

**PROPOSAL for THE HARMONIZATION of REGENERATIVE BRAKING SYSTEMS
between ECE R13H AND FMVSS135**

Transmitted by the Expert from Japan

(1) Amendment of FMVSS 135 concerning disconnection of a Regenerative Braking System
(S5.1.3)

Current

S 5.1.3

- (a) For an EV equipped with RBS, the RBS is considered to be part of the service brake system if it is automatically activated by an application of the service brake control, if there is no means provided for the driver to disconnect or otherwise deactivate it, and if it is activated in all transmission positions, including neutral.

Proposed amendment.

S5.1.3 amend to read:

- (a) The RBS is considered to be part of the service brake system if it is automatically activated by an application of the service brake control and it may only be disconnected if the friction braking source remains permanently connected and able to provide automatic compensation for the loss of RBS braking torque, in all transmission positions, including neutral.

In the case of short disconnection transients, incomplete compensation is accepted, but within 1 s, this compensation shall have attained at least 75% of its final value.

Nevertheless, in all cases, the permanently connected friction braking source shall ensure that the service brake system continues to operate with both the intact system performance of sections S7.5 to S7.7, S7.13 to 7.16 and the failed system performance of sections S7.8. to S7.11.

Justification

1. It is reasonable to permit RBS disconnection but only under the special circumstances which were recently clarified in ECE R13H and which, in this proposal, would be extended to **FMVSS 135**.
2. **FMVSS 135** currently recognizes an RBS which is linked to an application of the service brake control but classifies this as not being part of the service brake system if RBS disconnection is possible. The only requirement imposed on such a system is that the prescribed stopping distance shall be met without the RBS contribution.
3. Any RBS system operating from the service brake control, should be classified as part of the service braking system and RBS disconnection without compensation ought not to be permitted because of the variation in pedal feel caused by such uncompensated disconnection. Interruption of the RBS by disconnection of the drive-line should be permitted provided that loss of RBS braking torque is automatically compensated by friction braking, so as to maintain pedal feel.

(2) Amendment of FMVSS135 concerning RBS Operation Mode in Test (S.6.3.13.1)

Current

- S6.3.13.1 (a) For an EV equipped with an RBS that is part of the service brake system, the RBS is operational during the burnish and all tests, except for the test of a failed RBS.
- (b) For an EV equipped with an RBS that is not part of the service brake system, the RBS is operational and set to produce the maximum regenerative braking effect during the burnish, and is disabled during the test procedures. If the vehicle is equipped with a neutral gear that automatically disables the RBS, the test procedures, which are designated to be conducted in gear, may be conducted in neutral.

Proposed amendment

Delete S6.3.13.1 and renumber S6.3.13.2 to S6.3.13

Justification

The purpose of this provision is to clarify the RBS condition.

It is not necessary to prescribe because of the following reasons.

1. For RBS that is part of the service brake system, under definition harmonization with **ECE R13H**, will lead to a discrepancy in RBS during the tests.

For (a) in the current rules, the RBS which does not operate in neutral, will under this proposal, be forced to operate in neutral.

2. For RBS that is not part of the service brake system, the RBS operation is prohibited in any tests in FMVSS135 but not in burnish. Automatic activation of RBS, where provided on the vehicle, should be permitted as ECE R13-H.

(3) Amendment of FMVSS135 concerning the hybrid vehicles(S4.6)

Proposed amendment

Para. S4, amend to read:

Maximum speed of a vehicle or v_{max} means the highest speed attainable

..... with the propulsion batteries at a state of charge at the beginning of the run of either :

the value recommended by the vehicle manufacturer, and stated in the vehicle operators manual or on a label permanently attached to the vehicle

or a value not less than 95% at the beginning of the run

or with the state of charge level resulting from automatic regulation on the vehicle

Paragraph S.6.3.11.2, amend to read:

S.6.3.11.2. At the beginning of the burnish procedure (S7.1 of this standard) in the test sequence, each propulsion battery is at the maximum state of charge as listed in one of the three options in definition S.4. During the 200 stop burnish procedure, the propulsion batteries are restored to the maximum state of charge as listed in this definition, after each increment of 40 burnish stops

Para. S.6.3.11.3, amend to read

S6.3.11.3 At the beginning of each performance test in the test sequence (S7.2 through S7.17 of this standard), unless otherwise specified, an EV's propulsion batteries are at the maximum state of charge as listed in one of the three options in definition S.4. No further charging of any propulsion battery occurs

Justification

Both ECE R13H and FMVSS 135 are applicable to hybrid vehicles and should recognize the special regulated charge level which applies to such vehicles.

Therefore FMVSS135 should define the state of charge condition with a third option for hybrid vehicles.

(4) Amendment of ECE Reg.13-H concerning ABS control of Regenerative Braking Systems which are not part of the Service Braking System(5.2.18.5)

Current

5.2.18.5. For vehicles equipped with an anti-lock device, the anti-lock device must control the electric braking system.

Proposed Amendment.

Para.5.2.18.5 amend to read;

For vehicles with an electric regenerative braking system of category B and an anti-lock device, the anti-lock device must control the electric regenerative braking system.

Justification

It is accepted that ABS should control RBS of Category B, (ie. part of the service braking system)

However, on conventional braking systems for vehicles with internal combustion engines, ABS does not control engine braking, although ABS control may consider the influence of engine braking.

Vehicles with RBS of Category A will not have powerful regenerative braking and this can be comparable to engine braking and a similar approach is justifiably proposed.

Furthermore, a check of vehicle behavior on a low adhesion surface for Category A - RBS equipped vehicles is prescribed in paragraph 1.2.9.1 of **Annex 3**, so that control by ABS should be optional.

Reference

S5.1.3 in **FMVSS 135**

- (b) For an EV that is equipped with both ABS and RBS that is part of the service brake system, the ABS must control the RBS.

(5) The heating procedure of the Fade Test

It is difficult to find the best solution for harmonization since both **FMVSS135** and **ECE R13H** are reasonable from their own viewpoint given the differences in approval means. It can be said that **ECE R13H** is more aligned to Type Approval and practical. On the other hand **FMVSS135** is more theoretical but has faced the problem of executing the actual tests. **ECE R13H** is practical from the total judgement but it can not solve the shut down case called for in

FMVSS135.

- Specific points -

-- Annex 3 para.1.5.1.6 in ECE R13H;

prescribes the case in which the power of the vehicle is such that the prescribed speed is not repeatedly attained. After the first cycle, it permits the maximum speed attainable during the later test cycles to be used since this is related to the practical operation of a vehicle in which the tractive power falls with use.

-- S.6.3.11.3 in FMVSS135;

requires the prescribed test speed even to the extent of using auxiliary means to achieve it. This may be influenced by consideration of a hill descent where the electric energy consumption to achieve the speed is smaller and the decrease of the SOC is moderated to an extent compared with operation on a level road. **FMVSS135** clearly requires a more severe test but the method has the difficulty in engaging and removing the auxiliary means.

Several other methods can be considered but, given the fixed time cycle for heating the brakes, they do not seem to be practical.

(1) To add the extra battery on the test vehicle or replace it with a higher performance battery.

For an additional battery, the same voltage level is necessary which means it must be identical to original one. This seems to be very difficult to install within the permissible vehicle weight. The modification of the control ECU would be necessary to operate the system properly. It would appear that this modification is complicated and virtually not practical and it is also difficult for the surveillance test of a standard vehicle.

To replace the original battery with a higher performance version is also difficult because the car manufacturer can be expected to have already installed the best battery for capacity.

(2) To tow or push the vehicle using a second vehicle.

This leads to concerns about the safety and effectiveness during the tests which have to be conducted on a fixed and tight time scale such as to require the two vehicle to be very close during the tests.

Reference

ECE R13H

1.5.1.6 of Annex 3

For electric vehicles not having a sufficient autonomy to carry out the cycles of heating of the brakes, the tests shall be carried out by **achieving the prescribed speed before the first braking application** and thereafter by using the maximum acceleration available to regain speed and then braking successively at the speed reached at the end of each 45 second cycle duration.

This is to be compared with the current **FMVSS135** ruling as follows:

S6.3.11.3

At the beginning of each performance test in the test sequence (S7.2. through S7.17. of this standard), unless otherwise specified, an EV's propulsion batteries are at the state of charge recommended by the manufacturer, as stated in the vehicle operator's manual or on a label that is permanently attached to the vehicle, or, if the manufacturer has made no recommendation, at a state of charge of not less than 95%. No further charging of any propulsion battery occurs during any of the performance tests in the test sequence of this standard. **If the propulsion batteries are depleted during a test sequence such that the vehicle reaches automatic shut-down, will not accelerate, or the low state of charge brake warning lamp is illuminated, the vehicle is to be accelerated to brake test speed by auxiliary means. If a battery is replaced rather than recharged, the replacement battery shall be charged and measured for state of charge in accordance with these procedures.**