

0 MINUTES SOAK IN WATER 65 º F

2 MIN REMOVE STANDING WATER

4 MIN WET WEIGHT 159.65 GRAMS AVERAGE (+1.67 GRAMS AVERAGE)

6 MIN PUT IN CHAMBER

TEST RUN LOG

AVERAGE				AVERAGE	AVERAGE	AVERAGE
TIME (SECONDS)		PAD		PAD	PAD WT.	WEIGHT
IN CHAMBER		TARGET TEMP		WEIGHT	CHANGE	LOSS (%)
15		120º F		159.40	0.250	15.00%
16		130º F		159.15	0.500	30.00%
22		140º F		158.85	0.800	48.00%
28		145º F		158.62	1.030	62.00%
37		150º F		158.46	1.190	71.00%
96		155º F		158.32	1.330	80.00%

GLOBAL HARMONIZATION OF PTW, AND 3W [AND QUADRICYCLES[1]] BRAKING

SUMMARY CHART COMPARING FMVSS 122, ECE R78 AND JAPAN SAFETY STANDARD No. 12 + 61.

Updated : 29th Jan 2002 following 6/BHTF meeting + Japan SS data.

ITEM	FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
1	Scope	S1- S3. – Performance requirements for motorcycle brake systems. (including mopeds)	1. Applies to the braking of 2 and 3 wheeled vehicles. Excludes those with V max < 25 km/h and fitted for invalid drivers. Summary of vehicle categories : L1 = 2 wheels, engine < 50cc and max speed < 50 km/h L2 = 3 wheels, engine < 50cc and max speed < 50 km/h L3 = 2 wheels, engine > 50 cc or max speed > 50 km/h L4 = 3 wheels – asymmetric, engine > 50 cc or max speed > 50 km/h (motorcycle + sidecar) L5 = 3 wheels – symmetrical, max weight <1000kg., engine > 50 cc or max speed >50 km/h .	Applies to the braking of 2 wheeled motor vehicle and motor driven cycle with 2, 3, and 4 wheels. Summary of categories:-2 wheels, engine >125cc 2 wheels, with sidecar, engine >125cc Motor driven cycle: -Class = engine < 50cc and max speed <50 km/h -Class = engine >50 cc and max speed >50 km/h -Class =engine <125cc		In Europe and Japan, there are separate Moped requirements. Scope will apply to “L category” vehicles – depending on the outcome from GRSG Common Task Group. [1] – Inclusion of Quadricycles depends on outcome from GRSG Common Task Group.
2	Definitions	S4. – In total : - “Braking interval” - “Initial brake temperature” - “Skid number” - “Stopping distance” - “Split service braking system” = a system consisting of 2 or more subsystems actuated by a single control. Leakage in 1 subsystem shall not impair the other.	2. – Includes : - “Braking device” - “Control” - “Transmission” - “Brake” - “Combined brake system” “Skid number” is not used.	Includes : - “Service brake system” - “Operation system” - “Maximum speed” - “Brake temperature before braking” - “Stopping distance” -“Linked brake function” - “Average saturated deceleration”		Review after tests have been agreed.

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
3	Requirements	S5.– Conditions and test procedures Notes : - Brake performance is based on stopping distance measured in feet. - If vehicle cannot meet test speed, use 5 mph (ie. 4 to 8 mph) less than speed attainable in 1 mile. - Max speed = 120 mph.	- Brake performance based on Mean Fully Developed Deceleration – MFDD - If vehicle cannot meet test speed, generally use v max or % of v max.	- Brake performance based on stopping distance measured in m. - If vehicle cannot meet test speed, generally use v max or % of v max		To be specified for each test. - ECE philosophy proposed eg. brakes tested separately.
4	Type of service brake system	S5.1 – Each motorcycle shall have a split service brake system OR two independently actuated service brake systems. FMVSS 123 specifies requirements for controls: -123 S5.2.1 - For auto gearbox, supplemental rear brake control shall be on left. - 123 S5.2.1 - For self proportioning brakes or ABS with single control, the rear control position shall be used.	2.9.1 – For CBS, L_1 and L_3 vehicles have 2 brakes on different wheels actuated by a single control. 5.2.1 – For L_1 and L_3, 2 service braking devices with independent controls and transmissions acting on at least the front and rear wheel. 5.2.3 – L_2 and L_5 shall have 2 independent service braking devices which activate the brakes on all wheels.	The service brake system shall have 2 independent control devices and shall work on the wheel including the front one by means of one of the control devices and on the wheel including the rear one by means of the other control device.		FMVSS allows 1 or 2 controls but meaning must be clarified – see also definitions. Controls issue requires further discussion (13H : 5.2.2.1 – There must be at least 2 independent controls for service and parking)

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
5	**Mechanical service brake system**	S5.1.1. – Failure of any component in a mechanical service brake system shall not result in a loss of braking ability in the other service brake system.	5.2.1.1 – Parts such as the brake, cylinder, pistons, etc., shall not be regarded as liable to breakage if they are amply dimensioned, readily accessible for maintenance and exhibit sufficient safety features. The 2 service braking devices may have a common brake so long as a failure in 1 does not affect the performance of the other.	Similar to ECE		Propose ECE (13H : 5.2.2.8 - ..parts such as pedal etc. shall not be regarded as liable to breakage, exhibit safety features, able to brake the vehicle with a degree of effectiveness …)
6	Hydraulic service brake system	S5.1.2 – A leakage failure in a hydraulic service brake system shall not result in a loss of braking ability in the other service brake system.				Propose ECE (13H : 5.2.3 – hydraulic failure shall be signalled to the driver …tell tale to show differential pressure)
7	Master cylinder reservoirs	S5.1.2.1. – Each m/cylinder shall have a separate reservoir for each brake circuit and openings having their own cover etc Each reservoir shall have a min. capacity based on 1.5 times volume required to cover difference between new and fully worn linings – brakes applied.	5.2.8 – Design of these receptacles so that the level of the reserve fluid can be easily checked. 5.2.7.2 – Control, transmission, and brakes must have reserve of travel such that effective braking is ensured when the brakes are heated and worn.	No such requirements.	FMVSS is more severe	Propose FMVSS (13H : 5.2.3 - Tell tale to light up when reservoir is below a certain level – specified by manufacturer)
8	Reservoir labelling	S5.1.2.2. – Brake fluid warning statement that specifies : - Text and size of letters - Method of application - Location	No such requirements	No such requirements	FMVSS is more severe	Propose FMVSS Language requirements to be discussed.

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
9	Failure indicator lamp	S5.1.3 – Additional requirement for vehicles with split service brake systems S5.1.3.1 – Details of the lamp function : - Position - When it functions eg. pressure failure, low reservoir level. - Ignition switch activation etc. - Colour and marking of lens	No such requirements	Same as ECE	FMVSS is more severe	Propose FMVSS (13H : 5.2.3 – visible in daylight, easily seen, can be used for parking brake and hydraulics)
10	Parking brake characteristics	S5.1.4 – For 3 wheelers only	For 3 wheelers only. 5.1.2.3 – must hold the vehicle stationary on a slope in the absence of the driver. Working parts locked in position by a mechanical device, actuated from the driving seat. 5.2.3 – L_2 and L_5 shall be equipped with : a secondary (emergency) braking device which may be the parking brake. 5.2.4.1. and 5.2.4.2 for L5	Applies to 2 wheeled motor vehicle with sidecar if fitted parking brake system only.	See item 17	(13H : 5.1.2.3 – Similar note to Reg 78)
11	Inspection of pad/lining	S5.1..5 – Lining thickness of drum brakes shall be visually inspected without removing drums and pad thickness visible without removal.	No such requirements	Same as ECE	FMVSS is more severe	Propose FMVSS (13H : 5.2.11.2 – must be possible to check wear on linings from outside or underside vehicle with normal tools)

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
12	Pre burnish	S5.2.1& S7.3.1 – Service brake. Stops from 30 and 60 mph to meet requirements. S5.2.2 & S7.3.2 – Partial service brake. As S5.2.1 but for each independently actuated brake system.	No such requirements	Same as ECE	FMVSS is more severe	Modern friction materials require less burnishing. Burnishing procedure should be manufacturers responsibility. (FMVSS 135 S6.3.3 – At start of tests, brakes are in same condition as when vehicle manufactured. No burnishing is allowed unless all vehicle are sold that way.)

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
13	Dry stop tests -High speed test	S5.3 & S7.5 Second Effectiveness– Stops using both brakes, engine disconnected, and vehicle unladen with following requirements: 30 mph – 43 ft → a_{30} = 6.87 m/s^2 60 mph – 185 ft → a_{60} = 6..38 m/s^2 80 mph – 345 ft → a_{80} = 6.07 m/s^2	Annex 3 – 2.1.1 – 2.2.2.2 Single braking device or CBS tests with the vehicle generally laden from 60 km/h. (L_1 + L_2 at 40 km/h) If single brake cannot reach prescribed decel (L_3 = 4.4 m/s^2 Front , 2.9 m/s^2 Rear) , use vehicle laden with both braking devices together to meet (L^3 = 5.8 m/s^2)	Similar to ECE but no requirement for using vehicle laden with both braking devices together.	Report to 49/GRRF :- A range of motorcycles were tested to compare brake force req'd for FMVSS & ECE decels and to compare resulting decels using same braking force. Result – For front, FMVSS & ECE similar For rear, ECE requires more force Lowest braking force for FMVSS does not meet ECE requirement. ECE test is therefore more severe.	60 km/h test speed is adequate because: - the motorcycle is laden - brakes tested seperately - high speed test covers upto 192 km/h - fade test is at 100 km/h Thus, performance is covered over a range of speeds.
		As above but from a speed of : 1 mile full accel. . Max speed = 120 mph (192 km/h) Stopping distance = 861 ft. max (equivalent to 5.4 m/s^2)	Annex 3 – 1.4.3 L_3,L_4 & L_5 vehicles unladen using both brakes with engine connected from a speed of 160 km/h or 0.8 v max whichever is less. Max practical performance and vehicle behaviour shall be recorded. Note : Test also performed at lower speeds – down to 30% v max.	Similar to ECE but with min. mfdd = 5.8 m/s^2	Report to 50/GRRF :- The following were compared for each regulation: a. Braking force b. Kinetic energy c. Behaviour when braking Result (from above): aJapan reg is more severe due to higher decel. b.FMVSS is more severe due to higher speed c.Japan/ECE is more severe as it is not specified in FMVSS Japan test more severe.	An increase in test speed to 192 km/h results in the Japan test being more stringent in all aspects. Use the Japan test procedure with increased test speed.

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
14	Fade and recovery Fade baseline check Fade test Recovery test	S5.4 - Not applicable when the max speed attainable in 1 mile < 30 mph * S5.4.1 & S7.6.1 – Using both brakes, 3 stops from 30 mph at 10 to 11 f/s^2 (= 3.05 to 3.35 m/s^2) Compute the average of the max brake pedal and max brake lever forces → F_{ave} (pedal and lever forces to be within specified limits) S5.4.2 & S7.6.2– Using both brakes, and vehicle unladen, 10 stops from 60 mph at > 15 f/s^2 (= 4.57 m/s^2) with 0.4 mile between each service brake application. After 10th stop, drive 1 mile at 30 mph and conduct recovery test. S5.4.3 & S7.6.3- 5 stops from 30 mph at 10 to 11 f/s^2. Braking interval < 1 mile. 5th stop forces within +20 and –10 pounds of baseline F_{ave}	Annex 3 – 1.6.1.1 L_3,L_4, and L_5 in laden condition. If CBS, only CBS to be fade tested Annex 3 – 1.6.1.2 1 Dry stop test (Service braking) – as in item 13 above. Annex 3 – 1.6.1.2.2 - 10 stops with vehicle laden. - Test each brake separately (if CBS, then only CBS) - Speeds – Front + CBS = 100 km/h Rear = 80 km/h - Braking interval = 1000 m - Suitable gear for 50% stop, engine disconnected for remainder. - Decel = 3 m/s^2 with constant force. Annex 3 – 1.6.1.2.3 Repeat Fade Baseline Check ASAP or at least within 1 minute after completion of fade test. 1.6.3 – Decel = > 60% of baseline test	Same as ECE	Report to 49/GRRF :- A mid size (600cc) motorcycle was tested – performing 10 fade stops to both FMVSS and ECE. Brake temperatures during tests were compared. Result – Front and rear brake temperatures were higher during ECE test. Therefore ECE test is more severe.	Mopeds not included in ECE (*or FMVSS)

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
15	Final effectiveness test	S5.5,S5.5.1 & S7.8 , S7.8.1 – Repeat of Dry stop test S5.3 & 7.5 above. Not applicable to motorcycles with a max speed attainable in 1 mile of < 30mph.	No such requirements	No such requirements		Not required – brakes fully burnished before testing. For dry stops, see item 13.
16	Partial failure	S5.5.2 – In the event of a hydraulic type failure, the remaining portion of the service brake system shall be able to meet the required stopping performance. eg. 173 ft from 40 mph (Approx 3.4 m/s^2) S7.8.2 – For 3 wheelers only. Simulate failures of subsystems and make 6 stops from 30 and 60 mph to check reservoir and failure warning device performance.	Covered by having 2 separate brake systems.	Similar to ECE		FMVSS partial failure tests are with single brake therefore same principle as ECE. See 13 – dry test comparison. Severity of partial failure tests needs checking because ECE is laden and FMVSS unladen. Further investigation on the exact application of FMVSS under investigation by USSMA.

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
17	Parking brake system efficiency	Only for laden 3 wheelers. S5.6 Static - - 30% slope; both directions - 5 minutes. - Brake forces: hand operated system< 55 pounds; foot operated system< 90 pounds (= 245 N/400 N) S7.9 Dynamic – As Static but: - Drive the motorcycle down the slope and stop using 90 lbs service brake force. - Apply parking brake as above for 5 mins. - Repeat up the slope.	Annex 3 – 2.3 - Laden vehicle - 18% slope - up and down. Brake forces: hand < 400N; foot < 500 N	Same as ECE	FMVSS test is more severe for slope and applied forces but vehicle is unladen.	See item 10. IMMA has no strong view but prefers ECE.

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
18	Wet braking Baseline check Wet brake test	S5.7 – Tests with both brakes and unladen vehicle. S5.7.1 - 3 stops from 30 mph at 10 to 11 f/s ^{2} ¨ . Compute the average of the max input forces to F_{ave} S5.7..2 - Completely immerse the rear brake and then the front brakes for 2 minutes with the brakes fully released. Followed by 5 stops from 30 mph at 10 to 11 f/s^2. Braking interval < 1 mile. For the 5 stops, lever/ pedal forces shall not exceed 55 lbs. For 5th stop forces shall be within + 20 and – 10 pounds of F_{ave}.	Annex 3 – 1.4.4 - Same vehicle/test conditions as Dry brake test (Item 13) - For vehicle categories L_1, L_2, L_3, L_4. - Exemption for conventional drum and fully enclosed disc brakes Annex 3 – 2.5.2 - Carry out a Dry Brake test and measure the control force at 2.5 m/s^2 Annex 3 – 2.5 - With equipment continuously wetting the brakes at a flow rate of 15 l/h., Mfdd attained between 0.5 and 1 sec after brake application to be > 60% and <120% of mfdd for dry brakes performance ie. Base line check.	Same as ECE	Report to 49/GRRF :- A large motorcycle was tested in laden and unladen condition to compare the %age recovery rate (FMVSS) with wet v dry brake (ECE). Result- At first recovery stop, FMVSS is similar to ECE. After 5 FMVSS stops, brake is dry. ECE test is more severe.	There are different FMVSS v ECE philosophies – - FMVSS is a static immersion test to simulate passing through deep water. - ECE is a dynamic spray test to simulate very heavy rain on a normal road. Disc and drum brakes will behave differently for each test. New test proposal for CBS under discussion in IMMA.
19	Design durability	S5.8 – During tests, there shall be no lining detachment, no component fracture, and no leakage of fluid.	No such requirements	No such requirements	FMVSS is more severe	No experience of such failures. If necessary, FMVSS text could be used. (13H : 5.1.1.1 + 5.1.1.2 – Braking system designed so that it complies despite vibration, corrosion and ageing)

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
20	**Test conditions**					
21	Vehicle weight	S6.1 Unloaded vehicle (including driver and instrumentation) plus 200 pounds	In general, vehicle is fully laden except : - High speed test(1.4.3) unladen. - CBS tests laden and unladen - ABS tests unladen Notes: 1. Fully laden = manufacturers max mass. unladen = rider and test equipment 2. Test with rider alone not required if calcs show that >2.5 m/s^2 is possible	In general, vehicle is fully laden except : - High speed test unladen - ABS test unladen - CBS test laden only Definitions : 1.Laden = "Loaded" From GVW to GVW + 65 kg. 2.Unladen = "Unloaded" From vehicle weight plus 55 kg to 100 kg.	ECE is more severe	Loading conditions to be specified for each test. General definitions of mass will be decided by GRSG.
22	Tyre pressure	S6.2 Manufacturers recommendation.	Annex 3 – 1.3.1.1 Prescribed by manufacturer.	Prescribed by manufacturer +/- 10kpa		Recommend ECE (13H : 1.2.6 – at the start of the tests, tyres must be cold and at the pressure prescribed for the load borne by the wheels)
23	Transmission	S6.3 Unless otherwise stated, all stops are made with the clutch disengaged (engine disconnected)	In general, apart from vehicles with automatic gearboxes, tests are with engine disconnected except: - High speed test(1.4.3)			Specified for each test
24	Engine	S6.4 – Idle speed and timing to manufacturers recommendations	No such requirements	No such requirements		Not necessary
25	Ambient temperature	S6.5 – Between 32° and 100°F (= 0 and 38° C)	No such requirements	No such requirements	FMVSS is more severe	IMMA proposal = 4° – 38° C to avoid ice on road.
26	Wind velocity	S6.6 Zero	Annex 3 – 1.3.1.6 No wind liable to affect the test result.	Not more than 5 m/s		IMMA propose Japan Standard. (13H : 1.2.5 – there shall be no wind liable to affect the results) (FMVSS 135 – Max 5 m/s)

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
27	Road surface	S6.7 – - Skid number of 81 - 8 feet wide for 2 wheelers - overall vehicle width plus 5 feet for 3 wheelers - parking brake test surface is clean, dry, smooth portland cement.	Annex 3 – 1.3.1.5 Test area must be level, dry and have a surface affording good adhesion. Note also Annex 4 ABS test surfaces	Test area must be level, dry and have a straight paved road	FMVSS is more precise	(13H : 1.2.4 – road must have a surface affording good adhesion unless specified otherwise. 1.4.1.2.4 – Road must be level) IMMA proposes ECE with a note stating that the surface should be consistent for each test.
28	Vehicle position and wheel lock	S6.8 – - Vehicle in center of roadway at start of each brake application - Stops without any part of motorcycle leaving the roadway and without lockup of any wheel.	Annex 3 – 1.2.3 No lockup, no deviation from course and no abnormal vibration.	No lock up more than 15km/h, no deviation from course and no abnormal vibration. For 2 wheelers, no out of lines having 2.5 m width. For 3 & 4 wheelers and 2 wheelers with sidecar, width increased.	Japan spec. is more precise.	IMMA proposes Japan. (13H : 1.2.7 – performance must be obtained without locking of the wheels at > 15 km/h, without deviation from 3.5 m lane, without exceeding 15° yaw angle, without abnormal vibrations.)
29	Thermocouples	S6.9 – Brake temperature is measured by plug type thermocouples installed in the center of the most heavily loaded pad/shoe.	Annex 3 – 1.3.1.3 …temperature measured on the disc or on the outside of the drum …...			Pyrometer or a surface thermometer proposed. (13H : 1.4.1.1 - ..temperature measured inside the brake linings or on the braking path of the disc or drum, is …) IMMA proposes 13H
30	Brake actuation force	S6.10 Hand lever force: > 5 lb → 22.7 N < 55 lb→ 249 N Foot pedal force: >10 lb → 45.4 N < 90 lb→ 408 N Point of application 1.2 inches (=3 cm) from end of grip.	Annex 3 – 1.2.4.2.4 Hand control: < 200N Foot control: < 350 N (L_1, L_2, L_3, L_4) <500 N (L_5) Point of application 5 cm from end of lever.	Same as ECE	Considering max values, and comparing torques, FMVSS allows more force to be applied. For max values, ECE is more severe.	IMMA proposes ECE IMMA does not think minimum values are necessary. Front control application point needs harmonisation – see ISO

ITEM		FMVSS 122	ECE REG 78	JAPAN SS 12 - 61	SEVERITY TEST RESULT	COMMENTS ( )= Car regs 13H/FMVSS 135
31	**Test procedure and sequence**	S7 specifies a sequence.	No sequence	TRIAS11-5-1996 – specifies heat fade test as last test.		With manufacturers pre burnishing, no sequence necessary
32	Brake warming	S7.1- To be performed if the brake temperature for the first stop has not been reached. (30 mph + 10 ft/s^2 On independently operated brake systems, the coldest brake shall be within 10° F of the hottest brake.	No such requirements	No such requirements		Not required for ECE tests as brakes are tested individually.
33	Pretest instrumentation check	S7.2 – For general checking. Not more than 10 stops from not more than 30 mph at a deceleration of not more than 10 f/s^2	No such requirements	No such requirements		Not required. Testers responsibility.
34	Preburnish Test	S7.3 - 6 stops from 30 mph and 6 stops from 60 mph	No such requirements	No such requirements		Manufacturers responsibility
35	Burnishing	S7.4 – 200 stops from 30 mph at 12 ft/s^2 After burnishing adjust brakes.	No such requirements	No such requirements		Manufacturers responsibility
36	Final inspection	S7.11 – - Inspect in assembled condition. - Disassemble and inspect for fractures, lining damage, and fluid leakage.	No disassembling of brakes.	No disassembling of brakes	FMVSS is more severe	Experience shows that dismantling is not necessary
37	**Anti-lock (ABS) Systems**	No such inclusion	Annex 4 L_1 + L_3 vehicles only ABS optional fitment.	Same as ECE but no mu jump test.	ECE is more severe	If fitted,must meet ECE Annex 4. IMMA propose ECE.

GLOBAL HARMONIZATION OF PTW, AND 3W [AND QUADRICYCLES[1]] BRAKING

DRAFT GTR DEVELOPMENT

Updated : 2 Jan 2002 following 6/BHTF

ITEM		SEVERITY TEST RESULT	IMMA GTR PROPOSAL	COMMENTS ( )= Car regs 13H/FMVSS 135
1	Scope		ECE REG 78 :- 1. Applies to the braking of 2 and 3 wheeled vehicles. Excludes those with V max < 25 km/h and fitted for invalid drivers. Summary of vehicle categories : L1 = 2 wheels, engine < 50cc and max speed < 50 km/h L2 = 3 wheels, engine < 50cc and max speed < 50 km/h L3 = 2 wheels, engine > 50 cc or max speed > 50 km/h L4 = 3 wheels – asymmetric, engine > 50 cc or max speed > 50 km/h (motorcycle + sidecar) L5 = 3 wheels – symmetrical, max weight <1000kg., engine > 50 cc or max speed >50 km/h .	In Europe and Japan, there are separate Moped requirements. . Scope will apply to “L category” vehicles – depending on the outcome from GRSG Common Task Group. [1] – Inclusion of Quadricycles depends on outcome from GRSG Common Task Group.
2	Definitions		Review after tests have been agreed.	
3	Requirements		ECE REG 78 philosophy :- - Test brakes separately - Brake performance based on Mean Fully Developed Deceleration – MFDD - If vehicle cannot meet test speed, generally use v max or % of v max - Specify for each test	
4	Type of service brake system		In principle :- - 2 separate braking systems - 1 or 2 brake controls – subject to future discussion	FMVSS allows 1 or 2 controls but meaning must be clarified – see also definitions. Controls issue requires further discussion. (13H : 5.2.2.1 – There must be at least 2 independent controls for service and parking)

ITEM		SEVERITY TEST RESULT	IMMA GTR PROPOSAL	COMMENTS ( )= Car regs 13H/FMVSS 135
5	**Mechanical service brake system**		ECE REG 78 :- 5.2.1.1 – Parts such as the brake, cylinder, pistons, etc., shall not be regarded as liable to breakage if they are amply dimensioned, readily accessible for maintenance and exhibit sufficient safety features. The 2 service braking devices may have a common brake so long as a failure in 1 does not affect the performance of the other.	(13H : 5.2.2.8 - ..parts such as pedal etc. shall not be regarded as liable to breakage, exhibit safety features, able to brake the vehicle with a degree of effectiveness …)
6	Hydraulic service brake system			(13H : 5.2.3 – hydraulic failure shall be signalled to the driver …tell tale to show differential pressure)
7	Master cylinder reservoirs	FMVSS is more severe	FMVSS 122 :- S5.1.2.1. – Each m/cylinder shall have a separate reservoir for each brake circuit and openings having their own cover etc Each reservoir shall have a min. capacity based on 1.5 times volume required to cover difference between new and fully worn linings – brakes applied.	(13H : 5.2.3 - Tell tale to light up when reservoir is below a certain level – specified by manufacturer)
8	Reservoir labelling	FMVSS is more severe	FMVSS 122 :- S5.1.2.2. – Brake fluid warning statement that specifies : - Text and size of letters - Method of application - Location	Language requirements to be discussed.
9	Failure indicator lamp	FMVSS is more severe	FMVSS 122 :- S5.1.3 – Additional requirement for vehicles with split service brake systems S5.1.3.1 – Details of the lamp function : - Position - When it functions eg. pressure failure, low reservoir level. - Ignition switch activation etc. - Colour and marking of lens	(13H : 5.2.3 – visible in daylight, easily seen, can be used for parking brake and hydraulics)
10	Parking brake characteristics	See item 17	ECE REG 78 :- For 3 wheelers only. 5.1.2.3 – must hold the vehicle stationary on a slope in the absence of the driver. Working parts locked in position by a mechanical device, actuated from the driving seat. 5.2.3 – L_2 and L_5 shall be equipped with : a secondary (emergency) braking device which may be the parking brake. 5.2.4.1. and 5.2.4.2 for L5 vehicles.	(13H : 5.1.2.3 – Similar note to Reg 78)
11	Inspection of pad/lining	FMVSS is more severe	FMVSS 122 :- S5.1.5 – Lining thickness of drum brakes shall be visually inspected without removing drums and pad thickness visible without removal.	(13H : 5.2.11.2 – must be possible to check wear on linings from outside or underside vehicle with normal tools)

ITEM		SEVERITY TEST RESULT	IMMA GTR PROPOSAL	COMMENTS ( )= Car regs 13H/FMVSS 135
12	Pre burnish	FMVSS is more severe	Burnishing procedure should be manufacturers responsibility.	Modern friction materials require less burnishing. (FMVSS 135 S6.3.3 – At start of tests, brakes are in same condition as when vehicle manufactured. No burnishing is allowed unless all vehicle are sold that way.)
13	Dry stop tests	Report to 49/GRRF :- A range of motorcycles were tested to compare brake force req'd for FMVSS & ECE decels and to compare resulting decels using same braking force. Result – For front, FMVSS & ECE similar For rear, ECE requires more force Lowest braking force for FMVSS does not meet ECE requirement. ECE test is therefore more severe.	ECE REG 78 :- Annex 3 – 2.1.1 – 2.2.2.2 Single braking device or CBS tests with the vehicle generally laden from 60 km/h. (L_1 + L_2 at 40 km/h) If single brake cannot reach prescribed decel (L_3 = 4.4 m/s^2 Front , 2.9 m/s^2 Rear) , use vehicle laden with both braking devices together to meet (L^3 = 5.8 m/s^2)	60 km/h test speed is adequate because: - the motorcycle is laden - brakes tested separately - high speed test covers upto 192 km/h - fade test is at 100 km/h Thus, performance is covered over a range of speeds.
	-High speed test	Report to 50/GRRF :- Using motorcycle tests, the following were compared for each regulation: d. Braking force e. Kinetic energy f. Behaviour when braking Result (from above): aJapan reg is more severe – higher decel. b.FMVSS is more severe – higher speed c.Japan/ECE is more severe – not specified in FMVSS Japan test more severe.	JAPAN SS 12 – 61 with higher speed :- Applies to L_3, L_4, & L_5 vehicles. Unladen test using both brakes with engine connected from a speed of 192 km/h or 0.8 v max whichever is less. Decel – 5.8 m/s^2 and vehicle behaviour recorded.	An increase in test speed to 192 km/h results in the Japan test being more stringent in all aspects.

ITEM		SEVERITY TEST RESULT	IMMA GTR PROPOSAL	COMMENTS ( )= Car regs 13H/FMVSS 135
14	Fade and recovery Fade baseline check Fade test Recovery test	Report to 49/GRRF :- A mid size (600cc) motorcycle was tested – performing 10 fade stops to both FMVSS and ECE. Brake temperatures during test compared. Result – Front and rear brake temperatures higher during ECE test. Therefore ECE test is more severe.	ECE REG 78 :- Annex 3 – 1.6.1.1 L_3,L_4, and L_5 in laden condition. If CBS, only CBS to be fade tested Annex 3 – 1.6.1.2 1 Dry stop test (Service braking) – as in item 13 above. Annex 3 – 1.6.1.2.2 - 10 stops with vehicle laden. - Test each brake separately (if CBS, then only CBS) - Speeds – Front + CBS = 100 km/h Rear = 80 km/h - Braking interval = 1000 m - Suitable gear for 50% stop, engine disconnected for remainder. - Decel = 3 m/s^2 with constant force. Annex 3 – 1.6.1.2.3 Repeat Fade Baseline Check ASAP or at least within 1 minute after completion of fade test. 1.6.3 – Residual performance = > 60% of baseline test	Mopeds not included in ECE or FMVSS.
15	Final effectiveness test		Not required	For dry tests, see item 13.
16	Partial failure		Relevant for hydraulic leakage failure in "Split service brake system" – see FMVSS 122 S4. See also item 4 above.	Test procedure to be developed as necessary. FMVSS partial failure tests are with single brake therefore same principle as ECE. See 13 – dry test comparison. Severity of partial failure tests need checking because ECE is laden and FMVSS unladen. Further investigation on the exact application of FMVSS under way by USSMA.

ITEM		SEVERITY TEST RESULT	IMMA GTR PROPOSAL	COMMENTS ( )= Car regs 13H/FMVSS 135
17	Parking brake system efficiency	FMVSS is more severe for slope and applied force but vehicle is unladen.	ECE REG 78 :- Annex 3 – 2.3 - Laden vehicle - 18% slope - up and down. Brake forces: hand < 400N; foot < 500 N	See item 10. IMMA has no strong view but prefers ECE.
18	Wet braking Baseline check Wet brake test	Report to 49/GRRF :- A large motorcycle was tested in laden and unladen condition, compare the %age recovery rate (FMVSS) with wet v dry brake (ECE). Result- At first recovery stop, FMVSS is similar to ECE. After 5 FMVSS stops, brake is dry. ECE test is more severe.	ECE REG 78 :- Annex 3 – 1.4.4 - Same vehicle/test conditions as Dry brake test (Item 13) - For vehicle categories L_1, L_2, L_3, L_4. - Exemption for conventional drum and fully enclosed disc brakes - New test proposal for CBS under discussion in IMMA. Annex 3 – 2.5.2 - Carry out a Dry Brake test and measure the control force at 2.5 m/s^2 Annex 3 – 2.5 - With equipment continuously wetting the brakes at a flow rate of 15 l/h., Mfdd attained between 0.5 and 1 sec after brake application to be > 60% and <120% of mfdd for dry brakes performance ie. Base line check.	There are different FMVSS v ECE philosophies – - FMVSS is a static immersion test to simulate passing through deep water. - ECE is a dynamic spray test to simulate very heavy rain on a normal road. Disc and drum brakes will behave differently for each test.
19	Design durability	FMVSS is more severe	No experience of such failures. If necessary, FMVSS text could be used.	(13H : 5.1.1.1 + 5.1.1.2 – Braking system designed so that it complies despite vibration, corrosion and ageing)
20	**Test conditions**			
21	Vehicle weight	ECE is more severe	ECE REG 78 :- In general, vehicle is fully laden except : - High speed test(1.4.3) unladen. - CBS tests laden and unladen - ABS tests unladen Notes: 3. Fully laden = manufacturers max mass. unladen = rider and test equipment 4. Test with rider alone not required if calcs show that >2.5 m/s^2 is possible Loading conditions to be specified for each test.	General definitions of mass will be decided by GRSG.
22	Tyre pressure		ECE REG 78 :- Annex 3 – 1.3.1.1 Prescribed by manufacturer.	(13H : 1.2.6 – at the start of the tests, tyres must be cold and at the pressure prescribed for the load borne by the wheels)

ITEM		SEVERITY TEST RESULT	IMMA GTR PROPOSAL	COMMENTS ( )= Car regs 13H/FMVSS 135
23	Transmission		Specified for each test	
24	Engine		Not necessary	
25	Ambient temperature	FMVSS is more severe	4° - 38° C	To avoid ice on road.
26	Wind velocity		JAPAN SS 12 – 61 :- Not more than 5 m/s	(13H : 1.2.5 – there shall be no wind liable to affect the results) (FMVSS 135 – Max 5 m/s)
27	Road surface	FMVSS is more precise	ECE REG 78 :- Annex 3 – 1.3.1.5 Test area must be level, dry and have a surface affording good adhesion. Include a note stating that the surface should be consistent for each test. Note also Annex 4 ABS test surfaces	(13H : 1.2.4 – road must have a surface affording good adhesion unless specified otherwise. 1.4.1.2.4 – Road must be level)
28	Vehicle position and wheel lock	Japan spec. is more precise.	JAPAN SS 12 – 61 :- No lock up more than 15km/h, no deviation from course and no abnormal vibration. For 2 wheelers, no out of lines having 2.5 m width. For 3 wheelers, width increased.	(13H : 1.2.7 – performance must be obtained without locking of the wheels at > 15 km/h, without deviation from 3.5 m lane, without exceeding 15° yaw angle, without abnormal vibrations.)
29	Thermocouples		ECE REG 13H :- 1.4.1.1 – the temperature measured inside the brake linings or on the braking path of the disc or drum, is …	Pyrometer or a surface thermometer proposed.
30	Brake actuation force	Considering max values, and comparing torques, FMVSS allows more force to be applied. For max values, ECE is more severe.	ECE REG 78 :- Annex 3 – 1.2.4.2.4 Hand control: < 200N Foot control: < 350 N (L_1,L_2,L_3,L_4) <500 N (L_5) Point of application 5 cm from end of lever. IMMA does not think minimum values are necessary.	Front control application point needs harmonisation – see ISO.
31	**Test procedure and sequence**		With manufacturers pre burnishing, no sequence necessary	
32	Brake warming		Not required for ECE tests as brakes are tested individually.	
33	Pretest instrumentation check		Not required. Testers responsibility.	
34	Preburnish Test		Manufacturers responsibility	

ITEM		SEVERITY TEST RESULT	IMMA GTR PROPOSAL	COMMENTS ( )= Car regs 13H/FMVSS 135
35	Burnishing		Manufacturers responsibility	
36	Final inspection	FMVSS is more severe	No requirement	Experience shows that dismantling is not necessary.
37	**Anti-lock (ABS) Systems - Optional**	ECE is more severe	ECE REG 78 :- Annex 4 L_1 + L_3 vehicles only	ABS optional fitment If fitted, must meet ECE Annex 4.