

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,

Comment [T1]:
Comment (Sweden)
regarding scope and purpose of this requirements document

This document targets electrified vehicles ranging from mild HEVs to full EVs of different types and sizes, equipped with a broad range of RESS solutions in terms of chemistries, sizes and electrical specifications. Hence, there is not one, but many "normal operating conditions" and user patterns to consider and it is a challenge to cover all possibilities. One way of addressing the breadth of RESS solutions and operating conditions in order to ensure that the testing performed is relevant and meaningful is to make it the responsibility of the OEM to demonstrate that the RESS is safe and will be able to withstand the environment that the RESS will be exposed to during the life time of the vehicle it is mounted on. If the manufacturer can show documented proof that the safety requirements are fulfilled, including risk analysis (e.g FMEA or equivalent), test methodology, evaluation and acceptance criteria that are based on realistic operating and abuse situations for the vehicle type then those tests should be admissible for approval.

Comment [T2]:
<JASIC Comment>

The second sentence should be deleted or modified to avoid misinterpretation. Necessity and status of such subsystems shall be adequately prescribed for each test procedure. If the use of a subsystem is a condition to satisfy the requirement, such subsystem should be considered as a part of RESS to be approved.

If any additional description is considered as necessary, the following sentence is suggested:
"The RESS may consist of the battery module(s) or any other means to store electric energy and necessary ancillary subsystems for physical support, thermal management, electronic control as well as their enclosure."

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- 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
- Comment [T3]:**
Outcome of the 3. RESS Meeting
- Comment [T4]:**
Outcome of the 3. RESS Meeting
- Comment [T5]:**
<JASIC Comment>
"Battery module" can be defined here. It is better to use "battery module" rather than "module".
- Comment [T6]:**
Outcome of the 3. RESS Meeting
- Comment [T7]:**
Proposal JASIC

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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).~~

Comment [T8]:
Proposal Sweden

[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.....~~

Comment [T9]:
<JASIC Comment>
The definition of module is included into paragraph 2.4.

2.14 "Undefined venting" means Undefined visible venting means

Comment [T10]:
<JASIC Comment>
This definition is unnecessary as it is not appropriate to adopt as the criteria for this regulation.

"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.

Comment [T11]:
Proposal Sweden

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

Comment [T12]:
Proposal Sweden

2.16 "Closed chemical process" means

Comment [T13]:
<JASIC Comment>
Need to consider whether this definition is necessary or not.

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 °C

Comment [T14]:
Proposal Sweden

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A) **Technical Requirements**
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 25°C ± 5°C 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].

Comment [T15]:
Comment Sweden
It is recommended that testing starts with Standard Cycle as defined in Annex in order to verify DUT functionality.

Comment (Sweden) regarding test temperature and importance of temperature equilibration
The temperature of the DUT and the ambient are fundamental test parameters that define the test conditions and that may affect test results. It is important to allow sufficient time for temperature equilibration for reasons of reproducibility and repeatability.

Standard passive equilibration time is 12 h (ISO 12405 and UN38.3). When copying tests from existing or emerging battery industry standards, we suggest that the test methodology allows for harmonization with the source standard in order to minimize risk of repeated testing.

Comment [TG16]:
Proposal from Germany

Comment [TG17]:
Proposal from Germany

Comment [TG18]:
Comment from Korea

Comment [TG19]:
Proposal from Germany

Comment [TG20]:
Proposal from Germany

Comment [TG21]:
Comment from Korea
If test unit(module or RESS) is selective, ambiguous mention would be better to delete.

Comment [TG22]:
Proposal from Germany

Comment [T23]:
Proposal Sweden

Comment [T24]:
Comment (Sweden) regarding mode of vibration

We agree with the comment from France that the vibration mode in ISO 16750-3(IEC 68-2-4) is more representative of vehicle condition than UN38.3.

If the manufacturer can s... [1]

Comment [TG25]:
Proposal from Germany

Comment [TG26]:
Proposal from Germany

Comment [TG27]:
Proposal from Germany

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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_r 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_r occurs (approximately 50 Hz). A peak acceleration of 8 g_r is then maintained until the frequency is increased to 200 Hz.

For large DUT: from 7 Hz to a peak acceleration of 1 g_r 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_r occurs (approximately 25 Hz). A peak acceleration of 2 g_r is then maintained until the frequency is increased to 200 Hz.

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

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

Table 1:

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.

Comment [TG28]:
Proposal from Germany

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 or according to 3.1.3 or equivalent prior to initiation of vibration and after the vibration test.

Comment [TG29]:
Proposal from Germany

3.1.2.4. Records

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

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Isolation measurement shall be done in accordance with annex 1 ISO 6469-1:2009, Section 6.4.3; 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..

Comment [T30]:
Proposal from Sweden

Comment [T31]:
Comment Sweden
A standard charge/discharge cycle is performed in order to verify the functionality of the RESS after reliability/safety test.

When test prescribes OCV and isolation resistance measurements, these shall be performed prior to SC.

Comment Secretary
It has to be checked how such a requirement fits into the R 38.3 procedure.

Comment [TG32]:
Comment Continental
The acceptance criteria shall be kept because they are good guidance for the document user.

Comment [TG33]:
Comment from Korea
Because R100 is based on vehicle level, it is not an appropriate measurement procedure for [RESS] and module.

Comment [T34]:
Comment Sweden
If acceptance criteria in this document are to be based on performance of standard cycle after test, then the "standard cycle" must be defined. Since the purpose of the standard cycle is to verify that the RESS can does not exhibit dangerous behavior after being exposed to abusive conditions, the requirement on the load of the standard cycle is that it is reasonable and sufficient to trigger a hazardous response, in case of abnormal conditions in the RESS. 1C discharge current should be reasonable for Li-ion and NiMH technologies. Acceptable charge current levels depend on the battery technology and hence the manufacturer's ... [2]

Comment [TG35]:
Comment from Korea
•If test condition is for safety(abuse) test, acceptance criteria also shall be related to safety
•Acceptance criteria of st ... [3]

Comment [TG36]:
Proposal from Germany

Comment [TG37]:
Proposal from Germany

Comment [TG38]:
Proposal from Germany

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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.

Comment [TG39]:
Comments Korea
 Case 1.
 To be deleted.
 "Vehicle will not experience such rapid temperature change in the whole life"

 Case 2.
 Or harmonize with ISO 12405 not with UN 38.3 which is transportation standard.
 It's not efficient doing same test with different test conditions

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.

Comment [T40]:
Comment Sweden
 The conditions should be the same as for UN 38.3 in order to avoid duplicate testing but a SC should be performed after the temperature exposure.

[RESS] shall be stored for at least six hours at a test temperature equal to at a minimum of 70°C, followed by storage for at least six hours at a test temperature equal to or less than - 38°C. The maximum time interval 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 °C).

[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]].

Comment [T41]:
Comment Sweden
 A standard charge/discharge cycle is performed in order to verify the functionality of the RESS after reliability/safety test.

 When test prescribes OCV and isolation resistance measurements, these shall be performed prior to SC.

Comment Secretary
 It has to be checked how such a requirement fits into the R 38.3 procedure.

[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.

Comment [TG42]:
 For this test, IPXXA is not sufficient taking into account testing conditions. IPXXB should be required?

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.]

Comment [TG43]:
Comment Continental
 The acceptance criteria shall be kept because they are good guidance for the document user

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

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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.

Comment [T44]:
Comment (Sweden)
regarding performing tests on RESS under electrical load
As real life vehicle collisions may occur while electric vehicles are driving, the need of exposing the RESS to an electric load (analogous to driving the vehicle at the test speed of ECE-R 94) should be discussed during next RESS meeting.

Comment [T45]:
Proposal from Sweden

Comment [T46]:
Action item (RESS-3-13)
Get feedback from Informal Group on frontal impact regarding the question for which vehicle mass and dimension the test requirements of ECE R12, ECE R94 and ECE R95 are acceptable

Comment [T47]:
Comment Korea
•ECE-R12, R 94, R95 is just for M1, N1 respectively.
•It's hard to apply to N2, M2 without revision of R 12, R94 & R95.

Comment [T48]:
Comment (Sweden)
regarding the equivalence of the test conditions with those described in Table 5
Justification should be presented to the RESS g ... [4]

Comment [T49]:
Comment Korea
•ECE-R12, R 94, R95 is just for M1, N1 respectively.
•It's hard to apply to N2, M2 without revision of R 12, ... [5]

Comment [T50]: **Comment (Sweden)** regarding the equivalence of the test conditions with those described in Table 6
Justification should be pr ... [6]

Comment [T51]:
Comment Korea
Need to clear about vehicle of category between [M1, M2, N1 and N2] and [M1, M2, M3, N1, N2 and N3].

Comment [TG52]:
German proposal

Comment [T53]:
Comment Korea
•If test unit(module or RESS) is selective, ambiguous mention would be better to delete.
•Same opinion with 'Con ... [7]

Comment [TG54]:
German proposal

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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)

Comment [T55]:
Proposal Sweden

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

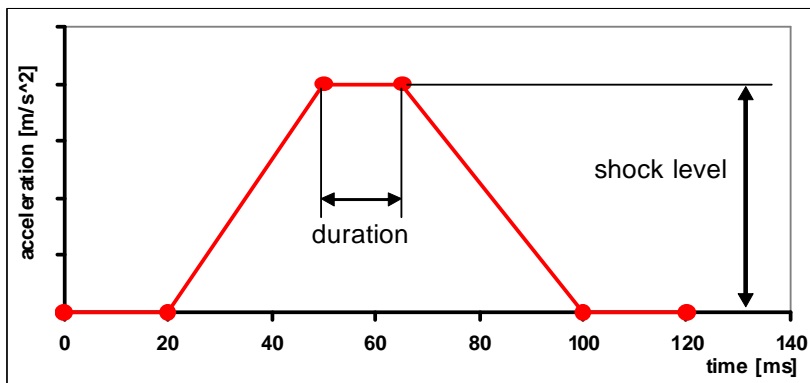
Comment [T56]:
Action item (RESS-3-13)
Advise for the right acceleration thresholds in table 5 and 6 by the Informal Group on frontal impact; also considering the presentation from Autoliv

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

Comment (Sweden) regarding M1 and N1 acceleration levels in Table 5
In their work in the European FIMCAR project the German group Verband der Automobilindustrie (VDA) have presented crash simulations (analogous to ECE R94) on Volkswagen, Mercedes E-class and Smart. Those acceleration levels indicate that the proposed acceleration pulse for M1 and N1 in Table 5 is exceeded by more than 50-100% in a full scale R94 vehicle crash test.

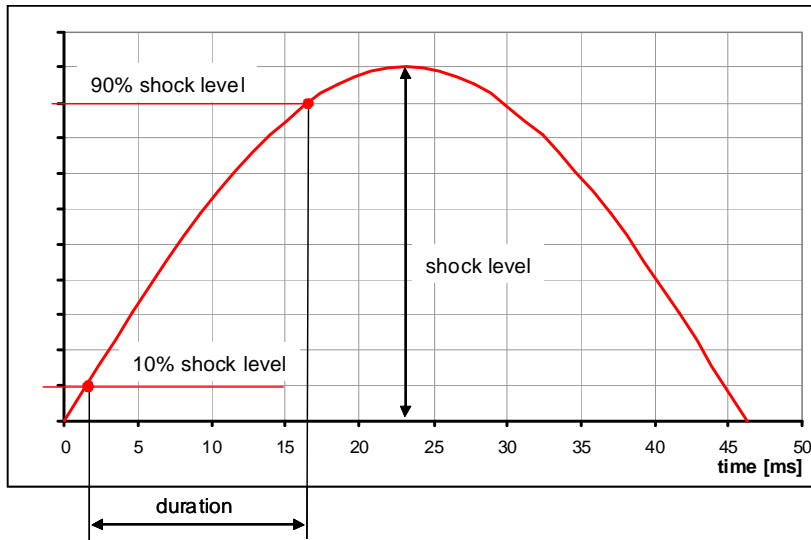
Diagram 1 – minimum shock pulse



Comment [T57]:
Comment Sweden
Acceleration pulses in Diagramm 1 and 2 do not represent acceleration pulses equivalent to acceleration pulses generated in a R94 crash test with modern vehicle

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Diagram 2 sinus shock pulse



Comment [TG58]:
German proposal

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

Comment [TG59]:
German proposal

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.

Action item (RESS-3-13)
Based on the input from France advise from the Informal Group on frontal impact which is the right diagram to describe the pulse for the impact

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

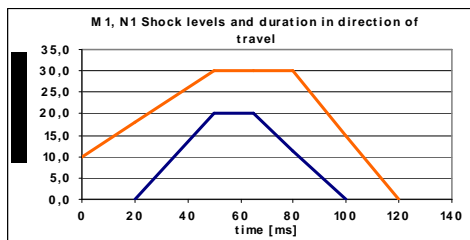


Diagram 2
M1, N1 Shock levels and duration in horizontally perpendicular to the direction of travel

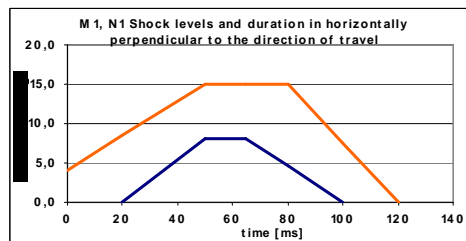


Diagram 3
M2, N2 Shock levels and duration in direction of travel

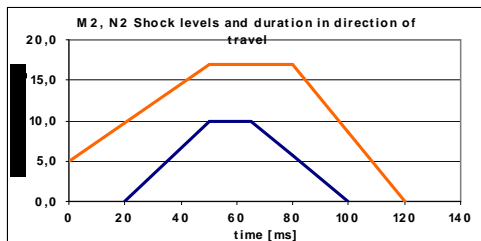


Diagram 4
M2, N2 Shock levels and duration in horizontally perpendicular to the direction of travel

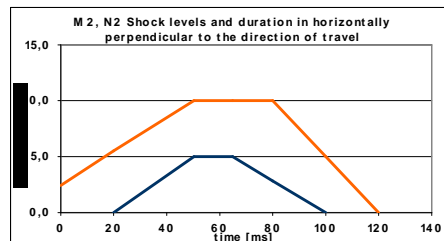
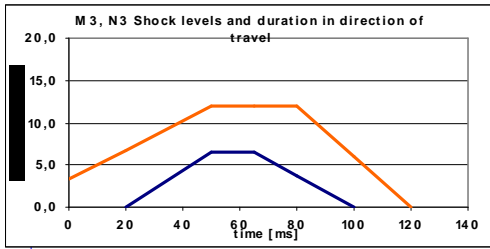


Diagram 5

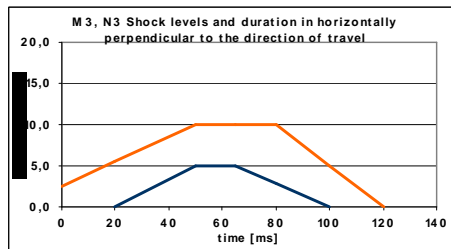
Diagram 6

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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.~~

Comment [TG60]:
German proposal

Comment Korea
Definition of duration time would be better harmonized to avoid confusion. (between ISO 16750)

Comment Continental:
Define a corridor (lower and upper limit) for the acceleration in diagram 1

Comment (Sweden) regarding the acceleration pulse found in R17 and R44
The upper limit of the acceleration pulse found in R17 and R44 is exceeded in the R94 crash simulations presented by VDA in the FIMCAR project. Modern vehicles represents higher structural stiffness and consequently also higher acceleration peaks than the vehicles on which the acceleration pulse corridor in R17 where designed for. The European Commission has asked for modifications of this pulse to better represent modern vehicles:

*“Commission proposed that the elements which shall be taken onboard, are as follows:
(---)
Improve the frontal crash pulse, whilst maintaining the appropriate speed of 50 km/h (...) to reflect modern vehicles under full overlap crash conditions (...);
(---)”*
(Reference: EUROPEAN COMMISSION ENTERPRISE AND INDUSTRY DIRECTORATE-GENERAL; “Industrial Innovation and Mobility Industries **Automotive industry**”; document D5/PB D(2011) – 252967; Brussel ... [8])

Comment [T61]:
German proposal

Comment [T62]:
Comment Continental
Acceptance criteria shall be aligned to R94/95

Comment [T63]:
Comment Korea
Measuring insulation resistance could not applied to module-based test.
Only necessary for vehicle-based test.

Comment [T64]:
German proposal

Comment [T65]:
German proposal

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.

Comment [T66]:
Proposal Sweden

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].

Comment [TG67]:
German Working Group

Comment [T68]:
Comment Continental
Define a maximum duration of the force. As crash conditions should be simulated with the test, the duration of the force should be limited to typical crash duration of [100] ms.

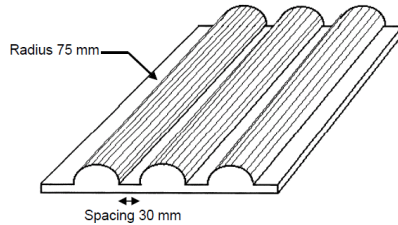
[Optionally, this test can be conducted with the mechanical load according to ECE-R12 Annex 3 or ECE R94 Annex 3 in the direction of travel and with the mechanical load according to ECE R95 Annex 4 in the direction horizontally perpendicular to the direction of travel. The mechanical load shall be determined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

Proposal how to structure the RESS safety requirements

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:
Orientation of the crush plate:

600 mm x 600 mm or smaller
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 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.

Comment [T69]:
Comment from (Sweden) regarding the use of protective framework
This is needed to avoid imposing design limitations on RESS. Without the option of performing the test with "a protective framework representative of what is provided in the vehicle" the test will not represent the mechanical load exerted onto a RESS located within the protective structure of the vehicle. This imposes a risk to make it more difficult to design large RESS for EV in comparison to smaller RESS for HEV, hence imposing design limitations on the EV market.

Comment [T70]:
Proposal from Sweden

Comment [T71]:
Comment Continental
The test will become more severe as the crush plate gets smaller by the higher force per area at the RESS. The use of smaller crush plates in a smaller press is useful for smaller RESS types (e.g. HEV batteries). Thus, smaller crush plates should be allowed in the test.

Comment [T72]:
Comment Continental
Acceptance criteria shall be aligned to R94/95

Comment [T73]:
Comment Korea
Measuring insulation resistance could not applied to module-based test. Only necessary for vehicle-based test.

Proposal how to structure the RESS safety requirements

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.

Comment [T74]:
SP proposal

Comment [T75]:
SP proposal

3.4.2.1.2. The [RESS] shall be conditioned of period of not less than 8 h at a temperature of $20 \pm 10.5^{\circ}\text{C}$ before the test starts.

Comment [T76]:
Comment Continental
As starting temperature of the RESS is not that critical in the test it should be allowed to widen the temperature window for the RESS start temperature. This would reflect the test conditions in not acclimatized halls.

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.

Comment [T77]:
Comment Continental
A test of the RESS without additional vehicle parts should be allowed, if in interest of battery manufacturer.

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/m². The fuel temperature should be $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$

Comment [T78]:
Comment Korea
Minimum fuel quantity(25 litres/m²) would be considered again. KATRI will present test data on the RESS 4th. Meeting.

Water should be poured at the bottom of the pan to ensure a flat bottom of the pan. The water temperature should be $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$. 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.

Comment [T79]:
SP proposal

Comment [T80]:
SP proposal

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 $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$ of the fuel and the water then the test needs to be conducted with a 1 minute pre-heating period.

Comment [T81]:
SP proposal

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.

Comment [T82]:
Comment Korea
Distance tolerance should be documented due to measurement error.

Proposal how to structure the RESS safety requirements

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°C ± 5°C of the fuel and the water then the test shall comprise of four phases.

Comment [T83]:
SP proposal

[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°C ± 5°C 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.]

Comment [T84]:
Comment Continental
Delete paragraph 3.4.2.1.8.1 to simplify the test and avoid moving burning fuel.

Comment [T85]:
SP proposal

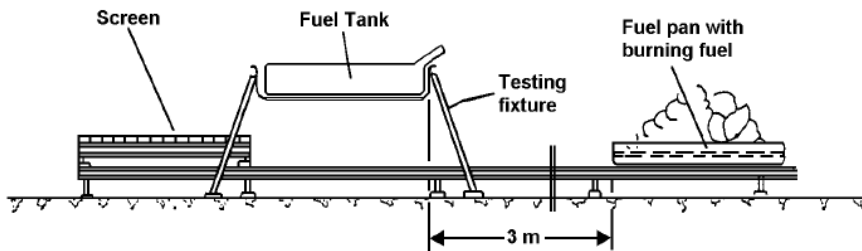


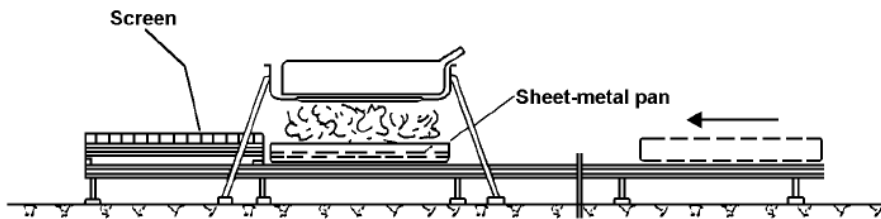
Figure 1

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.

Comment [T86]:
Comment Continental
To compensate for deletion of paragraph 3.5.2.1.7.1 the burning time shall be fixed to 90 seconds.

Comment [T87]:
SP proposal



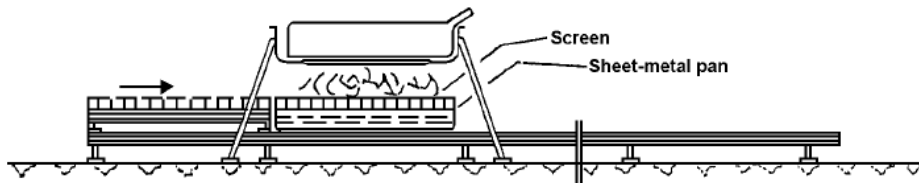
Proposal how to structure the RESS safety requirements

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.



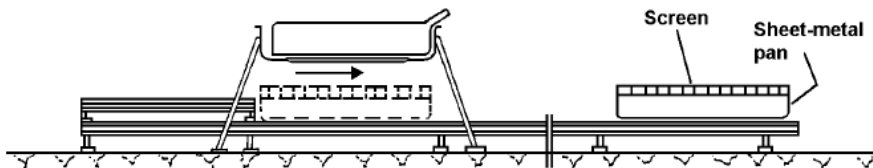
Comment [T88]:
Comment Continental
 As Phase C is not influenced by changing initial Phase A and B, we shall stick to the initial 60 seconds burning time.

Comment [T89]:
Comment Continental
 As Phase C is not influenced by changing initial Phase A and B, we shall stick to the initial 60 seconds burning time.

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 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.



Comment [T90]:
 Action item RESS-313

Comment [T91]:
Comment Korea
 •Temperature is too high to measure with thermocouple. Sensor with thermal shielding could measure about 1,000 degrees C. But it is hard to install a shielded sensor inside the RESS.
 •3 h of monitoring is enough. (24 h monitoring is too long)

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.

Proposal how to structure the RESS safety requirements

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 $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Water should be poured at the bottom of the pan to ensure a flat bottom of the pan. The water temperature should be $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$. 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 $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$ 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 $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$ of the fuel and the water then the 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 $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$ 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

Proposal how to structure the RESS safety requirements

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.

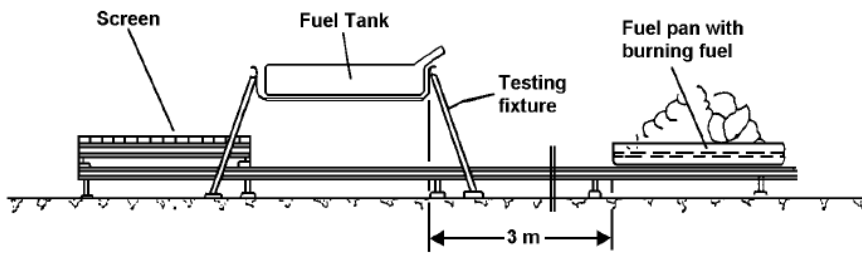


Figure 5

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.

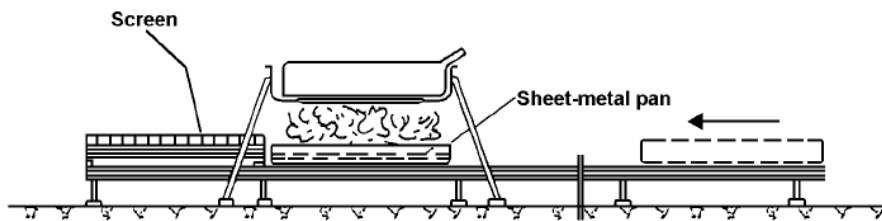


Figure 6

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.

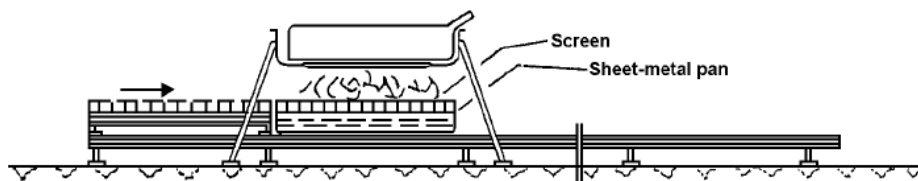


Figure 7

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

Proposal how to structure the RESS safety requirements

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

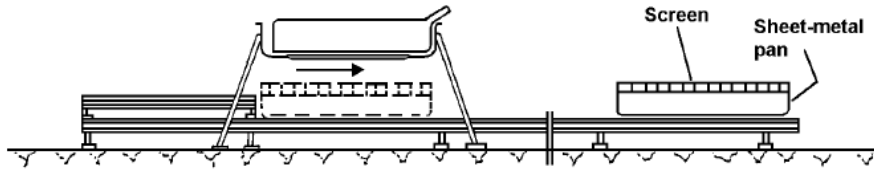


Figure 8

Comment [T92]:
SP proposal

3.4.2.3 Acceptance criteria

During Phase A to D of the test, the [RESS] shall exhibit no evidence of explosion or rupture, as defined in Table X of this document [ref: SAE J2464 or UL2580].

No dangerous voltages shall be available on the chassis or RESS.

Comment [TG93]:
Comment Sweden

3.4.3 Verification

The explosion and rupture criterion is verified by ocular visual inspection. Indicators of rupture or explosion include, but are not limited to: sudden increase in flame intensity or size, emission of projectiles, loud noise.

Comment [T94]:
SP proposal

Comment [TG95]:
Comment Sweden

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

Comment [TG96]:
Proposal Sweden

Comment [T97]:
SP proposal

If relevant after fire testing, isolation resistance shall be checked according to Annex 1.

Comment [TG98]:
Proposal Sweden

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

Comment [T99]:
Comment from ????

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 °C

The [RESS] to be tested shall be temperature stabilized at maximum operating temperature alternatively 55 °C so that its external case temperature reaches minimum [23 °C]

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 °C]. 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 °C] 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].

Comment [T100]:
Comment from Sweden

Comment [T101]:
Proposal from TÜV-SGS and BMW

Comment [T102]:
Comment (Sweden)
regarding test conditions
Recommend harmonizing with UN 38.3 to reduce redundancy testing. If harmonization is not done, then perform the test at MOSOC and max operating condition, since this defines the lowest margin to failure

Comment [T103]:
Comment from Sweden

Comment [T104]:
Proposal from TÜV-SGS and BMW

Comment [T105]:
Comment Korea
•It's very dangerous without any protection function.
•Test duration is too long to reach minimum [23 °C].(Some case, it may take several days)
•After inflection point, it could be assumed stabilized.
•IEC 62660-5 (20% decline)

Comment [T106]:
Proposal from Sweden
Requirement out of UN 38.3

Comment [T107]:
Comment Korea
•Lower limit would be better to document for test.
•Test with more low limit is disadvantageous.
•Appendix. ISO12405-1 :
•100 +0/-40 m Ohm
•Appendix. ISO12405-2 :
•20 +0/-10 m Ohm

Comment [T108]:
Comment Sweden

Comment [T109]:
Comment from Sweden

Comment [T110]:
Comment Sweden
A standard charge/discharge cycle is performed in order to verify the functionality of the RESS after reliability/safety test.

When test prescribes OCV and isolation resistance measurements, these shall be performed prior to SC.

Comment Secretary
It has to be checked how such a requirement fits into the R 38.3 procedure.

Proposal how to structure the RESS safety requirements

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.

Comment [T111]:
Comment Continental
 It is technically not necessary that venting appears in the tests "external short circuit", "overcharge protection" "over-discharge protection" and "over-temperature protection". If this statement is seen to strong by the majority of the delegates we could skip venting from the acceptance criteria.

Comment [T112]:
Comment Korea
 •It's not a kind of safety test criteria.
 •Sometimes [RESS] is designed ruptureable to avoid fire or explosion.

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

Comment [T113]: Proposal Sweden

Comment [T114]: Proposal Sweden

Comment [T115]: Proposal TÜV-SGS and BMW
 Todo: integrate "functionality", "normal operating conditions", "passive protection devices External charge control in definitions

Comment [T116]: Comment (Sweden) regarding tests conditions
 Extensive research is being done on Li-ion additives that will facilitate overvoltage protection at cell level. A realistic time frame for market introduction is ≥5 years. As an increasing number of potential Li-ion battery risks are being managed on a materials or chemical level, the necessity of protective electronic circuitry may diminish. This must be taken into consideration when determining test criteria, as these must not create obstacles for technology development.

Comment [T117]: Comment Korea
 It's hard to verify that module-based test represent [RESS]-based test. Same opinion with 'Condition of vibration test'

Comment [T118]: Proposal from TÜV-SGS and BMW

Comment [T119]: Comment (Sweden) regarding SOC levels for testing
 The SOC level has to be set in relation to the RESS under test, since this voltage working window is a design parameter and will vary between different vehicle manufacturers and types of electrified vehicles, otherwise the test conditions will not be "normal operating conditions".
 We suggest considering SAE J2929 and/or UL 2580 in addition to ISO 12405 as reference for test design and acceptance criteria.

Comment [T120]: Proposal TÜV-SGS and BMW

Comment [T121]: Proposal TÜV-SGS and BMW

Proposal how to structure the RESS safety requirements

- 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 °C.

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.

Comment [T122]:
Proposal from Korea
 If there are no special reason, termination condition of electrical safety test would be better to harmonize with ISO 12405.

Comment [T123]:
Comment Sweden
 A standard charge/discharge cycle is performed in order to verify the functionality of the RESS after reliability/safety test.

When test prescribes OCV and isolation resistance measurements, these shall be performed prior to SC.

Comment Secretary
 It has to be checked how such a requirement fits into the R 38.3 procedure.

Comment [T124]:
Comment Continental
 It is technically not necessary that venting appears in the tests "external short circuit", "overcharge protection" "over-discharge protection" and "over-temperature protection". If this statement is seen to strong by the majority of the delegates we could skip venting from the acceptance criteria.

Comment [T125]:
Proposal Korea
 •It's not a kind of safety test criteria.
 •Sometimes [RESS] is designed ruptureable to avoid fire or explosion

Comment [T126]:
Proposal Korea
 Measuring insulation resistance could not applied to module-based test.

Comment [T127]:
Comment Sweden
 If acceptance criteria in this document are to be based on performance of standard cycle after test, then the "standard cycle" must be defined. Since the purpose of the standard cycle is to verify that the RESS can does not exhibit dangerous behavior after being exposed to abusive conditions, the requirement on the load of the standard cycle is that it is reasonable and sufficient to trigger a hazardous resp(... [9]

Comment [T128]:
Proposal TÜV-SGS and BMW

Comment [T129]:
Comment TÜV-SGS and BMW
 Only a hint to the procedure in ECE R100

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.

Comment [T130]:
Proposal TÜV-SGS and BMW

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.

Comment [T131]:
Comment (Sweden)
regarding discharge conditions for overdischarge test
Discharge current needs to be adjusted depending on normal discharge conditions for the vehicle type, e.g. 1C may be "normal" for HEV/PHEV but too high for EV, where C/3 is used in other standards (SAE J2929).
We suggest considering SAE J2929 and UL2580 as reference in addition to ISO 12405

Comment [T132]:
Comment Korea
Over-discharge test is essential test to verify safety of RESS.

Comment [T133]:
Action item RESS-3-13
A footnote with explanation has to be integrated.

Comment [T134]:
Comment Korea
•It's hard to verify that module-based test represent [RESS]-based test.
•Same opinion with 'Condition of vibration test'

Comment [T135]:
Proposal TÜV-SGS and BMW

Comment [T136]:
Proposal TÜV-SGS and BMW

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 galvanical 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.

Comment [T137]:
Proposal Korea
 •There is no condition for end of test.
 •After inflection point, it could be assumed stabilized
 •If there are no special reason, termination condition of electrical safety test would be better to harmonize with ISO 12405.

Comment [T138]:
Comment Sweden
 A standard charge/discharge cycle is performed in order to verify the functionality of the RESS after reliability/safety test.

When test prescribes OCV and isolation resistance measurements, these shall be performed prior to SC.

Comment Secretary
 It has to be checked how such a requirement fits into the R 38.3 procedure.

Comment [T139]:
Comment Korea
 If test condition is for safety(abuse) test, there should be no condition for reliability.

Comment [T140]:
Comment Continental
 It is technically not necessary that venting appears in the tests "external short circuit", "overcharge protection" "over-discharge protection" and "over-temperature protection". If this statement is seen to strong by the majority of the delegates we could skip venting from the acceptance criteria.

Comment [T141]:
Proposal Korea
 •It's not a kind of safety test criteria.
 •Sometimes [RESS] is designed ruptureable to avoid fire or explosion.

Comment [T142]:
Proposal from Korea
 Measuring insulation resistance could not applied to module-based test.

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.

Comment [T143]:
Comment Korea
 Case 1.
 •To be deleted
 There is nearly no chance to happen any dangerous events.
 Case 2.
 •3.9 Heat exposure
 Korea has similar test regulation which is 'Heat exposure'
 This 'Heat exposure' is to verify whether SOC 80% of DUT could stand in the 80°C of chamber during 4 hr or not.

Comment [T144]:
Comment (Sweden)
 regarding performing tests on RESS under electrical load
 Unless there is some kind of load cycle this procedure will simulate parking in a (very?) hot area rather than loss of cooling functionality.
 As real life vehicle collisions may occur while electric vehicles are driving, the need of exposing the RESS to an electric load (analogue to driving the vehicle at the test speed of ECE-R 94) should be discussed during next RESS meeting.

Comment [T145]:
Proposal Sweden

Comment [T146]:
Comment Continental
 In the conditions paragraph the RESS is forced into a temperature range of 20 °C above maximum workin... [10]

Comment [TG147]:
Mercedes & Renault

Comment [T148]:
Comment Continental
 Insert temperature

Comment [T149]:
Comment Continental
 The operation of the RESS and the verification of the operation is not described in the test. It would be helpful to see ... [11]

Comment [T150]:
Comment (Sweden)
 regarding requirements for interrupting the test
 What is required to have the test requirement satisfie... [12]

Comment [T151]:
Proposal Korea

Comment [T152]:
Comment Sweden
 A standard charge/discharge cycle is performed in order to verify the functionality of the RESS after reliability/sa... [13]

Proposal how to structure the RESS safety requirements**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 ($25^{\circ}\text{C} \pm 5^{\circ}\text{C}$). 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.

Comment [T153]:

Comment Continental
Follow the Japanese proposal and delete paragraph 3.11

Action item RESS-3-13

It has to be checked by the German working group whether the requirements in ECE R100 regarding Hydrogen Emission consider only a first failure situation or also the normal operation.

Proposal how to structure the RESS safety requirements

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

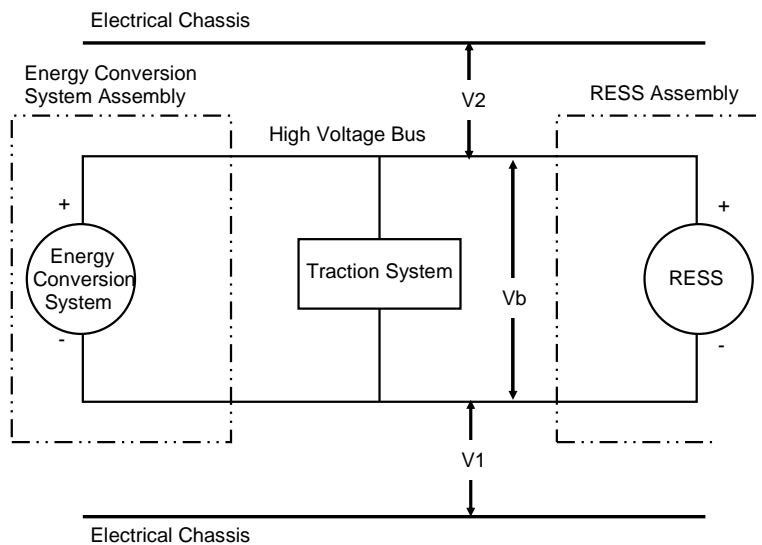
The voltmeter used in this test shall measure DC values and shall have an internal resistance of at least 10 MΩ.

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 (V_b) is recorded. V_b 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 V_b , V_1 , V_2



Proposal how to structure the RESS safety requirements

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).

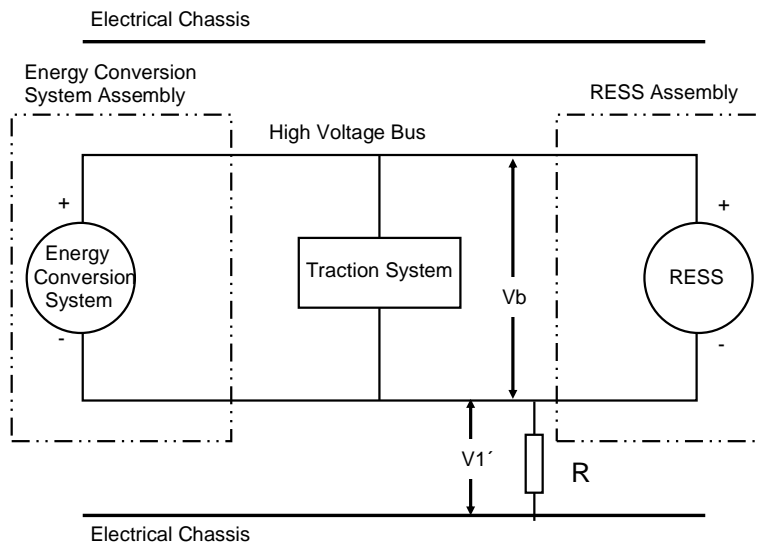
1.2.3.4. Fourth step

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:

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

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

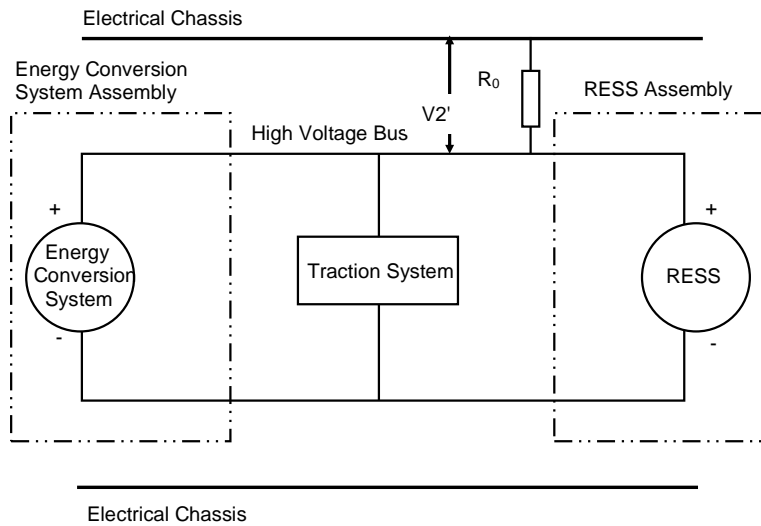
Proposal how to structure the RESS safety requirements

shown. Divide this electrical isolation value (in Ω) by the nominal operating voltage of the high voltage bus (in volts).

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

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

Figure 3 - Measurement of $V_{2'}$



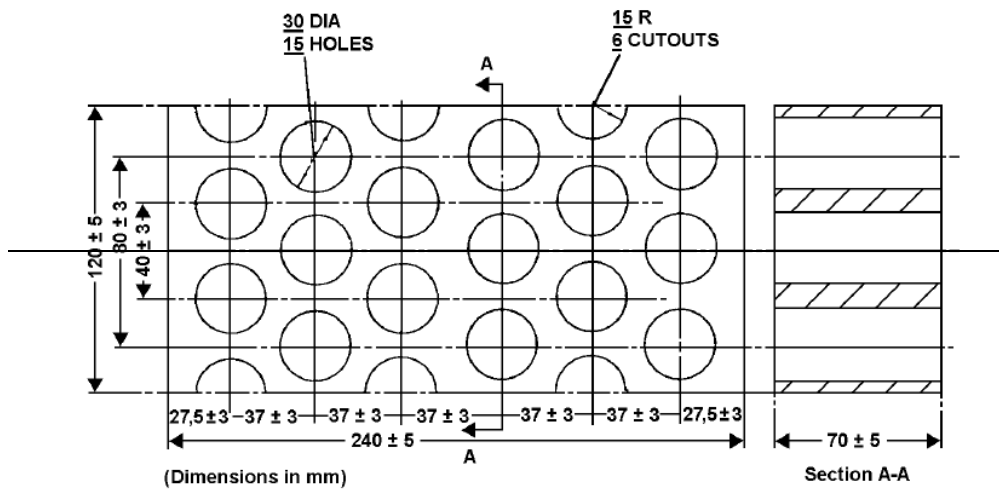
1.2.3.5. Fifth step

The electrical isolation value R_i (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 R_o (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). R_o is not required to be precisely this value since the equations are valid for any R_o ; however, a R_o value in this range should provide good resolution for the voltage measurements.

Proposal how to structure the RESS safety requirements

ANNEX 2: DIMENSIONS AND TECHNICAL DATA OF FIREBRICKS



Fire resistance	(Seger-Kegel) SK 30
Al ₂ O 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.

nC is the current rate equal to n times the 1 h discharge capacity expressed in Amperes.

Comment [T154]:
Proposal Sweden

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]

Comment (Sweden) regarding mode of vibration

We agree with the comment from France that the vibration mode in ISO 16750-3(IEC 68-2-4) is more representative of vehicle condition than UN38.3.

If the manufacturer can show that another mode of vibration is more relevant for normal usage of a specific vehicle type, then testing against that vibration profile should be allowed.

Delete 3.1.2.3 "Vibration"

Comment Sweden

If acceptance criteria in this document are to be based on performance of standard cycle after test, then the "standard cycle" must be defined. Since the purpose of the standard cycle is to verify that the RESS can does not exhibit dangerous behavior after being exposed to abusive conditions, the requirement on the load of the standard cycle is that it is reasonable and sufficient to trigger a hazardous response, in case of abnormal conditions in the RESS. 1C discharge current should be reasonable for Li-ion and NiMH technologies. Acceptable charge current levels depend on the battery technology and hence the manufacturer's recommendation should be used when applicable. A typical range for charge current is C/3 (ISO 12405-2) and 1C (ISO 12405-1)

Comment from Korea

- If test condition is for safety(abuse) test, acceptance criteria also shall be related to safety
- Acceptance criteria of safety test should have interest in dangerous events.

Comment (Sweden) regarding the equivalence of the test conditions with those described in Table 5

Justification should be presented to the RESS group that the acceleration levels of table 5 is indeed equivalent to a crash test according to ECE-R12 and ECE-R94 with a modern vehicle, before the above statement can be incorporated into this document

Comment Korea

- ECE-R12, R 94, R95 is just for M1, N1 respectively.
- It's hard to apply to N2, M2 without revision of R 12, R94 & R95.

Comment (Sweden) regarding the equivalence of the test conditions with those described in Table 6

Justification should be provided to the RESS group that the acceleration levels of table 6 is indeed equivalent to a crash test according to ECE-R95 with a modern vehicle, before the above statement can be incorporated into this document.

Page - 9 -: [7] Comment [T53]

Thomas

7/2/2011 2:50:00 PM

Comment Korea

- If test unit(module or RESS) is selective, ambiguous mention would be better to delete.
- Same opinion with 'Condition of vibration test'

Page - 12 -: [8] Comment [TG60]

Thomas Goldbach

7/3/2011 9:49:00 AM

German proposal

Comment Korea

Definition of duration time would be better harmonized to avoid confusion. (between ISO 16750)

Comment Continental:

Define a corridor (lower and upper limit) for the acceleration in diagram 1

Comment (Sweden) regarding the acceleration pulse found in R17 and R44

The upper limit of the acceleration pulse found in R17 and R44 is exceeded in the R94 crash simulations presented by VDA in the FIMCAR project. Modern vehicles represents higher structural stiffness and consequently also higher acceleration peaks than the vehicles on which the acceleration pulse corridor in R17 where designed for. The European Commission has asked for modifications of this pulse to better represent modern vehicles:

“Commission proposed that the elements which shall be taken onboard, are as follows:

(---)

Improve the frontal crash pulse, whilst maintaining the appropriate speed of 50 km/h (...) to reflect modern vehicles under full overlap crash conditions (...);

(---)”

(Reference: EUROPEAN COMMISSION ENTERPRISE AND INDUSTRY DIRECTORATE-GENERAL; “Industrial Innovation and Mobility Industries **Automotive industry**”; document D5/PB D(2011) – 252967; Brussels, 02 March 2011

Page - 24 -: [9] Comment [T127]

Thomas

7/2/2011 7:52:00 PM

Comment Sweden

If acceptance criteria in this document are to be based on performance of standard cycle after test, then the “standard cycle” must be defined. Since the purpose of the standard cycle is to verify that the RESS can does not exhibit dangerous behavior after being exposed to abusive conditions, the requirement on the load of the standard cycle is that it is reasonable and sufficient to trigger a hazardous response, in case of abnormal conditions in the RESS. 1C discharge current should be reasonable for Li-ion and NiMH technologies. Acceptable charge current levels depend on the battery technology and hence the manufacturer’s recommendation should be used when applicable. A typical range for charge current is C/3 (ISO 12405-2) and 1C (ISO 12405-1).

Page - 27 -: [10] Comment [T146]

Thomas

7/3/2011 12:10:00 PM

Comment Continental

In the conditions paragraph the RESS is forced into a temperature range of 20 °C above maximum working temperature. This is contradictory to the 3.9.3. verification paragraph which requires "The charge and discharge shall be functional."

Thus, the overtemperature range shall be limited to 10 K above maximum working temperature.

Page - 27 -: [11] Comment [T149]

Thomas

7/3/2011 12:07:00 PM

Comment Continental

The operation of the RESS and the verification of the operation is not described in the test. It would be helpful to see the interruption of low current at the overtemperature.

Page - 27 -: [12] Comment [T150]

Thomas

7/3/2011 12:19:00 PM

Comment (Sweden) regarding requirements for interrupting the test

What is required to have the test requirement satisfied? A disconnection of the battery?

Page - 27 -: [13] Comment [T152]

Thomas

7/2/2011 8:06:00 PM

Comment Sweden

A standard charge/discharge cycle is performed in order to verify the functionality of the RESS after reliability/safety test.

When test prescribes OCV and isolation resistance measurements, these shall be performed prior to SC.

Comment Secretary

It has to be checked how such a requirement fits into the R 38.3 procedure.