Proposal how to structure the RESS safety requirements

1. Scope

The following prescriptions apply to safety requirements with respect to the Rechargeable Energy Storage Systems [RESS] of road vehicles of categories M and N, equipped with one or more traction motor(s) operated by electric power and not permanently connected to the grid.

<JASIC Comment>
As suggested in RESS-2-3, the group should;
(1) at first, focus on Li-Ion rechargeable batteries to develop the technical requirement, and then
(2) examine applicability to other types of RESS considering the difference of the chemical characteristics.

2. DEFINITIONS

Color-code:

Red = RESS-3-7 Vibration_Draft_JP_Proposal
+ Further comment (in dotted box) / proposal (with yellow marker)
Green = Remarks or amendments by the secretary
Purple = Remarks from TÜV and BMW under § 3.7
Blue = Remarks from France

Remarks from Korea:
In some case of RESS, the tests proposed in the proposal may be hard to carry out due to the dimensions of a RESS.
If the RESS is installed in a regular bus, the RESS may be too big to handle in the test lab.

A new term represents the typical part of the RESS should be considered.

2.1 "Rechargeable energy storage system [RESS]" means the rechargeable energy storage system that provides electric energy for electric propulsion.~~[The [RESS] includes a completely functional energy storage system consisting of the [pack(s)] and necessary ancillary subsystems for physical support, thermal management, electronic control and enclosures.]~~

"Rechargeable energy storage system (RESS)" means a system providing rechargeable electric energy based on electro-chemical processes for vehicle propulsion.

The RESS includes cells, modules and/or packs. Furthermore, the necessary ancillary subsystems for physical support thermal management, electronic control and enclosures and enclosures are included in the RESS.

"RESS-Pack" means an energy storage device that includes cells or modules normally connected with cell electronics, voltage class B circuit and over-current shut-off device including electrical interconnections, interfaces for external systems(s(e.g. cooling, voltage class B, auxiliary voltage

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

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

2.3 "Lithium ion cell" means a rechargeable electrochemical cell whose electrical energy is derived from the insertion/extraction reactions of lithium ions between the anode and the cathode.

2.4 "Battery" or "Battery module" means two or more cells which are electrically connected together fitted with devices necessary for use, for example, case, terminals, marking and protective devices.

"RESS-Module" means an assembly of electrically connected cells with a mechanical supporting structure. In most cases, a serial electrical connection of cells will be applied. A module could contain further functionalities (or their parts) of the RESS as e.g. parts of the cooling system and/or first level cell electronics, but not the battery control unit. In a RESS, one or more modules could be used.

2.5 "Battery enclosure" means the physical housing surrounding ~~[RESS] components, particularly~~ cells or ~~[cell assemblies]~~ battery modules.

2.6 "Explosion" means very fast release of energy sufficient to cause pressure waves and/or projectiles that may cause considerable structural and/or bodily damage.

2.7 "Fire" means the emission of flames from a battery enclosure that may spread to the other part of the vehicle. Sparks are not flames.

[2.8 "Cell rupture" means the mechanical failure of a cell container induced by an internal or external cause, resulting in exposure or spillage but not ejection of solid materials.] **Remark:** not used for the moment in the text

[2.9 "Battery enclosure rupture" means openings through the battery enclosure which are created or enlarged by an event and which are sufficiently large for a 50 mm diameter sphere to contact battery system internal components (see ISO20653, IPXXA).]

2.10 "Working voltage" means the highest value of an electrical circuit voltage root mean square (rms), specified by the manufacturer or determined by measurement, which may occur between any conductive parts in open circuit conditions or under normal operating condition. If the electrical circuit is divided by galvanic isolation, the working voltage is defined for each divided circuit, respectively.

2.11 "High Voltage" means the classification of an electric component or circuit, if it's working voltage is > 60 V and ≤ 1500 V DC or > 30 V and ≤ 1000 V AC root mean square (rms).

"Hazardous Voltage" means the classification of an electric component or circuit, if it's working voltage is > 60 V ~~and ≤ 1500 V~~ DC or > 30 V ~~and ≤ 1000 V~~ AC root mean square (rms).

[2.12 Nominal voltage is the voltage given by the supplier as the recommended operating voltage of their battery system] **Remark:** not used for the moment in the text

~~2.13 "Module" means…….~~

2.14 "Undefined venting" means …. Undefined visible venting means

"Venting" means a condition when the cell electrolyte and/or battery solvent is emitted as vapor, smoke or aerosol from a designed vent or through a sealing edge on the cell.

2.15 ~~"Undefined venting"~~ "Undesired venting"means venting or vapors external to the RESS assembly except through designated ventilation systems or openings

2.16 "Closed chemical process" means

2.17 "SOC" means available capacity in a battery pack or system expressed as a percentage of rated capacity

2.18 "MOSOC" means Maximum Operating State of Charge (Reference: CSDS UL 2580-2011)

2.19 "SC" means standard cycle consisting of a standard charge and a standard discharge load based on the rated capacity of the RESS.

2.20 "Thermal equilibration" means to balance the temperature throughout the RESS as required before some tests

2.21 "Passive thermal equilibration" is achieved by allowing the RESS to adjust to ambient temperature during a time period of X hours.

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2.22 "Active thermal equilibration" is achieved by utilizing a thermal management system forcing the internal temperature of the DUT to the required testing temperature uniformly throughout the DUT

2.23 "DUT" means Device Under Test

2.24 "RT" means room temperature and is defined as 25 ± 5 °.

Proposal how to structure the RESS safety requirements

Technical Requirements
A) Priority Requirements

3.1 Vibration

3.1.1 Rationale

The purpose of this test is to verify the safety performance of the [RESS] (or a sub-assembly of [RESS]) under a vibration environment which the RESS will likely experience during the ~~lifetime~~ normal operation of the vehicle.

3.1.2 Requirement

3.1.2.1 Conditions

~~The following test can be conducted with the complete [RESS] or, at the discretion of the manufacturer, with the battery module(s) and related subsystems (module-based test).~~

This test shall ~~can~~ be carried out with a complete RESS or, at the discretion of the manufacturer, with Pack(s) of RESS.

~~If the manufacturer chose the module-based test with Pack(s), the manufacturer shall demonstrate such test result can reasonably represent the performance of the complete RESS with respect to the safety performance under similar condition.~~

For the purpose of this test, the devices of the [RESS] subject to the vibration test shall be referred to as DUT (Device Under Test). DUT shall be firmly secured to the platform of the vibration machine in such a manner as to faithfully transmit the vibration. If certain electronic management unit for [RESS] is not integrated, such control unit may not be installed on DUT.

3.1.2.2. Preconditioning of DUT

~~The state of charge (SOC) of DUT shall be at the maximum which is possible during normal vehicle operation. After the adjustment of SOC, the DUT shall be stored under the temperature of 25°C ± 5°C for more than 8 hours or until the temperature measured on DUT becomes stable within 25°C ± 5°C prior to initiation of the vibration.~~

Adjust the State of Charge (SOC) to a minimum 50 % before starting the vibration test profile.

~~Adjust the State of Charge (SOC) to a minimum 50 % before starting the vibration test profile.~~

The DUT should have an internal temperature of 25ºC ± 5ºC throughout the RESS prior to the initiation of the test.

3.1.2.3. Vibration

The vibration shall be a sinusoidal waveform with a logarithmic sweep between ~~7~~ 5 Hz and ~~200~~ 50 Hz and back to ~~7~~ 5 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the [~~cell~~ DUT].

~~One of the directions of vibration must be perpendicular to the terminal face.~~

~~The logarithmic frequency sweep shall differ for DUT with a gross mass of not more than 12 kg (small DUT), and for DUT with a gross mass of 12 kg and greater (large DUT).~~

~~For small DUT: from 7 Hz a peak acceleration of 1 g_n is maintained until 18 Hz is reached. The amplitude is then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 8 g_n occurs (approximately 50 Hz). A peak acceleration of 8 g_n is then maintained until the frequency is increased to 200 Hz.~~

~~For large DUT: from 7 Hz to a peak acceleration of 1 g_n is maintained until 18 Hz is reached. The amplitude is then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 2 g_n occurs (approximately 25 Hz). A peak acceleration of 2 g_n is then maintained until the frequency is increased to 200 Hz.~~

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

frequency [Hz]	acceleration [m/s^2]
5 - 18	10
18 - 30	5
30 – 50	2

Table1:

At the request of the manufacturer, a higher acceleration level as well as a higher maximum frequency can be conducted. In the case of a higher maximum frequency, the lowest frequency can be greater than 5 Hz, but shall not exceed 10% of the highest frequency.

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

~~**3.1.2.4. Records**~~
~~Open circuit voltage of DUT shall be measured prior to initiation of vibration and after the vibration test.~~

~~Isolation measurement shall be done in accordance with annex 1or according to 3.1.3 or equivalent prior to initiation of vibration and after the vibration test.~~

~~**3.1.2.4. Records**~~
Open circuit voltage of DUT shall be measured prior to initiation of vibration and after the vibration test.

Isolation measurement shall be done in accordance with annex 1 ~~ISO 6469-1:2009, Section 6.1.3;~~ or according to 3.1.3 or equivalent prior to initiation of vibration and after the vibration test

Direct after "Vibration" a standard cycle as described in Annex 3 has to be conducted if not inhibited by the [RESS].

3.1.2.5 Acceptance criteria

During the test, including [1] h after the test, the [DUT] shall exhibit no evidence of

a) venting
b) battery enclosure rupture
c) fire
d) explosion.
e) electrolyte leakage

If the RESS is dedicated to a vehicle where there is no galvanical connection in between DC and AC high voltage buses, the isolation resistance cannot be less than 100 Ω/Volt, otherwise it shall be 500 Ω/Volt.

~~A standard charging be performed, if not inhibited by the [RESS~~]

~~The charge and discharge function shall be functional.~~

~~During the test, the [RESS] (or the sub-assembly of RESS) shall exhibit no evidence of battery enclosure rupture, fire and explosion.~~

~~Post-test open circuit voltage shall be no less than 90% of the pre-test open circuit voltage.~~

3.1.3 Verification

The evidence of a) to e) of 3.1.2.2 ~~battery enclosure rupture, fire or explosion~~ shall be checked by visual inspection.

The isolation resistance shall be measured according to Annex 1 or equivalent..

Proposal how to structure the RESS safety requirements

3.2 Thermal Shock and Cycling

3.2.1 Rationale

Thermal shock cycling is performed to determine the resistance of the [RESS] to sudden changes in temperature. The [RESS] undergo a specified number of temperature cycles, which start at Room Temperature (RT) followed by high and low temperature cycling. It simulates a rapid environmental temperature change which a [battery system] will likely experience during its life.

3.2.2 Requirement

3.2.2.1 Conditions

The state of charge (SOC) of [RESS] shall be [at least 50 % or more] which is possible during normal vehicle operation.

[RESS] shall be stored for at least six hours at a test temperature equal to at a minimum of 70℃, followed by storage for at least s ix hours at a test temperature equal at to or less than - 38℃. The maximum time i nterval between test temperature extremes is 30 minutes. This procedure is to be repeated at least 5 times, after which the [RESS] shall be stored for 24 hours at ambient temperature (20 ± 5 ℃).

[Direct after "Thermal Shock and Cycling" a ~~standard charging~~ standard cycle as described in Annex 3 has to be conducted if not inhibited by the [RESS]].

[3.2.2.2 Acceptance criteria

During the test, including 1 h after the test, the [RESS battery system] shall exhibit no evidence of

a) venting
b) electrolyte leakage
c) battery enclosure rupture
d) fire
e) explosion.

If the RESS is dedicated to a vehicle where there is no galvanical connection in between DC and AC high voltage buses, the isolation resistance cannot be less than 100 Ω/Volt, otherwise it shall be 500 Ω/Volt.]

3.2.3 Verification

a) to d) of 3.2.2.2 shall be checked by visual inspection.

The isolation resistance shall be measured according to Annex 1

Proposal how to structure the RESS safety requirements

3.3 Mechanical impact

3.3.1 Mechanical Shock

3.3.1.1 Rationale

Simulates inertial loads which may occur during vehicle crash situation to [RESS].

3.3.1.2 Requirement

3.4.1.2.1 Conditions

For the longitudinal and lateral vehicle direction, one of the conditions described in 3.3.1.2.1.1 or 3.3.1.2.1.2 shall be applied.

The RESS shall be set at Maximum Operating State of Charge (MOSOC) as recommended by the manufacturer

3.3.1.2.1.1 Vehicle based test

[RESS] installed in a vehicle of category [M1, M2, N1 and N2] that undergoes a vehicle crash test according to ECE-R12 Annex 3 or ECE-R 94 Annex 3 shall meet the acceptance criteria under 3.3.1.2.2.
This test is equivalent to the test conditions described in table 5 in 3.3.1.2.1.2.

[RESS] installed in a vehicle of category [M1, M2, N1 and N2] that undergoes a vehicle crash test according to ECE-R95 Annex 4 shall meet the acceptance criteria under 3.3.1.2.2.
This test is equivalent to the test conditions described in table 6 in 3.3.1.2.1.2.

The approval of the [RESS] tested under this condition is limited to the installation in the specific vehicle type.

3.3.1.2.1.2 Component based test

~~Open circuit voltage of DUT shall be measured prior to initiation of impact test.~~

~~Isolation measurement shall be done in accordance with annex1 or equivalent prior to initiation of impact test.~~

[A complete [RESS] is to be tested for this condition. However, if conducting this test on a [RESS] is deemed inappropriate due to size or weight, this test may be conducted utilizing subsystem(s) including respective battery module(s), provided that all portions of the [battery module(s) of the RESS] are evaluated~~. If tests are performed on [subsystem basis], evidence shall be provided that the results are representative for [RESS].]~~

The [RESS] shall be at any state of charge, which allows the normal operation of the power train as recommended by the manufacturer.

The complete [RESS or ~~pack(s)~~ subsystem(s)] shall be applied to the shock levels described in Table 5 and 6 in both positive and negative directions.

Proposal how to structure the RESS safety requirements

For every of the 4 evaluation conditions, a separate [RESS or subsystem(s)] can be used. The [RESS or subsystem(s)] shall be connected to the test fixture only by the intended mounting methods.

In order to determine potential for fire hazard an evaluation for potential flammable concentrations of vapors shall be included by use of a minimum of two continuous spark sources located near anticipated sources of vapour such as vent opening or at the vent duct. The continuous spark sources are to provide at least two sparks per second with sufficient energy to ignite natural gas. (Reference to CSDS UL 2580-2011)

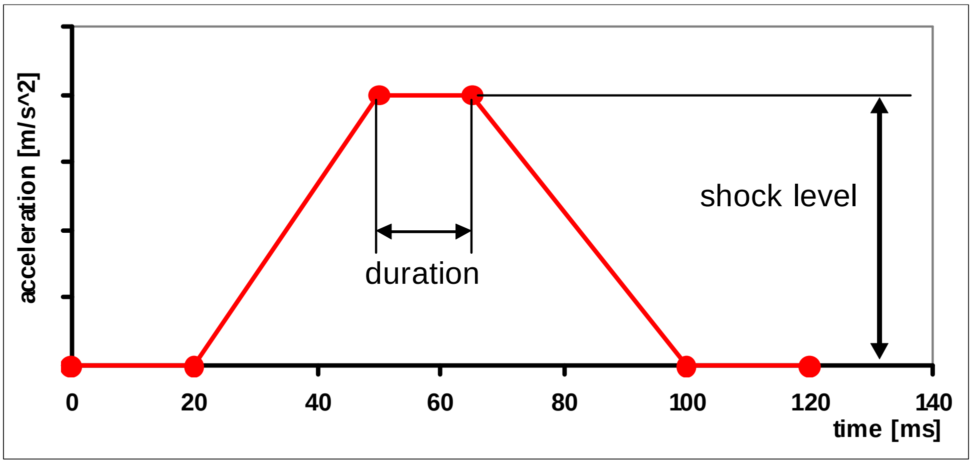
Table 5 – Shock levels in direction of travel

	Acceleration
[RESS] fitted vehicles of categories M1 and N1	20g
[RESS] fitted vehicles of categories M2 and N2	10g
[RESS] fitted vehicles of categories M3 and N3	6.6g

Table 6 – Shock levels horizontally perpendicular to the direction of travel

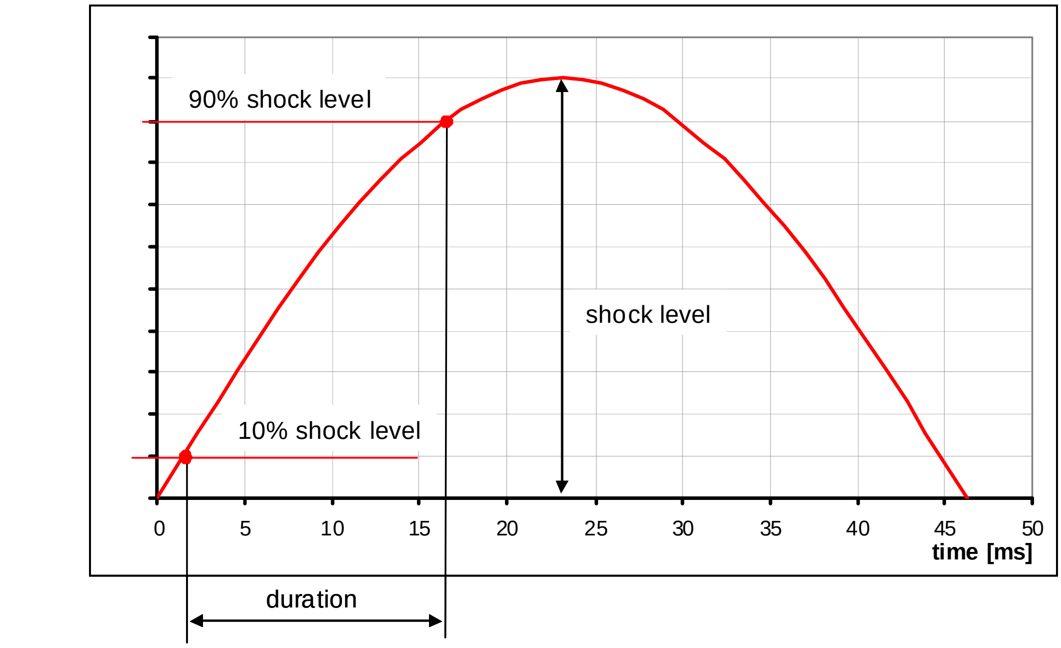
	Acceleration
[RESS] fitted vehicles of categories M1 and N1	8g
[RESS] fitted vehicles of categories M2 and N2	5g
[RESS] fitted vehicles of categories M3 and N3	5g

~~Diagram 1 – minimum shock pulse~~



Proposal how to structure the RESS safety requirements

~~Diagram 2 – sinus shock pulse~~



~~The test pulse shall describe a half sinus with duration of 15ms between 10% and 90% of the shock level.~~

The test pulse shall be within the minimum and maximum curve as described in diagram 1 to 6. a higher shock level and longer duration as described in the maximum curve in diagram 1 to 6 can be applied to RESS if recommended by the manufacturer.

Diagram 1
M1, N1 Shock levels and duration in direction of travel

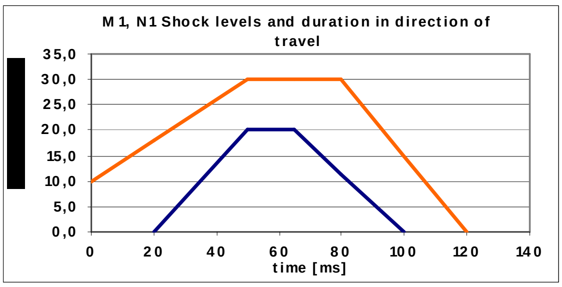


Diagram 2
M1, N1 Shock levels and duration in horizontally perpendicular to the direction of travel

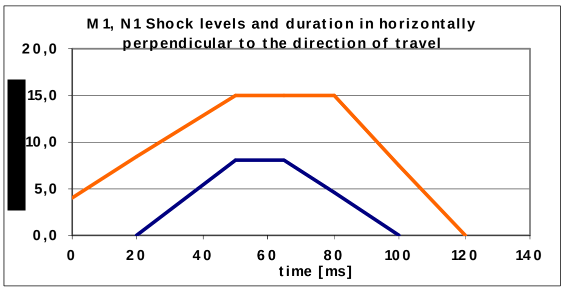


Diagram 3
M2, N2 Shock levels and duration in direction of travel

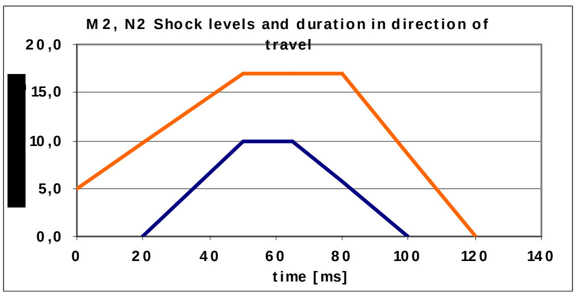


Diagram 4
M2, N2 Shock levels and duration in horizontally perpendicular to the direction of travel

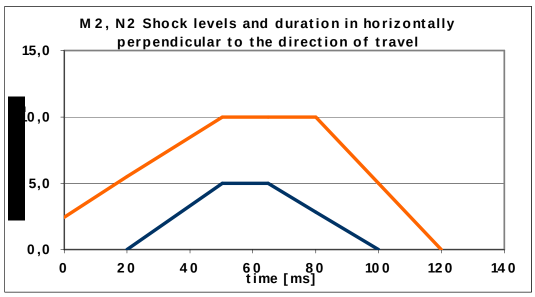
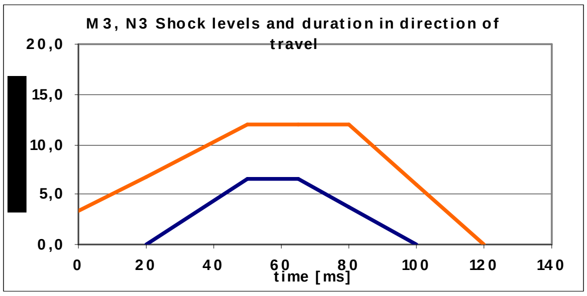


Diagram 5

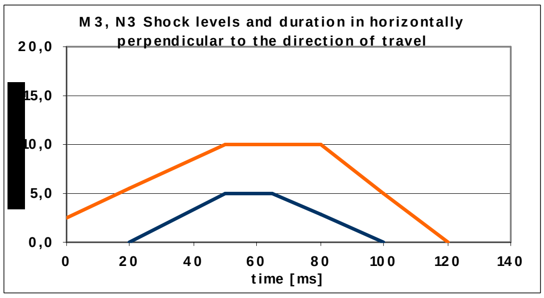
Diagram 6

Proposal how to structure the RESS safety requirements

M3, N3 Shock levels and duration in direction of travel



M3, N3 Shock levels and duration in horizontally perpendicular to the direction of travel



3.3.1.2.2 Acceptance criteria

During the test, including 1 h after the test, the [RESS or ~~pack(s)~~ subsystem(s)] shall exhibit no evidence of

a) fire
b) explosion.
c) electrolyte leakage to be less than 7% of the total electrolyte amount or less than 5 l whatever is smaller

After the vehicle based test (3.3.1.2.1.) the [RESS] located inside the passenger compartment shall remain in the location in which they are installed and [RESS] components shall remain inside [RESS] boundaries. No part of any [RESS] that is located outside the passenger compartment for electric safety assessment shall enter the passenger compartment during or after the impact test procedures.

After the component based test (3.3.1.2.2.) the [RESS or pack(s)] shall be retained at its mounting locations and components shall remain inside its boundaries.

~~If the RESS is dedicated to a vehicle where there is no galvanical connection in between DC and AC high voltage buses, the isolation resistance cannot be less than 100 Ω/Volt, otherwise it shall be 500 Ω/Volt.~~

3.3.1.3 Verification Method

The evidence of ~~fire, explosion electrolyte leakage~~ 3.3.1.2.2 shall be checked by visual inspection.

~~The isolation resistance shall be measured according to Annex 1.~~

Proposal how to structure the RESS safety requirements

3.3.2 Mechanical integrity

3.3.2.1 Rationale

Simulates contact loads which may occur during vehicle crash situation to [RESS].

3.3.2.2 Requirement

3.3.2.2.1 Conditions

The test applies only to [RESS] intended to be installed in vehicles of category M1 and N1.

~~The test applies only to [RESS] intended to be installed in vehicles of category M1 and N1~~

For the longitudinal and lateral vehicle direction, one of the conditions described in 3.3.2.2.1.1 or 3.3.2.2.1.2 shall be applied for vehicles of category M1 and N1.

The RESS shall be set at Maximum Operating State of Charge (MOSOC) as recommended by the manufacturer.

3.3.2.2.1.1 Vehicle based test

[RESS] installed in a vehicle that undergoes a vehicle crash test according to ECE-R12 Annex 3 or ECE-R 94 Annex 3 shall meet the acceptance criteria under 3.3.2.2.2.

[RESS] installed in a vehicle that undergoes a vehicle crash test according to ECE-R95 Annex 4 shall meet the acceptance criteria under 3.3.2.2.2.

The approval of the [RESS] tested under this condition is limited to the installation in the specific vehicle type.

3.3.2.2.1.2 Component based test

The [RESS] shall be at any state of charge, which allows the normal operation of the power train as recommended by the manufacturer.

Crush a [RESS or pack(s)] between a resistance and a crush plate described in figure 7 with a force of [100 kN] ~~[X seconds; how fast] during [Y seconds; how long]~~ at least 100 ms should be limited to a duration of [100] ms in direction of travel and horizontally perpendicular to the direction of travel of the [RESS].

[Optionally, this test can be conducted with the mechanical load according to ECE-R12 Annex 3 or ECE R94 Annex 3 in the direction of travel and with the mechanical load according to ECE R95 Annex 4 in the direction horizontally perpendicular to the direction of travel. The mechanical load shall be determined by the vehicle manufacturer using test or simulation data and agreed by the Technical Service.]

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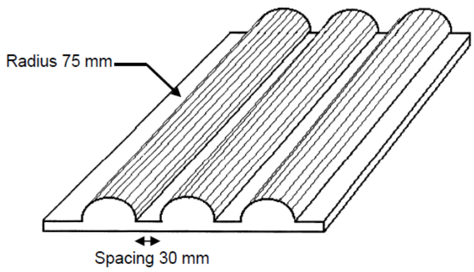
In order to determine potential for fire hazard an evaluation for potential flammable concentrations of vapors shall be included by use of a minimum of two continuous spark sources located near anticipated sources of vapour such as vent opening or at the vent duct. The continuous spark sources are to provide at least two sparks per second with sufficient energy to ignite natural gas. (Reference to UL 2580-2011)

The device under test may be installed in a protective framework representative of what is provided in the vehicle. (Reference to UL 2580-2011)

Figure 7:



[Dimension of the crush plate:	600 mm x 600 mm or smaller
Orientation of the crush plate:	The orientation shall be agreed by the manufacturer and the Technical Service.
Position of the crush plate:	The position shall be agreed by the manufacturer and the Technical Service.]

3.3.2.2.2 Acceptance criteria

During the test, including [1] h after the test, the [battery system] shall exhibit no evidence

a) fire
b) explosion
c) electrolyte leakage has to be less than 7% of the total electrolyte amount or less than 5 l whatever is smaller

If the RESS is dedicated to a vehicle where there is no galvanical connection in between DC and AC high voltage buses, the isolation resistance cannot be less than 100 Ω/Volt, otherwise it shall be 500 Ω/Volt.]

3.3.2.3 Verification

a) to d) of 3.3.1.2.2. shall be checked by visual inspection.

The isolation resistance shall be measured according to Annex 1.

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3.4 Fire Resistance

3.4.1 Rationale

Simulates exposure of [RESS] to fire from the 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 and no explosion should occur in a later stage.

3.4.2 Requirement

The test is required for [RESS] to be placed at a level less than 1.5 m above ground. The test is carried out on one item.

3.4.2.1 Conditions - vehicle based test

3.4.2.1.1. SOC

The [RESS] shall be at any state of charge, which allows the normal operation of the power train as recommended by the manufacturer.

3.4.2.1.2. The [RESS] shall be conditioned of period of not less than 8 h at a temperature of [20 ± 10 ~~5~~℃] before the test starts.

3.4.2.1.3. The [RESS] shall be installed in a testing fixture simulating actual mounting conditions as far as possible; no combustible material should be used for this except the material that is part of the [RESS]. The method whereby the [RESS] is fixed in the fixture shall correspond to the relevant specifications for its installation. In the case of [RESS] designed for a specific vehicle use, vehicle parts which affect the course of the fire in any way ~~shall~~ could be taken into consideration.

3.4.2.1.4. The flame to which the [RESS] is exposed shall be obtained by burning commercial fuel for positive-ignition engines (hereafter called "fuel") in a pan. The quantity of fuel poured into the pan shall be sufficient to permit the flame, under free-burning conditions, to burn for the whole test procedure, i.e. at least ~~25~~ 15 litres/m^2. The fuel temperature should be 20℃ ± 5℃

Water should be poured at the bottom of the pan to ensure a flat bottom of the pan. The water temperature should be 20℃ ± 5℃. The pan dimensions shall be chosen so as to ensure that the sides of the [RESS] are exposed to the flame. The pan shall therefore exceed the horizontal projection of the [RESS] 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.

In cases when the [RESS] is distributed over the vehicle it is possible to run the test on each subpart of the [RESS].

If it is not possible to arrange with a 20℃ ± 5℃ of the fuel and the water then the test needs to be conducted with a 1 minute pre-heating period.

3.4.2.1.5. The pan filled with fuel shall be placed under the [RESS] in such a way that the distance between the level of the fuel in the pan and the [RESS] bottom corresponds to the design height of the [RESS] above the road surface at the unladen (within +/- 1 cm of deviation) mass. Either the pan, or the testing fixture, or both, shall be freely movable.

3.4.2.1.6. During phase C of the test, the pan shall be covered by a screen placed 3 cm +/- 1 cm above the fuel level. The screen shall be made of a refractory material, as prescribed in [Annex 2]. 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 heated to 308 K +/- 5 K (35 degrees C +/- 5 degrees C). The firebricks may be wetted in order to guarantee the repeatable test conditions.

3.4.2.1.7. 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.

3.4.2.1.8. The test shall comprise of ~~four~~ three phases B-D. If it is not possible to arrange with a 20℃ ± 5℃ of the fuel and the water then the test shall comprise of four phases.

.

[3.4.2.1.8.1. Phase A: Pre-heating (Figure 1)
This phase is required if it is not possible to arrange with a 20℃ ± 5℃ of the fuel and the water. The fuel in the pan shall be ignited at a distance of at least 3 m from the [RESS] being tested. After 60 seconds pre-heating, the pan shall be placed under the [RESS]. If the size of the pan is too large to be moved without risking liquid spills etc. then the [RESS] and test rig can be moved instead of the pan.]

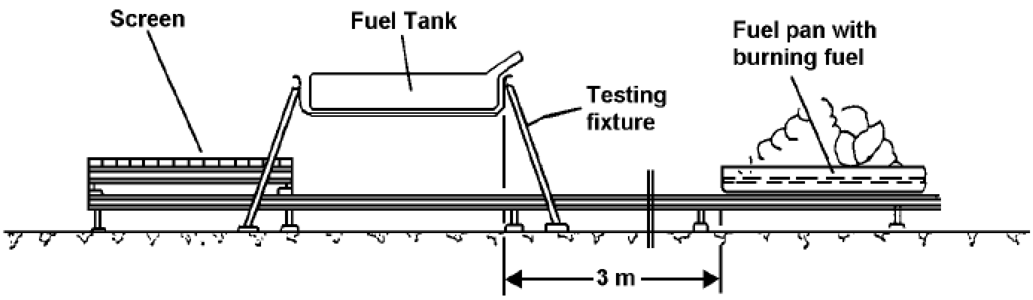


Figure 1

3.4.2.1.8.2. Phase B: Direct exposure to flame (Figure 2)
For ~~90~~ 70 seconds the [RESS] shall be exposed to the flame from the freely burning fuel.

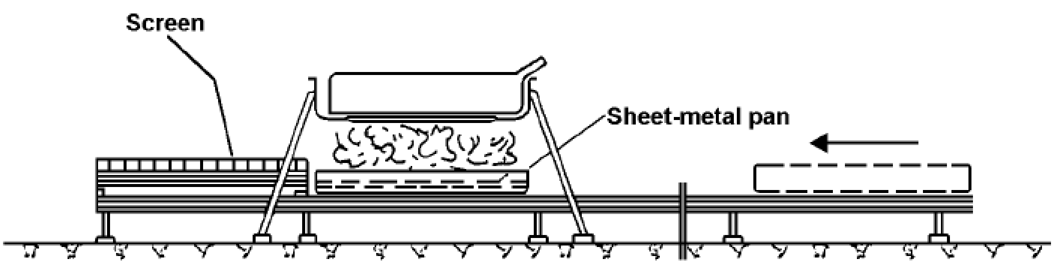


Figure 2

3.4.2.1.8.3. 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 [RESS]. The [RESS] shall be exposed to this reduced flame for a further [60] seconds.
Instead of conducting Phase C of the test, Phase B may be continued for additional [60] seconds at the manufacturer's discretion in those cases there is no reason to believe that this might pose a lower risk than the normal phase C.

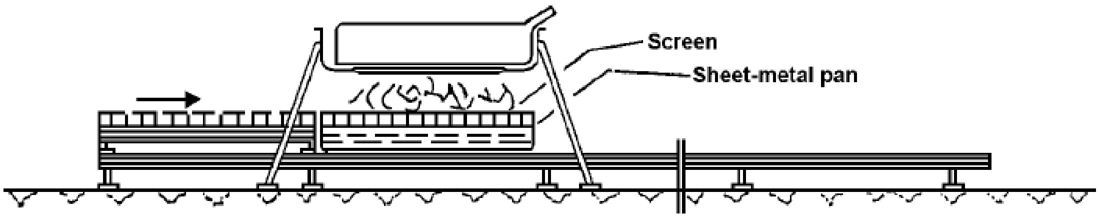


Figure 3

[3.4.2.1.8.4. Phase D: End of test (Figure 4)
The burning pan covered with the screen shall be moved back to its original position (phase A). No extinguishing of the [RESS] shall be done. The [RESS] ~~and its temperature~~ shall be monitored for ~~24~~ 3 h after the removal of the pan. During this time period the surface temperature has to be checked for [four times]. ~~The phase D can be stopped as soon as a decrease of the RESS temperature is observed~~**.]**

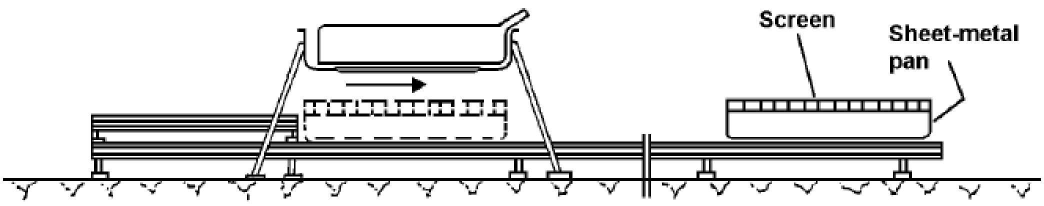


Figure 4

3.4.2.2 Conditions - component based test
A complete RESS is to be tested for this condition. However, if conducting this test on a RESS is deemed inappropriate due to size or weight; this test may be conducted utilizing subsystem(s) including respective battery module(s), provided that all portions of the battery module(s) of the RESS are evaluated. If tests are performed on subsystem basis, evidence shall be provided that the results are representative for RESS.

3.4.2.2.1. SOC
The [RESS] shall be at any state of charge, which allows the normal operation of the power train as recommended by the manufacturer.

3.4.2.2.2. The RESS shall be conditioned of period of not less than 6 h at a temperature of 20 ± 5 °C.

3.4.2.2.3. The RESS or module should be placed on a grating table positioned above the pan. 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.

3.4.2.2.4. The flame to which the RESS is exposed shall be obtained by burning commercial fuel for positive-ignition engines (hereafter called "fuel") in a pan. The quantity of fuel poured into the pan shall be sufficient to permit the flame, under free-burning conditions, to burn for the whole test procedure, i.e. at least 15 litres/m². The fuel temperature should be 20℃ ± 5 ℃.

Water should be poured at the bottom of the pan to ensure a flat bottom of the pan. The water temperature should be 20℃ ± 5℃.The pan dimensions shall be chosen so as to ensure that the sides of the RESS or module are exposed to the flame. The pan shall therefore exceed the horizontal projection of the RESS or module by at least 20 cm, but not more than 50 cm but for small RESS or module the minimum pan size shall be 50x50 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.

If it is not possible to arrange with a 20℃ ± 5℃ of the fuel and the water then the test needs to be conducted with a 1 minute pre-heating period.

3.4.2.2.5. The pan filled with fuel shall be placed under the RESS or module in such a way that the distance between the level of the fuel in the pan and the RESS bottom is 50 cm. Either the pan, or the testing fixture, or both, shall be freely movable.

3.4.2.2.6. During phase C of the test, the pan shall be covered by a screen placed 3 cm +/- 1 cm above the fuel level. The screen shall be made of a refractory material, as prescribed in [Annex 2]. 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 heated to 308 K +/- 5 K (35 degrees C +/- 5 degrees C). The firebricks may be wetted in order to guarantee the repeatable test conditions.

3.4.2.2.7. 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.

3.4.2.2.8. The test shall comprise of three phases. If it is not possible to arrange with a 20℃ ± 5℃ of the fuel and the water then th e test shall comprise of four phases.

3.4.2.2.8.1. Phase A: Pre-heating to ensure stable fuel temperature (Figure 5)
This phase is required if it is not possible to arrange with a 20℃ ± 5℃ of the fuel and the water. The fuel in the pan shall be ignited at a distance of at least 3 m from the RESS or module being tested. After 60 seconds pre-heating, the pan shall be

placed under the RESS or module. If the size of the pan is too large to be moved without risking liquid spills etc. then the RESS and test rig can be moved instead of the pan.

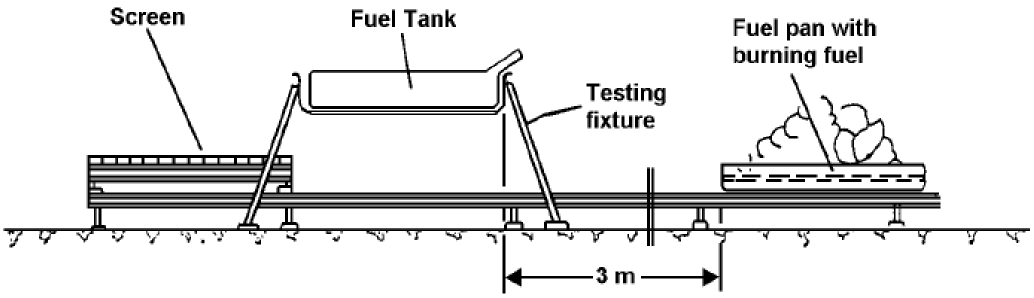


Figure 5

3.4.2.2.8.2. Phase B: Direct exposure to flame (Figure 6)
For 70 seconds the RESS or module shall be exposed to the flame from the freely burning fuel.

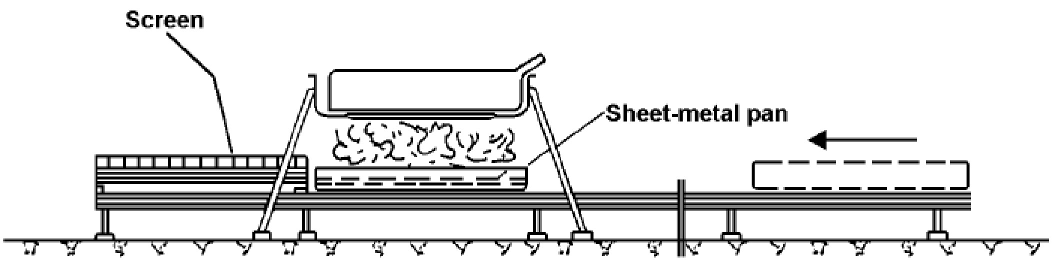


Figure 6

3.4.2.2.8.3. Phase C: Indirect exposure to flame (Figure 7)
As soon as phase B has been completed, the screen shall be placed between the burning pan and the RESS and mock-up. The RESS shall be exposed to this reduced flame for a further 60 seconds.

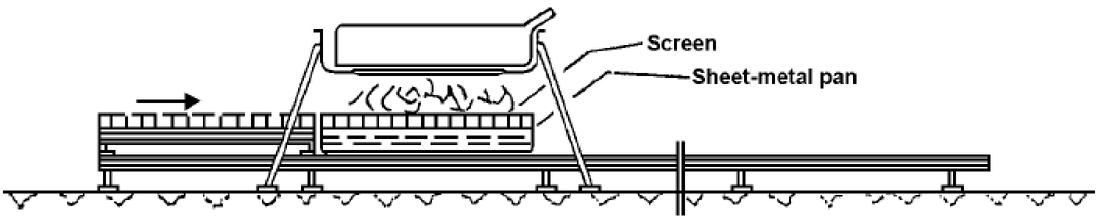


Figure 7

3.4.2.2.8.4. Phase D: End of test (Figure 8)
The burning pan covered with the screen shall be moved at least 3 m away from the RESS or module. No extinguishing of the RESS or module shall be done. The RESS or module shall be monitored for 24 h after the removal of the pan. At the manufacturers discretion temperature measurements might be installed in the

RESS or module and then phase D can be stopped as soon as a stable decrease of the RESS or module temperature is observed.

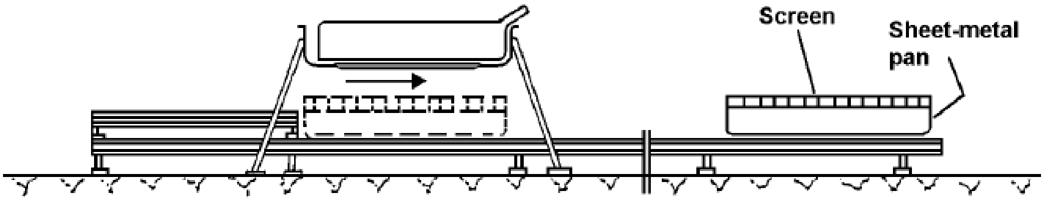


Figure 8

3.4.2.3 Acceptance criteria

During Phase A to D of the test, the [RESS] shall exhibit no evidence of explosion or rupture. Explosion is determined as no flying parts larger than 5 cm in size or sudden large increase of flames.

3.4.3 Verification

The explosion and rupture criterion is verified by visual inspection.

Voltage levels towards ground shall be continuously measured during phase A to D.

The pressure wave criteria needs to define a pressure limit and how to measure it

Proposal how to structure the RESS safety requirements

3.5 External Short Circuit Protection

3.5.1 Rationale

The purpose of the short circuit protection test it is to check the over-current protection function. This function shall interrupt the short circuit current in order to prevent the [RESS] from further related severe events caused by a short circuit current.

The purpose of the short circuit protection test it 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 [RESS] from any further related severe events caused by short circuit current.

3.5.2 Requirement

3.5.2.1 Conditions

The [RESS] shall be at MOSOC ~~any state of charge, which allows the normal operation of the power train~~ as recommended by the manufacturer.

A cooling system, if existing, which is part of the qualified safety concept according to [annex xyz] for short circuit protection shall be enabled, otherwise it shall be deactivated.

A battery management system, if existing, which is part of the qualified safety concept according to [annex xyz] for short circuit protection shall be enabled, otherwise it shall be deactivated.

All existing main contactors shall be closed.

The test shall be performed with all integrated passive protection devices operational.

The [RESS] to be tested shall be temperature stabilized at so that its external case temperature ~~reaches minimum [23 °C]~~ decline by 20% of the maximum temperature rise or 55 ℃

The [RESS] to be tested shall be temperature stabilized at maximum operating temperature alternatively 55 ℃ ~~so that its externa l case temperature reaches minimum [23 ℃]~~

and then the [RESS] shall be subjected to a short circuit condition with a total external resistance of less than 0.1 + 0/-0.04 ohm ~~at minimum [23℃].~~ The test equipment shall not limit the short circuit current during the test. This short circuit condition is continued for at least one hour after the [RESS] external case temperature has returned to initial temperature ~~minimum [23℃]~~ unless the operation of protection function to interrupt the short circuit current is confirmed. The [RESS] shall be observed for a further [six ours] for the test to be concluded.

Direct after "External Short Circuit" a ~~standard charging~~ standard cycle as described in Annex 3 has to be conducted if not inhibited by the [RESS].

3.5.2.2 Acceptance criteria

During the test, including [1] h after the test, the [battery system] shall exhibit no evidence

a~~) battery enclosure rupture (no degradation of protection degree)~~

b) fire

c) explosion

3.5.3 Verification

a) to c) of 3.5.2.2 shall be checked by visual inspection.

Proposal how to structure the RESS safety requirements

3.6 Overcharge Protection ~~(ISO 12405-1)~~

3.6.1 Rationale

The purpose of the overcharge protection is to verify the functionality of the overvoltage protection, i.e. that the RESS is protected against excessive voltage levels outside of the cell spec. to avoid severe events caused by an overcharging, for example it interrupts the current or voltage or limits it to an acceptable value.

The purpose of the over-charge protection test it is to ~~check~~ verify the ~~functionality~~ performance of the over-charge protection ~~function~~. This functionality ~~device~~, if ~~any~~ implemented, shall interrupt or limit the over-charge current ~~in order~~ to prevent the ~~Device under Test (DUT)~~ [RESS] from any further related severe events caused by over-charge current.

3.6.2 Requirement

3.6.2.1 Conditions

The following requirements can be conducted with the [RESS] [or with the battery module(s)] of the [RESS].
[If requirements are performed on [battery module basis], evidence shall be provided that the results are representative for [RESS].]

~~The [RESS] shall be at RT, with a SOC of at least [80] % and under normal operating conditions~~

A cooling system, if existing, which is part of the qualified safety concept according to [annex xyz] for over-charge protection shall be enabled, otherwise it shall be deactivated.

A battery management system, if existing, which is part of the qualified safety concept according to [annex xyz] for over-charge protection shall be enabled, otherwise it shall be deactivated.

All existing main contactors shall be closed.

~~[Main contactors are closed if any; battery system is controlled by the BCU]~~
~~If it includes safety features to prevent overcharging, if BCU has no safety features, the RESS or the battery module have to be safe “stand-alone”~~

The test shall be performed with all integrated passive protection devices operational.

~~Active~~ External charge control of the test equipment shall be ~~disconnected~~ disabled.

The normal charging of the application shall be described as multiple from 1C-Rate from cells. If cells with different C-Rates are used, the highest value shall be used.

The [RESS] shall be overcharged with at least two times C-Rate referring to normal charge mode of application which is agreed by manufacturer and Technical Service

Charging shall be continued

- until the [RESS] (automatically) interrupt the charging or
- ~~until the [RESS] is thermal stationary, which means the temperature change is lower than [2] K within [30] min~~
- whether SOC level is above 130% or DUT temperature levels are above 55 ℃.

Direct after "Overcharge Protection" a standard cycle as described in Annex 3 has to be conducted if not inhibited by the [RESS].

3.6.2.2 Acceptance criteria

During the test, including [1] h after the test, the battery system shall exhibit no evidence of

~~a) battery enclosure rupture (no degradation of protection degree)~~
b) fire
c) explosion.

~~If the RESS is dedicated to a vehicle where there is no galvanical connection in between DC and AC high voltage buses, the isolation resistance cannot be less than 100 Ω/Volt, otherwise it shall be 500 Ω/Volt.~~

~~Direct after Overcharge Protection a standard cycle as described in Annex 3 has to be conducted if not inhibited by the [RESS].~~

[[1] h after the test the [RESS] shall be re-used]

3.6.3 Verification

a) to c) of 3.6.2.2 shall be checked by visible inspection after test or

Review of safety concept according annex xyz or equal without test or

Analysis of measurement data and calculation or

Or any combination thereof.

The isolation resistance shall be measured according to Annex 1.

Proposal how to structure the RESS safety requirements

3.7 Over-discharge Protection

3.7.1 Rationale

The purpose of the over-discharge protection test it is to check the functionality of the over-discharge protection function. This functionality, if any, shall interrupt the over-discharge current in order to prevent the Device under Test (DUT) from any further related severe events caused by an over-discharge current.

The purpose of the short circuit protection test it is to verify the performance of the over-discharge protection. This functionality, if implemented, shall interrupt or limit the over-discharge current to prevent the [RESS] from any further related severe events caused by over-discharge current.

3.7.2 Requirement

3.7.2.1 Conditions

~~For [RESS] which do not need an over-discharge protection the manufacturer shall demonstrate to provide evidence to the Technical Service which shows that any over-discharge and standard charge afterwards does not lead to any situation described in the acceptance criteria.*~~

*There are possible RESS designs which have no problems with over-discharge because ....

For [RESS] which need an over-discharge protection the following test shall be conducted with the [RESS] [or with [module(s)] of the RESS].
[If tests are performed on [module basis], evidence shall be provided that the results are representative for [RESS].]

A cooling system, if existing, which is part of the qualified safety concept according to [annex xyz] for short circuit protection shall be enabled, otherwise it shall be deactivated.

A battery management system, if existing, which is part of the qualified safety concept according to [annex xyz] for over-discharge protection shall be enabled, otherwise it shall be deactivated.

All existing main contactors shall be closed.

The test shall be performed with all integrated passive protection devices operational.

The [RESS] shall be at room temperature (RT), charged as under normal operating conditions with the cooling system operating (main contactors are closed if any, battery system are controlled by the [battery control unit (BCU)].

~~The test shall be performed with integrated passive circuit protection devices operational.~~

The test equipment shall not prevent the over-discharge of the DUT.

Proposal how to structure the RESS safety requirements

Perform a standard discharge. When reaching the normal discharge limits, discharging with 1C rate shall be continued.
Discharging shall be continued until

- the [RESS] interrupt the discharging automatically or
- if 25% of the nominal voltage level or a time limit of 30 min after passing the normal discharge limits of the DUT have been achieved.

~~Direct after the over-discharging a standard charging cycle has to be conducted if not inhibited by the [RESS].~~

3.7.2.2 Acceptance criteria

During the test, including [1] h after the test, the [battery system] shall exhibit no evidence of

~~a) battery enclosure rupture (no degradation of protection degree)~~
b) fire
c) explosion.

~~For [RESS] using high voltage the isolation resistance measured at the end of the test shall maintain high voltage to ground isolation not less than 100 Ω/Volt when the RESS is dedicated to a vehicle where the RESS is not galavanical connected to an AC system. Otherwise the high voltage to ground isolation has to be not less than 500 Ω/Volt.~~

~~However, if all AC high voltage buses are protected by one of the 2 following measures, isolation resistance between the high voltage bus and the electrical chassis shall have a minimum value of 100 Ω/V of the working voltage:~~
~~(a) Double or more layers of solid insulators, barriers or enclosures that meet the requirement in paragraph [5.1.1. of ECE R100.0]1 independently, for example wiring harness;~~
~~(b) Mechanically robust protections that have sufficient durability over vehicle service life such as motor housings, electronic converter cases or connectors;~~

3.7.3 Verification

[a) to d) of 3.8.2.2 shall be checked by visual inspection.]

The isolation resistance shall be measured according to Annex 1.

Proposal how to structure the RESS safety requirements

3.8 Over-temperature Protection

3.8.1 Rationale

Verify the functionality of the over-temperature protection, if any necessary for safety reasons that prevents the operation at over-temperatures inside the [RESS]. This test should simulate the lost of thermal control.

3.8.2 Requirement

When the maximum working temperature of the [RESS], specified by the manufacturer, is exceeded, the battery cannot be operated at the latest [5 min] after this temperature is reached.

3.8.2.1 Conditions

The [RESS] shall be at MOSOC ~~any state of charge~~, which allows the normal operation of the power train as recommended by the manufacturer.
The [RESS] shall be placed in a convective oven or climatic chamber (hereby called over-temperature room). The over-temperature room temperature shall be increased at a rate of de 5 °C/min ± 2 °C/min until it reaches the maximum working temperature of the [RESS] by 10 k. ~~specified by the manufacturer + 20°C~~. The [RESS] temperature shall be monitored by the measurement devices which are integrated inside the [RESS] by the manufacturer.

Cooling system, if any, shall be deactivated if the [RESS] is able to operate under this condition. In the other cases, the manufacturer shall demonstrate by test that the operation of the [RESS] stops when deactivating its cooling system. Then the [RESS] doesn't have to fulfill over-temperature test requirements, but the manufacturer shall provide the technical service with the relevant information showing that the cooling system is well-dimensioned and fits with the [RESS]' thermal exchanges.

The manufacturer shall provide the technical service with the relevant technical information dossier of the temperature measurement device.

The RESS shall be continuously charged and discharged between the maximum and minimum voltage at a C/5 current.

The test shall be interrupted when the requirement is satisfied or when the [RESS] reaches or exceeds the maximum working temperature specified by the manufacturer for more than ~~5 min~~ 4 hr without satisfying the requirement.

Direct after "Over-temperature Protection" the a standard cycle as described in Annex 3 has to be conducted if not inhibited by the [RESS].

3.8.2.2 Acceptance criteria

The [RESS] complies with the requirement when operation of the RESS stops.

a) battery enclosure rupture (no degradation of protection degree)
b) fire
c) explosion.

3.8.3 Verification

[The internal temperature and the signal related to the opening of the high voltage buses of the [RESS] are monitored. In order to verify the functionality of the components, the [RESS] shall rest until it reaches the ambient temperature (25℃ ± 5℃). A charge/discharge cycle shall be applied to the [RESS]. The charge and discharge shall be functional.

Proposal how to structure the RESS safety requirements

3.9 [Protection against direct contact (related to R100)

3.9.1 Rationale

Verify the functionality that protects persons to come in contact with high voltage live parts (only for [RESS] above 60 VDC). This requirement has to be proved under ECE R100.]

Proposal how to structure the RESS safety requirements

3.10 Emission

3.10.1 Rationale

Possible emission of gases caused by the energy conversion process during normal use shall be considered.

3.10.2 Requirement

[Open type traction batteries shall meet the requirements of ECE R100 according to hydrogen emissions.]
Systems with a closed chemical process are considered as emission-free under normal operation (e.g. Li-ion).

Other technologies shall be evaluated by the manufacturer and the Technical Service according possible emissions under normal operation.

3.10.2.1 Conditions

3.10.2.2 Acceptance criteria

For hydrogen emissions see ECE R100.

Systems with closed chemical process are emission-free and no verification is necessary.

3.10.3 Verification

For hydrogen emissions see ECE R100.

The closed chemical process has to be described by the manufacturer.

ANNEX 1: MEASUREMENT OF ISOLATION RESISTANCE

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.

The range of the electrical circuit to be measured shall be clarified in advance, using electrical circuit diagrams, etc.

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 on-board isolation resistance monitoring system, etc., necessary modification for conducting the measurement may be carried out, such as stopping of 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 electrical chassis.

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 DC voltage from off-vehicle sources

1.1.1. Measurement instrument

An isolation resistance test instrument capable of applying a DC voltage higher than the working voltage of the high voltage bus shall be used.

1.1.2. Measurement method

An insulator resistance test instrument shall be connected between the live parts and the electrical chassis. Then, the isolation resistance shall be measured by applying a DC voltage at least half of the working voltage of the high voltage bus.

If the system has several voltage ranges (e.g. because of boost converter) in 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 electrical chassis can be measured separately by applying at least half of their own working voltage with those component disconnected.

Proposal how to structure the RESS safety requirements

1.2. Measurement method using the vehicle's own [RESS] as DC voltage source

1.2.1. Test vehicle conditions

The high voltage-bus shall be energized by the vehicle's own [RESS] and/or energy conversion system and the voltage level of the [RESS] and/or energy conversion system throughout the test shall be at least the nominal operating voltage as specified by the vehicle manufacturer.

1.2.2. Measurement instrument

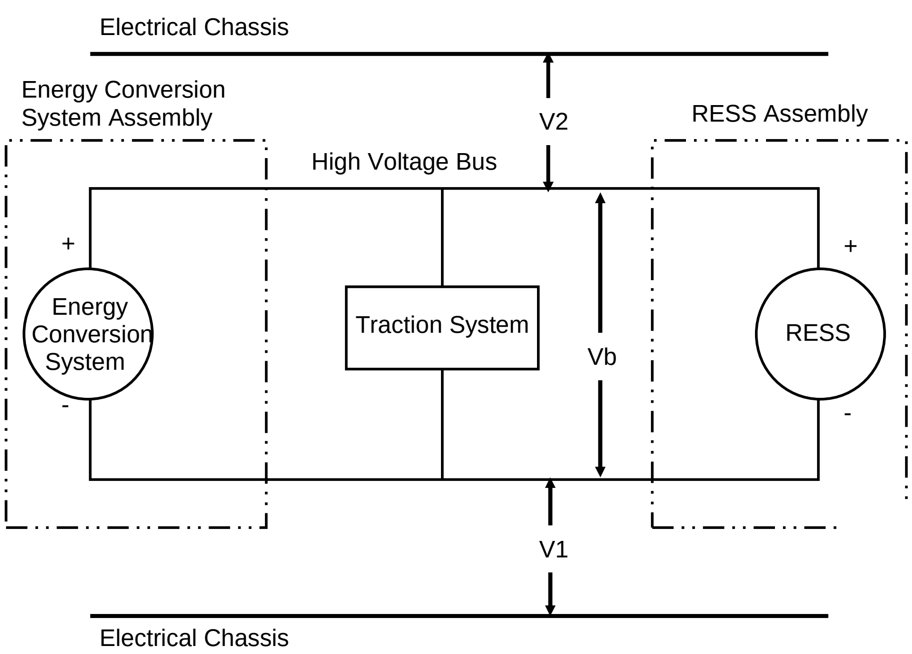
The voltmeter used in this test shall measure DC values and shall have an internal resistance of at least 10 MΩ.

1.2.3. Measurement method

1.2.3.1. First step

The voltage is measured as shown in Figure 1 and the high voltage Bus voltage (Vb) is recorded. Vb shall be equal to or greater than the nominal operating voltage of the [RESS] and/or energy conversion system as specified by the vehicle manufacturer.

Figure 1 **-** Measurement of Vb, V1, V2



1.2.3.2. Second step

Measure and record the voltage (V1) between the negative side of the high voltage bus and the electrical chassis (see Figure 1).

1.2.3.3. Third step

Measure and record the voltage (V2) between the positive side of the high voltage bus and the electrical chassis (see Figure 1).

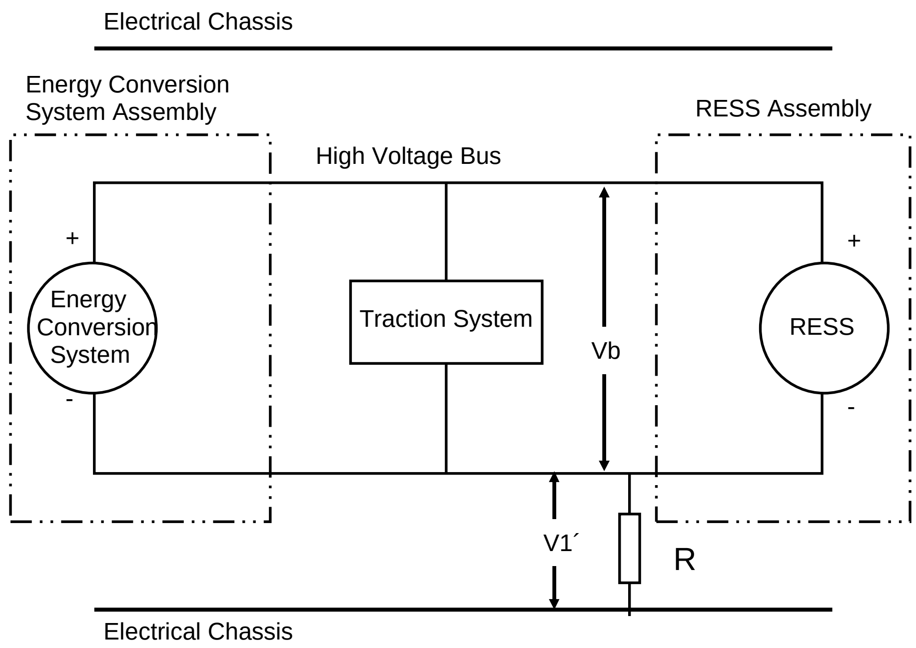
1.2.3.4. Fourth step

If V1 is greater than or equal to V2, insert a standard known resistance (Ro) between the negative side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V1') between the negative side of the high voltage bus and the electrical chassis (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 - Measurement of V1'

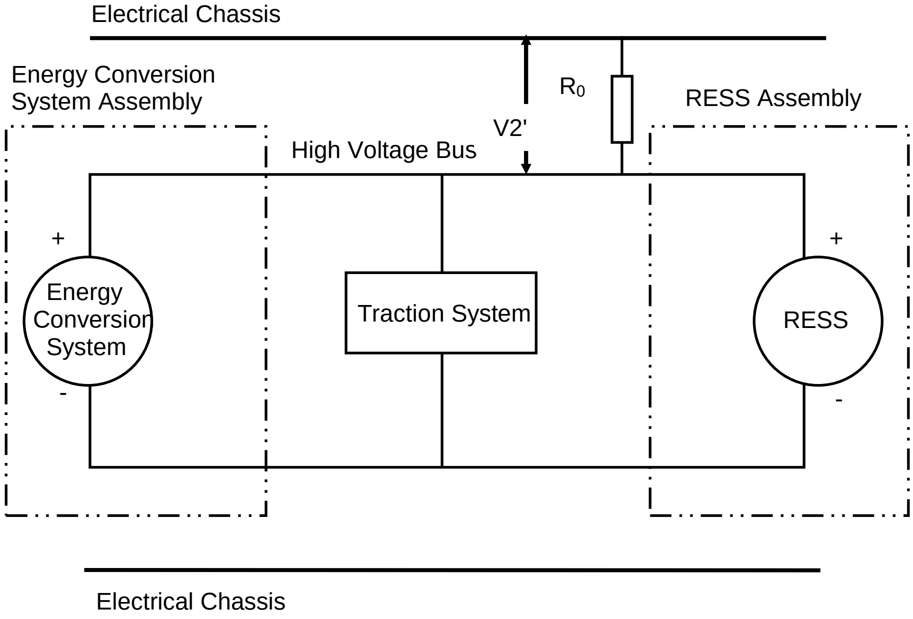


If V2 is greater than V1, insert a standard known resistance (Ro) between the positive side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V2') between the positive side of the high voltage bus and the electrical chassis. (See Figure 3). Calculate the electrical isolation (Ri) according to the formula shown. Divide this electrical isolation value (in Ω) by the nominal operating voltage of the high voltage bus (in volts).

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 - Measurement of V2'

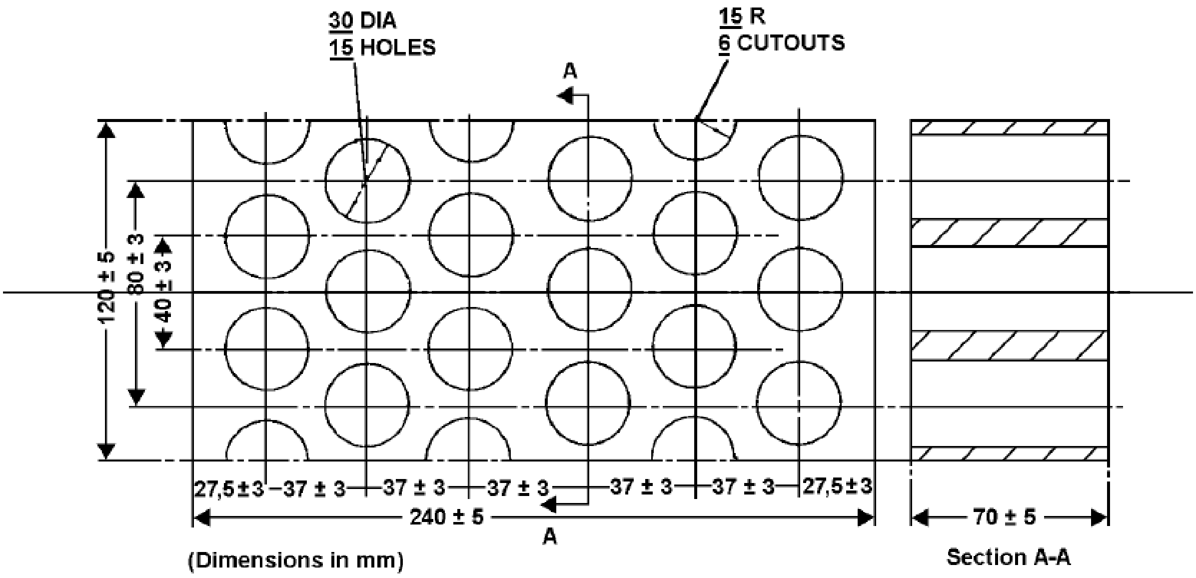


1.2.3.5. Fifth step

The electrical isolation value Ri (in Ω) divided by the working voltage of the high voltage bus (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 working voltage of the vehicle 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 2: DIMENSIONS AND TECHNICAL DATA OF FIREBRICKS



Fire resistance	(Seger-Kegel) SK 30
Al_2O_3 content	30 - 33 per cent
Open porosity (P_o)	20 - 22 per cent vol.
Density	1,900 - 2,000 kg/m^3
Effective holed area	44.18 per cent

Proposal how to structure the RESS safety requirements

ANNEX 3: REQUIREMENTS FOR A STANDARD CYCLE

Conditions
The standard cycle is performed at RT (25 ± 5 °C). If needed, the DUT shall be acclimatized at the test temperature prior to performing the SC.

Standard discharge (SDCH):
Discharge rate: 1C
Discharge limit (end voltage): specified by battery manufacturer
Rest period after discharge: 30 min or thermal equilibrium at test temperature

Standard charge (SCH):
Charge procedure including termination criteria as defined by battery manufacturer. If not specified, charge with C/3 current.
Rest after charge: 1 h or thermal equilibrium at test temperature

Note: C rate is the marked capacity rating of the cell/battery.
*n*C is the current rate equal to *n* times the 1 h discharge capacity expressed in Amperes.

Proposal how to structure the RESS safety requirements

B) ADDITIONAL REQUIREMENTS?

Color-code:

Red = RESS-3-7 Vibration_Draft_JP_Proposal
+ Further comment (in dotted box) / proposal (with yellow marker)
Green = Remarks or amendments by the secretary
Purple = Remarks from TÜV and BMW under § 3.7
Blue = Remarks from France

IMMERSION TEST (RESS COMPLETE UNDER WATER)
Rationale for the necessity maybe by NL.
Flooded roads are common in other areas also. A test is specified in SAE J2464.

REMARK: Immersion will not cause any safety critical phenomena for RESS.

Remark from Korea:
§ Additional Requirement: Immersion Test

In the past decade, we witnessed many floods around the world. The **Hurricane Katrina** in 2005 has left huge flood damage to the southern part of USA. The Queensland in Australia also was flooded as recently as January this year. The centre of Seoul, Korea, was flooded to the waist deep in Sep, 2010.

An immersion test should be included. The sea water, as fluid, may be appropriate. The electrical safety as well as chemical safety (for example, toxicity) should be secured.

<JASIC Comment>
Immersion will not cause any safety critical phenomena for RESS and therefore no need to make this requirement in this regulation.

[DUST]

MARKING
ISO 6469-3 and R100

EMC
R10

Tell-tale

<JASIC Comment>
General requirement in case of single failure to the system component, such as safe-mode operation, indication to the customer, tell-tale, etc., should be examined.

[Storage of RESS at low and high temperature]