

Distr.
GENERAL

TRANS/WP.29/GRRF/2000/12
22 June 2000

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

INLAND TRANSPORT COMMITTEE

World Forum for Harmonization of Vehicle Regulations (WP.29)

Working Party on Brakes and Running Gear (GRRF)

(Forty-eighth session, 11-13 September 2000,
agenda item 1.5.)

PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION No. 13
(Braking)

Transmitted by the expert from the United Kingdom

Note: The text reproduced below was prepared by the expert from the United Kingdom in order to amend the definitions for "Electric Regenerative Braking" and introduce a new definition for "Phased Braking". The amendments to the text also include changes to the annexes to refer to electric regenerative braking systems rather than specific electric vehicles.

Note: This document is distributed to the Experts on Brakes and Running Gear only.

GE.00-22057

A. PROPOSAL

Insert a new paragraph 2.14., to read:

"2.14. "Phased Braking" is a means which may be used where two or more sources of braking are operated from a common control, whereby one source may be given priority by phasing back the other source(s) so as to make increased control movement necessary before they begin to be brought into operation. This technique may, for example, be applied in vehicles equipped with endurance braking systems or regenerative braking systems."

Paragraphs 2.14. to 2.19. (former), renumber as paragraphs 2.15. to 2.20.

Paragraph 2.20. (former), should be deleted.

Paragraph 2.20.1.(former), renumber as paragraph 2.21., and amend to read:

"2.21. "Electric Regenerative Braking" means a braking system which, during deceleration, provides for the conversion of vehicle kinetic energy into electrical energy."

Paragraphs 2.20.2. to 2.20.6. (former), renumber as paragraphs 2.21.1. to 2.21.5.

Paragraphs 2.21. to 2.27.3. (former), renumber as paragraphs 2.22. to 2.28.3.

Paragraphs 5.2.1.7. to 5.2.1.7.2., amend to read:

"5.2.1.7. The service braking system shall act on all wheels of the vehicle and shall distribute its action appropriately among the axles.

5.2.1.7.1. In the case of vehicles with more than two axles, in order to avoid wheel-locking or glazing of the brake linings, the brake force on certain axles may be reduced to zero automatically when carrying a much reduced load, provided that the vehicle meets all the performance requirements prescribed in annex 4 to this Regulation.

5.2.1.7.2. In the case of M₁ and N₁ category vehicles with electric regenerative braking systems of category B, the braking input from other sources of braking, may be suitably phased to allow the electric regenerative braking system alone to be applied, provided that both the following conditions are met:"

Insert a new paragraphs 5.2.1.7.2.1. and 5.2.1.7.2.2., including their corresponding footnote */ , to read:

"5.2.1.7.2.1. Intrinsic variations in the torque output of the electrical regenerative braking system (e.g. as a result of changes in the electric state of charge in the traction batteries) are automatically compensated by appropriate variation in the phasing

relationship as long as the requirements */ of one of the following annexes to this Regulation are satisfied:

Annex 4, paragraph 1.3.2., or
Annex 13 paragraph 5.3. (including the case with the electric motor engaged),
and

- 5.2.1.7.2.2. Wherever necessary, to ensure that braking rate */ remains related to the driver's braking demand, having regard to the available tyre/road adhesion, braking shall automatically be caused to act on all wheels of the vehicle.

*/ The Authority, which is to grant approval, shall have the right to check the service braking system by additional vehicle test procedures."

Paragraph 5.2.1.10., amend to read:

- "5.2.1.10. The service, secondary and parking braking systems must act on braking surfaces connected to the wheels through components of adequate strength.

Where braking torque for a particular axle or axles is provided by both a friction braking system and an electrical regenerative braking system of category B, disconnection of the latter source is permitted, providing that the friction braking source remains permanently connected and able to provide the compensation referred to in paragraph 5.2.1.7.2.1.

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

Nevertheless, in all cases the permanently connected friction braking source shall ensure that both the service and secondary braking systems continue to operate with the prescribed degree of effectiveness.

Disconnection of the braking surfaces of the parking braking system shall be permitted only on condition that the disconnection is controlled exclusively by the driver from his driving seat, by a system incapable of being brought into action by a leak.

Paragraph 5.2.1.25., amend to read:

- "5.2.1.25. Additional requirements for vehicles of categories M₁, M₂, N₁ and category N₂ < 5 tonnes equipped with an electric regenerative braking system."

Paragraph 5.2.1.25.1., amend to read:

"5.2.1.25.1. Vehicles fitted with an electric regenerative braking system of category A."

Paragraph 5.2.1.25.2., amend to read:

"5.2.1.25.2. Vehicles fitted with an electric regenerative braking system of category B."

Paragraph 5.2.1.25.2.1., amend to read:

"5.2.1.25.2.1. It shall not be possible to disconnect, partially or totally, one part of the service braking system other than by automatic means. This should not be construed as a departure from the requirements of paragraph 5.2.1.10."

Paragraph 5.2.1.25.2.3., amend to read:

"5.2.1.25.2.3. For vehicles fitted with an electric regenerative braking system of both categories
..... "

Annex 4,

Paragraph 1.2.8., amend to read:

"1.2.8. For vehicles powered completely or partially by an electric motor (or motors), permanently connected to the wheels, all tests must be carried out with the motor(s) connected."

Paragraph 1.2.9., amend to read:

"1.2.9. For vehicles as described in paragraph 1.2.8. above, fitted with an electric regenerative braking system "

Paragraph 1.3.2., amend to read:

"
is reduced, must meet the relevant requirements of annex 10 and/or annex 13 to this Regulation."

Insert a new paragraph 1.3.2.1. (including a new footnote 2/) to read:

"1.3.2.1. In the case of a braking system according to paragraph 5.2.1.7.2., where the braking for a particular axle (or axles) is comprised of more than one source of braking torque, and any individual source can be varied with respect to the other(s), the vehicle shall satisfy the requirements of annex 10, or alternatively, annex 13 under all relationships permitted by its control strategy 2/."

2/ The manufacturer shall provide the Technical Service with the family of braking curves permitted by the automatic control strategy employed. These curves may be verified by the Technical Service.

Paragraph 1.4.1.2.2., amend to read:

" in annex 2 of this Regulation
In the case of a vehicle equipped with an electric regenerative braking system, the requirements depend on the category of this system:

Category A. Any separate electric regenerative braking control which is provided, shall not be used during the Type-0 tests.

Category B. The contribution of the electric regenerative braking system to the braking force generated shall not exceed that minimum level guaranteed by the system design.

This requirement is deemed to be satisfied if the batteries are at one of the following state of charge conditions:

at the maximum charge level as recommended by the manufacturer in the vehicle specification, or

at a level not less than 95 per cent of the full charge level, where the manufacturer has made no specific recommendation, or

at the maximum level which results from automatic charge control on the vehicle."

Paragraph 1.5.1.6., amend to read:

"1.5.1.6. For vehicles not having 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."

Insert a new paragraph 1.5.1.7., to read:

"1.5.1.7. 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 4th clause of paragraph 1.4.1.2.2. above."

Paragraph 1.5.3.1.2., amend to read:

"1.5.3.1.2. For vehicles fitted with an electric regenerative braking system "

Insert a new paragraph 1.5.3.1.3., to read:

"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 1.4.3.2. 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.

Reconditioning of the linings shall be permitted before the test is made to compare this second Type-0 cold performance with that achieved in the hot test, against the criteria of paragraphs 1.5.3.1.1. and 1.5.3.2. of this annex."

Paragraph 1.5.3.1.3. (former), renumber as paragraph 1.5.3.1.4.

Paragraph 1.5.3.3., should be deleted.

Paragraphs 2.2.6. to 2.2.6.2., amend to read:

- "2.2.6. For vehicles employing electric regenerative braking systems, the braking performance shall additionally be checked under the two following failure conditions:
- 2.2.6.1. For a total failure of the electric component of the service braking output.
- 2.2.6.2. In the case where the failure condition causes the electric component to deliver its maximum braking force."

Annex 10,

Paragraph 3.1.4.5., amend to read:

- "3.1.4.5. For vehicles fitted with an electric regenerative braking
..... "

Annex 13,

Paragraph 5.2.5., amend by the addition of a new footnote 8/ to read:

- "5.2.5. The condition $a \geq 0.75$ shall be checked with the vehicle both laden and unladen 8/. The laden test

8/ Until a uniform test procedure is established, the tests required by this paragraph may have to be repeated for vehicles equipped with electrical regenerative braking systems, in order to determine the effect of different braking distribution values provided by automatic functions on the vehicle."

Footnotes, 8/ to 13/ (former) along with the corresponding references to them, renumber as footnotes 9/ to 14/.

Paragraph 5.3.7., amend by the addition of a reference to the new footnote 8/, to read:

- "5.3.7. During the tests provided and during these tests no part of the (outer) tyres must cross this boundary 8/."

* * *

B. JUSTIFICATION

Many of the brief changes are to make these paragraphs refer to vehicles, which have electric regenerative braking systems, rather than specific electric vehicles. This means that hybrid vehicles (which have engines and electric motors) will be covered as will electric vehicles powered by fuel cells.

In order to permit the maximum recovery of kinetic energy in vehicles with electric traction motors, means should be allowed for as much light braking as possible to be achieved using the electric regenerative braking system alone, rather than having some energy converted to heat in friction brakes.

Re. to paragraph 5.2.1.7.2.

To allow this to occur, the friction braking commands are phased to come into play at a higher control movement than would normally be adopted in a friction only braking system.

It is accepted that this phasing situation will be selected so as to permit the low level regenerative braking on its own, only up to a preset threshold of vehicle retardation, since this braking might be applied through a single drive axle. This threshold should be set at a level, which allows the majority of normal braking applications to be achieved by regenerative braking alone, thereby recovering useful amounts of vehicle energy.

Re. to paragraph 5.2.1.7.2.1.

It is further recognised that electric regenerative braking torque is subject to variations depending on speed and battery conditions so that compensation has to be provided to maintain, in category B systems, the relationship between control input and vehicle deceleration. Compensation will be achieved by applying friction braking to make up for a fall in regenerative braking torque. The friction braking source, normally held off by the phasing setting, is to be brought, automatically, into compensating operation by a suitable graduated reduction of the phasing setting. This action is only allowed on the condition that the friction braking application should respect the braking distribution requirements, i.e. be applied to the front axle only or to both axles in a suitable proportion.

Re. to paragraph 5.2.1.7.2.2.

At higher braking commands, both sources of braking will, as the phasing threshold is exceeded, be brought into operation whenever necessary to meet the requirements of this paragraph.

All systems would be required to automatically apply friction braking to all axles of the vehicle once this occurred, but of course, the achieved deceleration will always be limited by the available road/tyre adhesion.

This paragraph covers the required action under conditions of low adhesion where single axle braking must be discontinued by setting the phasing to zero (and possibly, at the choice of the manufacturer, removing regenerative braking at the same time).

Re. to paragraph 5.2.1.10.

In certain vehicle operations, such as when neutral is selected, the regenerative braking motor may be disconnected but the friction source must remain permanently connected. This is still the case where the source is phased, since it can always be brought into operation by further movement of the control. However compensation removes the need for such further input to maintain a constant braking level and, in so doing, preserves the pedal feel.

It is, in practice, unlikely that compensation could ensure a disturbance free braking action during gear changing, where, synchronous to the disconnection, compensation would need to be applied and removed within a 1s period without transient errors.

It is recognised however, that compensation should be commenced within such a short transient since, at the outset, the duration of any drive disconnection is unknown. Thus in a short gear changing transient incomplete compensation has to be accepted and a response free of any jolt, will be an industry target for system development.

Re. to annex 4, paragraph 1.5.3.1.3.

The hot test, which uses a combination of friction and regenerative braking, has to be compared with a repeated Type 0 test made with cold brakes but also with approximately the same RGB contribution as used in the hot test. This repeat is necessary since, only at the time of commencing the hot test, is the RGB contribution known.

Because reconditioning the linings is allowed, a battery recharge should be permitted as this may be necessary to ensure completion of the procedure and produce the state of charge needed to generate an approximately correct RGB component for the Type 0 repeat test.

(Note: 'Similar' and 'approximately correct' are terms used because of the impractical nature of a test in which it is required to achieve an exact repeat of an electric regenerative braking component used in an earlier test.)
