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**UN Regulations Nos. 13, 13-H, 139, 140 and UN GTR No. 8:
Clarifications**

Proposal for a Supplement to UN Regulation No. 13 (Heavy vehicle braking)

**Submitted by the expert from the International Organization of Motor
Vehicle Manufacturers ***

The text reproduced below was prepared by the expert from International Organization of Motor Vehicle Manufacturers (OICA). It is aimed to insert requirements for endurance braking systems for vehicles equipped with an electric regenerative endurance braking system. It is based on document GRVA-05-39-Rev.1. The proposed changes to the current text of the Regulation are marked in bold for new, and strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2020 as outlined in proposed programme budget for 2020 (A/74/6 (part V sect. 20) para 20.37), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.



I. Introduction (recall of relevant definitions)

- 2.21. "Electric regenerative braking" means a braking system which, during deceleration, provides for the conversion of vehicle kinetic energy into electrical energy.
- 2.21.1. "Electric regenerative braking control" means a device which modulates the action of the electric regenerative braking system.
- 2.21.2. "Electric regenerative braking system of category A" means an electric regenerative braking system which is not part of the service braking system.
- 2.21.3. "Electric regenerative braking systems of category B" means an electric regenerative braking system which is part of the service braking system.
- 2.21.4. "Electric state of charge" means the instantaneous ratio of electric quantity of energy stored in the traction battery relative to the maximum quantity of electric energy which could be stored in this battery.
- 2.21.5. "Traction battery" means an assembly of accumulators constituting the storage of energy used for powering the traction motor(s) of the vehicle.

II. Proposal

Insert a new paragraph 5.2.1.29.7., to read:

- 5.2.1.29.7. Vehicles equipped with an electric regenerative braking system of category A or B (as defined in paragraphs 2.21.2. and 2.21.3.), using the alternative Type-IV test defined in paragraph 1.9 of Annex 4, shall warn the driver at the latest when the service braking performance is decreased below the minimum hot performance specified in the Type-II test of Annex 4. The yellow warning signal according to paragraph 5.2.1.29.1.2. shall be used.**

The method to assess the service braking performance [(e.g. by temperature/energy calculation and/or deceleration control)] shall be described by the vehicle manufacturer together with the documentation package required in Annex 18 of this Regulation to the Technical Services.

Annex 4,

Paragraph 1.5.1.8., amend to read:

- 1.5.1.8. For vehicles equipped with an electric regenerative braking system of category B, the condition of the vehicle batteries at the start of the test, shall be such that the braking force contribution provided by the electric regenerative braking system does not exceed the minimum guaranteed by the system design.

This requirement is deemed to be satisfied if the batteries are at one of the state of charge conditions listed in the ~~fourth clause~~ **four clauses** of paragraph 1.4.1.2.2. above.

Paragraphs 1.5.3. to 1.5.3.1.3., amend to read:

- 1.5.3. Hot performance
- 1.5.3.1.2. For vehicles fitted with an electric regenerative braking system of category A, during brake applications, the highest gear shall be continuously engaged and the separate electric regenerative braking control, if any, shall not be used.
- 1.5.3.1.3. In the case of vehicles equipped with an electric regenerative braking system of category B, having carried out the heating cycles according to paragraph 1.5.1.6. of this annex, the hot performance test shall be carried out at the maximum speed which can be reached by the vehicle at the end of the

brake heating cycles, unless the speed specified in paragraph 1.4.2. of this annex can be reached.

For comparison, the Type-0 test with cold brakes shall be repeated from this same speed and with a similar electric regenerative braking contribution, as set by an appropriate state of battery charge, as was available during the hot performance test.

[...]

The tests may be conducted without a regenerative braking component. In this case, the requirement on the state of charge of the batteries is not applicable.

Insert a new paragraph 1.6.5., to read:

1.6.5. For vehicles equipped with an electric regenerative braking system, the condition of the vehicle batteries at the start of the test, shall be such that the braking force contribution provided by the electric regenerative braking system does not exceed the minimum guaranteed by the system design.

This requirement is deemed to be satisfied if the batteries are at one of the state of charge conditions listed in the four clauses of paragraph 1.4.1.2.2. above.

Insert a new paragraph 1.8.2.4., to read:

1.8.2.4. For vehicles equipped with an electric regenerative braking system, the condition of the vehicle batteries at the start of the test shall be such that the braking force contribution provided by the electric regenerative braking system does not exceed the minimum guaranteed by the system design.

Insert a new paragraph 1.9. (and subparagraphs), to read:

1.9. Type-IV test (downhill behaviour and endurance braking performance test for vehicles equipped with an electric regenerative braking)

1.9.1. The requirements of paragraph 1.9.2. below may be used as an alternative to the Type-IIA test for vehicles listed in paragraph 1.8.1. of this Annex, in case they are equipped with an electric regenerative braking system.

1.9.2. Test conditions and performance requirements

1.9.2.1. Type-II test with increased performance

The vehicle shall fulfil the requirements of the Type-II test, with the exception of the following parameters:

(a) [The vehicle shall be driven on a [7] per cent down-gradient, instead of the 6 per cent value specified in paragraph 1.6.1.]

(b) [For the hot performance of the service braking system, the mean fully developed deceleration d_m (as defined in paragraph 1.6.3.) shall at least be equal to [5m/s²].]

1.9.2.2. As an alternative to paragraph 1.9.2.1. above, the following requirements may be used:

1.9.2.2.1. The electric regenerative braking system shall implement technical measures to secure that the necessary retardation capacity in the batteries is available for the vehicle to be able to absorb at least the energy to stabilize speed in the forthcoming (predicted) downhill on the route of the vehicle [that the vehicle may potentially follow].

1.9.2.2.2. The vehicle equipped with an electric regenerative braking system shall be able to secure a sufficient retardation to ensure the stabilization of the vehicle speed during a Type-II test.

- 1.9.2.2.3.** The driver shall be informed about the available battery capacity prior to the time when the braking force of the electric regenerative braking can no longer be provided [(e.g. when the battery is fully loaded)].
- 1.9.2.2.4.** Notwithstanding the paragraphs 1.9.2.2.1. to 1.9.2.2.3. above, in case the vehicle is equipped with a supplementary endurance braking system able to absorb kinetic energy of the vehicle independently from the regenerative braking system, the following requirements may be used:
- (a) The electric regenerative braking system shall implement technical measures to secure that the necessary retardation capacity in the batteries of the vehicle is available to be able to absorb at least the portion of the energy to stabilize speed in the forthcoming (predicted) downhill on the route of the vehicle [that the vehicle may potentially follow], which is not absorbed by the supplementary endurance braking system.
- (b) The vehicle equipped with an electric regenerative braking system shall be able to secure a retardation at least equivalent to the portion of the energy necessary to stabilize the vehicle speed during a Type-II test, which is not absorbed by the supplementary endurance braking system.
- (c) The portion of the energy absorbed by the electric regenerative braking and the relevant control strategies to suitably distribute/phase energy absorption between the electric regenerative braking system and the supplementary endurance braking system installed on the vehicle shall be described by the vehicle manufacturer to the Technical Service.
- 1.9.2.2.5.** The technical measures taken to safeguard necessary retardation capacity in the batteries shall be described / demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex 18 [CEL]. The general principle of the means available to the driver to control the electric regenerative braking shall also be described (e.g. a separate control, an integrated control with other functions).
- 1.9.2.3.** The vehicle shall fulfil the requirements of Type-IIA test as specified above in this regulation. The condition of the vehicle batteries at the beginning of the test shall be such that the retardation capacity available in the batteries is:
- (a) At least equivalent to the energy necessary to pass the Type-IIA test.
- (b) At least equivalent to the portion of the energy which is not absorbed by a supplementary endurance braking system fulfilling the requirements of paragraph 1.9.2.2.4. above, and that is necessary to pass the Type-IIA test.

III. Justification

1. An electric vehicle with fully loaded traction batteries cannot pass the Type-IIA test, unless (for example) extra-battery capacity (which cannot be used for traction) is added to always ensure the Type-IIA equivalent kinetic energy can be absorbed by the batteries. Given the risk to jeopardize the energetic efficiency of these emission-free vehicles, industry is proposing an alternative to Type-IIA test, by creating a new Type-IV test, as per paragraph 1.9.

A. Paragraph 5.2.1.29.7.

2. Vehicles using the Type-IV test of Annex 4 shall be equipped with a brake estimator alerting the driver in case the efficiency of the brakes falls below the Type-II hot performance (3.3m/s² for N₃, 3.75m/s² for M₃ category vehicles)

B. Paragraph 1.5.1.8.

3. The proposed amendment is correction of an editorial mistake in current text or the Regulation.

C. Paragraph 1.6.5.

4. This proposes the same requirement concept as in paragraph 1.5.1.8. of Type-I fade test.

D. Paragraph 1.8.2.4.

5. This proposes the same requirement concept as in paragraph 1.5.1.8. of Type-I fade test.

E. Paragraph 1.9.1.

6. This paragraph specifies when the Type-IV test can be used.

F. Paragraph 1.9.2.1.

7. It contains specification of the Type-II test with increased performance from slope six per cent to seven per cent, and hot-stop requirement from 3.3m/s^2 for N_3 category vehicles (3.75m/s^2 for M_3) to 5m/s^2 , which is the required value of the service braking system in Type-0 test. This is a drastic increase of friction brake performance, since it is meant to be applied in the case where the batteries of the electric regenerative braking system are fully charged (i.e. the worst case). With this alternative, the system is not required to preserve any free battery charge for the purpose of retardation, it can fully use the capacity of the battery for the purpose of traction.

G. Paragraph 1.9.2.2.

8. This paragraph is proposing an alternative to the increased Type-II performance as per paragraph 1.9.2.1. In this alternative, the system shall implement “smart charging strategies” able predict the potential downhills on the route of the vehicle, e.g. based on the altitude (height), the topology of the roads “around” the vehicle, “geo-fencing” strategies, in order to secure that the vehicle is able to absorb the kinetic energy.

H. Paragraph 1.9.2.2.1.

9. It specifies the expected functionality of the smart charging strategy.

I. Paragraph 1.9.2.2.2.

10. It stipulates that the vehicle shall be able to secure (for the sole purpose of retardation, if needed to pass the forthcoming downhill) the energy equivalent to the potential energy of a Type-II.

J. Paragraph 1.9.2.2.3.

11. The aim of informing the driver of the available retardation capacity available in the batteries is to permit him/her to anticipate and adapt speed prior to the point when the batteries are full, in other terms to handle in the best way the retardation capacity of the vehicle (as he/she does with the available traction energy in the batteries).

K. Paragraph 1.9.2.2.4.

12. It adapts the requirements to the case where a supplementary retardation means is installed on the vehicle.

L. Paragraph 1.9.2.2.5.

13. The smart charging strategies shall be described and assessed according to the Complex Electronic Annex.

14. Additionally, the vehicle manufacturer may, in order to pass requirements specifying retardation capacity to be secured in the batteries (paragraphs 1.9.2.2.1., 1.9.2.2.2. and 1.9.2.2.4.), account for that the kinetic energy is not only converted into electric energy in the batteries, but is also absorbed by mechanical air and rolling resistance, as well as by the efficiency of the electric components converting kinetic energy transmitted by the wheels into electric energy in the batteries.

M. Paragraph 1.9.2.3.

15. This paragraph requires the application of Type-IIA, starting from a battery charge where the equivalent kinetic energy to the Type-IIA is reserved.
