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#### World Forum for Harmonization of Vehicle Regulations

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Item 4.9.7 of the provisional agenda

##### **1958 Agreement – Consideration of draft amendments to existing Regulations submitted by GRSP**

### **Proposal for the 02 series of amendments to Regulation No. 100 (Battery electric vehicle safety)**

#### **Submitted by the Working Party on Passive Safety \***

The text reproduced below was adopted by the Working Party on Passive Safety (GRSP) at its fifty-first session to update provisions of UN Regulation No. 100. It is based on document ECE/TRANS/WP.29/GRSP/2012/10, as amended by Annex V to the report (ECE/TRANS/WP.29/GRSP/51, para. 33). It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee AC.1 for consideration.

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\* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

*Contents,*

*Paragraph 5, amend to read:*

"5. Part I: Requirements of a vehicle with regard to its electrical safety ....." "

*Insert a new paragraph 6, to read:*

"6. Part II: Requirements of a Rechargeable Energy Storage System (REESS) with regard to its safety ....." "

*Paragraph 6, renumber as paragraph 7 and amend to read:*

"7. Modifications and extension of the type approval ....." "

*Paragraphs 7 to 11, renumber as paragraphs 8 to 12*

*List of Annexes,*

*Annex 1, amend to read:*

"Annex 1 - Communication:

- Part 1: Communication of a vehicle type with regard to its electrical safety pursuant to Regulation No. 100 .....
- Part 2: Communication of a type of component or separate technical unit as a REESS with regard to its safety pursuant to Regulation No. 100 ....." "

*Annex 4, amend to read:*

- "Annex 4 -
- A. Isolation resistance measurement method for vehicle based tests.....
  - B. Isolation resistance measurement method for component based tests of a REESS....." "

*Annex 6, amend to read:*

- "Annex 6
- Part 1 – Essential characteristics of road vehicles or systems .....
  - Part 2 - Essential characteristics of REESS....." "

*Annex 7, amend to read:*

- "Annex 7. - Determination of hydrogen emissions during the charge procedures of the REESS
- Appendix 1 - Calibration of equipment for hydrogen emission testing..
  - Appendix 2 - Essential characteristics of the vehicle family ....." "

*Insert new Annex 8, to read:*

- "Annex 8 - REESS Test procedures
- Appendix 1 - Procedure for conducting a Standard Cycle
  - A. Vibration
  - B. Thermal shock and cycling
  - C. Mechanical shock (component based tests)
  - D. Mechanical integrity (component based tests)

E. Fire resistance

Appendix 1 - Dimension and technical data of firebricks

F. External short circuit protection

G. Overcharge protection

H. Over-discharge protections

I. Over-temperature protection

*Text of the Regulation,*

*Paragraph 1., amend to read:*

"1. Scope

"1.1. *Part I:* safety requirements with respect to the electric power train of road vehicles of categories M and N <sup>1</sup>, with a maximum design speed exceeding 25 km/h, equipped with one or more traction motor(s) operated by electric power and not permanently connected to the grid, as well as their high voltage components and systems which are galvanically connected to the high voltage bus of the electric power train."

Part I of this Regulation does not cover post crash safety requirements of road vehicles;"

*Insert a new paragraph 1.2., to read:*

"1.2. Part II: safety requirements with respect to the Rechargeable Energy Storage System (REESS), of road vehicles of categories M and N equipped with one or more traction motors operated by electric power and not permanently connected to the grid.

Part II of this Regulation does not apply to REESS(s) whose primary use is to supply power for starting the engine and/or lighting and/or other vehicle auxiliaries systems."

*Insert a new paragraph 2.3., to read:*

"2.3. "Cell" means a single encased electrochemical unit containing one positive and one negative electrode which exhibits a voltage differential across its two terminals."

*Paragraphs 2.3 and 2.4., renumber as paragraphs 2.4. and 2.5. and amend to read:*

"2.4. "*Conductive connection*" means the connection using connectors to an external power supply when the rechargeable energy storage system (REESS) is charged.

2.5. "*Coupling system for charging the rechargeable energy storage system (REESS)*" means the electrical circuit used for charging the REESS from an external electric power supply including the vehicle inlet."

<sup>1</sup> As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.2, para. 2.

*Insert a new paragraph 2.6., to read:*

"2.6. "C Rate" of "n C" is defined as the constant current of the tested-device, which takes 1/n hours to charge or discharge the tested-device between 0 per cent of the state of charge and 100 per cent of the state of charge."

*Paragraphs 2.5. to 2.8.(former), renumber as paragraphs 2.7. to 2.10:*

*Paragraph 2.9.(former), renumber as paragraph 2.11. and amend to read:*

"2.11. "Electric power train" means the electrical circuit which includes the traction motor(s), and may include the REESS, the electric energy conversion system, the electronic converters, the associated wiring harness and connectors, and the coupling system for charging the REESS."

*Paragraphs 2.10. to 2.12., renumber as paragraphs 2.12. to 2.14.*

*Insert a new paragraph 2.15., to read:*

"2.15. "Explosion" means the sudden release of energy sufficient to cause pressure waves and/or projectiles that may cause structural and/or physical damage to the surrounding of the tested-device."

*Paragraphs 2.13. to 2.14., renumber as paragraphs 2.16. to 2.17.*

*Insert new paragraphs 2.18. and 2.19., to read:*

"2.18. "Fire" means the emission of flames from a tested-device. Sparks and arcing shall not be considered as flames.

2.19. "Flammable electrolyte" means an electrolyte that contains substances classified as Class 3 "flammable liquid" under "UN Recommendations on the Transport of Dangerous Goods – Model Regulations (Revision 17 from June 2011), Volume I, Chapter 2.3"<sup>2</sup>

*Paragraph 2.15., renumber as paragraph 2.20. and amend to read:*

"2.20. "High voltage bus" means the electrical circuit, including the coupling system for charging the REESS that operates on high voltage."

*Paragraphs 2.16. to 2.18.(former), renumber as paragraphs 2.21. to 2.23*

*Insert a new paragraph 2.24., to read:*

"2.24. "Manufacturer" means the person or body who is responsible to the approval authority for all aspects of the type approval process and for ensuring conformity of production. It is not essential that the person or body be directly involved in all stages of the construction of the vehicle, system, component or component which is the subject of the approval process."

*Paragraphs 2.19. to 2.22., renumber as paragraphs 2.25. to 2.28.*

*Paragraph 2.23., renumber as paragraph 2.29. and amend to read:*

"2.29. "Rechargeable energy storage system (REESS)" means the rechargeable energy storage system that provides electric energy for electrical propulsion.

The REESS may include subsystem(s) together with the necessary ancillary systems for physical support, thermal management, electronic control and enclosures."

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<sup>2</sup> [www.unece.org/trans/danger/publi/unrec/rev17/17files\\_e.html](http://www.unece.org/trans/danger/publi/unrec/rev17/17files_e.html)

*Insert a new paragraph 2.30., to read:*

"2.30. "Rupture" means opening(s) through the casing of any functional cell assembly created or enlarged by an event, large enough for a 12 mm diameter test finger (IPXXB) to penetrate and make contact with live parts (see Annex 3)."

*Paragraph 2.24.(former), renumber as paragraph 2.31. and amend to read:*

"2.31. "Service disconnect" means the device for deactivation of the electrical circuit when conducting checks and services of the REESS, fuel cell stack, etc."

*Insert a new paragraph 2.32., to read:*

"2.32. "State of Charge (SOC)" means the available electrical charge in a tested-device expressed as a percentage of its rated capacity."

*Paragraph 2.25., renumber as paragraph 2.33*

*Insert new paragraphs 2.34 to 2.36., to read:*

"2.34. "Subsystem" means any functional assembly of REESS components.

2.35. " tested-device " means either the complete REESS or the subsystem of a REESS that is subjected to the tests prescribed by this Regulation.

2.36. "Type of REESS" means systems which do not differ significantly in such essential aspects as:

- (a) the manufacturer's trade name or mark,
- (b) the chemistry, capacity and physical dimensions of its cells,
- (c) the number of cells, the mode of connection of the cells and the physical support of the cells,
- (d) the construction, materials and physical dimensions of the casing and
- (e) the necessary ancillary devices for physical support, thermal management and electronic control."

*Paragraphs 2.26 to 2.27., renumber as paragraphs 2.37 to 2.38.*

*Insert new a paragraph 3.1., to read:*

"3.1. Part I: Approval of a vehicle type with regard to the High Voltage System"

*Paragraph 3.1.(former), renumber as paragraph 3.1.1. and amend to read:*

"3.1.1. The application ... be submitted by the vehicle manufacturer ..."

*Paragraphs 3.2. to 3.2.1.(former), renumber as paragraphs 3.1.2. to 3.1.2.1.*

*Insert a new paragraph 3.1.2.2., to read:*

"3.1.2.2. For vehicles with REESS, additional evidence showing that the REESS is in compliance with the requirements of paragraph 6 of this Regulation."

*Paragraph 3.3.(former), renumber as paragraph 3.1.3. and amend to read:*

"3.1.3. A vehicle representative of the vehicle type to be approved shall be submitted to the Technical Service responsible for conducting the approval tests and, if applicable, at the manufacturer's discretion with the agreement of the Technical Service, either additional vehicle(s), or those parts of the vehicle

regarded by the Technical Service as essential for the test(s) referred to in the Paragraph 6 of this Regulation."

*Insert new paragraphs 3.2. to 3.2.3., to read:*

- "3.2. Part II: Approval of a Rechargeable Energy Storage System (REESS)
- 3.2.1. The application for approval of a type of REESS or separate technical unit with regard to the safety requirements of the REESS shall be submitted by the REESS manufacturer or by his duly accredited Representative.
- 3.2.2. It shall be accompanied by the under-mentioned documents in triplicate and comply with the following particulars:
- 3.2.2.1. Detailed description of the type of REESS or separate technical unit as regards the safety of the REESS.
- 3.2.3. A component(s) representative of the type of REESS to be approved plus, at the manufacturer's discretion, and with the agreement of the Technical Service, those parts of the vehicle regarded by the Technical Service as essential for the test, shall be submitted to the Technical Service responsible for conducting the approval tests."

*Paragraph 3.4.(former), renumber as paragraph 3.3.*

*Paragraph 4.1., amend to read:*

- "4.1. If the type submitted for approval pursuant to this Regulation meets the requirements relevant parts of this Regulation, approval of that type shall be granted."

*Paragraphs 4.3. and 4.4., amend to read:*

- "4.3. Notice of approval or of refusal or of extension or withdrawal of approval or production definitely discontinued of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation, by means of a form conforming to the model in Annex 1, Part 1 or 2 as appropriate to this Regulation.
- 4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle or REESS or separate technical unit conforming to a type approved under this Regulation an international approval mark consisting of:"

*Paragraph 4.4.1., the reference to footnote <sup>1</sup> and footnote <sup>1</sup> renumber as footnote <sup>3</sup> and amend to read:*

<sup>3</sup> The distinguish numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to Consolidated resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.2/Amend.1."

*Insert a new paragraph 4.4.3., to read:*

- "4.4.3. In the case of an approval of a REESS or a separate technical unit of the REESS the "R" shall be followed by the symbol "ES"."

*Paragraph 4.5., amend to read:*

- "4.5. If the vehicle or REESS conforms to a type ..."

*Paragraph 4.7., renumber as paragraph 4.6.1. and amend to read:*

"4.6.1. In the case of a vehicle, the approval mark shall be placed on or close to the vehicle data plate affixed by the Manufacturer."

*Insert a new paragraph 4.6.2., to read:*

"4.6.2. In the case of a REESS or separate technical unit approved as a REESS, the approval mark shall be affixed on the major element of the REESS by the Manufacturer."

*Paragraph 4.8., renumber as paragraph 4.7.*

*Paragraph 5., amend to read:*

"5. Requirements of a vehicle with regard to its electrical safety"

*Paragraph 5.1.1., amend to read:*

"5.1.1. Protection against direct contact

Protection against direct contact with live parts is also required for vehicles equipped with any REESS type approved under Part II of this Regulation.

The protection against direct contact with the live parts, shall comply with paragraphs 5.1.1.1. and..."

*Paragraph 5.1.1.5.1, amend to read:*

"5.1.1.5.1. In the case of a REESS having high voltage capability the symbol shown in Figure 1 shall appear on or near the REESS. The symbol background shall be yellow, the bordering and the arrow shall be black.

..."

*Paragraph 5.1.2., amend to read:*

"5.1.2. Protection against indirect contact

Protection against indirect contact is also required for vehicles equipped with any REESS type approved under Part II of this Regulation."

*Paragraph 5.1.3.1., amend to read:*

"5.1.3.1. Electric power train ..... for AC buses.

The measurement shall be conducted according to Annex 4A "Isolation resistance measurement method for vehicle based tests."

*Paragraph 5.1.3.2., amend to read:*

"5.1.3.2. Electric power train ...

...

The measurement shall be conducted according to Annex 4A "Isolation resistance measurement method for vehicle based tests."

*Paragraph 5.1.3.3., amend to read:*

"5.1.3.3. Fuel cell vehicles

...

(b) On-board isolation resistance monitoring system together with a warning to the driver if the isolation resistance drops below the minimum required value. The isolation resistance between the high

voltage bus of the coupling system for charging the REESS, which is not energized besides during charging the REESS, and the electrical chassis need not be monitored. The function of the on-board isolation resistance monitoring system shall be confirmed as described in Annex 5."

*Paragraph 5.1.3.4.*, amend to read:

"5.1.3.4. Isolation resistance requirement for the coupling system for charging the REESS

For the .... charging of the REESS, the isolation resistance between the high voltage bus ...."

*Paragraph 5.2.*, amend to read:

"5.2. Rechargeable Energy Storage System (REESS)"

*Paragraph 5.2.1.*, amend to read:

"5.2.1. For a vehicle with a REESS, the requirement of either paragraph 5.2.1.1. or Paragraph 5.2.1.2. shall be satisfied."

*Insert new paragraphs 5.2.1.1. and 5.2.1.2.*, to read:

"5.2.1.1. For a REESS which has been type approved in accordance with PART II of this Regulation, it shall be installed in accordance with the instructions provided by the manufacturer of the REESS, and in conformity with the description provided in Annex 6 – Part 2 of this Regulation.

5.2.1.2. The REESS shall comply with the respective requirements of Paragraph 6 of this Regulation."

*Paragraph 5.2.2.*, amend to read:

"5.2.2. Accumulation of gas

Places for containing open type traction batteries that may produce hydrogen gas shall be provided with a ventilation fan or a ventilation duct to prevent the accumulation of hydrogen gas."

*Paragraph 5.3.*, amend to read:

"5.3. Functional safety

....

If the on-board REESS can be externally charged by the user, vehicle movement by its own propulsion ...

...."

*Paragraph 5.4.1.*, amend to read:

"5.4.1. This test shall be carried out on all vehicles equipped with open type traction batteries. If the REESS has been approved under Part 2 of this Regulation and installed in accordance with paragraph 5.2.1.1. this test can be omitted for the approval of the vehicle."

*Paragraph 5.4.4.*, amend to read:

"5.4.4. During a charge carried out by a charger presenting a failure (conditions given in Annex 7), hydrogen emissions shall be below 42 g. Furthermore the charger shall limit this possible failure to 30 minutes."



*Paragraph 5.4.5.*, amend to read:

"5.4.5. All the operations linked to the REESS charging shall be controlled automatically, included the stop for charging."

*Paragraph 5.4.8.*, amend to read:

"5.4.8. Important charging failures shall be permanently indicated. An important failure is a failure that can lead to a malfunction of the charger during charging later on."

*Insert new paragraphs 6. to 6.10.2.*, to read:

"6. Part II: Requirements of a Rechargeable Energy Storage System (REESS) with regard to its safety

6.1. General

The procedures prescribed in Annex 8 of this Regulation shall be applied.

6.2. Vibration

6.2.1. The test shall be conducted in accordance with Annex 8A of this Regulation.

6.2.2. Acceptance criteria

6.2.2.1. During the test, there shall be no evidence of:

- (a) electrolyte leakage,
- (b) rupture (applicable to high voltage REESS (s) only),
- (c) fire,
- (d) explosion.

Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.

6.2.2.2. For a high voltage REESS, the isolation resistance measured after the test in accordance with Annex 4B of this Regulation shall not be less than 100  $\Omega$ /Volt.

6.3. Thermal shock and cycling

6.3.1. The test shall be conducted in accordance with Annex 8B of this Regulation.

6.3.2. Acceptance criteria

6.3.2.1. During the test, there shall be no evidence of:

- (a) electrolyte leakage,
- (b) rupture (applicable to high voltage REESS(s) only),
- (c) fire,
- (d) explosion.

Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.

6.3.2.2. For a high voltage REESS, the isolation resistance measured after the test in accordance with Annex 4B of this Regulation shall not be less than 100  $\Omega$ /Volt.

6.4. Mechanical impact

6.4.1. Mechanical Shock

At the manufacturer's choice the test may be performed as, either

- (a) Vehicle based tests in accordance with paragraph 6.4.1.1. of this Regulation, or
- (b) Component based tests in accordance with paragraph 6.4.1.2. of this Regulation, or
- (c) Any combination of (a) and (b) above, for different direction of vehicle travel.

6.4.1.1. Vehicle based test

Compliance with the requirements of the acceptance criteria of Paragraph 6.4.1.3. below may be demonstrated by REESS(s) installed in vehicles that have been subjected to vehicle crash tests in accordance with UNECE Regulations No. 12 Annex 3 or UNECE Regulation No. 94 Annex 3 for frontal impact, and UNECE No. 95 Annex 4 for side impact. The ambient temperature and the SOC shall be in accordance with the said Regulation.

The approval of a REESS tested under this paragraph shall be limited to the specific vehicle type.

6.4.1.2. Component based test

The test shall be conducted in accordance with Annex 8C of this Regulation.

6.4.1.3. Acceptance criteria

During the test there shall be no evidence of:

- (a) Fire
- (b) Explosion
- (c1) Electrolyte leakage if tested according to paragraph 6.4.1.1.
  - (i) For a period from the impact until 30 minutes after the impact there shall be no electrolyte spillage from the REESS into the passenger compartment.
  - (ii) No more than 7 per cent by volume of the REESS electrolyte capacity shall spill from the REESS to the outside of the passenger department (for open type traction batteries a limitation to a maximum of 5 litres also applies).
- (c2) Electrolyte leakage if tested according to paragraph 6.4.1.2.

After the vehicle based test (paragraph 6.4.1.1.), a REESS which is located inside the passenger compartment shall remain in the installed location and the REESS components shall remain inside REESS boundaries. No part of any REESS that is located outside the passenger compartment shall enter the passenger compartment during or after the impact test procedures.

After the component based test (paragraph 6.4.1.2.) the tested-device shall be retained by its mounting and its components shall remain inside its boundaries.

For a high voltage REESS the isolation resistance of the Tested-Device shall ensure at least 100  $\Omega$ /Volt for the whole REESS measured after the test in

accordance with Annex 4A or Annex 4B of this Regulation, or the protection degree IPXXB shall be fulfilled for the Tested-Device.

For a REESS tested in accordance with paragraph 6.4.1.2., the evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.

To confirm compliance to c1) of paragraph 6.4.1.3. an appropriate coating shall, if necessary, be applied to the physical protection (casing) in order to confirm if there is any electrolyte leakage from the REESS resulting from the impact test. Unless the manufacturer provides a means to differentiate between the leakage of different liquids, all liquid leakage shall be considered as the electrolyte.

#### 6.4.2. Mechanical Integrity

This test applies only to a REESS intended for installation in vehicles of category M<sub>1</sub> and N<sub>1</sub>.

At the manufacturer's choice, the test may be performed as, either

- (a) Vehicle based tests in accordance with paragraph 6.4.2.1. of this Regulation, or
- (b) Component based tests in accordance with paragraph 6.4.2.2. of this Regulation.

##### 6.4.2.1. Vehicle specific test

At the manufacturer's choice, the test may be performed as either

- (a) A vehicle based dynamic tests in accordance with paragraph 6.4.2.1.1. of this Regulation, or
- (b) A vehicle specific component test in accordance with paragraph 6.4.2.1.2. of this Regulation, or
- (c) Any combination of (a) and (b) above, for different directions of vehicle travel.

When the REESS is mounted in a position which is between a line from the rear edge of the vehicle perpendicular to the centre line of the vehicle and 300 mm forward and parallel to this line, the manufacturer shall demonstrate the mechanical integrity performance of the REESS in the vehicle to the Technical Service.

The approval of a REESS tested under this Paragraph shall be limited to specific vehicle type.

##### 6.4.2.1.1. Vehicle based dynamic test

Compliance with the requirements of the acceptance criteria of paragraph 6.4.2.3. below may be demonstrated by REESS(s) installed in vehicles that have been subjected to a vehicle crash test in accordance with the Annex 3 of Regulation Nos. 12 or 94 for frontal impact, and Annex 4 of Regulation No. 95 for side impact. The ambient temperature and the SOC shall be in accordance with the said Regulation.

##### 6.4.2.1.2. Vehicle specific component test

The test shall be conducted in accordance with Annex 8D of this Regulation.

The crush force replacing the prescribed force specified in paragraph 3.2.1. of Annex 8D shall be determined by the vehicle manufacturer using the data obtained from either actual crash tests or its simulation as specified in Annex 3 of Regulation No. 12 or No. 94 in the direction of travel and according to Annex 4 of Regulation No. 95 in the direction horizontally perpendicular to the direction of travel. These forces shall be agreed by the Technical Service.

The manufacturers may, in agreement with the Technical Services, use forces derived from the data obtained from alternative crash test procedures, but these forces shall be equal to or greater than the forces that would result from using data in accordance with the regulations specified above.

The manufacturer may define the relevant parts of the vehicle structure used for the mechanical protection of the REESS components. The test shall be conducted with the REESS mounted to this vehicle structure in a way which is representative of its mounting in the vehicle.

#### 6.4.2.2. Component based test

The test shall be conducted in accordance with Annex 8D of this Regulation.

REESS approved according to this paragraph shall be mounted in a position which is between the two planes; (a) a vertical plane perpendicular to the centre line of the vehicle located 420mm rearward from the front edge of the vehicle, and (b) a vertical plane perpendicular to the centre line of the vehicle located 300 mm forward from the rear edge of the vehicle.

The mounting restrictions shall be documented in Annex 6 - Part 2.

The crush force specified in paragraph 3.2.1. of Annex 8D may be replaced with the value declared by the manufacturer, where the crush force shall be documented in Annex 6 Part 2 as a mounting restriction. In this case, the vehicle manufacture who uses such REESS shall demonstrate, during the process of approval for Part 1 of this Regulation, that the contact force to the REESS will not exceed the figure declared by the REESS manufacturer. Such force shall be determined by the vehicle manufacturer using the data obtained from either actual crash test or its simulation as specified in Annex 3 of Regulation No. 12 or 94 in the direction of travel and according to Annex 4 of Regulation No. 95 in the direction horizontally perpendicular to the direction of travel. These forces shall be agreed by the manufacturer together with the Technical Service.

The manufacturers may, in agreement with the Technical Services, use forces derived from the data obtained from alternative crash test procedures, but these forces shall be equal to or greater than the forces that would result from using data in accordance with the regulations specified above.

#### 6.4.2.3. Acceptance criteria

During the test there shall be no evidence of:

- (a) Fire
- (b) Explosion
- (c1) Electrolyte leakage if tested according to paragraph 6.4.1.1.:

- (i) For a period from the impact until 30 minutes after the impact there shall be no electrolyte spillage from the REESS into the passenger compartment.
- (ii) No more than 7 per cent by volume of the REESS electrolyte capacity shall spill from the REESS to the outside of the passenger department (for open type traction batteries a limitation to a maximum of 5 litres also applies).

(c2) Electrolyte leakage if tested according to paragraph 6.4.2.2.

For a high voltage REESS, the isolation resistance of the Tested-Device shall ensure at least 100  $\Omega$ /Volt for the whole REESS measured in accordance with Annex 4A or Annex 4B of this Regulation, or the protection degree IPXXB shall be fulfilled for the Tested-Device.

If tested according to Paragraph 6.4.2.2., the evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.

To confirm compliance to c1) of paragraph 6.4.2.3. an appropriate coating shall, if necessary, be applied to the physical protection (casing) in order to confirm if there is any electrolyte leakage from the REESS resulting from the impact test. Unless the manufacturer provides a means to differentiate between the leakage of different liquids, all liquid leakage shall be considered as the electrolyte.

#### 6.5. Fire resistance

This test is required for REESS containing flammable electrolyte.

This test is not required when the REESS as installed in the vehicle, is mounted such that the lowest surface of the casing of the REESS is more than 1.5m above the ground. At the option of the manufacturer, this test may be performed where the of the REESS's lower surface is higher than 1.5m above the ground. The test shall be carried out on one test sample.

At the manufacturer's choice the test may be performed as, either

- (a) A vehicle based test in accordance with paragraph 6.5.1. of this Regulation, or
- (b) A component based test in accordance with paragraph 6.5.2. of this Regulation.

##### 6.5.1. Vehicle based test

The test shall be conducted in accordance with Annex 8E paragraph 3.2.1. of this Regulation.

The approval of a REESS tested according to this paragraph shall be limited to approvals for a specific vehicle type.

##### 6.5.2. Component based test

The test shall be conducted in accordance with Annex 8E paragraph 3.2.2. of this Regulation.

##### 6.5.3. Acceptance criteria;

6.5.3.1. During the test, the tested-device shall exhibit no evidence of explosion.

#### 6.6. External short circuit protection

- 6.6.1. The test shall be conducted in accordance with Annex 8F of this Regulation.
- 6.6.2. Acceptance criteria;
  - 6.6.2.1. During the test there shall be no evidence of
    - (a) Electrolyte leakage,
    - (b) Rupture (applicable to high voltage REESS(s) only),
    - (c) Fire,
    - (d) Explosion.Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.
  - 6.6.2.2. For a high voltage REESS, the isolation resistance measured after the test in accordance with Annex 4 B of this Regulation shall not be less than 100  $\Omega$ /Volt.
- 6.7. Overcharge protection
  - 6.7.1. The test shall be conducted in accordance with Annex 8 G of this Regulation.
  - 6.7.2. Acceptance criteria;
    - 6.7.2.1. During the test there shall be no evidence of:
      - (a) Electrolyte leakage,
      - (b) Rupture (applicable to high voltage REESS(s) only),
      - (c) Fire,
      - (d) Explosion.Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.
    - 6.7.2.2. For a high voltage REESS, the isolation resistance measured after the test in accordance with Annex 4B of this Regulation shall not be less than 100  $\Omega$ /Volt.
- 6.8. Over-discharge protection
  - 6.8.1. The test shall be conducted in accordance with Annex 8 H of this Regulation.
  - 6.8.2. Acceptance criteria;
    - 6.8.2.1. During the test there shall be no evidence of:
      - (a) Electrolyte leakage,
      - (b) Rupture (applicable to high voltage REESS(s) only),
      - (c) Fire,
      - (d) Explosion.Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.
    - 6.8.2.2. For a high voltage REESS the isolation resistance measured after the test in accordance with Annex 4B of this Regulation shall not be less than 100  $\Omega$ /Volt.
- 6.9. Over-temperature protection

- 6.9.1. The test shall be conducted in accordance with Annex 8I of this Regulation.
- 6.9.2. Acceptance criteria;
- 6.9.2.1. During the test there shall be no evidence of:
- (a) Electrolyte leakage,
  - (b) Rupture (applicable to high voltage REESS(s) only),
  - (c) Fire,
  - (d) Explosion.
- Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.
- 6.9.2.2. For a high voltage REESS, the isolation resistance measured after the test in accordance with Annex 4 B of this Regulation shall not be less than 100  $\Omega$ /Volt.
- 6.10. Emission
- Possible emission of gases caused by the energy conversion process during normal use shall be considered.
- 6.10.1. Open type traction batteries shall meet the requirements of paragraph 5.4. of this Regulation with regard to hydrogen emissions.
- Systems with a closed chemical process shall be considered as emission-free under normal operation (e.g. Lithium-ion battery).
- The closed chemical process shall be described and documented by the battery manufacturer in Annex 6 - Part 2.
- Other technologies shall be evaluated by the manufacturer and the Technical Service regarding any possible emissions under normal operation.
- 6.10.2. Acceptance criteria
- For hydrogen emissions see paragraph 5.4. of this Regulation.
- For emission free systems with closed chemical process no verification is necessary."

*Paragraph 6*, renumber as paragraph 7 and amend to read:

"7. Modifications and extension of the Type Approval"

*Paragraph 6.1.*, renumber as paragraph 7.1. and amend to read:

"7.1. Every modification of the vehicle or REESS type with regard to this Regulation shall be notified to Type Approval Authority which approved the vehicle or REESS type. The department may then either:"

*Paragraph 6.1.1.*, renumber as paragraph 7.1.1. and amend to read:

"7.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle or the REESS still complies with the requirements, or"

*Paragraphs 6.1.2. and 6.2.*, renumber as paragraphs 7.1.2. and 7.2.

*Paragraph 6.3.*, renumber as paragraph 7.3. and amend to read:

"7.3. The Type Approval Authority issuing the extension of approval shall assign a serial number to each communication form drawn up for such an extension and inform thereof the other Parties to the 1958 Agreement applying the Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation."

*Paragraph 7*, renumber as paragraph 8.

*Paragraph 7.1.*, renumber as paragraph 8.1. and amend to read:

"8.1. Vehicles or REESS approved under this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements of the relevant part(s) of this Regulation."

*Paragraph 7.2.*, renumber as paragraph 8.2. and amend to read:

"8.2. In order to verify that the requirements of paragraph 8.1. are met, appropriate production checks shall be carried out."

*Paragraph 7.3.*, renumber as paragraph 8.3.

*Paragraph 7.3.1.*, renumber as paragraph 8.3.1. and amend to read:

"8.3.1. Ensure the existence of procedures for the effective quality control of vehicles or REESS;"

*Paragraphs 7.3.2. and 7.3.3.*, renumber as paragraphs 8.3.2. and 8.3.3.

*Paragraph 7.3.4.*, renumber as paragraph 8.3.4. and amend to read:

"8.3.4. Analyse the results of each type of test, in order to verify and ensure the consistency of characteristics of the vehicle or REESS, making allowance for permissible variations in industrial production;"

*Paragraph 7.3.5.*, renumber as paragraph 8.3.5. and amend to read:

"8.3.5. Ensure that for each type of vehicle or component type at least the tests prescribed in the relevant part(s) of this Regulation are carried out;"

*Paragraphs 7.3.6. to 7.4.2.*, renumber as paragraphs 8.3.6. to 8.4.2.

*Paragraph 7.4.3.*, renumber as paragraph 8.4.3. and amend to read:

"8.4.3. When the quality ... in application of paragraph 8.4.2., ..."

*Paragraph 8*, renumber as paragraph 9.

*Paragraph 8.1.*, renumber as paragraph 9.1. and amend to read:

"9.1. The approval granted in respect of a vehicle/REESS type, pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8 above are not complied with, or if the vehicle/REESS or its components fail to pass the tests provided for in paragraph 8.3.5. above."

*Paragraph 8.2.*, renumber as paragraph 9.2.

*Paragraph 9*, renumber as paragraph 10 and amend to read:

"10. Production definitively discontinued

If the holder of the approval completely ceases to manufacture a vehicle/REESS type approved in accordance with this Regulation, he shall so inform the Authority which granted the approval. Upon receiving the relevant communication, that Authority shall inform thereof the other Contracting Parties to the 1958 Agreement applying this Regulation by means of a



communication form conforming to the model in Annex 1 to this Regulation."

*Paragraph 10*, renumber as paragraph 11.

*Paragraph 11*, renumber as paragraph 12.

*Paragraphs 11.1. to 11.2.*, renumber as paragraphs 12.1 to 12.2. and amend to read:

"12.1. As from the official date of entry into force of the 02 series of amendments, no Contracting Party applying this Regulation shall refuse to grant approval under this Regulation as amended by the 02 series of amendments.

12.2 As from [36] months after the date of entry into force of the 02 series of amendments, Contracting Parties applying this Regulation shall grant approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 02 series of amendments."

*Insert a new paragraph 12.3.*, to read:

"12.3. Contracting Parties applying this Regulation shall continue to grant approvals to those types of vehicles which comply with the requirements of this Regulation as amended by the preceding series of amendments during the [36] months' period which follows the date of entry into force of the 02 series of amendments."

*Paragraph 11.3.(former)*, renumber as paragraph 12.4.

*Paragraph 11.4.(former)*, shall be deleted

*Paragraph 11.5. (former)*, renumber as paragraph 12.5.

*Annex 1*,

*The title*, amend to read:

## "Annex 1 – Part 1

...

of a vehicle type with regard to its electrical safety pursuant to Regulation No. 100

..."

*Item 6.1.*, amend to read:

"6.1. REESS type: ....."

*Insert a new item 6.1.1.*, to read:

"6.1.1. The approval number of the REESS or description of the REESS <sup>2</sup>....."

Insert new Annex 1 – Part 2, to read:

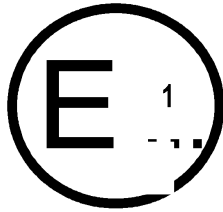
## "Annex 1 – Part 2

### Communication

(maximum format: A4 (210 x 297 mm))

issued by: Name of administration:

.....  
.....  
.....



concerning:<sup>2</sup> Approval granted  
Approval extended  
Approval refused  
Approval withdrawn  
Production definitively discontinued

of a REESS type as component/ separate technical unit <sup>2</sup> pursuant to Regulation No. 100

Approval No. ....

Extension No. ....

1. Trade name or mark of the REESS: .....
2. Type of REESS: .....
3. Manufacturer's name and address: .....
4. If applicable, name and address of manufacturer's representative: .....
5. Description of the REESS: .....
6. Installation restrictions applicable to the REESS as described in Paragraphs 6.4 and 6.5: .....
7. REESS submitted for approval on: .....
8. Technical Service responsible for conducting approval tests: .....
9. Date of report issued by that service: .....
10. Number of report issued by that service: .....
11. Location of the approval mark: .....
12. Reason(s) for extension of approval (if applicable): <sup>2</sup> .....
13. Approval granted/extended/refused/withdrawn: <sup>2</sup> .....

<sup>1</sup> Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

<sup>2</sup> Strike out what does not apply.

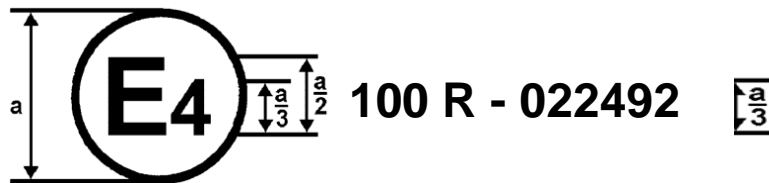
14. Place:.....
15. Date:.....
16. Signature:.....
17. The documents filed with the request for approval or extension may be obtained on request:....."

*Annex 2, amend to read:*

## "Annex 2

### Arrangements of the approval marks

Figure 1



a = 8 mm min.

The approval mark in Figure 1 affixed to a vehicle shows that the road vehicle type concerned has been approved in the Netherlands (E4), pursuant to Regulation No. 100, and under the approval number 022492. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No. 100 as amended by 02 series of amendments.

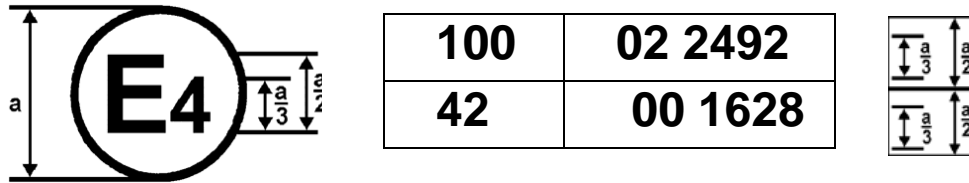
Figure 2



a = 8 mm min.

The approval mark in Figure 2 affixed to a REESS shows that the REESS type ("ES") concerned has been approved in the Netherlands (E4), pursuant to Regulation No. 100, and under the approval number 022492. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No. 100 as amended by 02 series of amendments.

Model B  
(see Paragraph 4.5. of this Regulation)



a = 8 mm min.

The above approval mark affixed to a vehicle shows that the road vehicle concerned has been approved in the Netherlands (E4) pursuant to Regulations Nos. 100 and 42. \* The approval number indicates that, at the dates when the respective approvals were granted, Regulation No. 100 was amended by the 02 series of amendments and Regulation No. 42 was still in its original form.

\* The latter number is given only as an example."

*Annex 4,*

*The title, amend to read:*

## "Annex 4A

### **Isolation resistance measurement method for vehicle based tests"**

*Paragraph 2.1, amend to read:*

"2.1. Measurement method using voltage from off-vehicle sources"

*Paragraphs 2.2. and 2.2.1., amend to read:*

"2.2. Measurement method using the vehicle's own REESS as DC voltage source

2.2.1. Test vehicle conditions

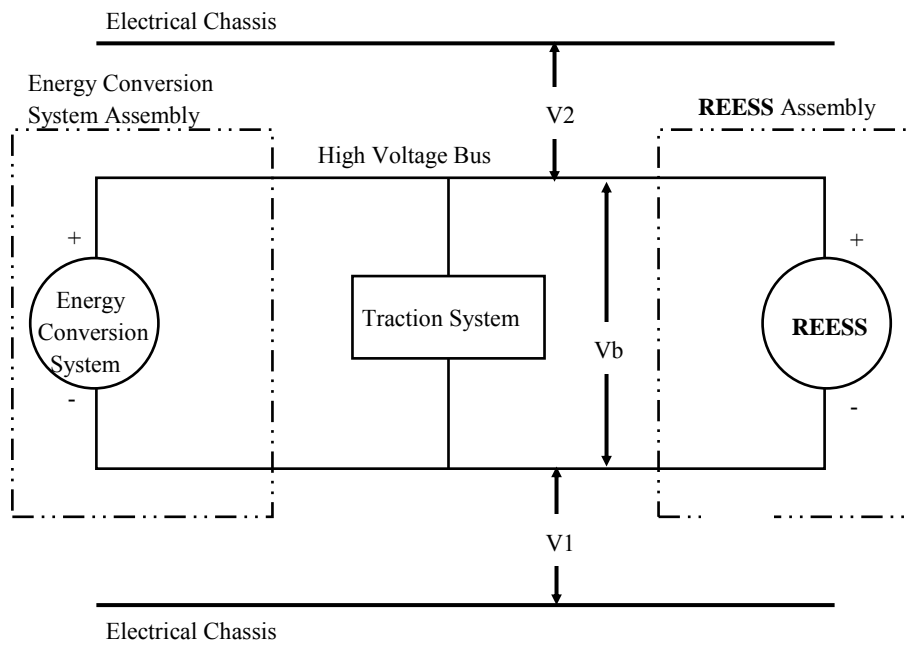
The high voltage-bus shall be energized by the vehicle's own REESS and/or energy conversion system and the voltage level of the REESS and/or energy ..."

*Paragraph 2.2.3.1., amend to read:*

"2.2.3.1. First step

The voltage is ... the nominal operating voltage of the REESS and/or energy conversion system as specified by the vehicle manufacturer.

Figure 1  
Measurement of  $V_b$ ,  $V_1$ ,  $V_2$

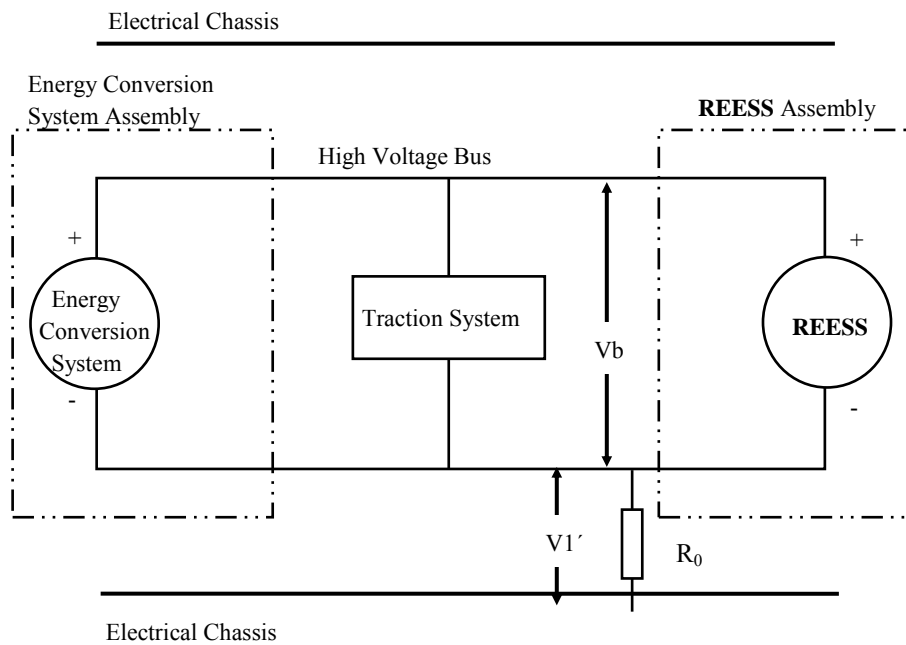


"

Paragraph 2.2.3.4., Figures 2 and 3, amend to read:

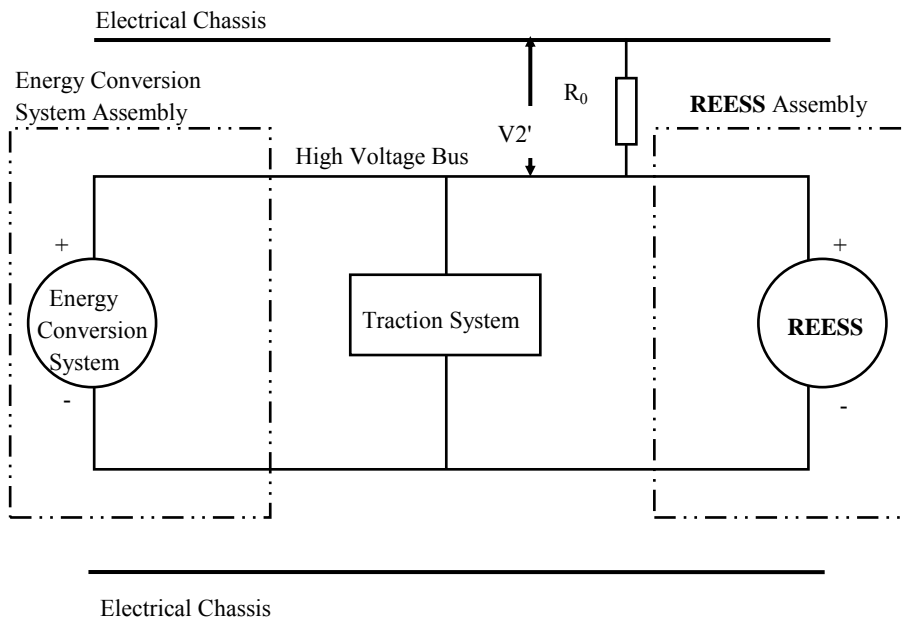
"2.2.3.4. ....

Figure 2  
Measurement of  $V_1'$



...

Figure 3  
Measurement of  $V_2'$



"

Insert a new Annex 4B ., to read:

## "Annex 4B

### **Isolation Resistance Measurement Method for component based tests of a REESS**

#### 1. Measurement method

The isolation resistance measurement shall be conducted by selecting an appropriate measurement method from among those listed in Paragraphs 1.1. through 1.2., depending on the electrical charge of the live parts or the isolation resistance, etc.

If the operating voltage of the tested-device ( $V_b$ , Figure 1) cannot be measured (e.g. due to disconnection of the electric circuit caused by main contactors or fuse operation) the test may be performed with a modified test device to allow measurement of the internal voltages (upstream the main contactors).

These modifications shall not influence the test results.

The range of the electrical circuit to be measured shall be clarified in advance, using electrical circuit diagrams, etc. If the high voltage buses are galvanically isolated from each other, isolation resistance shall be measured for each electrical circuit.

Moreover, modification necessary for measuring the isolation resistance may be carried out, such as removal of the cover in order to reach the live parts, drawing of measurement lines, change in software, etc.

In cases where the measured values are not stable due to the operation of the isolation resistance monitoring system, etc., necessary modification for conducting the measurement may be carried out, such as stopping the operation of the device concerned or removing it. Furthermore, when the device is removed, it shall be proven, using drawings, etc., that it will not change the isolation resistance between the live parts and the ground connection designated by the manufacturer as a point to be connected to the electrical chassis when installed on the vehicle.

Utmost care shall be exercised as to short circuit, electric shock, etc., for this confirmation might require direct operations of the high-voltage circuit.

#### 1.1. Measurement method using voltage from external sources

##### 1.1.1. Measurement instrument

An isolation resistance test instrument capable of applying a DC voltage higher than the nominal voltage of the tested-device shall be used.

##### 1.1.2. Measurement method

An insulation resistance test instrument shall be connected between the live parts and the ground connection. Then, the isolation resistance shall be measured.

If the system has several voltage ranges (e.g. because of boost converter) in a galvanically connected circuit and some of the components cannot withstand

the working voltage of the entire circuit, the isolation resistance between those components and the ground connection can be measured separately by applying at least half of their own working voltage with those component disconnected.

1.2. Measurement method using the tested-device as DC voltage source

1.2.1. Test conditions

The voltage level of the tested-device throughout the test shall be at least the nominal operating voltage of the tested-device.

1.2.2. Measurement instrument

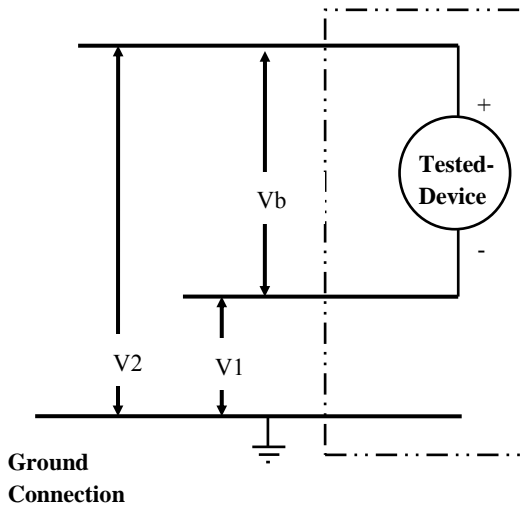
The voltmeter used in this test shall measure DC values and shall have an internal resistance of at least 10 MΩ.

1.2.3. Measurement method

1.2.3.1. First step

The voltage is measured as shown in Figure 1 and the operating voltage of the tested-device ( $V_b$ , Figure 1) is recorded.  $V_b$  shall be equal to or greater than the nominal operating voltage of the tested-device.

Figure 1



1.2.3.2. Second step

Measure and record the voltage ( $V_1$ ) between the negative pole of the tested-device and the ground connection (Figure 1).

1.2.3.3. Third step

Measure and record the voltage ( $V_2$ ) between the positive pole of the tested-device and the ground connection (Figure 1).

1.2.3.4. Fourth step

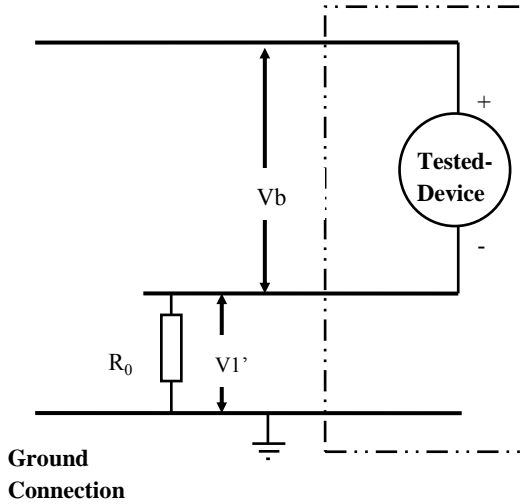
If  $V_1$  is greater than or equal to  $V_2$ , insert a standard known resistance ( $R_o$ ) between the negative pole of the tested-device and the ground connection. With  $R_o$  installed, measure the voltage ( $V_1'$ ) between the negative pole of the tested-device and the ground connection (see Figure 2).



Calculate the electrical isolation ( $R_i$ ) according to the following formula:

$$R_i = R_o * (V_b / V_{1'} - V_b / V_1) \quad \text{or} \quad R_i = R_o * V_b * (1 / V_{1'} - 1 / V_1)$$

Figure 2

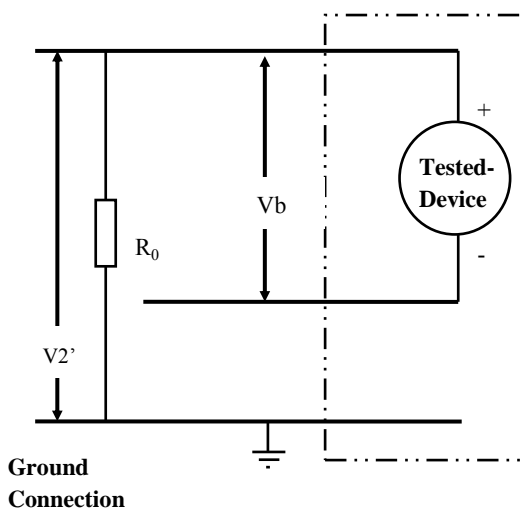


If  $V_2$  is greater than  $V_1$ , insert a standard known resistance ( $R_o$ ) between the positive pole of the tested-device and the ground connection. With  $R_o$  installed, measure the voltage ( $V_2'$ ) between the positive pole of the tested-device and the ground connection (see Figure 3).

Calculate the electrical isolation ( $R_i$ ) according to the following formula:

$$R_i = R_o * (V_b / V_{2'} - V_b / V_2) \quad \text{or} \quad R_i = R_o * V_b * (1 / V_{2'} - 1 / V_2)$$

Figure 3



1.2.3.5. Fifth step

The electrical isolation value  $R_i$  (in  $\Omega$ ) divided by the nominal voltage of the tested-device (in volts) results in the isolation resistance (in  $\Omega/V$ ).

NOTE 1: The standard known resistance  $R_o$  (in  $\Omega$ ) should be the value of the minimum required isolation resistance (in  $\Omega/V$ ) multiplied by the nominal voltage of the tested-device plus/minus 20 per cent (in volts).  $R_o$  is not required to be precisely this value since the equations are valid for any  $R_o$ ; however, a  $R_o$  value in this range should provide good resolution for the voltage measurements."

*Annex 6,*

*The title, amend to read:*

## "Annex 6 - Part 1

...."

*Insert a new item 1.8., to read:*

"1.8. Approval number of the REESS ....." "

*Item 2.2., amend to read:*

"2.2. Maximum net power and / or maximum 30 Minutes power (kW): ....." "

*Items 3 to 3.8., amend to read:*

"3. REESS: ....."

3.1. Trade name and mark of the REESS: ....."

3.2. Indication of all types of cells: ....."

3.2.1. The cell chemistry: ....."

3.2.2. Physical dimensions: ....."

3.2.3. Capacity of the cell (Ah): ....."

3.3. Description or drawing(s) or picture(s) of the REESS explaining: ....."

3.3.1. Structure: ....."

3.3.2. Configuration (number of cells, mode of connection, etc.): ....."

3.3.3. Dimensions: ....."

3.3.4. Casing (construction, materials and physical dimensions): ....."

3.4. Electrical specification: ....."

3.4.1. Nominal voltage (V): ....."

3.4.2. Working voltage (V): ....."

3.4.3. Capacity (Ah): ....."

3.4.4. Maximum current (A): ....."

3.5. Gas combination rate (in per cent): ....."

3.6. Description or drawing(s) or picture(s) of the installation of the REESS in the vehicle: ....."

3.6.1. Physical support: ....."

3.7. Type of thermal management: ....."

3.8. Electronic control: ....."

*Insert new Annex 6 – Part 2, to read:*

**"Annex 6 - Part 2**

**Essential characteristics of REESS**

- 1. REESS
- 1.1. Trade name and mark of the REESS: .....
- 1.2. Indication of all types of cells:.....
- 1.2.1. The cell chemistry: .....
- 1.2.2. Physical dimensions: .....
- 1.2.3. Capacity of the cell (Ah): .....
- 1.3. Description or drawing(s) or picture(s) of the REESS explaining
  - 1.3.1. Structure: .....
  - 1.3.2. Configuration (number of cells, mode of connection, etc.): .....
  - 1.3.3. Dimensions: .....
  - 1.3.4. Casing (construction, materials and physical dimensions): .....
- 1.4. Electrical specification
  - 1.4.1. Nominal voltage (V): .....
  - 1.4.2. Working voltage (V):.....
  - 1.4.3. Capacity (Ah): .....
  - 1.4.4. Maximum current (A):.....
- 1.5. Gas combination rate (in percentage): .....
- 1.6. Description or drawing(s) or picture(s) of the installation of the REESS in the vehicle: .....
- 1.6.1. Physical support:.....
- 1.7. Type of thermal management: .....
- 1.8. Electronic control: .....
- 1.9. Category of vehicles on which the REESS can be installed: ....."

*Annex 7*

*The title, amend to read:*

**"Determination of hydrogen emissions during the charge procedures of the REESS"**

*Paragraphs 1 to 3.2., amend to read:*

- "1. Introduction
- This annex describes the procedure for the determination of hydrogen emissions during the charge procedures of the REESS of all road vehicles, according to Paragraph 5.4. of this Regulation.
2. Description of test
- The hydrogen emission test (Figure 7.1) is conducted in order to determine hydrogen emissions during the charge procedures of the REESS with the charger. The test consists in the following steps:
- (a) Vehicle/REESS preparation,
  - (b) Discharge of the REESS,
  - (c) Determination of hydrogen emissions during a normal charge,
  - (d) Determination of hydrogen emissions during a charge carried out with the charger failure.
3. Tests
- 3.1. Vehicle based test
- 3.1.1 The vehicle shall be in good mechanical condition and have been driven at least 300 km during seven days before the test. The vehicle shall be equipped with the REESS subject to the test of hydrogen emissions, over this period.
- 3.1.2. If the REESS is used at a temperature above the ambient temperature, the operator shall follow the manufacturer's procedure in order to keep the REESS temperature in normal functioning range.
- The manufacturer's representative shall be able to certify that the temperature conditioning system of the REESS is neither damaged nor presenting a capacity defect."

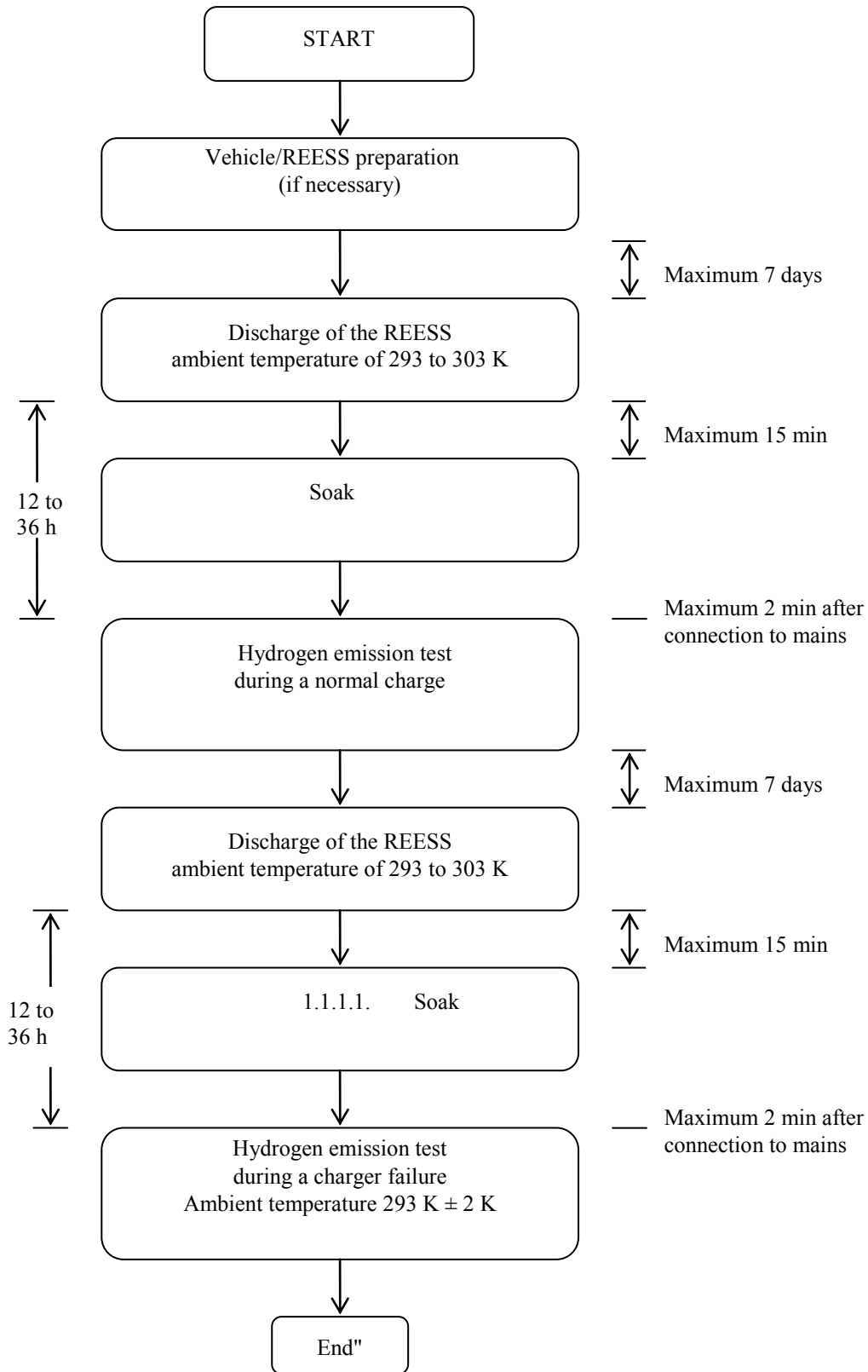
*Insert new paragraphs 3.2. to 3.2.2., to read:*

- "3.2. Component based test
- 3.2.1. The REESS shall be in good mechanical condition and have been subject to minimum of 5 standard cycles (as specified in Annex 8 Appendix 1).
- 3.2.2. If the REESS is used at a temperature above the ambient temperature, the operator shall follow the manufacturer's procedure in order to keep the REESS temperature in its normal functioning range.
- The manufacturer's representative shall be able to certify that the temperature conditioning system of the REESS is neither damaged nor presenting a capacity defect."

Figure 7.1., amend to read.

"Figure 7.1.

Determination of hydrogen emissions during the charge procedures of the REESS



*Paragraphs 4.1. to 4.2., amend to read:*

- "4.1. Chassis dynamometer  
The chassis dynamometer shall meet the requirements of the **06** series of amendments to Regulation No. 83.
- 4.2. Hydrogen emission measurement enclosure  
The hydrogen emission measurement enclosure shall be a gas-tight measuring chamber able to contain the vehicle/REESS under test. The vehicle/REESS shall be ...."

*Paragraph 4.4.2., amend to read:*

- "4.4.2. The temperatures in the proximity of the cells are recorded by means of the sensors."

*Paragraph 4.6.1., amend to read:*

- "4.6.1. The charger voltage and current intensity (battery) shall, throughout the hydrogen emission measurements, be recorded at a frequency of at least once per minute."

*Paragraphs 5 to 5.2., amend to read:*

- "5. Test procedure  
The test consists in the five following steps:  
(a) Vehicle/REESS preparation,  
(b) Discharge of the REESS,  
...  
(e) Determination of hydrogen emissions during a charge carried out with the charger failure.  
If the vehicle/REESS has to be moved between two steps, it shall be pushed to the following test area.
- 5.1. Vehicle based test
- 5.1.1. Vehicle preparation  
The ageing of REESS shall be checked, proving that the vehicle has performed at least 300 km ...
- 5.1.1.1. Discharges and initial charges of the REESS  
The procedure starts with the discharge of the REESS of the vehicle ...  
...
- 5.1.1.2. Initial charge of the REESS  
The charge is carried out:  
(a) With the charger,  
(b) In an ambient temperature between 293 K and 303 K.  
The procedure excludes all types of external chargers.  
The end of REESS charge criteria corresponds to an automatic stop given by the charger.

This procedure ...

5.1.1.3. Procedure from Paragraphs 5.1.1.1. to 5.1.1.2. shall be repeated two times.

5.1.2. Discharge of the REESS

The REESS is discharged while driving on the test track or on a chassis dynamometer at a steady speed of 70 per cent  $\pm$  5 per cent from the maximum thirty minutes speed of the vehicle.

Stopping the discharge occurs:

(a) When an indication...

..."

*Paragraph 5.3 to 5.4.3.*, renumber as 5.1.3 to 5.1.4.3.

*Paragraph 5.4.4. (former)*, renumber as paragraph 5.1.4.4. and amend to read:

"5.1.4.4. The vehicle shall be connected to the mains. The REESS is charged according to normal charge procedure as specified in Paragraph 5.1.4.7 below."

*Paragraph 5.4.5. to 5.4.6. (former)* renumber as 5.1.4.5. to 5.1.4.6.

*Paragraph 5.4.7.*, renumber as paragraph 5.1.4.7. and amend to read:

"5.1.4.7. Procedure of normal charge

The normal charge is carried out with the charger and consists of the following steps:

(a) Charging at constant power during  $t_1$ ,

(b) Over-charging at constant current during  $t_2$ . Over-charging intensity is specified by manufacturer and corresponds to the one used during equalisation charging.

The end of REESS charge criteria corresponds to an automatic stop given by the charger to a charging time of  $t_1 + t_2$ . This charging time will be limited to  $t_1 + 5$  h, even if a clear indication is given to the driver by the standard instrumentation that the battery is not yet fully charged."

*Paragraph 5.4.8.*, renumber as paragraph 5.1.4.8.

*Paragraph 5.4.9.*, renumber as paragraph 5.1.4.9. and amend to read:

"5.1.4.9. The end of the ... paragraph 5.1.4.6. The different times ..."

*Paragraphs 5.5. to 5.5.2. (former)*, renumber as paragraphs 5.1.5. to 5.1.5.2. and amend to read:

"5.1.5. Hydrogen emission test with the charger failure

5.1.5.1. Within seven days maximum after having completed the prior test, the procedure starts with the discharge of the REESS of the vehicle according to Paragraph 5.1.2.

5.1.5.2. The steps of the procedure in Paragraph 5.1.3. shall be repeated."

*Paragraph 5.5.3. to 5.5.5.*, renumber as paragraphs 5.1.5.3. to 5.1.5.5.

Paragraph 5.5.6. (former), renumber as paragraph 5.1.5.6. and amend to read:

"5.1.5.6. The vehicle shall be connected to the mains. The REESS is charged according to failure charge procedure as specified in Paragraph 5.1.5.9. below."

*Paragraph 5.5.7. to 5.5.8.*, renumber as paragraphs 5.1.5.7. to 5.1.5.8.

*Paragraph 5.5.9. (former)*, renumber as paragraph 5.1.5.9. and amend to read.

"5.1.5.9. Procedure of charging failure

The charging failure is carried out with the suitable charger and consists of the following steps:

- (a) Charging at constant power during  $t'_1$ ,
- (b) Charging at maximum current as recommended by the manufacturer during 30 minutes. During this phase, the charger shall supply maximum current as recommended by the manufacturer."

*Paragraph 5.5.10.*, renumber as paragraph 5.1.5.10.

*Paragraph 5.5.11.*, renumber as paragraph 5.1.5.11. and amend to read:

"5.1.5.11. The end of test period occurs  $t'_1 + 30$  minutes after the beginning of the initial sampling, as specified in Paragraph 5.1.5.8. The times ..."

*Insert new paragraphs 5.2. to 5.2.5.11.*, to read:

"5.2. Component based test

5.2.1. REESS preparation

The ageing of REESS shall be checked, to confirm that the REESS has performed at least 5 standard cycles (as specified in Annex Appendix 1).

5.2.2. Discharge of the REESS

The REESS is discharged at 70 per cent  $\pm$  5 per cent of the nominal power of the system.

Stopping the discharge occurs when minimum SOC as specified by the manufacturer is reached.

5.2.3. Soak

Within 15 minutes of the end of the REESS discharge operation specified in paragraph 5.2.2. above, and before the start of the hydrogen emission test, the REESS shall be soaked at 293 K  $\pm$  2 K for a minimum period of 12 hours and a maximum of period of 36 hours.

5.2.4. Hydrogen emission test during a normal charge

5.2.4.1. Before the completion of the REESS's soak period, the measuring chamber shall be purged for several minutes until a stable hydrogen background is obtained. The enclosure mixing fan(s) shall also be turned on at this time.

5.2.4.2. The hydrogen analyser shall be zeroed and spanned immediately prior to the test.

5.2.4.3. At the end of the soak period, the REESS shall be moved into the measuring chamber.



- 5.2.4.4. The REESS shall be charged in accordance with the normal charge procedure as specified in paragraph 5.2.4.7. below.
- 5.2.4.5. The chamber shall be closed and sealed gas-tight within two minutes of the electrical interlock of the normal charge step.
- 5.2.4.6. The start of a normal charge for hydrogen emission test period shall begin when the chamber is sealed. The hydrogen concentration, temperature and barometric pressure are measured to give the initial readings  $CH_2i$ ,  $T_i$  and  $P_i$  for the normal charge test.
- These figures are used in the hydrogen emission calculation (paragraph 6). The ambient enclosure temperature  $T$  shall not be less than 291 K and no more than 295 K during the normal charge period.
- 5.2.4.7. Procedure of normal charge
- The normal charge is carried out with a suitable charger and consists of the following steps:
- (a) Charging at constant power during  $t_1$ ;
  - (a) Over-charging at constant current during  $t_2$ . Over-charging intensity is specified by manufacturer and corresponding to that used during equalisation charging.
- The end of REESS charge criteria corresponds to an automatic stop given by the charger to a charging time of  $t_1 + t_2$ . This charging time will be limited to  $t_1 + 5$  h, even if a clear indication is given by a suitable instrumentation that the REESS is not yet fully charged.
- 5.2.4.8. The hydrogen analyser shall be zeroed and spanned immediately before the end of the test.
- 5.2.4.9. The end of the emission sampling period occurs  $t_1 + t_2$  or  $t_1 + 5$  h after the beginning of the initial sampling, as specified in paragraph 5.2.4.6. The different times elapsed are recorded. The hydrogen concentration, temperature and barometric pressure are measured to give the final readings  $CH_2f$ ,  $T_f$  and  $P_f$  for the normal charge test, used for the calculation in Paragraph 6.
- 5.2.5. Hydrogen emission test with the charger failure
- 5.2.5.1. The test procedure shall start within a maximum of seven days after having completed the test in paragraph 5.2.4, the procedure shall start with the discharge of the REESS of the vehicle in accordance with paragraph 5.2.2.
- 5.2.5.2. The steps of the procedure in paragraph 5.2.3. shall be repeated.
- 5.2.5.3. Before the completion of the soak period, the measuring chamber shall be purged for several minutes until a stable hydrogen background is obtained. The enclosure mixing fan(s) shall also be turned on at this time.
- 5.2.5.4. The hydrogen analyser shall be zeroed and spanned immediately prior to the test.
- 5.2.5.5. At the end of the soak the REESS shall be moved into the measuring chamber.
- 5.2.5.6. The REESS shall be charged according to the failure charge procedure as specified in paragraph 5.2.5.9. below.

- 5.2.5.7. The chamber shall be closed and sealed gas-tight within two minutes from electrical interlock of the failure charge step.
- 5.2.5.8. The start of a failure charge for hydrogen emission test period begins when the chamber is sealed. The hydrogen concentration, temperature and barometric pressure are measured to give the initial readings  $CH_{2i}$ ,  $T_i$  and  $P_i$  for the failure charge test.
- These figures are used in the hydrogen emission calculation (Paragraph 6). The ambient enclosure temperature  $T$  shall not be less than 291 K and no more than 295 K during the charging failure period.
- 5.2.5.9. Procedure of charging failure
- The charging failure is carried out with a suitable charger and consists of the following steps:
- Charging at constant power during  $t'_1$ ,
  - Charging at maximum current as recommended by the manufacturer during 30 minutes. During this phase, the charger shall supply maximum current as recommended by the manufacturer.
- 5.2.5.10. The hydrogen analyser shall be zeroed and spanned immediately before the end of the test.
- 5.2.5.11. The end of test period occurs  $t'_1 + 30$  minutes after the beginning of the initial sampling, as specified in paragraph 5.2.5.8. The times elapsed are recorded. The hydrogen concentration, temperature and barometric pressure are measured to give the final readings  $C_{H_{2f}}$ ,  $T_f$  and  $P_f$  for the charging failure test, used for the calculation in paragraph 6."

*Paragraph 6.1.*, amend to read:

- "6.1. Results of test
- The hydrogen mass emissions for the REESS are:
- ..."

*Annex 7- Appendix 1, paragraph 2.1.2.*, amend to read:

- "2.1.2. The net internal volume is determined by subtracting 1.42 m<sup>3</sup> from the internal volume of the chamber. Alternatively the volume of the test vehicle with the luggage compartment and windows open or REESS may be used instead of the 1.42 m<sup>3</sup>."

*Annex 7- Appendix 2, paragraph 2.*, amend to read:

- "2. To this end, those vehicle types whose parameters described below are identical are considered to belong to the same hydrogen emissions.
- REESS:
- Trade name or mark of the REESS,
  - Indication of all types of electro-chemical couples used,
  - Number of REESS cells,
  - Number of REESS subsystems,
  - Nominal voltage of the REESS (V),
  - REESS energy (kWh),

- (g) Gas combination rate (in per cent),
  - (h) Type(s) of ventilation for REESS subsystem(s),
  - (i) Type of cooling system (if any).
- ..."

*Insert new Annexes 8 to 8 I, to read:*

## **"Annex 8**

### **REESS test procedures**

Appendix 1 - Procedure for conducting a Standard Cycle

A standard cycle will start with a standard discharge followed by a standard charge.

Standard discharge:

Discharge rate: The discharge procedure including termination criteria shall be defined by the manufacturer. If not specified, then it shall be a discharge with 1C current.

Discharge limit (end voltage): specified by the manufacturer

Rest period after discharge: minimum 30 min

Standard charge: The charge procedure including termination criteria shall be defined by the manufacturer. If not specified, then it shall be a charge with C/3 current.

## Annex 8 A

### Vibration test

#### 1. Purpose

The purpose of this test is to verify the safety performance of the REESS under a vibration environment which the REESS will likely experience during the normal operation of the vehicle.

#### 2. Installations

2.1. This test shall be conducted either with the complete REESS or with a related REESS subsystem(s) including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the tested-device if so requested by the manufacturer.

2.2. The tested-device shall be firmly secured to the platform of the vibration machine in such a manner as to ensure that the vibrations are directly transmitted to the tested-device.

#### 3. Procedures

##### 3.1. General test conditions

The following conditions shall apply to the tested-device:

- (a) The test shall be conducted at an ambient temperature of  $20 \pm 10$  °C,
- (b) At the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range of the tested-device,
- (c) At the beginning of the test, all protection devices which affect the function(s) of the tested-device that are relevant to the outcome of the test shall be operational.

##### 3.2. Test Procedures

The tested-devices shall be subjected to a vibration having a sinusoidal waveform with a logarithmic sweep between 7 Hz and 50 Hz and back to 7 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours in the vertical direction of the mounting orientation of the REESS as specified by the manufacturer.

The correlation between frequency and acceleration shall be as shown in table 1:

Table 1:  
**Frequency and acceleration**

<i>Frequency (Hz)</i>	<i>Acceleration (m/s<sup>2</sup>)</i>
7 - 18	10
18 - 30	gradually reduced from 10 to 2
30 - 50	2

At the request of the manufacturer, a higher acceleration level as well as a higher maximum frequency may be used.

At the request of the manufacturer a vibration test profile determined by the vehicle-manufacturer, verified for the vehicle application and agreed with the Technical Service may be used as a substitute for the frequency - acceleration correlation of table 1. The approval of a REESS tested according to this condition shall be limited to approvals for a specific vehicle type.

After the vibration, a standard cycle as described in Annex 8 Appendix 1 shall be conducted, if not inhibited by the tested-device.

The test shall end with an observation period of 1 h at the ambient temperature conditions of the test environment.

## Annex 8 B

### Thermal shock and cycling test

#### 1. Purpose

The purpose of this test is to verify the resistance of the REESS to sudden changes in temperature. The REESS shall undergo a specified number of temperature cycles, which start at ambient temperature followed by high and low temperature cycling. It simulates a rapid environmental temperature change which a REESS would likely experience during its life.

#### 2. Installations

This test shall be conducted either with the complete REESS or with related REESS subsystem(s) of the REESS including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the tested-device if so requested by the manufacturer.

#### 3. Procedures

##### 3.1. General test conditions

The following conditions shall apply to the tested-device at the start of the test

- (a) The SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,
- (b) All protection devices, which would affect the function of the tested-device and which are relevant to the outcome of the test shall be operational.

##### 3.2. Test Procedure

The tested-device shall be stored for at least six hours at a test temperature equal to  $60 \pm 2$  °C or higher if requested by the manufacturer, followed by storage for at least six hours at a test temperature equal to  $-40 \pm 2$  °C or lower if requested by the manufacturer. The maximum time interval between test temperature extremes shall be 30 minutes. This procedure shall be repeated until a minimum of 5 total cycles are completed, after which the tested-device shall be stored for 24 hours at an ambient temperature of  $20 \pm 10$  °C.

After the storage for 24 hours, a standard cycle as described in Annex 8, Appendix 1 shall be conducted, if not inhibited by the tested-device.

The test shall end with an observation period of 1 h at the ambient temperature conditions of the test environment.

## Annex 8 C

### Mechanical shock

1. Purpose

The purpose of this test is to verify the safety performance of the REESS under inertial loads which may occur during a vehicle crash.
2. Installation
  - 2.1. This test shall be conducted either with the complete REESS or with related REESS subsystem(s) including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the tested-device if so requested by the manufacturer
  - 2.2. The tested-device shall be connected to the test fixture only by the intended mountings provided for the purpose of attaching the REESS or REESS subsystem to the vehicle.
3. Procedures
  - 3.1. General test conditions and requirements

The following condition shall apply to the test:

    - (a) The test shall be conducted at an ambient temperature of  $20 \pm 10^{\circ}\text{C}$ ,
    - (b) At the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,
    - (c) At the beginning of the test, all protection devices which effect the function of the tested-device and which are relevant to the outcome of the test, shall be operational.
  - 3.2. Test Procedure

The tested-device shall be decelerated or, at the choice of the applicant, accelerated in compliance with the acceleration corridors which are specified in tables 1 - 3. The Technical Service in consultation with the manufacturer shall decide whether the tests shall be conducted in either the positive or negative direction or both.

For each of the test pulses specified, a separate tested-device may be used.

The test pulse shall be within the minimum and maximum value as specified in tables 1 to 3. A higher shock level and /or longer duration as described in the maximum value in tables 1 to 3 can be applied to the tested-device if recommended by the manufacturer.

Figure 1  
Generic description of test pulses

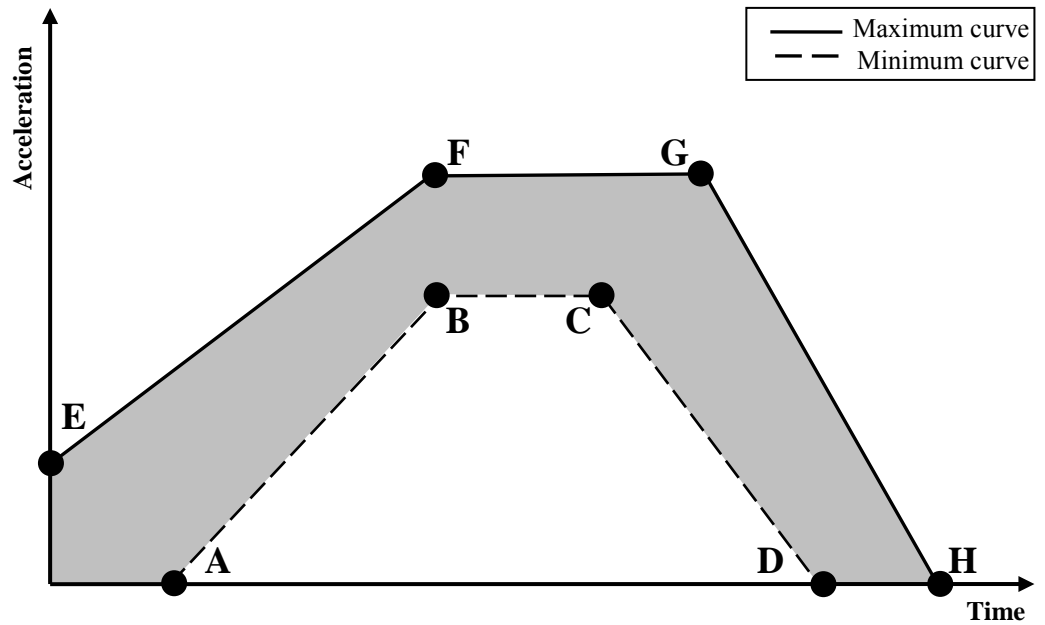


Table 1 for M<sub>1</sub> and N<sub>1</sub> vehicles:

Point	Time (ms)	Acceleration (g)	
		Longitudinal	Transverse
A	20	0	0
B	50	20	8
C	65	20	8
D	100	0	0
E	0	10	4.5
F	50	28	15
G	80	28	15
H	120	0	0

Table 2 for M<sub>2</sub> and N<sub>2</sub> vehicles:

Point	Time (ms)	Acceleration (g)	
		Longitudinal	Transverse
A	20	0	0
B	50	10	5
C	65	10	5



D	100	0	0
E	0	5	2.5
F	50	17	10
G	80	17	10
H	120	0	0

Table 3 for M<sub>3</sub> and N<sub>3</sub> vehicles:

<i>Point</i>	<i>Time (ms)</i>	<i>Acceleration (g)</i>	
		<i>Longitudinal</i>	<i>Transverse</i>
A	20	0	0
B	50	6,6	5
C	65	6,6	5
D	100	0	0
E	0	4	2.5
F	50	12	10
G	80	12	10
H	120	0	0

The test shall end with an observation period of 1 h at the ambient temperature conditions of the test environment.

## Annex 8 D

### Mechanical integrity

1. Purpose

The purpose of this test is to verify the safety performance of the REESS under contact loads which may occur during vehicle crash situation.
2. Installations
  - 2.1. This test shall be conducted with either the complete REESS or with a related REESS subsystem(s) including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the tested-device if so requested by the manufacturer.
  - 2.2. The tested-device shall be connected to the test fixture as recommended by the manufacturer.
3. Procedures
  - 3.1. General test conditions

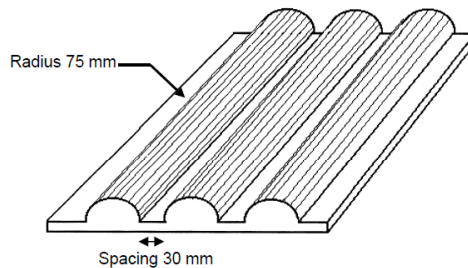
The following condition and requirements shall apply to the test:

    - (a) The test shall be conducted at an ambient temperature of  $20 \pm 10$  °C,
    - (b) At the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,
    - (c) At the beginning of the test, all internal and external protection devices which would affect the function of the tested-device and which are relevant to the outcome of the test shall be operational.
  - 3.2. Crush test

### 3.2.1. Crush force

The tested-device shall be crushed between a resistance and a crush plate as described in figure 1 with a force of at least 100 kN, but not exceeding 105 kN, unless otherwise specified in accordance with Paragraph 6.4.2 of this Regulation, with an onset time less than 3 minutes and a hold time of at least 100 ms but not exceeding 10s.

Figure 1



Dimension of the crush plate:  
600 mm x 600 mm or smaller

A higher crush force, a longer onset time, a longer hold time, or a combination of these, may be applied at the request of the manufacturer.

The application of the force shall be decided by the manufacturer together with the Technical Service having consideration to the direction of travel of the REESS relative to its installation in the vehicle. The application force being applied horizontally and perpendicular to the direction of travel of the REESS.

The test shall end with an observation period of 1 h at the ambient temperature conditions of the test environment.

## Annex 8 E

### Fire resistance

1. Purpose

The purpose of this test is to verify the resistance of the REESS, against exposure to fire from outside of the vehicle due to e.g. a fuel spill from a vehicle (either the vehicle itself or a nearby vehicle). This situation should leave the driver and passengers with enough time to evacuate.
2. Installations
  - 2.1. This test shall be conducted either with the complete REESS or with related REESS subsystem(s) including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the tested-device if so requested by the manufacturer. Where the relevant REESS subsystems are distributed throughout the vehicle, the test may be conducted on each relevant of the REESS subsystem.
3. Procedures
  - 3.1. General test conditions

The following requirements and conditions shall apply to the test:

    - (a) The test shall be conducted at a temperature of at least 0°C,
    - (b) At the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,
    - (c) At the beginning of the test, all protection devices which effect the function of the tested-device and are relevant for the outcome of the test shall be operational.
  - 3.2. Test Procedure

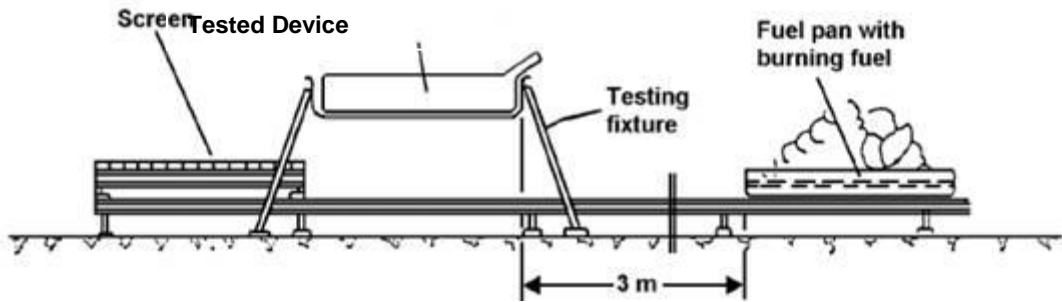
A vehicle based test or a component based test shall be performed at the discretion of the manufacturer:

    - 3.2.1. Vehicle based test

The tested-device shall be mounted in a testing fixture simulating actual mounting conditions as far as possible; no combustible material should be used for this with the exception of material that is part of the REESS. The method whereby the tested-device is fixed in the fixture shall correspond to the relevant specifications for its installation in a vehicle. In the case of a REESS designed for a specific vehicle use, vehicle parts which affect the course of the fire in any way shall be taken into consideration.

- 3.2.2. Component based test
- The tested-device shall be placed on a grating table positioned above the pan, in an orientation according to the manufacturer's design intent.
- The grating table shall be constructed by steel rods, diameter 6-10 mm, with 4-6 cm in between. If needed the steel rods could be supported by flat steel parts.
- 3.3. The flame to which the tested-device is exposed shall be obtained by burning commercial fuel for positive-ignition engines (hereafter called "fuel") in a pan. The quantity of fuel shall be sufficient to permit the flame, under free-burning conditions, to burn for the whole test procedure.
- The fire shall cover the whole area of the pan during whole fire exposure. The pan dimensions shall be chosen so as to ensure that the sides of the tested-device are exposed to the flame. The pan shall therefore exceed the horizontal projection of the tested-device by at least 20 cm, but not more than 50 cm. The sidewalls of the pan shall not project more than 8 cm above the level of the fuel at the start of the test.
- 3.4. The pan filled with fuel shall be placed under the tested-device in such a way that the distance between the level of the fuel in the pan and the bottom of the tested-device corresponds to the design height of the tested-device above the road surface at the unladen mass if paragraph 3.2.1. is applied or approximately 50 cm if Paragraph 3.2.2. is applied. Either the pan, or the testing fixture, or both, shall be freely movable.
- 3.5. During phase C of the test, the pan shall be covered by a screen. The screen shall be placed 3 cm +/- 1 cm above the fuel level measured prior to the ignition of the fuel. The screen shall be made of a refractory material, as prescribed in Annex 8F - Appendix 1. There shall be no gap between the bricks and they shall be supported over the fuel pan in such a manner that the holes in the bricks are not obstructed. The length and width of the frame shall be 2 cm to 4 cm smaller than the interior dimensions of the pan so that a gap of 1 cm to 2 cm exists between the frame and the wall of the pan to allow ventilation. Before the test the screen shall be at least at the ambient temperature. The firebricks may be wetted in order to guarantee repeatable test conditions.
- 3.6. If the tests are carried out in the open air, sufficient wind protection shall be provided and the wind velocity at pan level shall not exceed 2.5 km/h.
- 3.7. The test shall comprise of three phases B-D, if the fuel is at least at temperature of 20 °C. Otherwise the test shall comprise four phases A-D.
- 3.7.1. Phase A: Pre-heating (Figure 1)
- The fuel in the pan shall be ignited at a distance of at least 3 m from the tested-device. After 60 seconds pre-heating, the pan shall be placed under the tested-device. If the size of the pan is too large to be moved without risking liquid spills etc. then the tested-device and test rig can be moved over the pan instead.

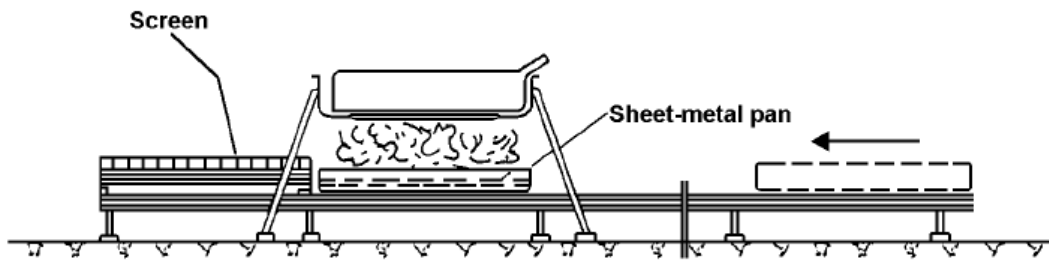
Figure 1  
**Phase A: Pre-heating**



3.7.2. Phase B: Direct exposure to flame (Figure 2)

The tested-device shall be exposed to the flame from the freely burning fuel for 70 seconds.

Figure 2  
**Phase B: Direct exposure to flame**



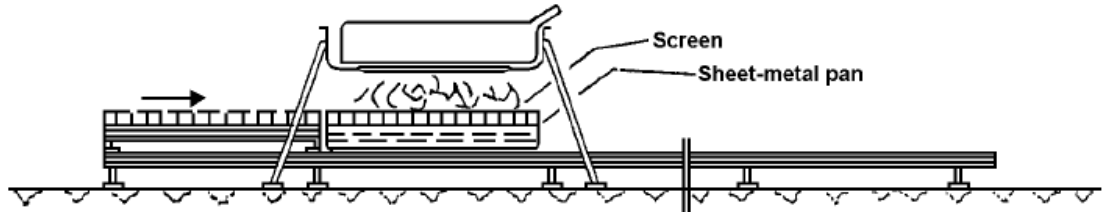
3.7.3. Phase C: Indirect exposure to flame (Figure 3)

As soon as phase B has been completed, the screen shall be placed between the burning pan and the tested-device. The tested-device shall be exposed to this reduced flame for a further 60 seconds.

Instead of conducting Phase C of the test, Phase B may at the manufacturer's discretion be continued for an additional 60 seconds.

However this shall only be permitted where it is demonstrable to the satisfaction of the Technical Service that it will not result in a reduction in the severity of the test.

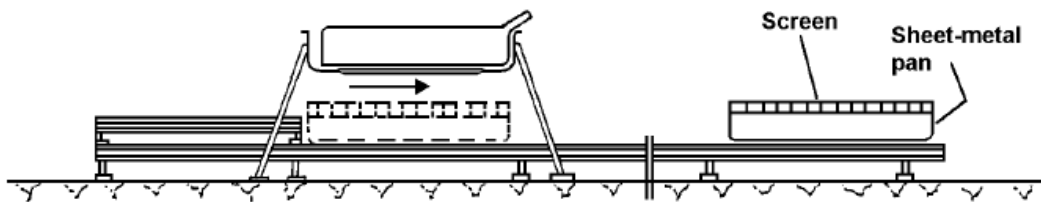
Figure 3  
**Phase C: Indirect exposure to flame**



3.7.4. Phase D: End of test (Figure 4)

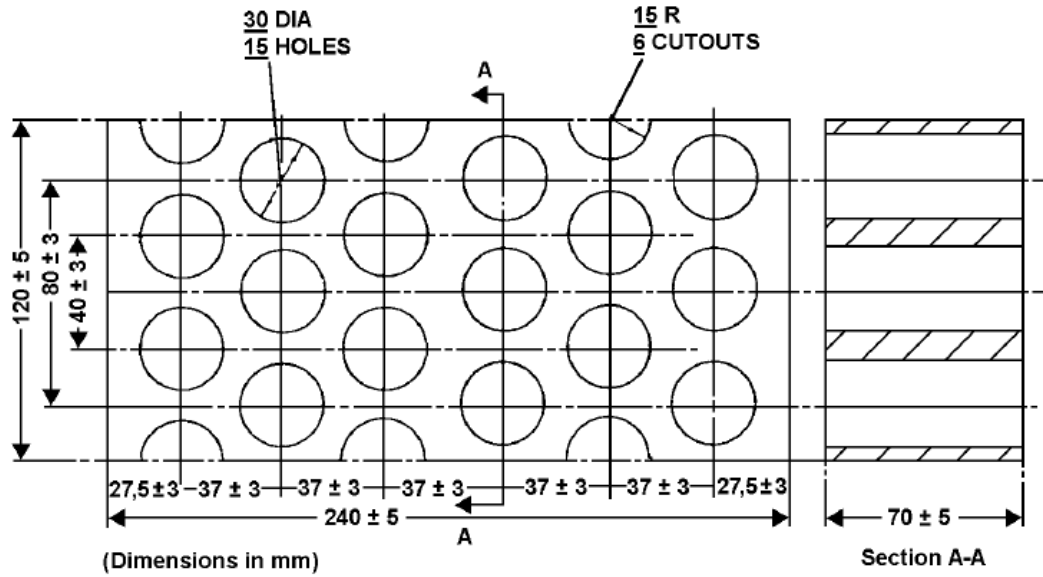
The burning pan covered with the screen shall be moved back to the position described in phase A. No extinguishing of the tested-device shall be done. After removal of the pan the tested-device shall be observed until such time as the surface temperature of the tested-device has decreased to ambient temperature or has been decreasing for a minimum of 3 hours.

Figure 4  
**Phase D: End of test**



## Annex 8 E - Appendix 1

### Dimension and Technical Data of Firebricks



Fire resistance:	(Seger-Kegel) SK 30
Al <sub>2</sub> O <sub>3</sub> content:	30 - 33 per cent
Open porosity (Po):	20 - 22 per cent vol.
Density:	1,900 - 2,000 kg/m <sup>3</sup>
Effective holed area:	44.18 per cent



## Annex 8 F

### External short circuit protection

#### 1. Purpose

The purpose of this test is to verify the performance of the short circuit protection. This functionality, if implemented, shall interrupt or limit the short circuit current to prevent the REESS from any further related severe events caused by short circuit current.

#### 2. Installations

This test shall be conducted either with the complete REESS or with related REESS subsystem(s), including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the tested-device if so requested by the manufacturer.

#### 3. Procedures

##### 3.1. General test conditions

The following condition shall apply to the test:

- (a) The test shall be conducted at a ambient temperature of  $20 \pm 10$  °C or at higher temperature if requested by the manufacturer,
- (b) At the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,
- (c) At the beginning of the test, all protection devices which would affect the function of the tested-device and which are relevant to the outcome of the test shall be operational.

##### 3.2. Short circuit

At the start of the test all relevant main contactors for charging and discharging shall be closed to represent the active driving possible mode as well as the mode to enable external charging. If this cannot be completed in a single test, then two or more tests shall be conducted.

The positive and negative terminals of the tested-device shall be connected to each other to produce a short circuit. The connection used for this purpose shall have a resistance not exceeding 5 mΩ.

The short circuit condition shall be continued until the operation of the REESS's protection function to interrupt or limit the short circuit current is confirmed, or for at least one hour after the temperature measured on the casing of the tested-device has stabilised, such that the temperature gradient varies by a less than 4°C through 1 hour.

3.3. Standard Cycle and observation period

Directly after the termination of the short circuit a standard cycle as described in Annex 8 Appendix 1 shall be conducted, if not inhibited by the tested-device.

The test shall end with an observation period of 1 h at the ambient temperature conditions of the test environment.

## Annex 8 G

### Overcharge protection

1. Purpose

The purpose of this test is to verify the performance of the overcharge protection.
2. Installations

This test shall be conducted, under standard operating conditions, either with the complete REESS (this maybe a complete vehicle) or with related REESS subsystem(s), including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions.

The test may be performed with a modified tested-device as agreed by the manufacturer and the Technical Service. These modifications shall not influence the test results.
3. Procedures
  - 3.1. General test conditions

The following requirements and conditions shall apply to the test:

    - (a) The test shall be conducted at an ambient temperature of  $20 \pm 10$  °C or at higher temperature if requested by the manufacturer,
    - (b) At the beginning of the test, all protection devices which would affect the function of the tested-device and which are relevant to the outcome of the test shall be operational.
  - 3.2. Charging

At the beginning all relevant main contactors for charging shall be closed.

The charge control limits of the test equipment shall be disabled.

The tested-device shall be charged with a charge current of at least 1/3C rate but not exceeding the maximum current within the normal operating range as specified by the manufacturer.

The charging shall be continued until the tested-device (automatically) interrupts or limits the charging. Where an automatic interrupt function fails to operate, or if there is no such function the charging shall be continued until the tested-device is charged to twice of its rated charge capacity.
  - 3.3. Standard cycle and observation period

Directly after the termination of charging a standard cycle as described in Annex 8 shall be conducted, if not inhibited by the tested-device.

The test shall end with an observation period of 1 h at the ambient temperature conditions of the test environment.

## Annex 8 H

### Over-discharge protection

1. Purpose

The purpose of this test is to verify the performance of the over-discharge protection. This functionality, if implemented, shall interrupt or limit the discharge current to prevent the REESS from any severe events caused by a too low SOC as specified by the manufacturer.

2. Installations

This test shall be conducted, under standard operating conditions, either with the complete REESS (this maybe a complete vehicle) or with related REESS subsystem(s), including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions.

The test may be performed with a modified tested-device as agreed by the manufacturer and the Technical Service. These modifications shall not influence the test results.

3. Procedures

3.1. General test conditions

The following requirements and condition shall apply to the test:

- (a) The test shall be conducted at an ambient temperature of  $20 \pm 10$  °C or at higher temperature if requested by the manufacturer,
- (b) At the beginning of the test, all protection devices which would affect the function of the tested-device and which are relevant for the outcome of the test shall be operational.

3.2. Discharging

At the beginning of the test, all relevant main contactors shall be closed.

A discharge shall be performed with at least 1/3 C rate but shall not exceed the maximum current within the normal operating range as specified by the manufacturer.

The discharging shall be continued until the tested-device (automatically) interrupts or limits the discharging. Where an automatic interrupt function fails to operate, or if there is no such function then the discharging shall be continued until the tested-device is discharged to 25 per cent of its nominal voltage level.

3.3. Standard charge and observation period

Directly after termination of the discharging the tested-device shall be charged with a standard charge as specified in Annex 8 if not inhibited by the tested-device.

The test shall end with an observation period of 1 h at the ambient temperature conditions of the test environment.

## Annex 8 I

### Over-temperature protection

1. Purpose

The purpose of this test is to verify the performance of the protection measures of the REESS against internal overheating during the operation, even under the failure of the cooling function if applicable. In the case that no specific protection measures are necessary to prevent the REESS from reaching an unsafe state due to internal over-temperature, this safe operation must be demonstrated.
2. Installations
  - 2.1. The following test may be conducted with the complete REESS (maybe as a complete vehicle) or with related REESS subsystem(s), including the cells and their electrical connections. If the manufacturer chooses to test with related subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. The test may be performed with a modified Tested-Device as agreed by the manufacturer and the Technical Service. These modifications shall not influence the test results.
  - 2.2. Where a REESS is fitted with a cooling function and where the REESS will remain functional without a cooling function system being operational, the cooling system shall be deactivated for the test.
  - 2.3. The temperature of the tested-device shall be continuously measured inside the casing in the proximity of the cells during the test in order to monitor the changes of the temperature. The onboard sensor if existing may be used. The manufacturer and Technical Service shall agree on the location of the temperature sensor(s) used.
3. Procedures
  - 3.1. At the beginning of the test, all protection devices which affect the function of the tested-device and are relevant to the outcome of the test shall be operational, except for any system deactivation implemented in accordance with Paragraph 2.2.
  - 3.2. During the test, the tested-device shall be continuously charged and discharged with a steady current that will increase the temperature of cells as rapidly as possible within the range of normal operation as defined by the manufacturer.
  - 3.3. The tested-device shall be placed in a convective oven or climatic chamber. The temperature of the chamber or oven shall be gradually increased until it reaches the temperature determined in accordance with Paragraph 3.3.1 or 3.3.2 below as applicable, and then maintained at a temperature that is equal to or higher than this, until the end of the test.
    - 3.3.1. Where the REESS is equipped with protective measures against internal overheating, the temperature shall be increased to the temperature defined by the manufacturer as being the operational temperature threshold for such protective measures, to insure that the temperature of the tested-device will increase as specified in Paragraph 3.2.

- 3.3.2. Where the REESS is not equipped with any specific measures against internal over-heating, the temperature shall be increased to the maximum operational temperature specified by the manufacturer.
- 3.4. The end of test: The test will end when one of the followings is observed:
- (a) The tested-device inhibits and/or limits the charge and/or discharge to prevent the temperature increase,
  - (b) The temperature of the tested-device is stabilised, which means that the temperature varies by a gradient of less than 4°C through 2 hours,
  - (c) Any failure of the acceptance criteria prescribed in paragraph 6.9.2.1.
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