United Nations ECE/TRANS/WP.29/GRVA/2024/26

Economic and Social Council

Distr.: General
12 April 2024

Original: English

Economic Commission for Europe

Inland Transport Committee

World Forum for Harmonization of Vehicle Regulations

Working Party on Automated/Autonomous and Connected Vehicles

Nineteenth session
Geneva, 25 June 2024
Item 8(b) of the provisional agenda
UN Regulations Nos. 13, 13-H, 139, 140 and UN GTR No. 8: Electromechanical braking

Proposal for a new series of amendments to UN Regulation No. 13-H (Braking of passenger cars)

Submitted by the Special Interest Group on electrical braking systems *

The text reproduced below was prepared by the Special Interest Group concerning electrical braking systems and is based on informal document GRVA-15-17. It supersedes document ECE/TRANS/WP.29/GRVA/2024/14.

It is aimed at recognising technical advances and the emergence of a new type of braking system that employs stored electrical energy for both the control transmission and the energy transmission. The modifications to the existing text of the Regulation are marked in bold for new characters and in bold strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2024 as outlined in proposed programme budget for 2024 (A/78/6 (part V sect. 20) para 20.5), 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. Proposal

Table of Contents, title of Annex 8, amend to read:

8. Special requirements to be applied to the safety aspects of ~~**complex**~~ electronic ~~**vehicle**~~ control systems

Table of Contents, after Annex 8, insert a reference to the new appendix:

Appendix - Model Annex 8 assessment report

Paragraph 2.17.4., amend to read:

2.17.4. *"Electric State of Charge* ***(*****SOC*****)"*** means the instantaneous ratio of electric quantity of energy stored in ~~**a traction battery**~~ **an electrical storage device (e.g.,** battery**, capacitor, etc.)** relative to the maximum quantity of electric energy which could be stored in this ~~**battery**~~ **device**.

Insert new paragraphs 2.26. to 2.37., to read:

2.26. **"*Wheel brake demand value*" means the demand value for the braking force of a single wheel brake being electrically actuated.**

2.27. **The "*performance of an electrical storage device*" means its ability to provide power (W) and quantity of energy (Wh) when fully charged.**

2.28. **"P_w" (W) means the low electrical supply power warning as required by paragraph 5.2.24.9. in the case of an electrical transmission braking system.**

2.29. **"*Energy source*" means a device that both generates and provides energy required for the braking system.**

2.30. **"*Electrical storage device*" means a device, or combination of individual devices, each capable of storing an electrical charge and of providing electrical power to the braking system transmission. Electrical storage devices which are connected in series and/or parallel for the purpose of supplying a single braking circuit, shall be considered as one electrical storage device within this Regulation.**

2.31. **The "*effect of ageing*" is quantifying the irreversible degradation of the performance of an electrical storage device, due to e.g., the effects of time, use, and environmental exposure.**

2.32. **"*Electrical supply*" means a device (e.g. battery, REESS, generator, fuel-cell or a combination of these components) that supplies electrical power to the braking system's electrical storage device(s).**

2.33. **"*Energy Management System*" means, an electrical device(s), being part of, or used by, an electrical transmission braking system, that monitors critical variables that impact on the performance and state of the electrical storage devices (e.g., voltage, temperature, internal resistance, effect of ageing, state of charge, power consumption, charging cycles, etc.) and deduces the actual capability of the devices to fulfil the performance requirements of this Regulation.**

2.34. **"*Electrical Transmission Braking System*" (ETBS) means a braking system of a power-driven vehicle where the service braking force, and transmission, depend exclusively on the use, controlled by the driver, of energy provided from electrical storage devices.**

2.35. **"*Auxiliary equipment*" means, for the purposes of this Regulation, the collective of systems, functions, or components, including those that are essential to the operation of the vehicle, that are supplied with energy from the same energy reserves as the braking system.**

2.36. **The "*state of an electrical storage device*" means its ability to provide power (W) and quantity of energy (Wh) at the time.**

2.37. **"*Reference braking forces*" means the braking forces of one axle generated at the circumference of the tyre on a roller brake tester, relative to brake actuator pressure or brake demand value respectively and declared at the time of type approval.**

Renumber 5.1.4.2., 5.1.4.2.1., and 5.1.4.2.2. as 5.1.4.5., 5.1.4.5.1., and 5.1.4.5.2.;

Renumber paragraph 5.1.4.3. as 5.1.4.2.

Insert new paragraph 5.1.4.3., and 5.1.4.3.1., and 5.1.4.3.2. to read:

5.1.4.3. **Data for braking systems**

5.1.4.3.1. **The data of the electrical transmission braking system for the functional and efficiency test shall be specified at the vehicle in a visible position in indelible form or made freely available in another way (e.g. handbook, electronic data record).**

5.1.4.3.2. **For power-driven vehicle equipped with an electrical transmission braking system the vehicle manufacturer shall describe, at the time of type approval, the procedure by which it can be checked that the detection means triggering the warning signals specified in paragraphs 5.2.24.6., 5.2.24.7. and 5.2.24.9. are operational.**

Insert new paragraph 5.1.4.4. to read:

5.1.4.4. **Reference braking forces**

5.1.4.4.1. **Reference braking forces for an electrical transmission braking system using a roller brake tester shall be defined according to the following requirements.**

5.1.4.4.1.1. **It shall be possible on the vehicle to evaluate the relationship between the brake demand value(s) (e.g. as a percent value, voltage, brake pedal force or stroke) and the measured braking force on a roller brake tester. The vehicle manufacturer shall describe the method by which this can be realized, and make this information available freely by e.g. handbook, electronic data record etc.**

5.1.4.4.1.2. **Reference braking forces are to be determined for each axle for a brake demand value from zero to a value corresponding to a braking force generated under Type-0 conditions. The applicant for type approval shall nominate these reference braking forces. These data shall be made available by the vehicle manufacturer, according to paragraph 5.1.4.3. above.**

5.1.4.1.3. **The reference braking forces shall be declared such that the vehicle is capable of generating a braking rate equivalent to that defined in Annex 3 of this Regulation for the relevant vehicle whenever the measured roller braking force, for each axle irrespective of load, is not less than the reference braking force for a given brake demand value within the declared operating brake demand value range*.**

***Footnote reads:* * For the purpose of periodic technical inspection, the minimum limit braking rate values defined for the whole vehicle may need adjustment to reflect national or international in-service requirements.**

Paragraph 5.2.4. amend to read:

5.2.4. Where use is made of energy other than the muscular energy of the driver, there need not be more than one **supply (energy** source **or electrical supply, as relevant)** of such energy (hydraulic pump, air compressor, etc.), but the means

by which the device constituting that ~~source~~ **supply** is driven shall be as safe as practicable.

Insert a new paragraphs 5.2.4.4. and 5.2.4.5., to read:

5.2.4.4. **However, as an alternative to the provisions of paragraphs 5.2.4.1. and 5.2.4.2., for an electrical transmission braking system these requirements are considered to be met if the requirements of paragraph 5.2.4.4.1. are satisfied.**

5.2.4.4.1. **After any single transmission failure it shall still be possible after eight full actuations of the service braking system control, to achieve, at the ninth application, at least the performance prescribed for the secondary braking system or, where secondary performance requiring the use of stored energy is achieved by a separate control, it shall still be possible after eight full actuations to achieve, at the ninth application, the secondary performance prescribed in paragraph 2.3. of Annex 3. of this Regulation. Each full actuation shall be as specified in Annex 4 Part B paragraph 1.2.3.3.**

Insert a new paragraph 5.2.1.7.3., to read:

5.2.1.7.3. **Compensation provided, at any time, to ensure that the braking rate* of the vehicle remains related to the driver's braking demand, shall be declared. The manufacturer shall provide the Technical Service with a description of the compensation function(s), including the limits of operation, and the strategy that ensures this compensation does not compromise the safety of the vehicle, its occupants, or other road users.**

***Footnote reads:* * The Type Approval Authority, which is to grant approval, shall have the right to check the service braking system by additional vehicle test procedures. The assessment of the function shall be recorded in the test report.**

Paragraph 5.2.8.1.1., amend to read:

5.2.8.1.1. A difference in transverse braking pressures**, or wheel brake demand value,** on any axle of:

(a) 25 per cent of the higher value for vehicle decelerations ≥ 2 m/s²;

(b) A value corresponding to 25 per cent at 2 m/s^2 for decelerations below this rate.

Paragraph 5.2.14.1., amend to read:

5.2.14.1. Any vehicle fitted with a service brake actuated from an energy ~~**reservoir**~~ **reserve** shall, where the prescribed secondary braking performance cannot be obtained by means of this braking system without the use of the stored energy, be provided with a warning device, in addition to **an indication of the available energy (e.g.** a pressure gauge**)** where fitted, giving an optical or acoustic signal **at the latest** when the stored energy **(or the state of an electrical storage device, as relevant)** in any part of the system, falls to a **level** ~~**value**~~ at which without re-charging of the ~~reservoir~~ **reserve** and irrespective of the load conditions of the vehicle:

(a) For braking systems other than an electrical transmission braking system, it is possible to apply the service brake control a fifth time after four full-stroke actuations and obtain the prescribed secondary braking performance;

(b) For electrical transmission braking systems, the prescribed service brake performance cannot be achieved, or it is still possible to apply the service brake control a fifth time after four full*/ actuations and obtain at least the secondary braking performance, whichever occurs first,

without faults in the service brake transmission and with the brakes adjusted as closely as possible.

This warning device shall be directly and permanently connected to the circuit. **The red warning signal specified in paragraph 5.2.21.1.1. shall be used as the optical warning signal.** When the engine is running, **or during a run cycle (e.g., in case of a vehicle propelled by an electric motor),** under normal operating conditions and there are no faults in the braking system, as is the case in approval tests for this type, the warning device shall give no signal except during the time required for charging the energy **reserve(s) after each new engine start/run cycle, as relevant.**

Footnote reads: *** A full actuation means the actuation of the control in accordance with Annex 4, Part B, paragraph 1.2.3.3. for a duration of 8.0 seconds or for a time T as described in that paragraph.**

Renumber 5.2.14.3. as 5.2.14.1.4.

Insert a new paragraph 5.2.14.3., to read:

5.2.14.1.2. **In addition, for vehicles equipped with an electrical transmission braking system, there shall be an acoustic signal that is activated no later than 60 seconds after the activation of the red warning signal required by paragraph 5.2.14.1. (b) or following the first application of the service brake control after activation of that red warning signal, whichever occurs first.**

Vehicles which rely for their propulsion on energy from an electrical storage device or devices, shall be deemed to comply with this requirement if the energy to the traction motor(s) is stopped before the energy in the electrical storage device(s) has fallen to a level at which the red warning signal is activated.

Insert new paragraph 5.2.14.4., to read:

5.2.14.4. **In addition, any vehicle equipped with an electrical transmission braking system shall have an indicator reflecting the effect of ageing on each of the electrical storage devices. This requirement shall not apply to a traction battery that also has the function of an energy storage device (within the meaning of Annex 4, part B).**

The indicators for electrical storage devices may share a common space in accordance with UN Regulation No. 121. They need not be permanently visible; however, they shall be visible immediately to the driver in response to a manual demand at any time that the ignition/start switch is in the "on" (run) position.

The indicator shall provide at least four different levels of ageing above the level at which a maintenance of the electrical storage device(s) is recommended. This fifth level shall be given before the warning signal required by 5.2.24.6. is activated. The different levels above this indication shall be evenly distributed with respect to the performance of the electrical storage devices.

Paragraph 5.2.1.1.6., amend to read:

5.2.1.16. The pneumatic/hydraulic/**electrical auxiliary** equipment shall be supplied with energy in such a way that during its operation, the prescribed deceleration values can be reached and that**,** even in the event of damage to the source of energy**,** the operation of the auxiliary equipment cannot cause the reserves of energy **(i.e. reserve within reservoir, accumulator, or electrical storage devices ***) feeding the braking systems to fall below the level indicated in paragraph 5.2.14. above.

Footnote reads: *** It is understood that an electric control transmission, according to paragraph 5.2.20., is not equipped with an electrical storage device within the meaning of this regulation.**

Paragraph 5.2.19.3., amend to read:

5.2.19.3. Auxiliary equipment may be supplied with energy from the electric transmission of the parking braking system provided that the supply of energy is sufficient to allow the actuation of the parking braking system in addition to the vehicle electrical load under non-fault conditions. In addition, where the energy reserve is also used by the service braking system, the requirements of paragraph 5.2.20.6. **or, in the case of electrical transmission braking systems, paragraph 5.2.24.12. respectively** shall apply.

Paragraph 5.2.20., amend to read:

5.2.20. Special additional requirements for service braking systems with electric control transmission **except electrical transmission braking systems**

Insert new paragraph 5.2.21.1.3., to read:

5.2.21.1.3. The warning signals required by this paragraph shall employ the brake system malfunction symbol listed in UN Regulation No. 121.

Insert new paragraph 5.2.1.31.3.4., to read:

5.2.1.21.3.4. In the case of an electrical transmission braking system employing an electrical storage device (or devices) it shall be ensured that the value of electrical performance at which the warning signal required by paragraph 5.2.24.6. and 5.2.24.7. is activated, is respected despite the effect of environmental conditions (e.g., temperature) and ageing. The manufacture shall show to the satisfaction of the Technical Service, how this is achieved.

Renumber paragraph 5.2.24. to read 5.2.25.

Insert new paragraph 5.2.24. and subparagraphs, to read:

5.2.24. Special additional requirements for electrical transmission braking systems.

5.2.24.1. When the state of the electrical storage device(s) is insufficient to ensure the secondary performance as laid down in paragraph 2.2. of Annex3 to this Regulation by the actuation of the service brake control the release of the parking braking system shall be prevented.

5.2.24.2. With the parking brake released, the service braking system shall,

(a) With the propulsion system on/off control in the ''On'' (''Run'') position, generate a static total braking force at least equivalent to that required by the Type 0 test for service braking performance as prescribed in paragraph 2.1. of Annex 3 to this Regulation,

(b) During the first 60 seconds after the propulsion system on/off control has been deactivated to the ''Off'' or ''Lock'' position and/or the ignition key has been removed, three brake applications shall generate a static total braking force at least equivalent to that required by the Type 0 test for service braking performance as prescribed in paragraph 2.1. of Annex 3 to this Regulation, and

(c) After the period mentioned above, or as from the fourth brake application within the 60 second period, whichever occurs first, generate a static total braking force at least equivalent to that required by the Type 0 test for secondary braking performance as prescribed in paragraph 2.2. of Annex 3 to this Regulation.

It should be understood that sufficient energy is available in the energy transmission of the service braking system.

5.2.24.3. For an electrical storage device feeding only the electric control transmission, the full control range of the service braking system shall be guaranteed after the following test procedure.

This test shall be carried out starting from the nominal value of the energy level and the electrical storage device not being fed. With the control transmission in operation, the braking control shall be kept released for at least 20 minutes before performing 20 full* actuations of the service brakes control, with a released time of 5.0 seconds between each actuation.

This requirement shall not be construed as a departure from the requirements of Annex 4, Part B, paragraph 1.

In order to avoid the activation of the red warning signal due to the excessive consumption of electrical energy of the electrical energy transmission, the electrical energy transmission may be switched off.

Footnote reads: *** A full actuation means the actuation of the control in accordance with Annex 4, Part B, paragraph 1.2.3.3. for a duration of 8.0 seconds or for a time T as described in that paragraph.**

5.2.24.4. **In the case that the electrical storage devices are providing electrical energy for the electrical control and electrical energy transmission, the requirements of paragraph 1.2.1. of Part B of Annex 4 shall apply.**

5.2.24.5. **As an alternative to the requirements of Annex 4, Part B, paragraph 1.2., electrical storage devices that provide power only to the control transmission of the braking system may satisfy the following requirement.**

If the energy in an electrical storage device falls to a value at which the function or performance of a control transmission will be affected, the control transmission shall be provided with the power necessary for its correct operation directly from the electrical supply device. It should be understood that there is no fault or failure of the electrical supply device.

This alternative power supply shall be provided automatically no later than on the actuation of the control. The energy value at which this alternative supply is required shall be declared by the vehicle manufacturer to the technical service and the transition verified at the time of type-approval.

In addition, this condition shall be signalled to the driver by use of the red warning signal specified in paragraphs 5.2.21.1.1.

5.2.24.6. **A warning signal shall be displayed no later than when the effect of ageing on the electrical storage device(s) is such that its performance is not sufficient to fulfil the requirements of Annex 4, Part B, paragraph 1.2.1. The yellow warning signal described in paragraph 5.2.21.1.2. shall be used.**

5.2.24.7. **A warning signal shall be displayed no later than when the state of the electrical storage device(s) is insufficient for more than 60 seconds to fulfil the prescribed braking performance in Annex 4, Part B, paragraph 1.2.1. The yellow warning signal described in paragraph 5.2.21.1.2. shall be used.**

5.2.24.8. **There shall be an energy management system for the electrical storage devices of the transmission.**

5.2.24.8.1. **The energy management system shall be capable of continuously assessing the electrical storage devices, to determine their ability to deliver to the brake transmission the needed power, over time, to fulfil the performance requirements of this Regulation and, where appropriate, of activating the warning signals required by this Regulation.**

If the assessment is not complete at the time that the start/run switch is moved to the on (run) position, a red warning signal shall be activated and shall remain active until the safe status of the electrical transmission braking system has been confirmed. The red warning signal prescribed in paragraph 5.2.21.1.1. may be used. This requirement shall apply even after a maintenance operation on the electrical storage device and/or the energy management system (e.g. the replacement/temporary

disconnection of an electrical storage device, or the replacement of the energy management system itself).

The method by which the energy management system determines the safe status, including after maintenance, shall be described by the manufacturer at the time of type approval. Compliance with these requirements shall be demonstrated to the satisfaction of the Technical Service, including an assessment according to Annex 8.

5.2.24.8.2. It shall be demonstrated that the energy management system accurately identifies the condition at which the warning signals required by this Regulation are activated.

The Technical Service shall take account of the influence of the individual variables used by the energy management system, on both the performance and the state of the electrical storage device(s).

The Technical Service shall verify that the accuracy of the energy management system is ensured under all operating conditions (for example different environmental conditions) that can reasonably be foreseen by reviewing the documentation provided by the manufacturer and performing tests of the energy management system in different conditions (e.g., changes in temperature).

5.2.24.8.3. In the context of the assessment described in paragraph 5.2.24.8.2., the manufacturer shall provide the following information as part of the documentation required by Annex 8, paragraph 3:

(a) Regarding the Energy Management System;

(i) A detailed overview of the energy management system, explaining its architecture, components, and functionality,

(ii) A description of how the system monitors electrical storage device s.

(iii) Sufficient information about the energy management system strategy to illustrate the algorithms and logic used to assess the state and the performance of electrical storage devices.

(iv) A list of all the input variables considered by the energy management system in assessing the state and the performance of the electrical storage devices.

(v) A sensitivity analysis showing how each of the listed variables affects the ability of the energy management system to accurately identify when a warning signal shall be activated.

(b) Regarding the relevant verification testing the documentation shall include:

(i) The thresholds, or criteria, that trigger the warning signals described in paragraph 5.2.21.1.1. and paragraph 5.2.21.1.2.

(ii) Results of verification testing to assess the accuracy of the energy management system.

(iii) Data on different operating conditions, such as temperature or battery ageing.

(iv) An outline of the boundary conditions that could impact the accuracy of the energy management system (e.g., temperature, aging characteristics)

(v) In response to paragraph 3.4.4. of Annex 8, a description of the strategy in the event of a failure of the energy management system, or of an input channel to the energy management system, when relevant to the braking functionality.

(vi) When applicable, the procedures for updating the energy management system and ensuring its ongoing maintenance.

(vii) The appropriate testing procedures to be taken into account when performing the relevant verification testing to assess compliance with paragraph 5.2.24.6. and paragraph 5.2.24.7.

5.2.24.8.4. **In the event of a failure of the energy management system or an input channel of the energy management system that prevents the assessment of the state of the energy storage device(s), a red visual warning signal, accompanied by an audible signal, shall be activated at the moment of the detection of the failure (i.e. a first time in operation then at each start-up thereafter). The operation of the acoustic signal may be temporary, but the visual warning must remain active as long as the failure persists. The red warning signal prescribed in paragraph 5.2.21.1.1. may be used for visual alert. If the manufacturer's failure strategy affects braking functionality, details shall be given in the documentation required in paragraph 5.2.24.8.3.**

Even in the event of the failure described above, if the energy management system is still able to assess the status of the electrical storage device(s), it is sufficient to use only the yellow warning signal specified in paragraph 5.2.21.1.2.

5.2.24.9. **In the case that the supply of power requested by the electrical transmission cannot be met by the electrical supply, a power warning (Pw) to the driver shall be activated no later than 5.0 s after the appearance/detection. The yellow warning signal specified in paragraph 5.2.21.1.2. may be used.**

The functionality of the system triggering the warning level Pw shall be described by the vehicle manufacturer as part of the documentation package required in Annex 8 of this Regulation to the Technical Service.

5.2.24.10. **In case auxiliary equipment is supplied from the same electrical storage device(s) as the braking system, and in the event of a failure of the electrical supply (including the energy source, if fitted) that is providing energy to this electrical storage device(s) the**

- **Auxiliary equipment shall be switched off, and/or**
- **The vehicle shall be automatically brought to standstill,**

Before the critical level referred to in paragraph 5.2.14.1.(b) of this Regulation is reached.

In either case, the operation of auxiliary equipment required to satisfy subject to the performance requirements of another safety related UN regulation shall not be affected.

In the case of a vehicle that is not equipped with an onboard electrical supply (e.g. an electric vehicle with a traction battery having the function of an energy storage device) the mitigation required by this paragraph shall also be applied before the critical level referred to in paragraph 5.2.14.1. (b) of this Regulation is reached, or following a failure that would prevent the traction battery from providing power to the braking system.

5.2.24.11. **The red warning signal specified in paragraph 5.2.21.1.1. shall be activated when the service braking performance is not anymore ensured by at least two independent service braking circuits from each achieving the prescribed secondary braking performance.**

5.2.24.12. **The electrical supply shall be able to ensure that the state of the electrical storage device(s) remains sufficient to fulfil the prescribed service braking performance.**

Additionally, in case the auxiliary equipment is supplied from the same electrical supply (including the energy source, if fitted) as the braking system, the requirement above shall be fulfilled even when all the auxiliary equipment is functioning. Where two or more auxiliary equipment cannot operate simultaneously (e.g. the climate control system cannot provide both heating and cooling at the same time), only the highest power consuming system, function, or component, shall be considered during the assessment. The manufacturer shall declare the total power demand of the auxiliary equipment and provide evidence to justify the exclusion of any auxiliary equipment.

This shall be assessed in accordance with the requirements set out in Annex 4, part B, section 2 of this regulation.

In the case of a vehicle that is powered by an internal combustion engine, and which has a driven electrical energy source (e.g. an alternator), to maintain the electrical supply, compliance with this paragraph may be assessed with the engine running at a speed not greater than 80 per cent of the maximum power speed.

5.2.24.13. **A failure within the electric transmission,* that affects the function and performance of systems addressed in this Regulation shall be indicated to the driver by the red or yellow warning signal specified in paragraphs 5.2.21.1.1. and 5.2.21.1.2., respectively, as appropriate. When the prescribed service braking performance can no longer be achieved (red warning signal), failures resulting from a loss of electrical continuity (e.g. breakage, disconnection) shall be signalled to the driver as soon as they occur, and the prescribed secondary braking performance shall be fulfilled by operating the service braking control in accordance with paragraph 2.2. of Annex 3 to this Regulation.**

Footnote reads: *** Until uniform test procedures have been agreed, the manufacturer shall provide the Technical Service with an analysis of potential failures within the electrical transmission and their effects. This information shall be subject to discussion and agreement between the Technical Service and the vehicle manufacturer.**

5.2.24.14. **In the case of a single temporary failure (< 40 ms) within the electric control transmission, excluding its energy supply, (e.g. non-transmitted signal or data error) there shall be no distinguishable effect on the service braking performance.**

5.2.24.15. **If the auxiliary equipment is supplied with energy from the electric transmission, the following requirements shall be fulfilled.**

5.2.24.15.1. **In the event of a failure in the energy source or electrical supply, whilst the vehicle is in motion, the energy in the electrical storage device(s) shall be sufficient to satisfy the brake performance requirements defined in paragraph 5.2.14.1. (b).**

Where that electrical supply also has a role as an electrical storage device for one circuit of the transmission, a failure of that supply shall not affect ability of the electrical storage device of another circuit to provide the power necessary to achieve the prescribed secondary brake performance.

5.2.24.16. **In the event of a failure in the energy source or electrical supply, whilst the vehicle is stationary and the parking braking system applied, the energy in the electrical storage device(s) shall be sufficient to actuate the lights even when the brakes are applied.**

5.2.1.24.17. **Low Energy Emergency Function**

5.2.24.17.1. **Within 60 seconds of the activation of the acoustic warning signal required by paragraph 5.2.1.14.1.2., there shall be an automatic function to progressively reduce the vehicle's speed such that it cannot exceed 20 km/h. Once the**

vehicle has come to a standstill, it shall be prevented from rolling away and there shall be sufficient electrical power available for it to be possible to apply the parking brake.

Insert new transitional provisions (paragraph 12.), to read:

12. Transitional Provisions

12.1. […]

12.1.1. As from the official date of entry into force of the XX series of amendments, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type approvals under this Regulation as amended by the XX series of amendments.

12.1.2. As from the official date of entry into force of the XX series of amendments, Contracting Parties applying this Regulation shall grant type approvals for a vehicle equipped with an electrical transmission braking system only if the vehicle type to be approved meets the requirements of this Regulation as amended by the XX series of amendments.

12.1.3. As from 1 September 2028, Contracting Parties applying this Regulation shall not be obliged to accept type approvals to the preceding series of amendments, for a vehicle type having a braking system equipped with an electronic control system, first issued after 1 September 2028.

12.1.4. As from 1 September 2030, Contracting Parties applying this Regulation shall not be obliged to accept type approvals issued to the preceding series of amendments to this Regulation.

12.1.5. Notwithstanding paragraph 12.1.4., Contracting Parties applying this Regulation shall continue to accept type approvals issued according to the preceding series of amendments to this Regulation, for the vehicles which are not affected by the changes introduced by the XX series of amendments.

12.1.6. Notwithstanding the transitional provisions above, Contracting Parties whose application of this Regulation comes into force after the date of entry into force of the most recent series of amendments are not obliged to accept type approvals which were granted in accordance with any of the preceding series of amendments to this Regulation/ are only obliged to accept type approval granted in accordance with the XX series of amendments.

12.2. General transitional provisions:

12.2.1. Contracting Parties applying this Regulation may grant type approvals according to any preceding series of amendments to this Regulation.

12.2.2. Contracting Parties applying this Regulation shall continue to grant extensions of existing approvals to any preceding series of amendments to this Regulation.

Annex 1,

Renumber existing paragraph 20. to 26. as 21. to 27.

Insert a new paragraph 20., to read:

20. Additional information in the case of power-driven vehicle equipped with an electrical transmission braking system.

20.1. Vehicle is/is not[2] equipped with an electrical transmission braking system.

Annex 3,

Paragraph 1.2.11., amend to read:

1.2.11. **Status of the energy reserve during the Annex 3 tests:**

(a) For a vehicle with electrically actuated service brakes powered from traction batteries (or an auxiliary battery) which receive(s) energy only from an independent external charging system, these batteries shall, during braking performance testing, be at an average of not more than 5 per cent above that state of charge at which the brake failure warning prescribed in paragraph 5.2.20.5. is required to be given.

If this warning is given, the batteries may receive some recharge during the tests, to keep them in the required state of charge range.

(b) For a vehicle with an electrical transmission braking system, and without a simulated failure, the state of the electrical storage devices shall be kept above the level specified in paragraph 5.2.14.1. (b).

Paragraph 1.5.1.7.2., amend to read:

1.5.1.7.2. In the case of vehicles equipped with hydraulically operated disc brakes **or electrically controlled adjustment mechanisms** no setting requirements are deemed necessary."

Paragraph 1.5.2. amend to read:

1.5.2. Hot performance

15.2.1. At the end of the Type-I test (test described in paragraph 1.5.1.) the hot performance of the service braking system shall be measured in the same conditions (and, in particular, at a constant control force no greater than the mean force, **or brake demand value,** actually used) as for the Type-0 test with the engine disconnected (the temperature conditions may be different).

Any system or function that provides compensation for a loss of brake performance due to heat fade shall be inoperative during this test.

Insert a new paragraph 3.1.3., to read:

3.1.3. In the case of vehicles fitted with an electrical transmission braking system, the requirements of paragraph 3.1.1. above are considered to be satisfied if, in an emergency manoeuvre, the deceleration of the vehicle at the least favourable brake, reaches a level corresponding to the prescribed performance within 0.6 second.

Annex 4,

Introduction, amend to read:

"Provisions relating to energy sources and energy storage devices (energy accumulators)

A. Hydraulic braking systems with stored energy.

Insert new section B, to read:

B. Electrical transmission braking system.

1. Performance of electrical storage devices

1.1. General

1.1.1. Vehicles equipped with an electrical transmission braking system shall be equipped with electrical storage devices of a performance meeting the requirements of paragraph 1.2. of this annex (Part B).

1.1.2. Electrical storage devices that provide power only to the control transmission of the braking system may, as an alternative, satisfy the requirements of paragraph 5.2.24.7. to this Regulation.

1.1.3. It shall be possible to easily identify the electrical storage devices of the different braking circuits.

1.2. Vehicles equipped with an electrical transmission braking system with stored energy shall meet the following requirements:

1.2.1. **The performance of the electrical storage device(s) shall be such that, as a minimum, after eight full actuations of the service braking system control (as described in paragraph 1.2.3.3. below) the performance (at the ninth braking) at least fulfils the requirements specified for secondary braking. Additionally, it shall be such that, on at least the first actuation, the prescribed performance of the service braking system can be achieved.**

1.2.2. **Testing shall be performed in conformity with the following requirements:**

1.2.2.1. **At the commencement of the test, the state of the electrical storage device(s) of each braking circuit shall be such that the necessary condition to display the yellow warning signal specified in paragraph 5.2.24.7. is fulfilled. Additionally, the state shall not be higher than the value which can be delivered by an electrical storage device whose performance has degraded to a point where the warning specified in 5.2.24.6. is displayed.**

In the case that a traction battery also has the function of an energy storage device (within the meaning of this Annex), the state of the traction battery at the commencement of the test may be such that the battery can no longer provide power to the traction motors. This condition may be a result of the actual capability of the traction battery being insufficient, or when of the control strategy of the vehicle suspends the supply of energy to the traction motor(s).

1.2.3. **The electrical storage devices shall not be supplied with further energy during the test.**

1.2.3.1. **The procedure by which the electrical storage devices are prepared for this test shall be agreed between the manufacturer and the type-approval authority technical service. This procedure shall be recorded in the test report and included in the type-approval documentation.**

1.2.3.2. **Each full actuation shall be for a duration of at least 8.0 seconds with an interval, specified by the vehicle manufacturer, of at least 5.0 seconds between the release of the brake control and its subsequent actuation.**

The vehicle manufacturer may provide cooling to the electromechanical actuators during the static phase of the test.

1.2.3.3. **Each actuation shall cause a demand (a_{ref}) on the brake actuators necessary to deliver the maximum possible deceleration designed to be delivered by the system in the Type 0 condition (e.g. cold brakes, Type 0 speed, laden, fully charged electrical storage devices), limited to 8.0 m/s².**

The demand value to the brake actuators may be reduced to a lower value $a_{reduced}$, while not being lower than the prescribed service braking deceleration. In this case, the duration T of each full stroke actuation shall be increased as per according to the following formula below:

$$T = a_{ref} / a_{reduced} * 8 \text{ seconds}$$

The method by which the demand is calibrated to deliver a_{ref} or $a_{reduced}$, as relevant, shall be agreed between the between the manufacturer and the technical service. This procedure shall be recorded in the test report and included in the type-approval documentation.

It shall be ensured that the energy provided to the brake system transmission during this test is provided only by the electrical storage devices.

1.2.3.4. **In the case of power-driven vehicles to which the coupling of a trailer is authorized and with a pneumatic control line, the supply line shall be stopped and a compressed-air reservoir of 0.5 litre capacity shall be connected directly to the coupling head of the pneumatic control line. Before each braking actuation, the pressure in this compressed-air reservoir shall be completely eliminated. After eight full* actuations, at**

the additional (ninth) actuation of the service braking system control, the energy level supplied to the pneumatic control line shall not fall below a level equivalent to one-half the figure obtained at the first brake actuation.

Footnote reads: *** A full actuation means the actuation of the control in accordance with Annex 4, Part B, paragraph 1.2.3.3. for a duration of 8.0 seconds or for a time T as described in that paragraph.**

1.2.3.5. **It shall be ensured that, when carrying out the test during standstill compared to a driving situation, the energy consumed by the service braking system is not reduced below the demand specified in paragraph 1.2.3.3. by energy saving functions.**

1.2.3.6. **The capability to achieve the prescribed secondary braking performance (at the ninth actuation of the brake control) shall be confirmed by dynamic testing in accordance with Annex 3, using only the electrical energy available from the electrical storage devices at the completion of 8 full* actuations performed in static condition (i.e. with the vehicle at standstill), in the test conditions specified in the relevant tests of paragraph 1.2.3. above. However, the requirement of Annex 3, paragraph 2.2.3. to simulate a failure into the braking system shall not apply.**

As an alternative to the dynamic testing above, the ninth actuation of the brake control may be done in static condition. The vehicle manufacturer shall provide evidence that the power provided over the time of the actuation is sufficient to at least achieve the prescribed secondary braking performance in the test condition of Annex 3. The method used to construct this evidence (e.g. based on the comparison of the power consumed by the brake actuators with the value measured during a dynamic test) shall be agreed between the manufacturer and the technical service and verified by the technical service, recorded in the test report and included in the type-approval documentation.

Footnote reads: *** A full actuation means the actuation of the control in accordance with Annex 4, Part B, paragraph 1.2.3.3. for a duration of 8.0 seconds or for a time T as described in that paragraph.**

1.2.3.7. **The capability to achieve the prescribed service braking performance at the first actuation shall be confirmed by the Type-0 dynamic testing in accordance with Annex 4, with an initial level of energy in the electrical storage devices not greater than the specified values of energy specified in paragraph 1.2.2.1.**

As an alternative to the dynamic testing above, the actuation of the brake control may be done in static condition. The power necessary to deliver this performance shall be determined using the same procedures as those described in paragraph 1.2.3.6.

2. **Capacity of the electrical supply**

2.1. **General**

The electrical supply (including the energy source, if fitted) shall meet the requirements set forth in the following paragraphs.

In the case that a traction battery also has the function of an electrical storage device (within the meaning of this Annex), without a source to replenish the traction battery (i.e. beside regenerative braking), the requirements below shall not apply, for the relevant circuit(s).

Testing shall be performed in conformity with the following requirements:

2.2. **Conditions of measurement**

2.2.1. The capacity of the electrical supply shall be assessed using the procedures of paragraph 1.5.1. of Annex 3 (Type-I test) and paragraph 1.5.2.1. (Hot performance). Contrary to the requirements of the Type-I test, in all cases the number of brake actuations shall be 20.

2.2.2. This test may be conducted under static conditions. In this case the duration of the braking event, the energy consumed by the braking system and the interval between braking events, shall be determined during the dynamic Type-I and Hot performance tests of Annex 3.

The brake actuations 16 to 20 shall be of the same duration and with and equivalent energy demand to that of actuation number 15. The interval between brake actuations shall be the same. The energy provided to the electrical transmission during the static test shall be equivalent to the mean value of the energy provided by the electrical supply to the electrical transmission during 15 actuations of the dynamic Type-I followed by one actuation of the Hot Performance test of Annex 3.

2.2.3. At the commencement of the test:

(a) The electrical supply operates without any failure.

(b) The state of the electrical storage devices shall not exceed the value specified in paragraph 1.2.2.1.

2.2.4. Where the electrical supply provides power to auxiliary equipment, the total power demand of the auxiliary systems declared in paragraph 5.2.24.12. shall be represented during the test by an equivalent power demand on the electrical supply.

The total power demand shall be continuously present throughout the test procedure.

2.2.5. The state of the electrical storage device(s) on completion of the test defined in paragraph 2.2. above, shall not fall to a value at which the red warning signal specified in paragraph 5.2.14.1.(b) of this Regulation is activated.

2.2.6. The value of the power supplied by the electrical supply shall not fall to a level at which the warning signal (P_W) required by paragraph 5.2.24.9. is activated.

Annex 6,

Paragraph 5.1.1.3., amend to read:

5.1.1.3. The supply to the energy transmission storage device(s) shall then be cut off.

Paragraph 5.1.1.4., amend to read:

5.1.1.4. The service braking control device shall then be fully actuated four times in succession with the vehicle stationary. **In the case of an electrical transmission braking system, each full actuation shall be (as defined in Annex 4, Part B, paragraph 1.2.3.3.**

Annex 6,

Appendix 2 (Utilization of adhesion)

Paragraph 1.1.3., amend to read:

1.1.3. A number of tests at increments of line pressure ***/ wheel brake demand value*** shall be carried out to determine the maximum ...

Annex 8, amend to read:

Annex 8

Special requirements to be applied to the safety aspects of ~~complex~~ electronic ~~vehicle~~ control systems

1. General

This annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of **Electronic System(s) (paragraph 2.3.) and** complex electronic ~~vehicle~~ control systems (paragraph ~~2.3.~~ **2.4.** below) as far as this Regulation is concerned.

~~**This annex may also be called, by special paragraphs in this Regulation, for safety related functions which are controlled by electronic system(s).**~~

This annex does not specify the performance criteria for "the system" but covers the methodology applied to the design process and the information which shall be disclosed to the Technical Service, for type approval purposes.

This information shall show that "the system" respects, under ~~normal~~ **non-fault** and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation.

2. Definitions

For the purposes of this annex,

2.1. **"*The System*" means an electronic control system or complex electronic control system that provides or forms part of the control transmission of a function to which this Regulation applies. This also includes any other system covered in the scope of this Regulation, as well as transmission links to or from other systems that are outside the scope of this Regulation, that acts on a function to which this Regulation applies.**

2.2. "*Safety concept*" is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation **under fault and non-fault conditions, including** ~~even~~ in the event of an electrical failure.

The possibility of a fall-back to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept.

2.3. "*Electronic control system*" means a combination of units, designed to co-operate in the production of the stated vehicle control function by electronic data processing.

Such systems, ~~often~~ **commonly** controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, **electro-mechanical,** electro-pneumatic or electro-hydraulic elements.

"*The system*", referred to herein**,** is the one for which type approval is being sought.

2.4. "*Complex electronic* ~~*vehicle*~~ *control systems*" are those electronic control systems **in** which ~~are subject to a hierarchy of control in which a controlled~~ **a** function may be over-ridden by a higher-level electronic control system/function.

A function which is over-ridden becomes part of the complex **electronic control** system**, as well as any overriding system/function within the scope of this Regulation. The transmission links to and from overriding systems/function outside of the scope of this Regulation shall also be included.**

2.5. "*Higher-level control*" systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the normal function(s) of the vehicle control system.

This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances.

2.6. "*Units*" are the smallest divisions of system components which will be considered in this annex, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.

2.7. "*Transmission links*" are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply.

This equipment is generally electrical but may, in some part, be optical, pneumatic, hydraulic or mechanical.

2.8. "*Range of control*" refers to an output variable and defines the range over which the system is likely to exercise control.

2.9. "*Boundary of functional operation*" defines the boundaries of the external physical limits within which the system is able to maintain control.

2.10. **"*Control strategy*" means a strategy to ensure robust and safe operation of the function(s) of "The System" in response to the input from the vehicle or the driver.**

This may include the automatic deactivation of a function or temporary performance restrictions.

3. Documentation

3.1. Requirements

The manufacturer shall provide a documentation package which gives access to the basic design of "the system" and the means by which it is linked to other vehicle systems or by which it directly controls output variables.

The function(s) of "the system"**, including the control strategies,** and the safety concept, as laid down by the manufacturer, shall be explained.

Documentation shall be brief yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved.

For periodic technical inspections, the documentation shall describe how the current operational status of "the system" can be checked.

The Technical Service shall assess the documentation package, as specified in paragraph 3.4., to show that "The System":

(a) Is designed to operate, under fault conditions, in such a way that it does not induce safety critical risks,

(b) Implements strategies which do not, under non-fault conditions, prejudice the safe operation of systems which are subject to the prescriptions of this Regulation; and,

(c) Respects, under non-fault and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation; and,

(d) Was developed according to the development process/method ~~declared~~ chosen by the manufacturer according to paragraph 3.4.4.

3.1.1. Documentation shall be made available in two parts:

(a) The formal documentation package for the approval, containing the material listed in paragraph 3. (with the exception of that of paragraph 3.4.4. below) which shall be supplied to the Technical Service at the time

of submission of the type-approval application. ~~**This will be taken**~~ **This documentation package shall be used by the Technical Service** as the basic reference for the verification process set out in paragraph 4. of this annex. The Technical Service shall ensure that this documentation package remains available for a period determined in agreement with the Approval Authority. This period shall be at least 10 years counted from the time when production of the vehicle is definitely discontinued.

(b) Additional **confidential** material and analysis data (**intellectual property**) of paragraph 3.4.4., which shall be retained by the manufacturer, but made open for inspection **(e.g., on-site in the engineering facilities of the manufacturer)** at the time of type approval. **The manufacturer shall ensure that this material and analysis data remains available for a period of 10 years counted from the time when production of the vehicle is definitely discontinued.**

3.2. Description of the functions of "the system"**, including control strategies.**

A description shall be provided which gives a simple explanation of all the ~~**control**~~ functions**, including control strategies,** of "the system" and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.

Any described function that can be over-ridden shall be identified and a further description of the changed rationale of the function's operation provided.

3.2.1. A list of all input and sensed variables shall be provided and the working range of these defined**, along with a description of how each variable affects system behaviour.**

3.2.2. A list of all output variables which are controlled by "the system" shall be provided and an ~~**indication**~~ **explanation** given, in each case, of whether the control is direct or via another vehicle system. The range of control (paragraph **2.8.**~~2.7.~~) exercised on each such variable shall be defined.

3.2.3. Limits defining the boundaries of functional operation (paragraph **2.9.**~~2.8.~~ above) shall be stated where appropriate to system performance.

3.3. System layout and schematics

3.3.1. Inventory of components

A list shall be provided, collating all the units of "the system" and mentioning the other vehicle systems which are needed to achieve the control function in question.

An outline schematic showing these units in combination shall be provided with both the equipment distribution and the interconnections made clear.

3.3.2. Functions of the units

The function of each unit of "the system" shall be outlined and the signals linking it with other units or with other vehicle systems shall be shown. This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.

3.3.3. Interconnections

Interconnections within "the system" shall be shown by a circuit diagram for the electrical transmission links, by an optical-fibre diagram for optical links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages. **The transmission links both to and from other systems shall also be shown.**

3.3.4. Signal flow and priorities

There shall be a clear correspondence between these transmission links and the signals carried between units.

Priorities of signals on multiplexed data paths shall be stated, wherever priority may be an issue affecting performance or safety as far as this Regulation is concerned.

3.3.5. Identification of units

Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.

Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used.

The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

3.3.5.1. The identification defines the hardware and software version and, where the latter changes such as to alter the function of the unit as far as this Regulation is concerned, this identification shall also be changed.

3.4. Safety concept of the manufacturer

3.4.1. The manufacturer shall provide a statement which affirms that the strategy chosen to achieve "the system" objectives will not, under non-fault conditions, prejudice the safe operation of systems which are subject to the prescriptions of this Regulation.

The vehicle manufacturer shall supplement this statement by an explanation showing in overall terms how the chosen strategy ensures that "The System" objectives do not prejudice the safe operation of the systems referred above, and by a description of the part of the validation plan supporting the statement.

The Technical Service shall perform an assessment to establish that the vehicle manufacturer's explanation of the chosen strategy is understandable, logical and that the validation plan is suitable and has been completed.

The Technical Service may perform tests, or may require tests to be performed, as specified in paragraph 4. below, to verify that "the system" operates as per the chosen strategy.

3.4.2. In respect of software employed in "the system", the outline architecture shall be explained and the design methods and tools used shall be identified. The manufacturer shall ~~**be prepared, if required, to**~~ show ~~**some**~~ evidence of the means by which they determined the realisation of the system logic, during the design and development process.

3.4.3. The manufacturer shall provide the technical authorities with an explanation of the design provisions built into "the system" so as to generate safe operation under fault conditions. Possible design provisions for failure in "the system" are for example:

(a) Fall-back to operation using a partial system;

(b) Change-over to a separate back-up system;

(c) Removal of the high-level function.

In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, e.g. by turning the ignition (run) switch to "off", or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

3.4.3.1. If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.

3.4.3.2. If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built-in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

3.4.3.3. If the chosen provision selects the removal of the Higher-Level Function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.

3.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any ~~**one of those specified faults which will have a bearing on vehicle control performance or safety**~~ **fault identified by the procedure below which will have a bearing on vehicle control, performance, or safety**.

~~**This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations.**~~

The ~~**chosen**~~ analytical approach(es)**, chosen by the manufacturer,** shall be established and maintained by the manufacturer and shall be made open for inspection by the Technical Service at the time of the type-approval.

The Technical Service shall perform an assessment of the application of the analytical approach(es). The assessment shall include:

(a) Inspection of the safety approach at the concept (vehicle) level with confirmation that it includes consideration of interactions with other vehicle systems. This approach may be based on a Hazard / Risk analysis appropriate to system safety.

(b) Inspection of the safety approach at the system level. This approach may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety.

(c) Inspection of the validation plans and results. This validation may use, for example, Hardware in the Loop (HIL) testing, vehicle on–road operational testing, or any means appropriate for validation.

The assessment shall consist of checks of hazards and faults chosen by the Technical Service to establish that the manufacturer's explanation of the safety concept is understandable, logical and that the validation plan is suitable and has been completed.

The Technical Service may perform tests, or may require tests to be performed, as specified in paragraph 4. below, to verify the safety concept.

3.4.4.1. This documentation shall itemize the parameters being monitored and shall set out, for each fault condition of the type defined in paragraph 3.4.4. above, the warning signal to be given to the driver and/or to service/technical inspection personnel.

3.4.4.2. Where this Regulation contains particular requirements for the operation of "The System" under different environmental conditions, this documentation shall describe the measures in place to ensure compliance with those requirements.

4**.** Verification and test

4.1. The functional operation of "the system"**,** as laid out in the documents required in paragraph 3. above, shall be tested as follows:

4.1.1. Verification of the function of "the system"

~~**As the means of establishing the normal operational levels, verification of the performance of the vehicle system under non-fault conditions shall be conducted against the manufacturer's basic benchmark specification unless this is subject to a specified performance test as part of the approval procedure of this or another Regulation.**~~

The Technical Service shall verify "The System" under non-fault conditions by testing a number of selected functions from those described by the manufacturer in paragraph 3.2. above.

The verification of the performance of those selected functions shall be conducted following the manufacturer's test procedures unless a test procedure is specified in this Regulation.

For cases where the braking system is subject to input signal(s) from systems outside the scope of this Regulation, the test shall be conducted using the test procedure of the relevant UN regulation, or by another means that generates the relevant input signal(s), (e.g. simulation).

For complex electronic systems, these tests shall include scenarios whereby a declared function is overridden.

4.1.1.1. The verification results shall correspond with the description, including the control strategies, provided by the manufacturer in paragraph 3.2.

4.1.2. Verification of the safety concept of paragraph 3.4. above

The reaction of "the system" shall~~**, at the discretion of the type approval authority,**~~ be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit.

The Technical Service shall conduct this check for at least one individual unit but shall not check the reaction of "The System" to multiple simultaneous failures of individual units.

The Technical Service shall verify that these tests include aspects that may have an impact on vehicle controllability and user information (HMI aspects).

4.1.2.1. The verification results shall correspond with the documented summary of the failure analysis, to a level of overall effect such that the safety concept and execution are confirmed as being adequate.

4.2. Simulation tools and mathematical models for verification of the safety concept may be used in accordance with Schedule 8 of Revision 3 of the 1958 Agreement, in particular for scenarios that are difficult on a test track or in real driving conditions. Manufacturers shall demonstrate the scope of the simulation tool, its validity for the scenario concerned as well as the validation performed for the simulation tool chain (correlation of the outcome with physical tests).

5. Reporting by Technical Service

Reporting of the assessment by the Technical Service shall be performed in such a manner that allows traceability, e.g., versions of documents inspected are coded and listed in the records of the Technical Service.

An example of a possible layout for the assessment form from the Technical Service to the Type Approval Authority is given in Appendix 1 to this Annex."

Insert a new Annex 18 - Appendix, to read:

“Annex 8 – Appendix

Model assessment form for electronic, and/or complex electronic, control systems

Test report No: .....

1. Identification

1.1. Vehicle make: .....

1.2. Type: .....

1.3. Means of identification of type if marked on the vehicle: .....

1.4. Location of that marking: .....

1.5. Manufacturer’s name and address: .....

1.6. If applicable, name and address of manufacturer’s representative:

1.7. Manufacturer’s formal documentation package:

Documentation reference No: .....
Date of original issue: .....
Date of latest update: .....

2. Test vehicle(s)/system(s) description

2.1. General description: .....

2.2. Description of the functions of "The System", including control strategies (Annex 8, paragraph 3.2.): .....

2.2.1. List of input and sensed variables and their working range including a description the effect of the variable on system behaviour (Annex 8, paragraph 3.2.1.): .....

2.2.2. List of output variables and their range of control (Annex 8, paragraph 3.2.2.): .....

2.2.2.1. Directly controlled: .....

2.2.2.2. Controlled via other vehicle systems: .....

2.2.3 Boundaries of functional operation (Annex 8, paragraph 3.2.3.): .....

2.3. Description System layout and schematics (Annex 8, paragraph 3.3.): .....

2.3.1. Inventory of components (Annex 8, paragraph 3.3.1.): .....

2.3.2. Functions of the units (Annex 8, paragraph 3.3.2.): .....

2.3.3. Interconnections (Annex 8, paragraph 3.3.3.): .....

2.3.4. Signal flow and priorities (Annex 8, paragraph 3.3.4.): .....

2.3.5. Identification of units (hardware & software) (Annex 8, paragraph 3.3.5.): .....

3. Manufacturer’s safety concept.

3.1. Manufacturer’s declaration (Annex 8, paragraph 3.4.1.):

The manufacturer(s) ..... affirm(s) that the strategy chosen to achieve "The System", objectives will not, under non-fault conditions, prejudice the safe operation of the vehicle.

3.2. **Software (outline architecture, software design methods and tools used) (Annex 8, paragraph 3.4.2.): .....**

3.3. **Explanation of design provisions built into "The System" under fault conditions (Annex 8, paragraph 3.4.3.): .....**

3.4. **Documented analyses of the behaviour of "The System" under individual fault conditions (Annex 8, paragraph 3.4.4.1.): .....**

3.4.1. **Parameters monitored: .....**

3.4.2. **Warning signals generated: .....**

3.5. **Description of the measures in place for environmental conditions (Annex 8, paragraph 3.4.4.2.): .....**

3.6. **Provisions for the periodic technical inspection of "The System" (Annex 8, paragraph 3.1.).**

Description of the method by which the operational status of the system can be checked: .....

4. **Verification and test.**

4.1. **Verification of the function of "The System" (Annex 8, paragraph 4.1.1.): .....**

4.1.1. **List of the selected functions and a description of the test procedures used: .....**

4.1.2. **Test results verified according to Annex 8, paragraph 4.1.1.1. Yes/No.**

4.2. **Verification of the system safety concept (Annex 8, paragraph 4.1.2.): .....**

4.2.1. **Unit(s) tested and their function: .....**

4.2.2. **Simulated fault(s): .....**

4.2.3. **Test results verified according to Annex 8, paragraph 4.1.2. Yes/No.**

4.3. **Date of test: .....**

4.4. **This test has been carried out and the results reported in accordance with Annex 8 to UN Regulation No. 13 as last amended by the …….…… series of amendments.**

Technical Service carrying out the test:

Signed: .....Date: .....

4.5. Comments: .....

II. Justification

1. This proposal supersedes that of document ECE/TRANS/WP.29/GRVA/2024/14.

2. The proposal seeks to permit the use of braking systems that rely purely on the use of stored electrical energy, controlled by the driver, to provide the service braking performance prescribed in this Regulation. The proposal mirrors, where appropriate, the changes proposed for UN Regulation No. 13 (Heavy Vehicle Braking).

3. Provisional paragraphs or text in the former document (denoted by [ ]) have been refined and/or agreed and the term "electrical transmission braking system" has been agreed as the descriptor for this new technology.

4. New terms have been introduced that relate to the changed energy medium. The term "electrical storage device" is analogous to the term "reservoir/accumulator" in pneumatic/hydraulic braking systems. The term "performance", when related to an electrical storage device, is analogous to the "capacity" of an energy reserve or accumulator, and the term "state", can be viewed as analogous to "pressure" in a "reservoir" or "accumulator".

5. The use of electrical energy to fulfil certain functions of the braking has been acknowledged for many years. Higher level functions such as anti-lock braking and stability control employ electrical controls and electronically controlled braking systems, where the control transmission of the braking system primarily electric have been accepted for many years. Advances in technology present the opportunity for both the control and the energy transmissions of the service brake system to be delivered with electrical energy.

6. The proposal has been prepared to ensure that electrical braking systems will provide at least the same level of safety and security that is provided by the systems that we know today.

7. The security of the electrical energy is recognised as being the most significant concern for this new generation of braking systems. This proposal sets out the requirements for an energy management system to be an integral part of the monitoring requirements for electrical braking systems. The energy management system will ensure that, should the stored energy fall to a value at which prescribed performance criteria cannot be met, timely warnings are provided to the driver. This monitoring and warning requirement is in alignment with that which is expected of compressed-air braking systems used in heavy vehicles today, and where the braking function is also dependent on the use of stored energy.

8. At the seventeenth session of the Working Party on Automated/Autonomous and Connected Vehicles (GRVA), the Special Interest Group on electrical braking presented the philosophy of the "State of Function" that would be used to deduce the status of the reserves of energy available to the braking system (GRVA-17-19). This proposal does not refer directly to state of function, this will vary between technologies, but the principles that were described will be integral to the functioning of an energy management system.

9. The proposal includes provisions to ensure that the effect of ageing, duty cycles, charging cycles, temperature cycles, temperature extremes, etc., are thoroughly considered and warnings provided at any point that the ageing effect could compromise the fulfilment of the requirements of this Regulation.

10. This document builds on the requirements set out in ECE/TRANS/WP.29/GRVA/2024/14 and includes additional provisions that require the energy management system to display a warning at the start of a use cycle, unless it has established that sufficient energy exists within the braking transmission to fulfil the performance requirements of this regulation. This requirement applies even after a

maintenance event, for example after an electrical disconnection or a change of component.

11. There are also more detailed requirements associated with the information that the manufacturer has to provide about the energy management system at the time of type-approval and also about the expectation of the assessment of the system by the Technical Service during type-approval.

12. It is recognised that other vehicle systems, both essential and optional, will rely on electrical power from the same energy reserves as the braking system. This proposal includes specific measures that ensure that, in the event of there being low electrical energy, the braking system, and other essential safety systems, can continue to function, or that the vehicle is brought to a safe halt.

13. The proposal also includes a revision of Annex 8, safety aspects of complex electronic control systems. These changes had been proposed separately for UN Regulation No. 13 (ECE/TRANS/WP.29/GRVA/2023/10). The intention is that the changes to the electronic system safety requirements will apply to both Regulations on the introduction of braking systems that rely on the use of stored electrical energy.