

§	UN R100 series 02	Outcome RESS-9	Comments
1.2	<p>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.</p> <p>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.</p>		
2.3	<p>"Cell" means a single encased electrochemical unit containing one positive and one negative electrode which exhibits a voltage differential across its two terminals."</p>		
2.6	<p>"C Rate" of "n C" is defined as the constant current of the Tested-Device, which takes 1/n hours to charge or discharge the Tested-Device between 0 per cent of the state of charge and 100 per cent of the state of charge."</p>		
2.15	<p>"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."</p>		
2.18	<p>"Fire" means the emission of flames from a Tested-Device. Sparks and arcing shall not be considered as flames.</p>		

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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" "		
2.24	"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."		
2.29	"Rechargeable energy storage system (REESS)" means the rechargeable energy storage system that provides electric energy for electrical propulsion. The REESS may include subsystem(s) together with the necessary ancillary systems for physical support, thermal management, electronic control and enclosures."		

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

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2.36	<p>"Type of REESS" means systems which do not differ significantly in such essential aspects as:</p> <ul style="list-style-type: none">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 ande) (e) the necessary ancillary devices for physical support, thermal management and electronic control."		

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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: <ul style="list-style-type: none"> (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.		

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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.		
	Annex 8 A		
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.	<p>During the test, there shall be no evidence of:</p> <ul style="list-style-type: none"> (a) electrolyte leakage, (b) rupture (applicable to high voltage REESS(s) only), (c) fire, (d) explosion. <p>Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the Tested-Device.</p>		
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.		
	Annex B		

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6.4.	Mechanical impact		
6.4.1.	<p>Mechanical Shock</p> <p>At the manufacturer’s choice the test may be performed as, either</p> <ul style="list-style-type: none"> (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.	<p>Vehicle based test</p> <p>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.</p>		

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6.4.1.2.	<p>Component based test The test shall be conducted in accordance with Annex 8C of this Regulation.</p>		
6.4.1.3.	<p>Acceptance criteria During the test there shall be no evidence of:</p> <ul style="list-style-type: none"> (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. 		

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	<p>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.</p>		

§	UN R100 series 02	Outcome RESS-9	Comments
	<p>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.</p>		
	<p>Annex C</p>		
6.4.2.	<p>Mechanical Integrity This test applies only to a REESS intended for installation in vehicles of category M1 and N1.</p> <p>At the manufacturer's choice, the test may be performed as, either</p> <ul style="list-style-type: none"> (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. 		

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6.4.2.1.	<p>Vehicle specific test</p> <p>At the manufacturer's choice, the test may be performed as either</p> <ul style="list-style-type: none"> (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. <p>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.</p> <p>The approval of a REESS tested under this Paragraph shall be limited to specific vehicle type.</p>		

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6.4.2.1.1.	<p>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.</p>		
6.4.2.1.2.	<p>Vehicle specific component test The test shall be conducted in accordance with Annex 8D of this Regulation.</p> <p>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.</p>		

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	<p>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.</p> <p>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.</p>		
6.4.2.2.	<p>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.</p>		

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	<p>The mounting restrictions shall be documented in Annex 6 - Part 2.</p> <p>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.</p>		

§	UN R100 series 02	Outcome RESS-9	Comments
	<p>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.</p>		
6.4.2.3.	<p>Acceptance criteria During the test there shall be no evidence of:</p> <ul style="list-style-type: none"> (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 		

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	<p>liters. (c2) Electrolyte leakage if tested according to paragraph 6.4.2.2.</p> <p>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.</p> <p>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.</p> <p>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.</p>		
	Annex D		

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6.5.	<p>Fire resistance</p> <p>This test is required for REESS containing flammable electrolyte.</p> <p>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.</p> <p>At the manufacturer's choice the test may be performed as, either</p> <ul style="list-style-type: none"> (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.	<p>Vehicle based test</p> <p>The test shall be conducted in accordance with Annex 8E paragraph 3.2.1. of this Regulation.</p> <p>The approval of a REESS tested according to this paragraph shall be limited to approvals for a specific vehicle type.</p>		

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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.		
	Annex E		
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.		
	Annex F		

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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.	<p>During the test there shall be no evidence of:</p> <ul style="list-style-type: none"> (a) electrolyte leakage, (b) rupture (applicable to high voltage REESS(s) only), (c) fire, (d) explosion. <p>Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the Tested-Device.</p>		
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.		
	Annex G		
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;		

§	UN R100 series 02	Outcome RESS-9	Comments
6.8.2.1.	<p>During the test there shall be no evidence of:</p> <ul style="list-style-type: none"> (a) electrolyte leakage, (b) rupture (applicable to high voltage REESS(s) only), (c) fire, (d) explosion. <p>Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the Tested-Device.</p>		
6.8.2.2.	<p>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.</p>		
	Annex H		
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;		

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6.9.2.1.	<p><i>Acceptance criteria;</i> 6.9.2.1. During the test there shall be no evidence of:</p> <ul style="list-style-type: none"> (a) electrolyte leakage, (b) rupture (applicable to high voltage REESS(s) only), (c) fire, (d) explosion. <p>Evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the Tested-Device.</p>		
6.9.2.2.	<p>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.</p>		
	Annex I		
6.10.	<p>Emission Possible emission of gases caused by the energy conversion process during normal use shall be considered.</p>		

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6.10.1.	<p>Open type traction batteries shall meet the requirements of paragraph 5.4. of this Regulation with regard to hydrogen emissions.</p> <p>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.</p> <p>Other technologies shall be evaluated by the manufacturer and the Technical Service regarding any possible emissions under normal operation.</p>		
6.10.2.	<p>Acceptance criteria</p> <p>For hydrogen emissions see paragraph 5.4. of this Regulation.</p> <p>For emission free systems with closed chemical process no verification is necessary."</p>		

"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

<i>Frequency (Hz)</i>	<i>Acceleration (m/s²)</i>
7 - 18	10
18 - 30	gradually reduced from 10 to 2
30 - 50	2

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

At the request of the manufacturer a vibration test profile determined by the vehicle-manufacturer, verified for the vehicle application and agreed with the Technical Service may be used as a substitute for the frequency - acceleration correlation of table 1.

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.

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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.

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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 $20 \pm 10^{\circ}\text{C}$,
- (b) at the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,
- (c) at the beginning of the test, all protection devices which effect the function of the Tested-Device and which are relevant to the outcome of the test, shall be operational.

3.2. Test Procedure

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

For each of the test pulses specified, a separate Tested-Device may be used.

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

Figure 1
Generic description of test pulses

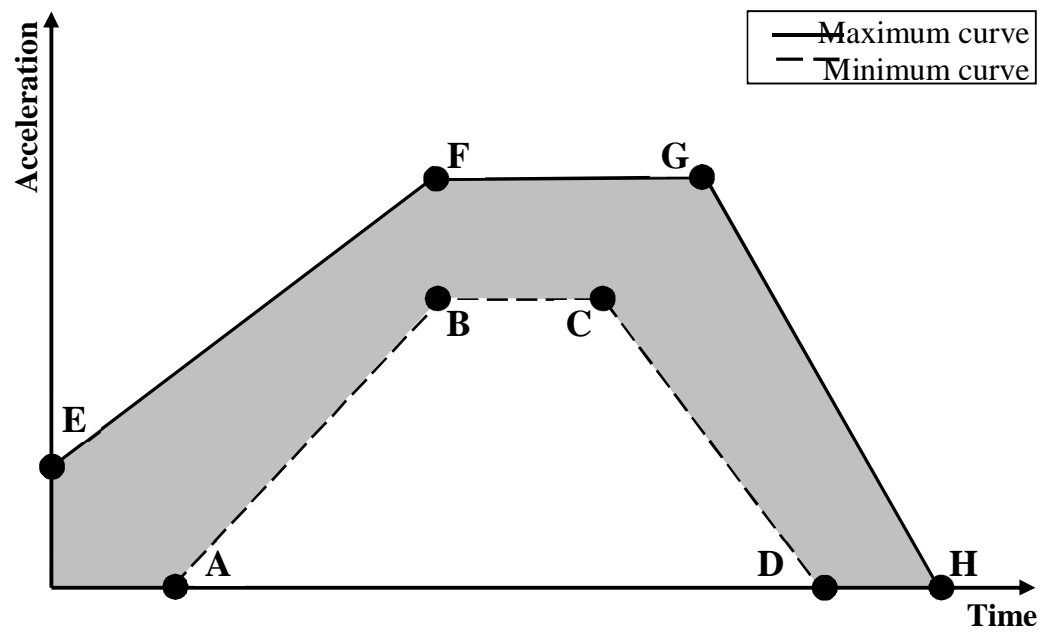


Table 1 for M₁ and N₁ vehicles:

<i>Point</i>	<i>Time (ms)</i>	<i>Acceleration (g)</i>	
		<i>Longitudinal</i>	<i>Transverse</i>
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:

<i>Point</i>	<i>Time (ms)</i>	<i>Acceleration (g)</i>	
		<i>Longitudinal</i>	<i>Transverse</i>
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 M₃ and N₃ vehicles:

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

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

Annex 8 D

Mechanical integrity

1. Purpose

The purpose of this test is to verify the safety performance of the REESS under contact loads which may occur during vehicle crash situation.

2. Installations

2.1. This test shall be conducted with either the complete REESS or with a related REESS subsystem(s) 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:

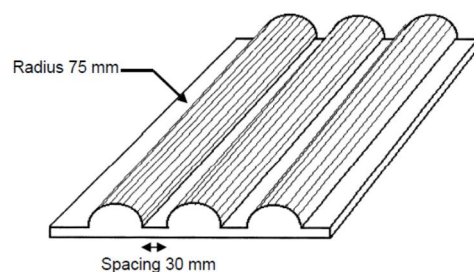
- (a) the test shall be conducted at an ambient temperature of 20 ± 10 °C,
- (b) at the beginning of the test, the SOC shall be adjusted to a value in the upper 50 per cent of the normal operating SOC range,

- (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.

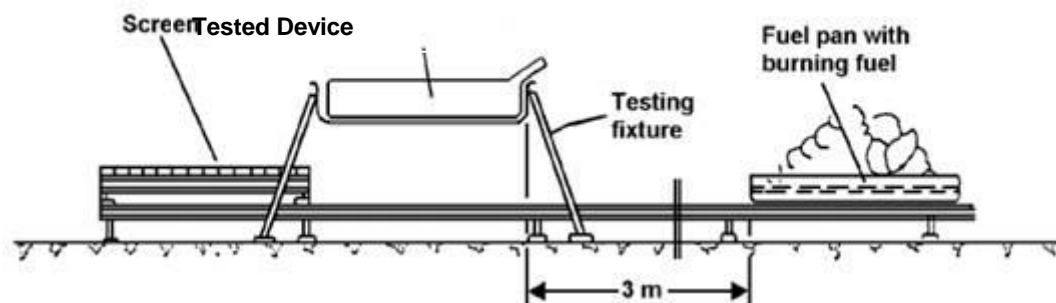
The fire shall cover the whole area of the pan during whole fire exposure. The pan dimensions shall be chosen so as to ensure that the sides of the Tested-Device are exposed to the flame. The pan shall therefore exceed the horizontal projection of the Tested-Device by at least 20 cm, but not

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)

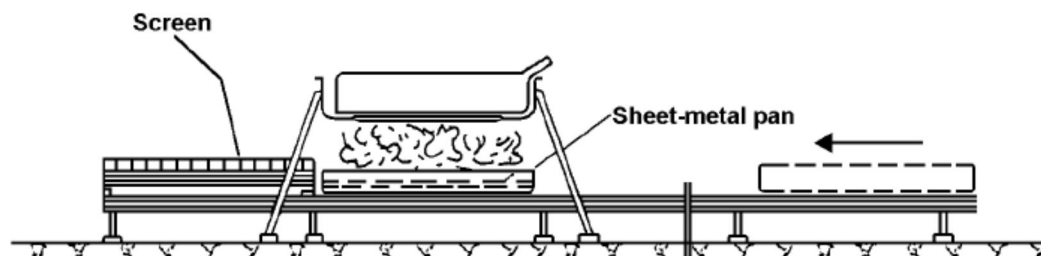
The fuel in the pan shall be ignited at a distance of at least 3 m from the Tested-Device. After 60 seconds pre-heating, the pan shall be placed under the Tested-Device. If the size of the pan is too large to be moved without risking liquid spills etc. then the Tested-Device and test rig can be moved 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



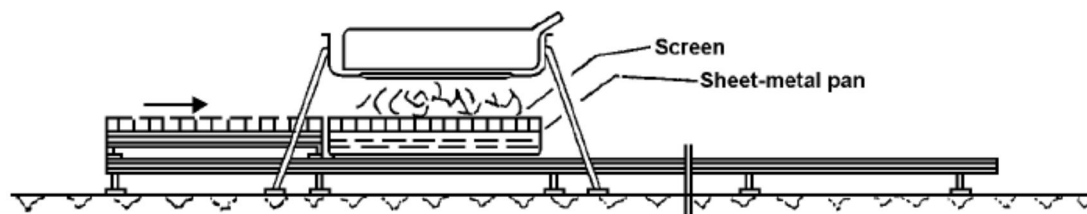
- 3.7.3. Phase C: Indirect exposure to flame (Figure 3)

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.

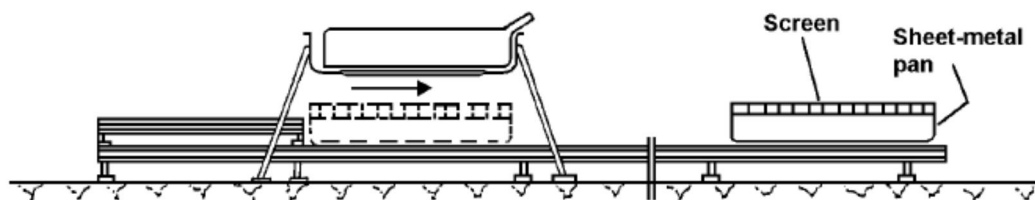
Figure 3
Phase C: Indirect exposure to flame



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

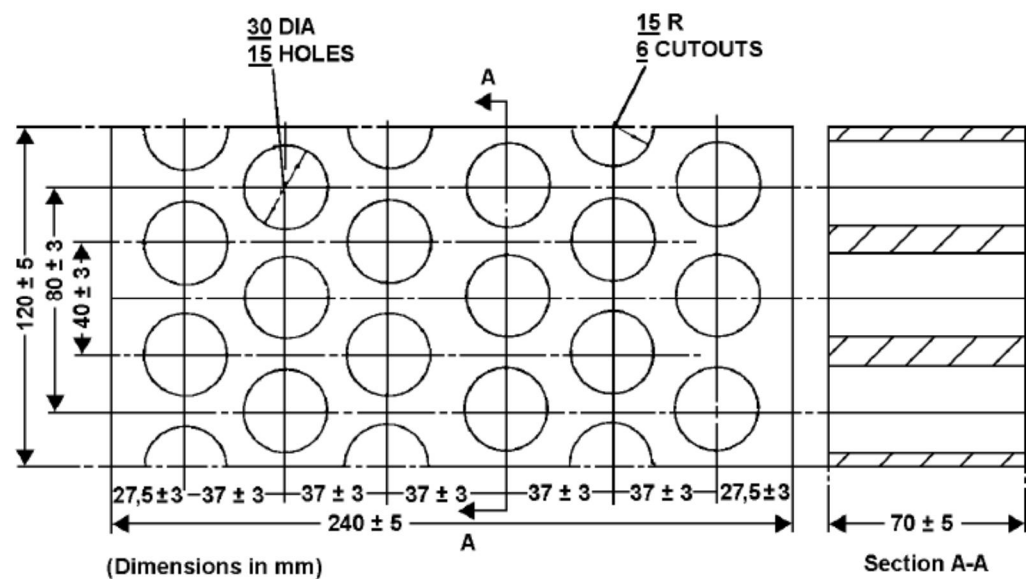
The burning pan covered with the screen shall be moved back to the position described in phase A. No extinguishing of the Tested-Device shall be done. After removal of the pan the Tested-Device shall be observed until such time as the surface temperature of the Tested-Device has decreased to ambient 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.