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Regulation No. 100 (Battery electric vehicle safety)

Proposal for the 02 series of amendments

Submitted by the Chair of the group of interested experts on Rechargeable Energy Storage Systems (REESS) *

The text reproduced below was prepared by the Chairman of the group of interested experts on Rechargeable Energy Storage Systems (REESS) and aims at extending the scope of the present Regulation to incorporate additional requirements on REESS in accordance with the terms of reference of the group adopted at the forty-ninth session of the Working Party on Passive Safety (GRSP) (see ECE/TRANS/WP.29/GRSP/49, para. 32). The modifications to the existing text of UN Regulation No. 100 are marked in bold for new or strikethrough for deleted characters.

* 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.

I. Proposal

Contents,

Paragraph 5, amend to read:

"5. ~~Specifications and tests~~ 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 ~~for vehicle type~~ ....."

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 7, amend to read:

"Annex 7. - Determination of hydrogen emissions during the charge procedures of the traction battery

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*****:** ~~the following prescriptions apply to~~ safety requirements with respect to the electric power train of road vehicles of categories M and N [1]**,** 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."

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**

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

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"** [2]"

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 separate technical unit which are 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."

Insert a new paragraph 2.30., to read:

[2] **www.unece.org/trans/danger/publi/unrec/rev17/17files_e.html**

"**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 cell´s 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 ~~vehicle~~ **type** submitted for approval pursuant to this Regulation meets the requirements ~~of paragraph 5 below and Annexes 3,4,5 and 7 to~~ **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 [1] and footnote [1] renumber as footnote [3] and amend to read:

"[3] **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 ~~vehicle~~ 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. ~~Specifications and tests~~ 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 as a component and part of the vehicles high voltage bus.

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 as a component and part of the vehicle high voltage bus."

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 4**A**"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 ~~on-board~~ charger presenting a failure (conditions given in Annex 7), hydrogen emissions shall be below 42 g. Furthermore the ~~on-board~~ 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 ~~battery~~ **REESS** charging ~~are~~ **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** ~~signaled to the driver~~. An important failure is a failure that can lead to a ~~disfunctioning~~ **malfunction** of the ~~on-board~~ 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 Ω/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 Ω/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 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. 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 with the exception of open type traction batteries where spillage to the outside of the passenger compartment shall be no more than 7 per cent by volume of the REESS electrolyte capacity but not exceeding a maximum of 5.0 liters.

(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 Ω/Volt for the whole REESS measured after the test in accordance with Annex 4A, 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_1 and N_1.

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 Nos. 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 shall be at least of equal or greater severity to the forces that would result from using data from those 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

A 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 420 mm rearward and parallel to a horizontal line taken at 90 deg to the centerline of the vehicle through the foremost point of the front of the vehicle structure, and which is 300 mm forward and parallel to a horizontal line taken at 90 deg to the centerline of the vehicle through the rearmost point of the vehicle structure.

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 shall be at least of equal or greater severity to the forces that would result from using data from those 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 6.4.2.1. 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. 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 with the exception of open type traction batteries where spillage to the outside of the passenger compartment shall be no more than 7 per cent by volume of the REESS electrolyte capacity but not exceeding a maximum of 5.0 liters.

(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 Ω/Volt for the whole REESS measured in accordance with Annex 4 A, 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 Ω/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 Ω/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 Ω/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 Ω/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 ~~for vehicle type~~"

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 the administrative department 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 ~~component~~ **approval** Authority issuing the extension of approval shall assign a ~~series~~ **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.** ~~Every vehicle~~ **Vehicles or REESS** approved under this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements ~~set out in Paragraph 5. above~~ **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 ~~7~~**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 ~~Paragraph 5~~ **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 ~~7~~**8** above are not complied with, or if the vehicle/**REESS** or its components fail to pass the tests provided for in paragraph ~~7~~**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 ~~road~~ 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 [2] ....."**

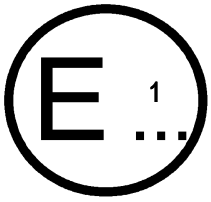
Insert new Annex 1 – Part 2, to read:

"Annex 1 – Part 2

Communication

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

issued by: **Name of administration:**
.....
.....
.....



concerning:[2] **APPROVAL GRANTED**
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a REESS type as component/ separate technical unit [2] **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): [2] **.....**

---

[1] **Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).**

[2] **Strike out what does not apply.**

13. Approval granted/extended/refused/withdrawn: [2] .....

14. Place: .....

15. Date: .....

16. Signature: .....

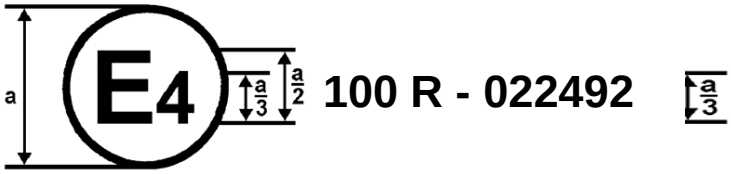
17. The documents filed with the request for approval or extension may be obtained on request: ....."

Annex 2, amend to read:

"Annex 2

Arrangements of the approval marks

Figure 1



a = 8 mm min.

The ~~above~~ 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.

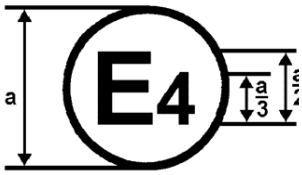
Figure 2

a = 8 mm min.

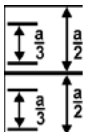
The approval mark in Figure 2 affixed to a REESS shows that the REESS type ("ES") concerned has been approved in the Netherlands (E4), pursuant to Regulation No. 100, and under the approval number 022492. The first two digits of the approval number indicate that the approval was granted in accordance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

Model B

(see Paragraph 4.5. of this Regulation)



100	02 2492
42	00 1628



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 ~~DC~~ 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 …"

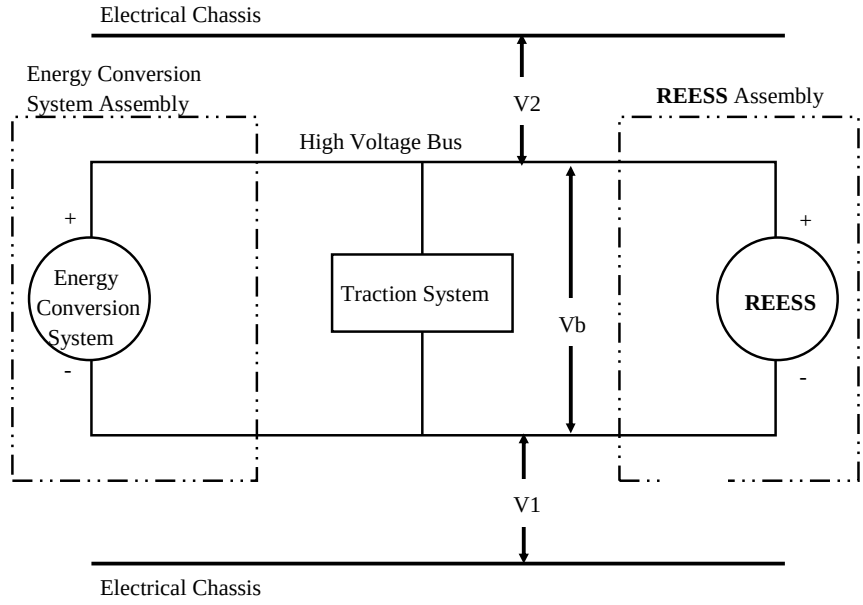
Paragraph 2.2.3.1., amend to read:

"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, amend to read:

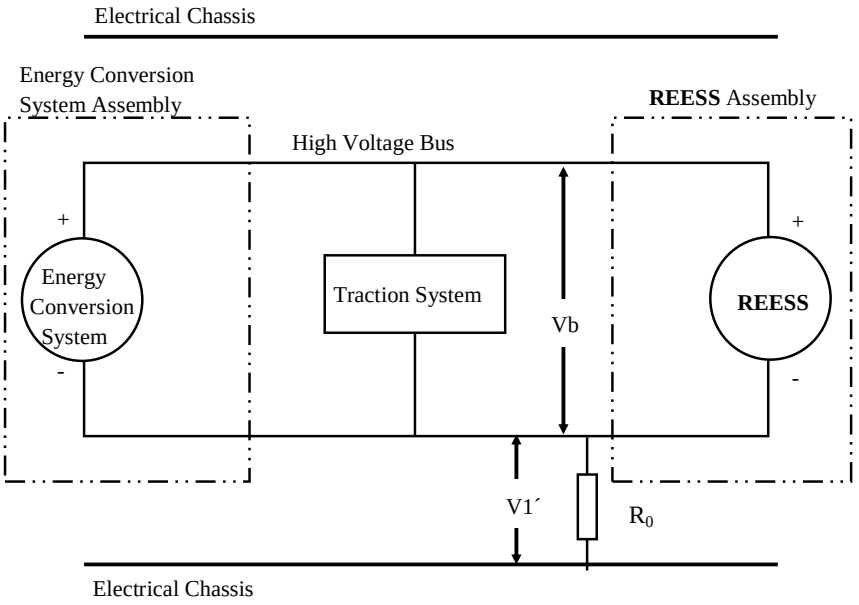
"Figure 1
Measurement of Vb, V1, V2



"

Figure 2, amend to read:

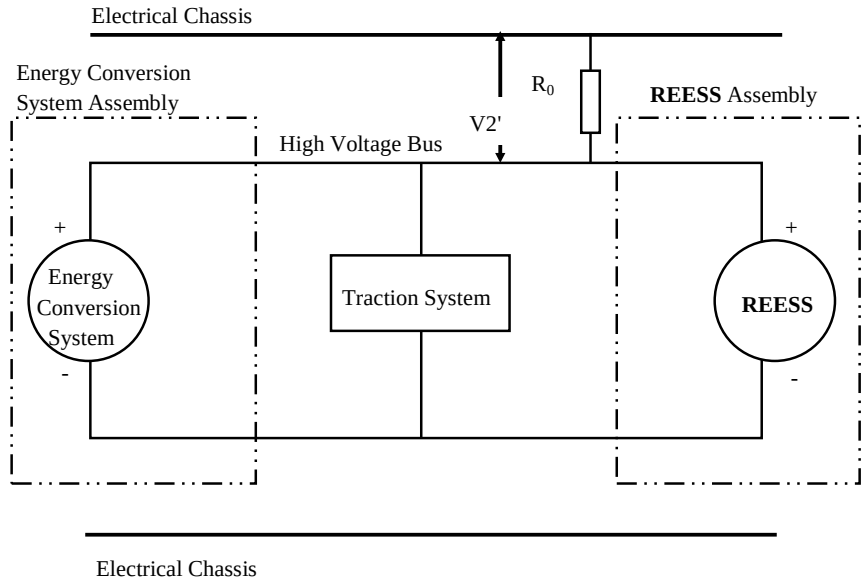
"Figure 2
Measurement of V1'



"

Figure 3, amend to read:

"Figure 3
Measurement of V2'



"

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 (Vb, 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

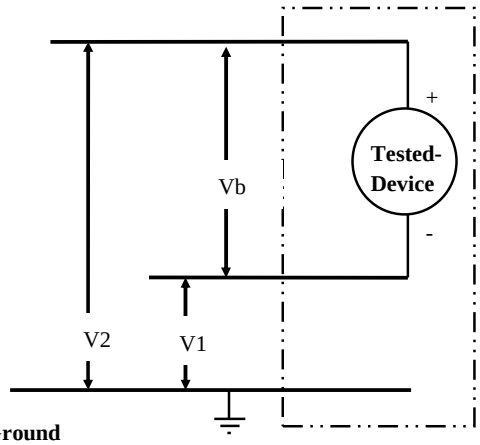
The voltmeter used in this test shall measure DC values and shall have an internal resistance of at least 10 MΩ.

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 (Vb, Figure 1) is recorded. Vb 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 (V1) 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 (V2) between the positive pole of the Tested-Device and the ground connection (Figure 1).

1.2.3.4. Fourth step

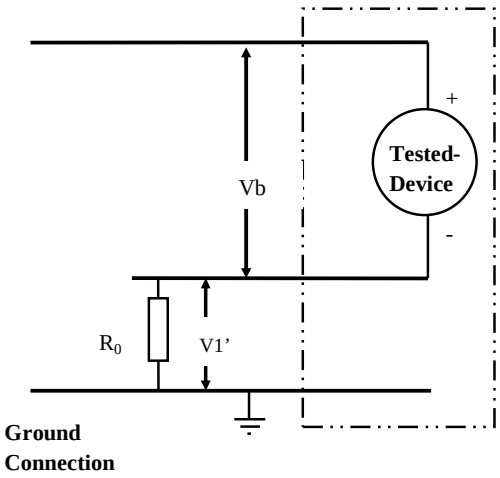
If V1 is greater than or equal to V2, insert a standard known resistance (Ro) between the negative pole of the Tested-Device and the ground connection. With Ro installed, measure the voltage (V1') between the

negative pole of the Tested-Device and the ground connection (see Figure 2).

Calculate the electrical isolation (Ri) according to the following formula:

Ri = Ro*(Vb/V1' – Vb/V1) or Ri = Ro*Vb*(1/V1' – 1/V1)

Figure 2

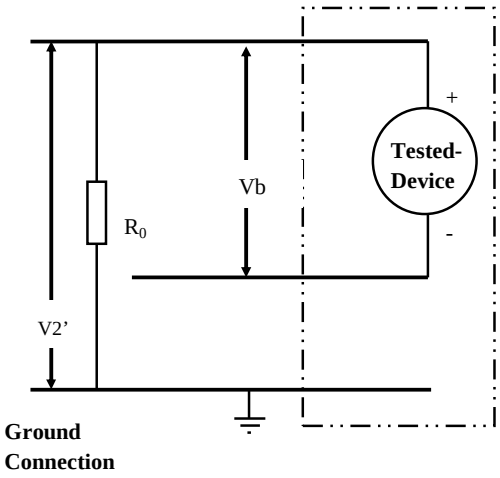


If V2 is greater than V1, insert a standard known resistance (Ro) between the positive pole of the Tested-Device and the ground connection. With Ro installed, measure the voltage (V2') between the positive pole of the Tested-Device and the ground connection (see Figure 3).

Calculate the electrical isolation (Ri) according to the following formula:

Ri = Ro*(Vb/V2' – Vb/V2) or Ri = Ro*Vb*(1/V2' – 1/V2)

Figure 3



1.2.3.5. Fifth step

The electrical isolation value Ri (in Ω) divided by the nominal voltage of the Tested-Device (in volts) results in the isolation resistance (in Ω/V).

NOTE 1: The standard known resistance Ro (in Ω) should be the value of the minimum required isolation resistance (in Ω/V) multiplied by the nominal voltage of the Tested-Device plus/minus 20 per cent (in volts). Ro is not required to be precisely this value since the equations are valid for any Ro; however, a Ro 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 ~~hourly output~~ **net power and / or maximum 30 Minutes power** (kW): ....."

Items 3 to 3.8., amend to read:

"3. ~~Battery (if REESS is battery)~~ **REESS: .....**

3.1. Trade name and mark of the ~~**battery**~~ **REESS**: **.....**

3.2. Indication of all types of ~~electroc-chemical~~ cells: .....

3.2.1. The cell chemistry: **.....**

3.2.2. Physical dimensions: .....

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

3.3. ~~Nominal voltage (V)~~ **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. Number of battery cells 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. ~~Type(s) of ventilation for battery module/pack~~ **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 cooling system (if any)~~ **Type of thermal management: .....**

3.8. ~~Capacity (Ah)~~ **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, amend to read:

Paragraphs 1 to 3.1.2., amend to read:

"1. Introduction

This annex describes the procedure for the determination of hydrogen emissions during the charge procedures of the ~~traction battery~~ **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 ~~traction battery~~ **REESS** with the ~~on-board~~ charger. The test consists in the following steps:

(a) vehicle/**REESS** preparation,

(b) discharge of the ~~traction battery~~ **REESS,**

(c) determination of hydrogen emissions during a normal charge,

(d) determination of hydrogen emissions during a charge carried out with **the** ~~on-board~~ charger failure.

3. Tests ~~vehicle~~

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 ~~traction battery~~ **REESS** subject to the test of hydrogen emissions, over this period.

3.1.2. If the ~~battery~~ **REESS** is used at a temperature above the ambient temperature, the operator shall follow the manufacturer's procedure in order to keep the ~~traction battery~~ **REESS** temperature in normal functioning range.

The manufacturer's representative shall be able to certify that the temperature conditioning system of the ~~traction battery~~ **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**

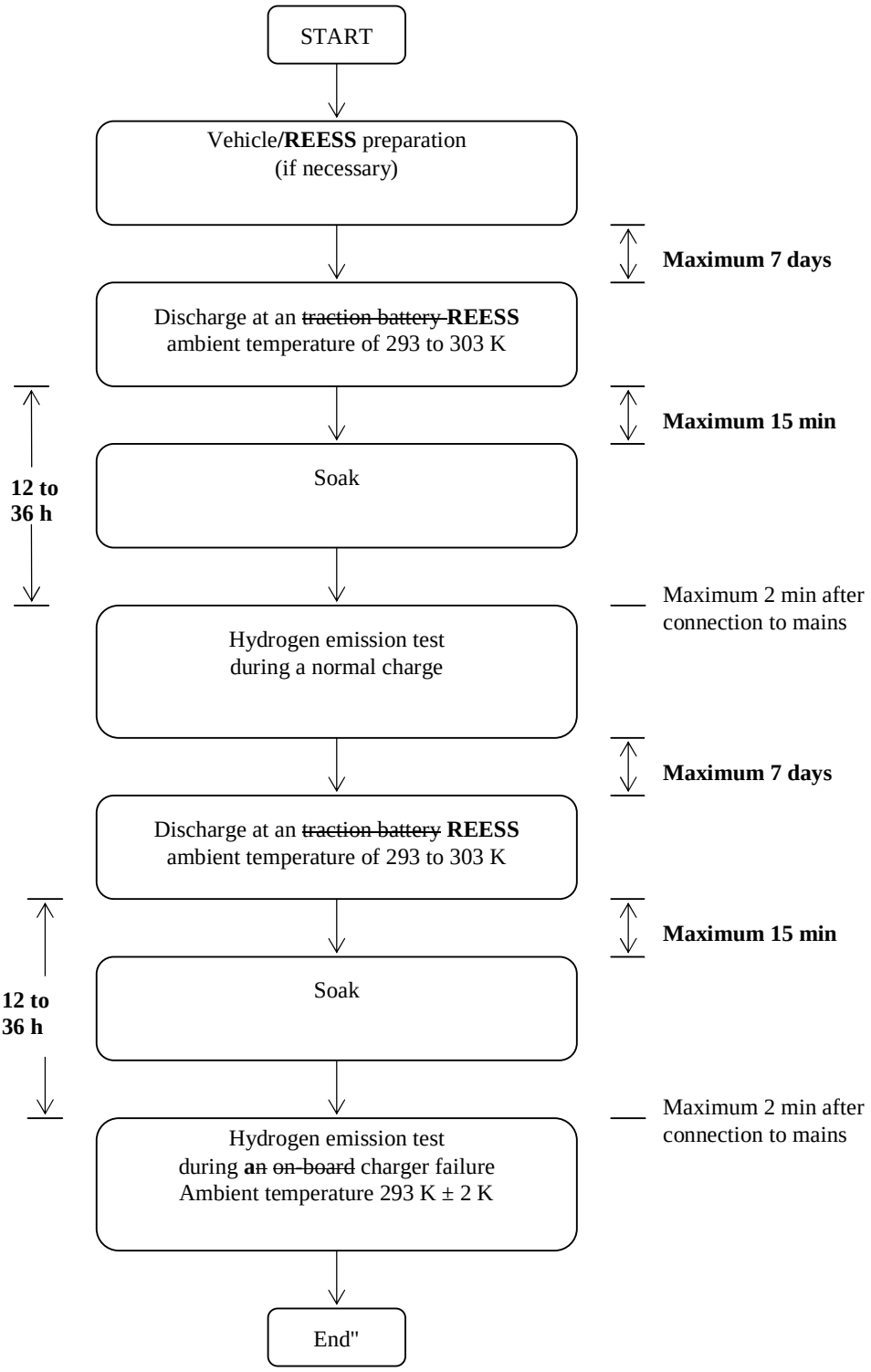
3.2.1. The REESS shall be in good mechanical condition and have been subject to minimum of 5 standard cycles (as specified in Annex 8 Appendix 1).

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 duringthe charge procedures of the ~~traction battery~~ **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** ~~of the battery modules~~ are recorded by means of the sensors."

Paragraph 4.6.1., amend to read:

"4.6.1. The ~~**on-board**~~ 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 ~~traction battery~~ **REESS**,

…

(e) determination of hydrogen emissions during a charge carried out with the ~~on-board~~ 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 ~~traction battery~~ **REESS** shall be checked, proving that the vehicle has performed at least 300 km ...

5.1.1.1. Discharges and initial charges of the ~~battery~~ **REESS**

The procedure starts with the discharge of the ~~traction battery~~ **REESS** of the vehicle ...

…

5.1.1.2. Initial charge of the ~~battery~~ **REESS**

The charge is carried out:

(a) with the ~~on-board~~ charger,

(b) in an ambient temperature between 293 K and 303 K.

The procedure excludes all types of external chargers.

The end of ~~traction battery~~ **REESS** charge criteria corresponds to an automatic stop given by the ~~on-board~~ charger.

This procedure ...

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

5.1.2. Discharge of the ~~battery~~ **REESS**

The ~~traction battery~~ **REESS** is discharged while driving on the test track or on a chassis dynamometer at a steady speed of 70 per cent ± 5 per cent from the maximum thirty minutes speed of the vehicle.

…"

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 ~~battery~~ **REESS** is charged according to normal charge procedure as specified in Paragraph 5.4.7 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 ~~on-board~~ 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 ~~traction battery~~ **REESS** charge criteria corresponds to an automatic stop given by the ~~on-board~~ 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. to 5.4.9., renumber as paragraphs 5.1.4.8. to 5.1.4.9.

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 ~~on-board~~ charger failure

5.1.5.1. Within seven days maximum after having completed the prior test, the procedure starts with the discharge of the ~~traction battery~~ **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 ~~battery~~ **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 ~~on-board~~ **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 ~~on-board~~ charger ~~is blocked at~~ **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 ± 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 ± 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 CH2i, Ti and Pi 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 5.4.6. The different times elapsed are recorded. The hydrogen concentration, temperature and barometric pressure are measured to give the final readings CH2f, 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 CH2i, 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:

(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.

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 5.5.8. The times elapsed are recorded. The hydrogen concentration, temperature and barometric pressure are measured to give the final readings C_{H2f}, 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 ~~vehicle~~ **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^3 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^3."

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.

~~Traction battery~~ **REESS:**

(a) trade name or mark of the ~~battery~~ **REESS,**

(b) indication of all types of electro-chemical couples used,

(c) number of ~~battery~~ **REESS** cells,

(d) number of ~~battery~~ **REESS** ~~modules~~ **subsystems,**

(e) nominal voltage of the ~~battery~~ **REESS** (V),

(f) ~~battery~~ **REESS** energy (kWh),

(g) gas combination rate (in per cent),

(h) type(s) of ventilation for ~~**battery**~~ **REESS** ~~**module(s) or pack**~~ **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:	**Discharge procedure including termination criteria as defined by the manufacturer. If not specified, 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 control unit for the REESS is not integral to the REESS then, such a control unit may be omitted from the test 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 ± 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-Device 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

Frequency (Hz)	*Acceleration (m/s2)*
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.

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 a 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 integral to the REESS then such a control unit may be omitted from the test 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 ± 2 °C or higher if requested by the manufacturer, followed by storage for at least six hours at a test temperature equal to -40 ± 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 ± 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 subsystems 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, then such a control 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 ± 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 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

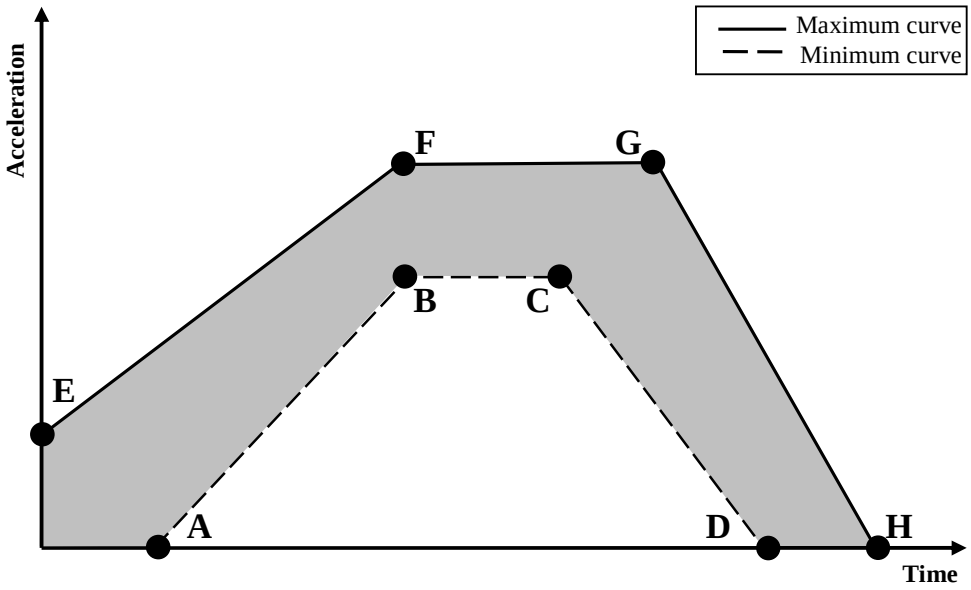


Table 1 for M_1 and N_1 vehicles:

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 M2 and N2 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_3 and N_3 vehicles:

Point	*Time (ms)*	*Acceleration (g)*	
		Longitudinal	*Transverse*
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) 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 integral to the REESS then such a control unit may be omitted from the test 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 ± 10 °C,

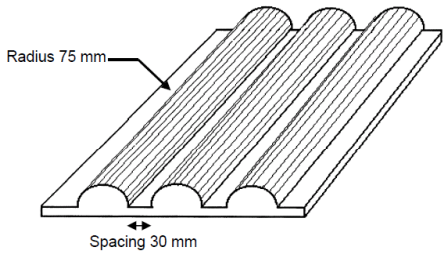
(b) at the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,

(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

3.2.0. Crush Plate

Figure 7



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

3.2.1. Crush force

The Tested-Device shall be crushed between a resistance and a crush plate as described in figure 7 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.

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 a 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 integral to the REESS then such a control unit may be omitted from the test 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 fuel temperature shall be ambient temperature.

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.

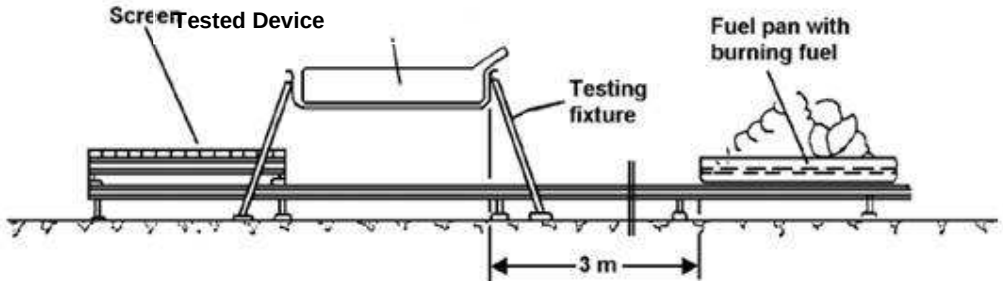
3.6. If the tests are carried out in the open air, sufficient wind protection shall be provided and the wind velocity at pan level shall not exceed 2.5 km/h.

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.

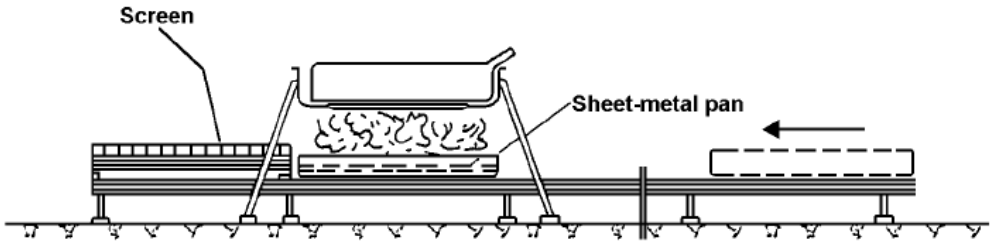
Figure 1
Phase A: Pre-heating



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



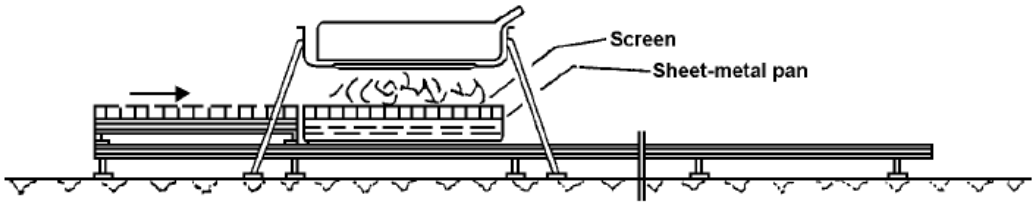
3.7.3. Phase C: Indirect exposure to flame (Figure 3)

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.

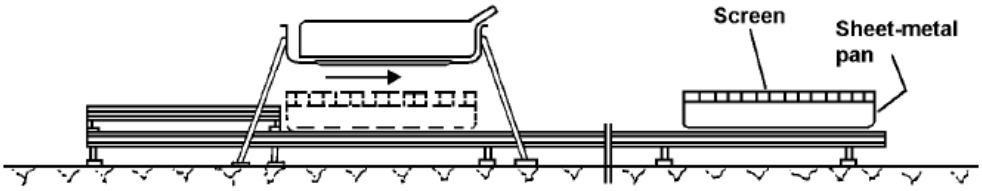
Figure 3
Phase C: Indirect exposure to flame



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

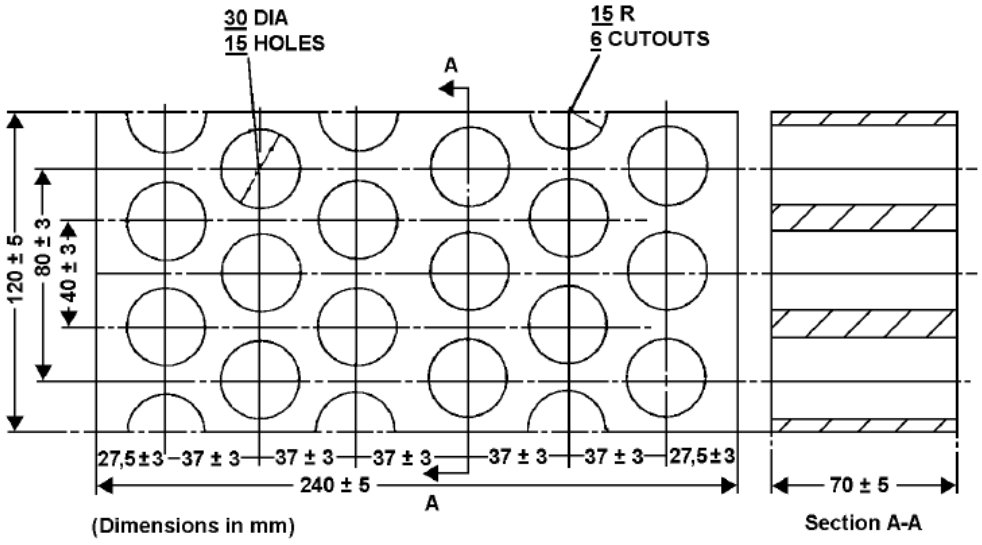
The burning pan covered with the screen shall be moved back to the position described in phase A. No extinguishing of the Tested-Device shall be done. After removal of the pan the Tested-Device shall be observed until such time as the surface temperature of the Tested-Device has decreased to ambient 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**
Al2O3 content:	**30 - 33 per cent**
Open porosity (Po):	**20 - 22 per cent vol.**
Density:	**1,900 - 2,000 kg/m3**
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 integral to the REESS, the unit may be omitted from the test at the request of 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 ± 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 REESS.

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 ± 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 REESS.

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 ± 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 operation, and the failure of the cooling function if available. 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 subsystems 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. In order to facilitate the test, necessary alteration of the REESS component may be implemented subject to the agreement between the manufacturer and the Technical Service to the extent that such alteration will not influence the results of this test.

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.**

II. Justification

A. Vibration: Paragraph 6.2 and Annex 8A

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

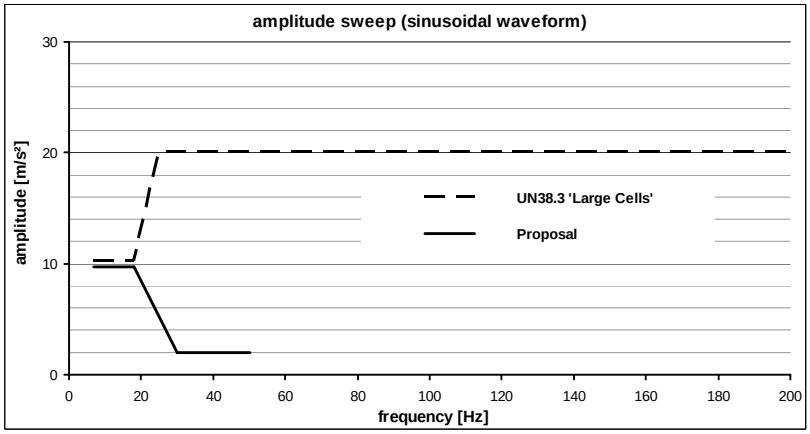
2. A vibration load spectrum for lithium cells and batteries including lithium ion cells/batteries and lithium polymer cells/batteries is already defined as a type proved test procedure of dangerous goods of class 9 in the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, paragraph 38.3.4.3 (UN38.3 Test T3: Vibration), with an amplitude sweep ranging from 7 Hz to 200 Hz.

3. As UN38.3 sign-off may often also be mandatory for types of REESS (such as lithium metal batteries, lithium ion batteries and lithium polymer batteries) subject to this regulation, having the opportunity to cover this test with UN38.3, test T3, is seen as an efficient approach.

4. However the load curve per UN38.3 is assessed as too severe for automotive applications. Despite the recent lowering of the high frequency amplitude in UN38.3 from 8g to 2g for "large batteries" with masses more than 12 kg, even this amplitude is still not considered representative for the typical sizes of REESS in vehicles, with a mass of 200kg or more. Particularly the height of the amplitudes above 18 Hz is seen as unrealistic and does not correlate to the loads seen in road vehicles (except for hypothetical cases of REESSs mounted close to or onto a combustion engine), as due to the stiffness of vehicle bodies in relation to the module weight frequencies higher than this cannot be transmitted at significant energy levels.

5. This UN Regulation, therefore, uses the same frequency vertices as UN38.3 test T3, albeit those for smaller cells, but lowers the load curve above 18Hz and truncates it at 50Hz.

Figure 1
Comparison of proposed with UN38.3 load curve



6. The test duration is also aligned with UN38.3, Test T3, requiring 12 transitions from the minimum to the maximum frequency and back within 15 min., resulting in a total test duration of 3 hours.

7. While UN38.3 requires the test to be performed in all 3 special directions, in vehicle applications this load occurs in the vertical direction only, while the longitudinal and lateral vehicle dynamic loads are significantly lower. The vibration test therefore needs to be performed in the vertical installation direction only. When utilizing this option, the orientation of the REESS in the vehicle must be restricted accordingly, which is to be defined per Annex 6 Part II (Essential Characteristics of REESS).

8. In many cases the vehicle manufacturer is assessing the vehicle's durability with full vehicle simulation, either by running a rough road test track or by simulating the lifetime fatigue on a 4-poster vibration rig. These methods provide a vehicle specific assessment of the durability of all vehicle components and shall be accepted in this context.

9. To finalize the certification of the REESS a standard cycle has to be performed, to verify that the mechanical loads have not had any negative effect on the electrical function.

B. Thermal Shock and Cycling: Paragraph 6.3 and Annex 8B

10. In a real world application, subsystems like the REESS are subjected to changes in environmental temperature, sometimes rapid changes in environmental temperature.

11. Such temperature changes could relate in thermal expansion of components. Since different materials with different coefficients of thermal expansion (CTE) are used, this could lead to different expansions of the components and mechanical stress.

12. A REESS would likely experience several changes in environmental temperature or rapid changes in environmental temperature during its life. The mechanical stress and/or different material expansions caused by this temperature changes may potentially influence cell and seal integrity or internal electrical connections.

13. Therefore, it is important to test the robustness of the REESS against temperature shocks.

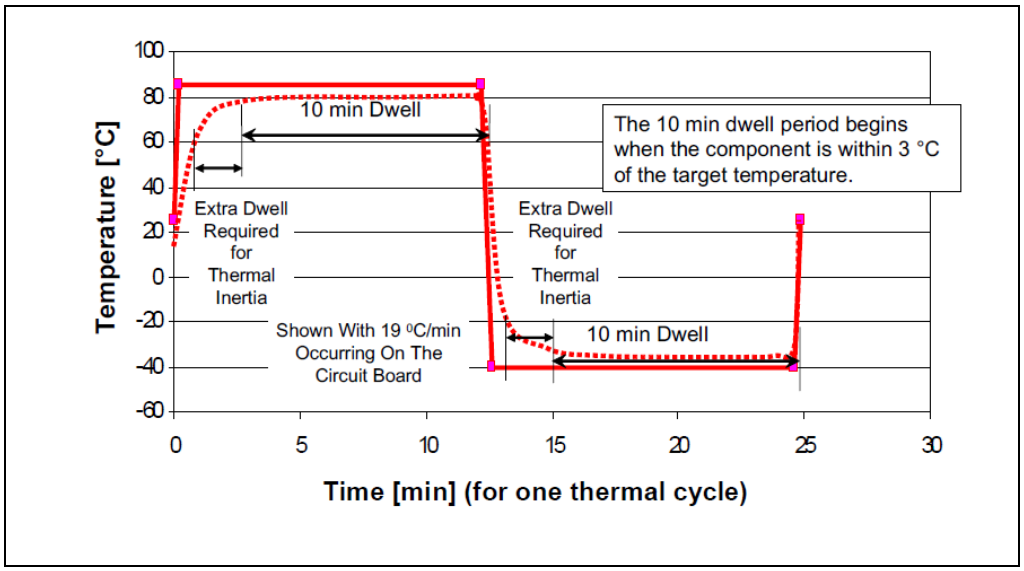
14. It has to be verified that a thermal shock will not cause defect cell seals or loose internal electrical contacts.

15. The Thermal Shock and Cycling Test shall verify that the REESS is immune to thermal fatigue and contact degradation that is caused by temperature changes and possible miss-matching of the CTE of materials.

16. Similar tests are a significant test within validation of electrical components and subsystems. Also, a thermal shock and cycling test is part of the test sequence of transportation tests according to UN38.3.

17. The following graph shows a typical thermal shock profile for electric / electronic components.

Figure 2
Thermal Shock Profile



18. Since the REESS has a different thermal mass and has different operation and storage temperature ranges than typical electric / electronic components, a modification of the test conditions i.e. lower maximum temperature and longer dwell time are needed.

D. Mechanical Shock: Paragraph 6.4.1 and Annex 8 C

19. The aim is to verify the safety performance of the REESS under inertial loads which may occur during a vehicle crash.

6.4.1.1 Vehicle based test:

20. Requirements for crash safety for vehicle with electric propulsion are already defined in the UN Regulation Nos. 12, 94 and 95. Therefore, conducting the vehicle crash test according to the said regulations is sufficient to ensure the safety of the REESS under inertial loads.

6.4.1.2 Component based test:

21. Alternatively existing regulations UN Regulation Nos. 67 and 110 already require inertial load validations for CNG and LPG tanks on component level. Furthermore the same inertial load requirements are implemented in the new regulation 79/2009 (EC) for hydrogen vehicles and in the Japanese regulation "Attachment 111" for the installation of high-voltage components. The acceleration values in the above mentioned regulations are defined and verified for each vehicle category. The expert group decided to adopt the inertial load values based on existing regulations for the REESS mechanical shock test on component level as well. Additionally a pulse shape and a pulse time have been defined to insure the repeatability and equivalency of the test. The shape and time are derived from the acceleration pulse of UN Regulation No. 17 (seat strength).

Mechanical Integrity: Paragraph 6.4.2 and Annex 8D.

22. It is the aim to verify the safety performance of the REESS under contact loads which may occur during vehicle crash.

General

23. The vehicle deformation tests, as described in the chapter "integrity test", and the component test derived thereof, have been defined based on existing ECE crash regulations.

24. This crash tests are mainly defined for passenger cars of category M_1. To cover the majority of hybrid and electric commercial vehicles which are currently on the market, the scope of the integrity test has been made as wide as possible. Therefore the integrity test (component or vehicle based test) is obligatory for vehicles of category M_1 and N_1. To proof the safety of the REESS in the case of a side crash, all REESS can be tested according to the conditions of UN Regulation No. 95 (independent from the "seat reference point" which is not relevant for the REESS position) or according to the derived component test. For validation of the safety of the REESS in the case of a front crash the group of experts agreed that the vehicle crash according to UN Regulation Nos. 12 or 94 or the derived component test could be applied for M_1 and N_1 vehicles up to 3.5 tons. Due to the enlarged scope of the integrity test to all vehicles of category M_1 and N_1, the majority of electric and hybrid vehicles, like vans or mini busses, have to fulfil the test requirements.

25. The integrity test requirements have not been adopted for other vehicle categories (M_2, M_3, N_2, N_3) since the structure of these vehicles and batteries, the mounting position of the batteries and the possible hazardous crash scenarios are different and not comparable to vehicles of category M_1 and N_1. Even the component test is not applicable for larger vehicles since the static forces (100 kN for at least 100 ms) are validated for M_1 and N_1 vehicles only.

26. The REESS is usually an integral part of the vehicle safety structure in vehicles of category M_1 and N_1. In contrast, a REESS installed in a bus or truck is typically mounted on or between frame parts of the vehicle, like a fuel tank, without any influence on the safety structure. Due to fuel tanks providing an adequate and accepted level of safety even without mandatory crash requirements, a REESS which is installed in an equivalent way and with comparable amount of energy, also, does not have to be crash tested.

27. Crash tests are not mandated for commercial vehicles over 3.5 tons since no empirical values are available for representative and typical crash scenarios involving these vehicle categories. Furthermore, heavy commercial electric and hybrid vehicles which are available on the market today do not show any potential risk concerning the deformation of REESS. Therefore in a first step an integrity test is not seen as necessary, while care is taken not to overly constrain the development and implementation of REESS for heavy commercial vehicles.

28. Should accident statistics show integrity tests inevitable in the future for heavy vehicles, the requirements (typical deformation forces and durations) should be defined in accordance with those statistics.

6.4.2.1 Vehicle specific test

6.4.2.1.1 Vehicle based dynamic test

29. Requirements for crash safety for vehicles with electric propulsion are already defined in UN Regulation Nos. 12, 94 and 95. Therefore conducting the vehicle crash test according to the said regulations is sufficient to ensure the safety of the REESS under contact loads.

6.4.2.1.2 Vehicle specific component test

30. It may be reasonable not to conduct a whole vehicle crash test to approve the safety of the REESS (e.g. change of the cell manufacturer of the REESS when the vehicle is already approved). For a specific vehicle it is also sufficient to conduct a component test of the REESS as described in Annex 8D, by replacing the generic contact load by the contact

load derived from vehicle crash tests or simulations according to UN Regulation Nos. 12, 94 and 95.

6.4.2.2 Component based test

31. A basic idea of the amendment of the UN Regulation No. 100, 02 series of amendments for REESS requirements is the possibility for REESS manufacturers to achieve a generic vehicle independent component approval for the REESS. In order to enable this generic component approval approach, a generic component based integrity test for the REESS was developed.

32. The loads have been derived from REESS contact loads which have been observed on vehicle crash tests according to UN Regulation Nos. 12, 94 and 95, using electric and hybrid-electric vehicles which are currently available on the market. The REESS were installed in various installation positions (see figure 1).

33. The contact loads onto the REESS observed during above tests and simulations did in no case exceed 100 kN (see table 1).

Figure 3

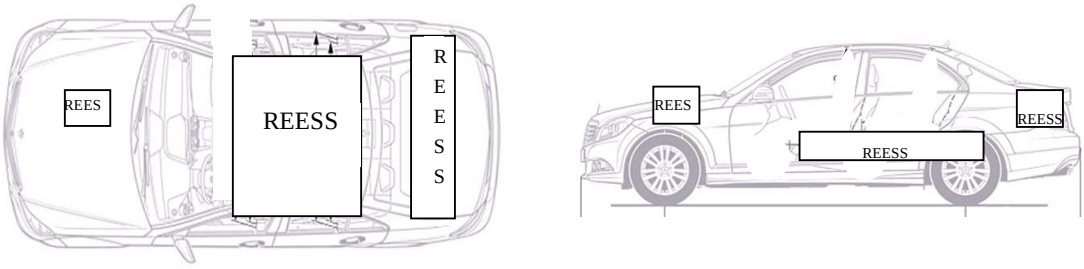


Table 1
maximum contact load

Vehicle	*REESS position*	*maximum contact load*
S 400 HYBRID	Front	
ML 450 HYBRID	Rear Axle	
B-Class F-CELL	Rear Axle	100 kN
A-Class E-CELL	Floor	
Smart ED	Floor	

34. Figure 3 shows, that the REESS in the investigated vehicles are not installed in the extreme positions in the front or the rear of the vehicle. This is confirmed by vehicle independent investigations (SAE 2011-01-0545 Analysis of Fuel Cell Vehicles Equipped with Compressed Hydrogen Storage Systems from a Road Accident Safety Perspective) that show that statistically the highest rates of the deformation will be observed at the front end and, at a smaller level, at the rear end of the vehicle (see figure 4). Therefore, these installation locations shall be excluded if the REESS is approved according to the generic 100 kN integrity test according to annex 8D.

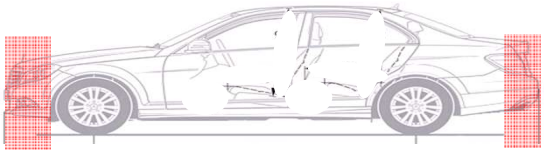
Figure 4
Cumulative frequency and 5th per centile in cars registered 2000 and later

(SAE 2011-01-0545 Analysis of Fuel Cell Vehicles Equipped with Compressed Hydrogen Storage Systems from a Road Accident Safety Perspective)

35. The dimension of the restricted mounting zones for the generically approved REESS is derived from the Japanese regulation Attachment 111 (technical standard for protection of occupants against high voltage after collision in electric vehicles and hybrid electric vehicles).

36. Considering this regulation, the installation of the REESS is prohibited in an area 420mm from the front of the vehicle rearwards and 300mm from the end of the vehicle forwards (see figure 5).

Figure 5
prohibited installation positions (red) for vehicle independent approved REESS



37. Although the whole vehicle crash test is a dynamic event with a very short duration time for the maximum REESS load, a static component test is proposed in Annex 8 D for the vehicle independent approval of the REESS. Being aware that a quasi-static load application might lead to a higher test severity, achieving a high pre-defined force level in a controllable manner is easier to conduct via a quasi-static testing.

38. Considering this, a REESS charged with the maximum observed contact load in the direction of travel and horizontal perpendicular to this direction can be assumed as save in the event of a vehicle crash.

39. The static REESS load that shall be reached is therefore proposed as 100 kN with a maximum aberration of 5 per cent to an upper threshold of 105 kN. The hold time of the maximum force shall be at least 100 ms as an agreed duration of the crash pulse during vehicle crash tests but shall not exceed 10s to avoid unrealistic severity. For the same reason, the onset time for reaching the maximum contact load is limited to 3 minutes. To allow the manufacturer more flexibility and since it makes the conditions more severe, higher forces, longer onset time and a longer hold time shall be allowed if requested by the manufacturer. The crush plate from SAE J2464 is used to apply the contact load.

40. Independent from the test method the acceptance criteria add the avoidance of fire and explosion to the High Voltage system related requirements of UN Regulation Nos. 12, 94 and 95.

41. To enable the manufacturer of the REESS to achieve a component approval for the REESS and considering that in numerous cases the contact load of the REESS during a vehicle crash may be lower than the above required worst case 100 kN, the manufacturer shall be allowed to conduct the integrity test with a lower contact force than 100 kN.

42. In this case, the vehicle manufacturer, installing the REESS in the vehicle, shall provide evidence, that in the discussed vehicle application the contact load on the RESS during vehicle crash does not exceed the contact load the REESS is approved with and the approval of the REESS is only valid for vehicle applications with contact loads during crash not exceeding the contact load used for REESS approval.

43. The technical service shall agree to the argumentation of the REESS contact load verification in the vehicle during the crash provided by the vehicle manufacturer.

E. Fire Resistance: paragraph 6.5. and Annex 8E

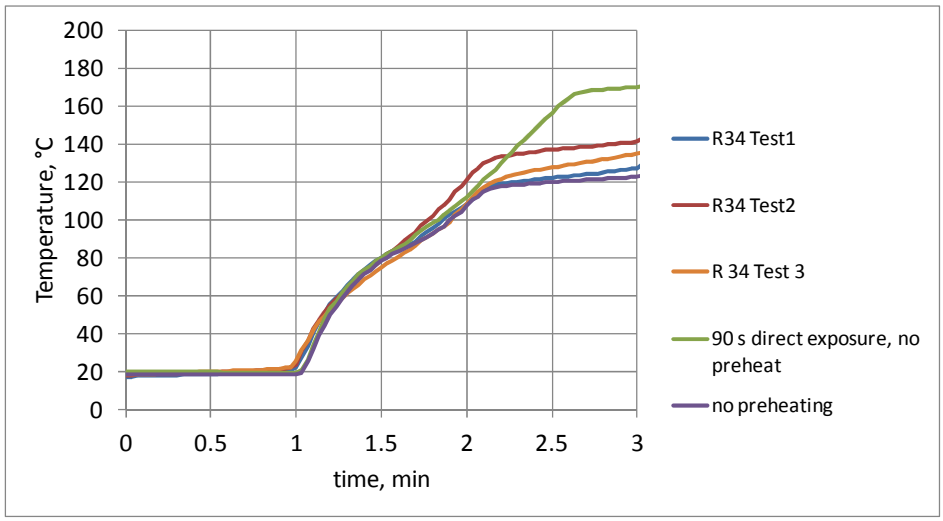
44. The purpose of the test is to ensure that the REESS does not increase the danger to passengers and surroundings caused by a fuel fire on the ground underneath the vehicle.

45. The proposal is similar to the requirements for plastic fuel tanks in UN Regulation No. 34.

46. The test is required for REESS placed at a level lower than 1.5 m above ground. The 1.5 m limit is due to that the fire impact will be significantly lower at this height especially considering that there will be plenty of material in between the fire and the REESS when it is placed at this height.

47. The requirement for plastic fuel tanks in UN Regulation No. 34 is that it should pass 3 tests. The requirements in paragraph 6.5 and Annex 8 E are only for one test. In order to compensate for potential variations in fire exposure the direct exposure phase of the test has been increased by 10 s. The 10 s change was determined based on experiments presented in Figure 6 below where temperatures were measured on a simulated vehicle during the exposure from 3 tests of UN Regulation No. 34 and modified versions of the test of UN Regulation No. 34 (e.g. 90 s direct exposure and no preheat period and 60 s direct exposure, no preheat period). These curves also confirm that the preheating period can be omitted if these 10s extra are used.

Figure 6
Mean of temperature readings on a vehicle Mock-up during different "Regulation No. 34" exposures



48. A testing procedure on component level is also suggested. This test procedure is similar to the procedure for the vehicle test. As this procedure should be valid for all possible placements of the REESS, the height at which the REESS is placed during the test is determined to represent the worst case. Experiments were conducted in which the temperature as a function of height was measured above the fuel surface for various pool sizes, some are presented in Figures 7 and 8 below. Based on the results of these tests, a height above the fuel surface of 50 cm was selected for component testing.

Figure 7
Temperature readings above a 2.2 m² pool

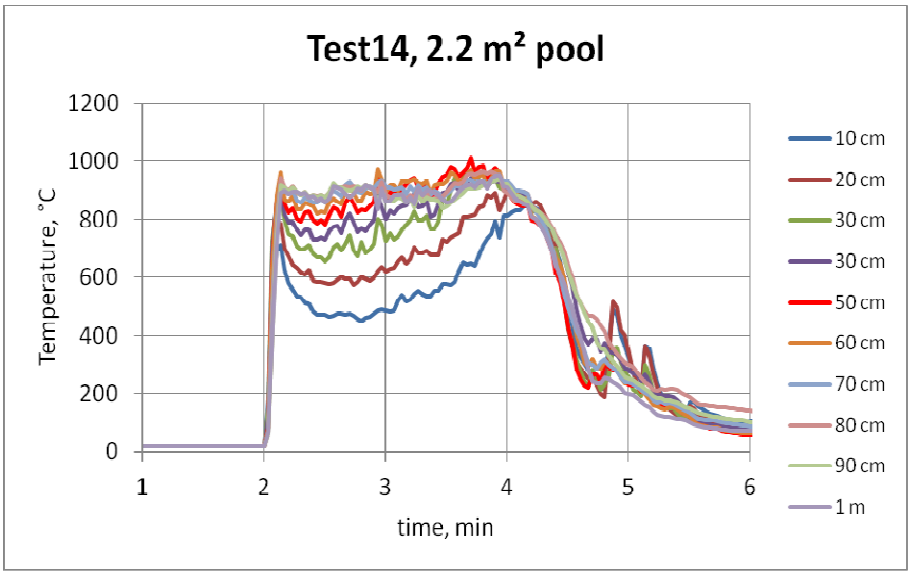
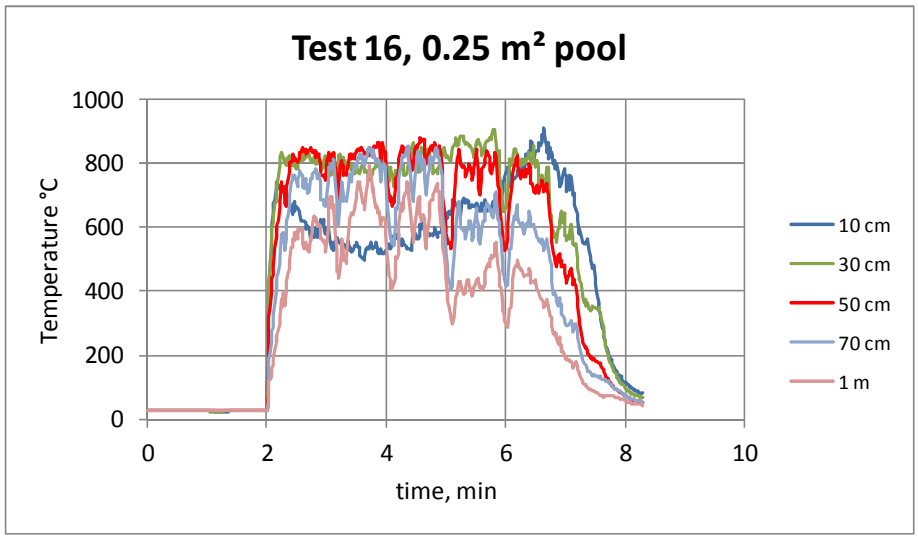


Figure 8
Temperature readings above a 0.25 m² pool



49. One major difference between fuel tanks and REESS is that REESSs can produce heat in their own right and possible get into a thermal runaway. Therefore the end test procedure is different from the procedure of the UN Regulation No. 34. No external cooling or extinguishment of the tested device is conducted to facilitate a search for leaks. Instead, the tested device is observed for at least 3 hours to confirm that the temperature decreases and no dangerous processes resulting in an explosion have been initiated during the exposure.

F. External Short Circuit Protection: paragraph 6.6. and Annex 8F

50. This test is to verify the performance of the protection measure against short circuit happened in the external circuit of the REESS. If certain protection device (e.g. fuse, contactor, etc.) exists in the REESS, the functionality of such device will be evaluated and if no such device exists, the robustness of the REESS against short circuit will be evaluated. The test procedure has been developed based on existing standards or other technical references. Due to the limited time available, the resistance of the connection (5mΩ or less) is taken from SAE J2464 (SURFACE VEHICLE RECOMMENDED PRACTICE, Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing, Nov.2009) as specified for pack hard short, without having in depth scientific consideration about the most reasonable value of this resistance. The figure may need to be reviewed in the future taking account for development of related regulations or standards.

51. This test procedure does not address the short circuit event inside the casing (battery pack enclosure) of REESS, since the occurrence of such short circuit events will be assessed by the other tests such as vibration, thermal shock and cycling, and mechanical impact.

G. Overcharge Protection: paragraph 6.7. and Annex 8G

52. Overcharging of REESS can lead to very high thermal power loss due to current flow and / or loss of chemical stability due to high temperatures. This may result in severe events like fire or explosion. The aim of the requested test is to verify the performance of the protection measures of the REESS against overcharge by an external power supply during its operation. If such a protection measures (e.g. battery management system connected to contactors) is installed in the REESS, the functionality of the protection measures has to be proven by interrupting or limiting the charge current to a safe value. In the case such functionality is not installed and the cells are not protected against overcharge, the REESS has to be charged to twice its rated capacity. The test end criteria has been mentioned in further safety test standards e.g. IEC 62660-2 "Secondary batteries for the propulsion of electric road vehicles" and SAE J2464 "Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing".

H. Over-discharge Protection: paragraph 6.8. and Annex 8H

53. Over discharging of REESS for itself can not lead to a severe event. Some kinds of REESS have special chemical reaction which can occur very slow and are irreversible. Charging such an over discharged REESS may lead to fire or explosion. The aim of the requested test is to verify the performance of the protection measures of the REESS against over-discharge during its operation. In the case of the installation of over-discharge protection measures (e.g. battery management system connected to contactors) in the REESS, the functionality of the protection measure has to be proven by interrupting or limiting the discharge current to a safe value. If no over-discharge protection measures have been installed, the REESS has to be discharged to 25 per cent of its nominal voltage level. The test end criteria has been given in the ISO-12405 "Electrically propelled road vehicles - Test specification for lithium-ion traction battery packs and systems" and the SAE J2929 "Electric and Hybrid Vehicle Propulsion Battery System Safety Standard".

I. Over-temperature: paragraph 6.9. and Annex 8I

54. 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 available.

55. The temperature of the REESS will be increased by charge-discharge operation (within normal mode of operation) with aid of the high temperature atmosphere and the functionality of the protection measures (e.g. inhibit/limit the charge-discharge, emergency cooling, etc.) will be confirmed.

56. In the case that no specific protection measures are necessary to prevent the REESS from reaching an unsafe state due to internal over-temperature, the charge-discharge shall be continued until the temperature of the REESS becomes stable.

F. Emissions: paragraph 6.10.

57. Electrochemical systems which electrolytes contain water (e.g. lead acid, nickel cadmium) might emit hydrogen during normal operation. Possible hydrogen emissions of such systems are considered under paragraph 6.10. and Annex 7.

58. Electrochemical systems containing non-aqueous electrolytes (e.g. lithium-ion chemistries, sodium nickel chloride) are not able to produce hydrogen during normal operation. In addition, cells of such systems are sealed and thus, gas tight by design to keep them non-aqueous. Gas exchange of such cells with the environment during normal use has not to be expected and thus, not considered in the regulation.