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 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."

interfaces for external systems(s(e.g. cooling, voltage class B, auxiliary voltage

Comment [T3]: Outcome of the 3. RESS Meeting

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.

Comment [T4]: Outcome of the 3. RESS Meeting

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.

Comment [T5]: <JASIC Comment> "Battery module" can be defined here. It is better to use "battery module" rather than "module".

"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.

Comment [T6]: Outcome of the 3. RESS Meeting

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

Comment [T7]: Proposal JASIC

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

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

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

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

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

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

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

Comment [T8]: Proposal Sweden

2.12 Nominal voltage is the voltage given by the manufacturer ~~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

"Venting" means the release of excessive internal pressure from a cell or battery in a manner intended by design to preclude rupture or disassembly.

2.15 ~~"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.

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. This may be either the complete RESS or subsystem thereof.

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

Comment [T14]: Proposal Sweden

2.25 C rate is the marked capacity rating of the DUT.
*n*C is the current rate equal to *n* times the 1 h discharge capacity expressed in Amperes.

Proposal how to structure the RESS safety requirements

Technical Requirements

A) Priority Requirements

3.0 General

If not otherwise stated in the test procedure

- the test has to be conducted under standard ambient temperature of 20± 10 ℃.
- at the end of each test the device under test (DUT) has to be observed for [1] h at the ambient temperature conditions of the test environment.
- adjust the device under test state of charge to a value in the upper 50% of the normal operating state of charge range.
- at the beginning of the test all internal and external protection devices which effect the function of the DUT and are relevant for the outcome of the test shall be operational.

3.0.1 Tests of subsystems of the RESS

If the manufacturer chose related subsystems of the RESS, 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.

3.1 Vibration

3.1.1 Rationale

The purpose of this test is to verify the safety performance of the [RESS] under a vibration environment which the RESS will likely experience during the 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 with related subsystems.

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.

3.1.2.3. Vibration

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

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

frequency [Hz]	acceleration [m/s²]
7~~5~~ - 18	10
18 - 30	5
30 – 50	2

Table1:

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

Open circuit voltage of device under test (DUT) if requested by the manufacturer be measured prior to initiation of vibration and after the vibration test.

After the vibration test 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 the device under test (DUT) shall exhibit no evidence of

a) [venting]
b) enclosure rupture
c) fire
d) explosion
e) electrolyte leakage

After the test, the isolation resistance shall not be less than 100 Ω/Volt .

3.1.3 Verification

The evidence of a) to e) of 3.1.2.5 shall be checked by visual inspection.

The isolation resistance shall be measured according to Annex 1.

3.2 Thermal Shock and Cycling

3.2.1 Rationale

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

3.2.2 Requirement

3.2.2.1 Conditions

[RESS] shall be stored for at least six hours at a test temperature equal to at a minimum of 70℃, followed by storage for at least s ix hours at a test temperature equal at to or less than - 38℃. The maximum time i nterval between test temperature extremes is 30 minutes. This procedure is to be repeated at least 5 times, after which the [RESS] shall be stored for 24 hours at ambient temperature (20 ± 10 ℃).

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

3.2.2.2 Acceptance criteria

During the test the [RESS battery system] shall exhibit no evidence of

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

After the test, the isolation resistance shall not be less than 100 Ω/Volt .

3.2.3 Verification

The evidence of a) to e) of 3.2.2.2 shall be checked by visual inspection.

The isolation resistance shall be measured according to Annex 1

Proposal how to structure the RESS safety requirements

3.3 Mechanical impact

3.3.1 Mechanical Shock

3.3.1.1 Rationale

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

3.3.1.2 Requirement

3.3.1.2.1 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 [T15]: 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 [T16]: Proposal from Sweden

Comment [T17]: 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 [T18]: 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 [T19]: Comment (Sweden) regarding the equivalence of the test conditions with those described in Table 5
Justification should be presented to the RESS g ... [1]

Comment [T20]: 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, ... [2]

Comment [T21]: Comment (Sweden) regarding the equivalence of the test conditions with those described in Table 6
Justification should be pr ... [3]

Comment [T22]: Comment Korea
Need to clear about vehicle of category between [M1, M2, N1 and N2] and [M1, M2, M3, N1, N2 and N3].

Comment [TG23]: German proposal

Comment [T24]: Comment Korea
•If test unit(module or RESS) is selective, ambiguous mention would be better to delete.
•Same opinion with 'Con ... [4]

Comment [TG25]: German proposal

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

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

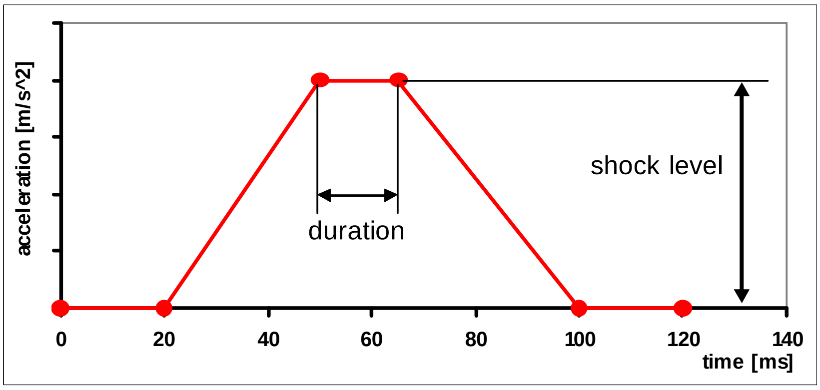
Table 5 – Shock levels in direction of travel

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

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

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

~~Diagram 1 – minimum shock pulse~~



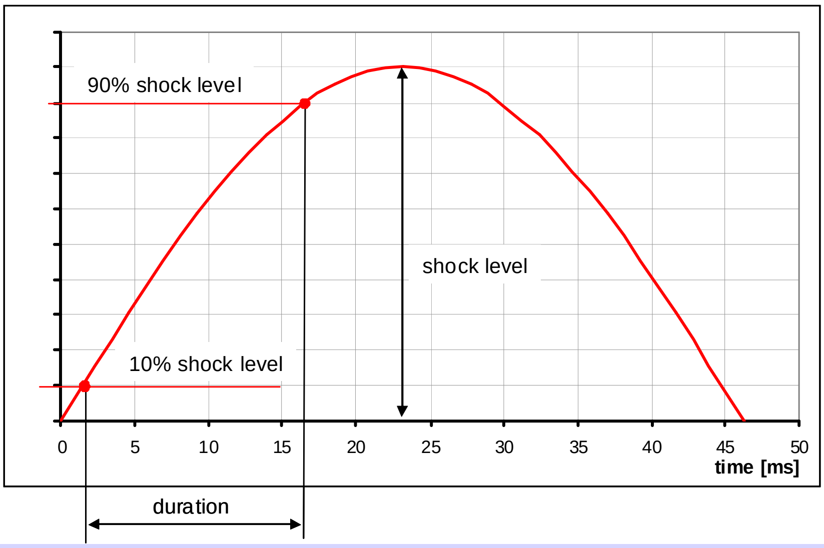
Comment [T26]:
Proposal Sweden

Comment [T27]:
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

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.

Comment [T28]:
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

~~Diagram 2 – sinus shock pulse~~



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

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

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

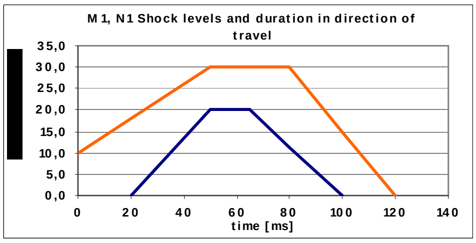


Diagram 2
M1, N1 Shock levels and duration in horizontally perpendicular to the direction of travel

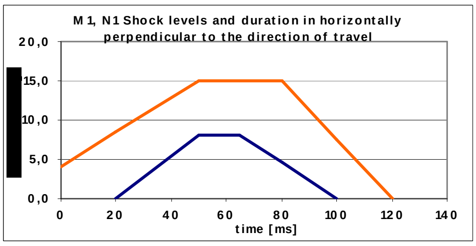


Diagram 3
M2, N2 Shock levels and duration in direction of travel

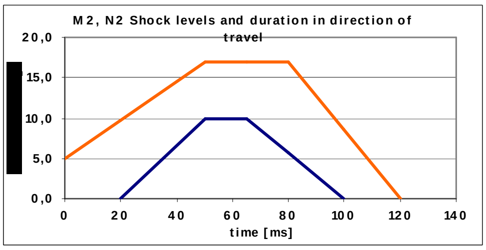


Diagram 4
M2, N2 Shock levels and duration in horizontally perpendicular to the direction of travel

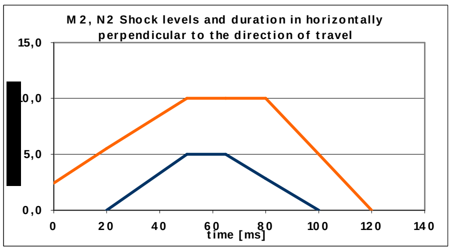


Diagram 5

Diagram 6

Comment [TG29]:
German proposal

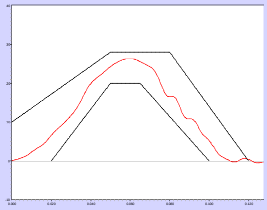
Comment [TG30]:
German proposal

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

Comment [TG31]:
Comment Frontal Impact Informal Group & France
Frontal impact test for M1, N1
The Proposal validated by the Frontal Impact informal group (GRSP) is to apply the R17 dynamic corridor.

Justification: the batteries anchorages shall undergo the same deceleration than the seats fixation points, Therefore they have to undergo the same test level.

The pulse into the corridor is a simulated pulse, H axis: seconds, V axis: acceleration in g.

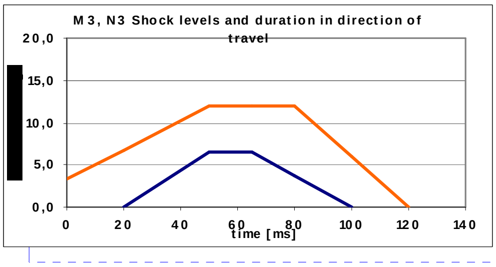


Comment [TG32]:
Comment Frontal Impact Informal Group & France
Side impact test for M1, N1
No existence of corridor corresponding to a R95 for component test.
We studied a corridor based on our experience of R95 impact tests (average of several tests).

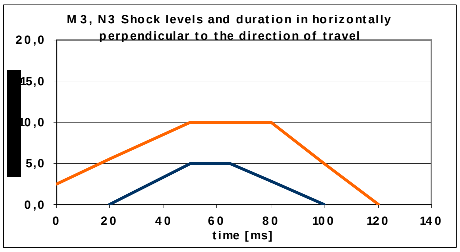
Pulse proposal
The pulse into the corridor is a simulated pulse. ... [5]

Comment [TG33]:
Comment Frontal Impact Informal Group & France
Corridor for M2, N2 and M3, N3 frontal and side impact tests
We agree with values from RESS 3-3 rev 1 (which are the same values introduced in R110 and R67). Furthermore, we have to define a hold time, and we propose to apply the hold time from R80, which is 50ms, for the M2, N2, M3 ... [6]

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 [TG34]:
Comment Frontal Impact Informal Group & France
Corridor for M2, N2 and M3, N3 frontal and side impact tests
We agree with values from RESS 3-3 rev 1 (which are the same values introduced in R110 and R67). Furthermore, we have to define a hold time, and we propose to apply the hold time from R80, which is 50ms, for the M2, N2, M3 and N3 categories.

Extract of R67:
« … The fuel container(s) must be mounted and fixed so that the following accelerations can be absorbed (without damage occurring) when the containers are full:
Vehicles of categories M1 and N1:
(a) 20 g in the direction of travel
(b) 8 g horizontally perpendicular to the direction of travel
Vehicles of categories M2 and N2:
(a) 10 g in the direction of travel
(b) 5 g horizontally perpendicular to the direction of travel
Vehicles of categories M3 and N3:
(a) 6. 6 g in the direction of travel
(b) 5 g horizontally perpendicular to the direction of travel

Comment [TG35]:
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 accele ... [7]

Comment [T36]:
German proposal

Comment [T37]:
Comment Continental
Acceptance criteria shall be aligned to R94/95

Comment [T38]:
Comment Korea
Measuring insulation resistance could not applied to module-based test.
Only necessary for vehicle-based test.

Comment [T39]:
German proposal

Comment [T40]:
German proposal

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 [T41]: 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 [TG42]: German Working Group

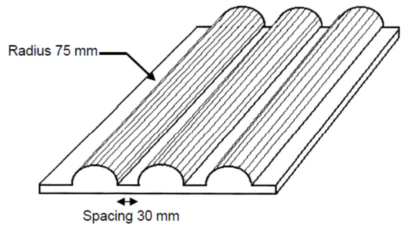
Comment [T43]: Comment Continental
Define a maximum duration of the force. As crash conditions should be simulated with the test, the duration of the force should be limited to typical crash duration of [100] ms.

[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.]

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

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

Figure 7:



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

3.3.2.2.2 Acceptance criteria

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

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

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

3.3.2.3 Verification

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

The isolation resistance shall be measured according to Annex 1.

Comment [T44]: 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 [T45]: Proposal from Sweden

Comment [T46]: 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 [T47]: Comment Continental
Acceptance criteria shall be aligned to R94/95

Comment [T48]: Comment Korea
Measuring insulation resistance could not applied to module-based test.
Only necessary for vehicle-based test.

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.

The test shall be conducted to either 3.4.2.1 or 3.4.2.2.

3.4.2.1 Conditions - vehicle based test

3.4.2.1.2. The RESS shall be conditioned of period of not less than 8 h at the standard ambient temperature before the test starts.

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

3.4.2.1.4. The flame to which the [RESS] is exposed shall be obtained by burning commercial fuel for positive-ignition engines (hereafter called "fuel") in a pan. The quantity of fuel poured into the pan shall be sufficient to permit the flame, under free-burning conditions, to burn for the whole test procedure. The fuel temperature should be standard ambient temperature.

It shall be insured that the fire covers the whole area of the pan during whole fire exposure. The pan dimensions shall be chosen so as to ensure that the sides of the [RESS] are exposed to the flame. The pan shall therefore exceed the horizontal projection of the [RESS] by at least 20 cm, but not more than 50 cm. The sidewalls of the pan shall not project more than 8 cm above the level of the fuel at the start of the test.

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

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 mass. Either the pan, or the testing fixture, or both, shall be freely movable.

3.4.2.1.6. . During phase C of the test, the pan shall be covered by a screen. The screen shall be placed 3 cm +/- 1 cm above the fuel level measured prior to the ignition of the fuel. The screen shall be made of a refractory material, as prescribed in [Annex 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 three phases B-D if the fuel is at standard ambient temperature. Otherwise the test shall comprise of four phases A-D.

[3.4.2.1.8.1. Phase A: Pre-heating (Figure 1)
The fuel in the pan shall be ignited at a distance of at least 3 m from the [RESS] being tested. After 60 seconds pre-heating, the pan shall be placed under the [RESS]. If the size of the pan is too large to be moved without risking liquid spills etc. then the [RESS] and test rig can be moved instead of the pan.]

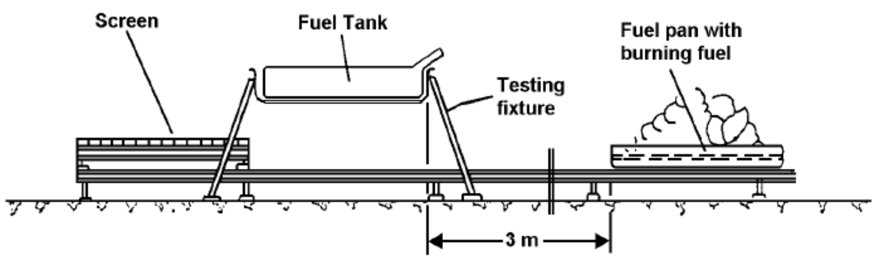


Figure 1

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

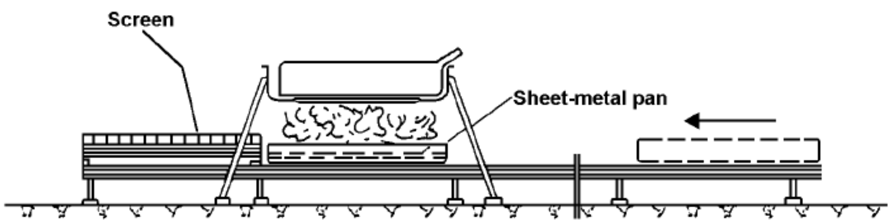


Figure 2

3.4.2.1.8.3. Phase C: Indirect exposure to flame (Figure 3)
As soon as phase B has been completed, the screen shall be placed between the burning pan and the [RESS]. The [RESS] shall be exposed to this reduced flame for a further [60] seconds.

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

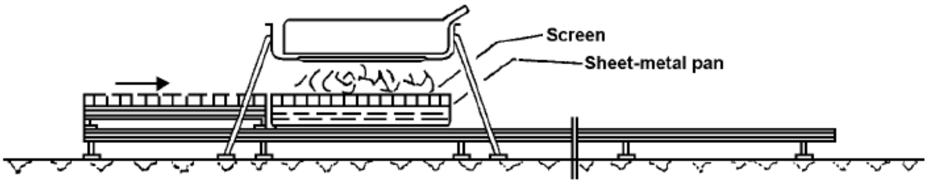


Figure 3

[3.4.2.1.8.4. Phase D: End of test (Figure 4)
The burning pan covered with the screen shall be moved back to its original position (phase A). No extinguishing of the [RESS] shall be done. After removal of the pan the surface temperature of the RESS shall be observed until such time as the temperature has decreased to ambient temperature or has been decreasing for a minimum of 3 hours.

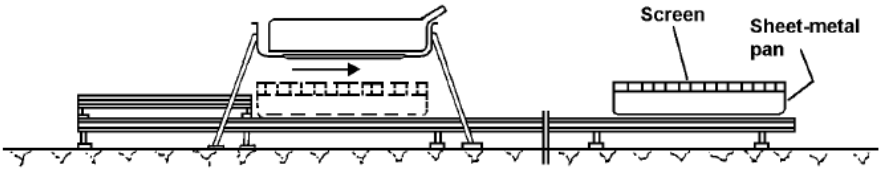


Figure 4

3.4.2.2 Conditions - component based test
As alternative to 3.4.2.1 a complete device under test may be tested for this condition. If tests are performed on a subsystem of the RESS, evidence shall be provided that the results are representative for RESS.

3.4.2.2.1. ~~**SOC**~~ During the component based test the orientation of the device under test shall be according to the manufacturers design intent.

~~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 $\pm$ 5 °C.

3.4.2.2.3. The RESS or module should be placed on a grating table positioned above the pan. The grating table shall be constructed by steel rods, diameter 6-10 mm, with 4-6 cm in between. If needed the steel rods could be supported by flat steel parts.

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

Water should be poured at the bottom of the pan to ensure a flat bottom of the pan. The water temperature should be 20℃ ± 5℃.The pan dimensions shall be chosen so as to ensure that the sides of the RESS or module are exposed to the flame. The pan shall therefore exceed the horizontal projection of the RESS or module by at least 20 cm, but not more than 50 cm but for small RESS or module the minimum pan size shall be 50x50 cm. The sidewalls of the pan shall not project more than 8 cm above the level of the fuel at the start of the test.

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

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

3.4.2.2.6. During phase C of the test, the pan shall be covered by a screen. The screen shall be placed 3 cm +/- 1 cm above the fuel level measured prior to the ignition of the fuel. The screen shall be made of a refractory material, as prescribed in [Annex 2]. There shall be no gap between the bricks and they shall be supported over the fuel pan in such a manner that the holes in the bricks are not obstructed. The length and width of the frame shall be 2 cm to 4 cm smaller than the interior dimensions of the pan so that a gap of 1 cm to 2 cm exists between the frame and the wall of the pan to allow ventilation. Before the test the screen shall be heated to 308 K +/- 5 K (35 degrees C +/- 5 degrees C). The firebricks may be wetted in order to guarantee the repeatable test conditions.

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

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

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

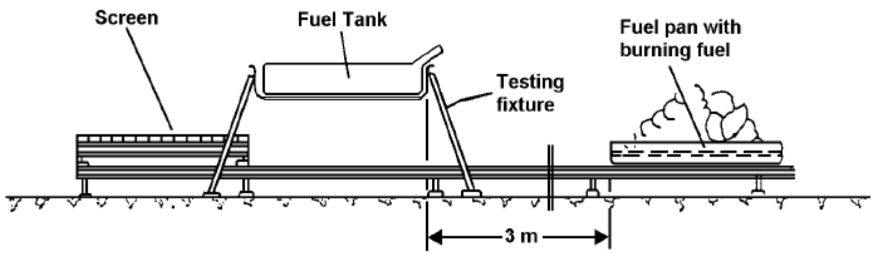


Figure 5

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

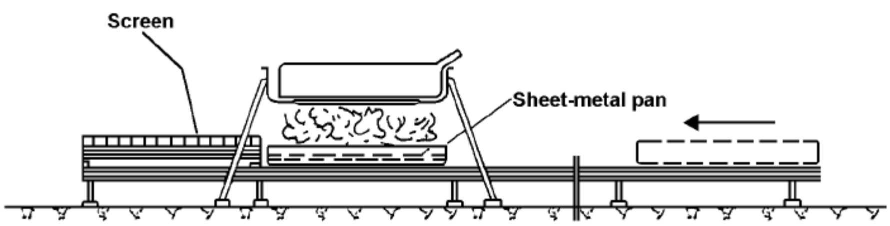


Figure 6

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

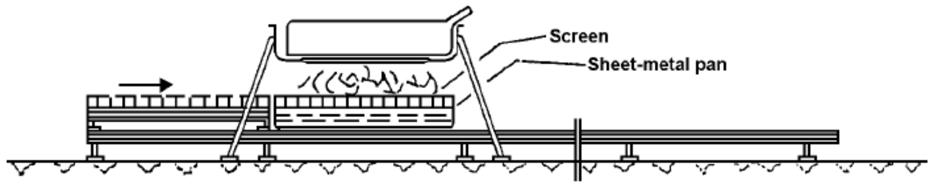


Figure 7

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

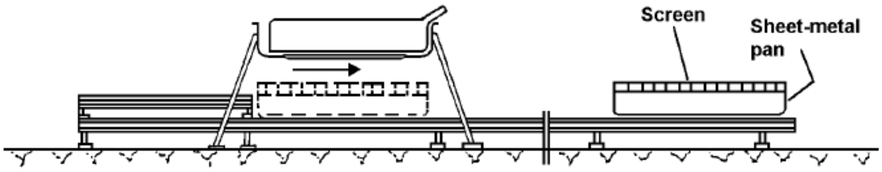


Figure 8

3.4.2.3 Acceptance criteria

During Phase A to D of the test the DUT shall exhibit no evidence of explosion.

During Phase D no sustained fire shall be present and there shall be no fire (continuous for more than [10] seconds) due to re-ignition.

3.4.3 Verification

The fire and explosion criteria are verified by inspection.

3.5 External Short Circuit Protection

3.5.1 Rationale

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 following test may be conducted with either the [RESS] [or with the subsystems] of the [RESS].

The [RESS] shall be tested under standard operating conditions as defined by the manufacturer.

At the beginning all relevant main contactors shall be closed.

During the external short circuit protection test the external resistance shall not exceed [0.1] ohm.

This short circuit condition is continued for at least one hour after the [RESS] external case temperature has stabilised, which means that the temperature varies by a gradient of less than [4℃ through 1 hour] or the operation of the protection function to interrupt or limit the short circuit current is confirmed.

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

3.5.2.2 Acceptance criteria

During the test the [battery system] shall exhibit no evidence of

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

After the test, the isolation resistance shall not be less than 100 Ω/Volt.

3.5.3 Verification

The evidence of a) to d) of 3.5.2.2 shall be checked by inspection.

The isolation resistance shall be measured according to Annex 1.

3.6 Overcharge Protection

3.6.1 Rationale

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

3.6.2 Requirement

3.6.2.1 Conditions

The following test may be conducted with either the [RESS] [or with the subsystems] of the [RESS].

The [RESS] shall be tested under standard operating conditions as defined by the manufacturer.

At the beginning all relevant main contactors shall be closed.

External charge control of the test equipment shall be disabled.

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

The upper limit of the power supply voltage shall be set to not exceed 20% of the maximum RESS voltage.

Charging shall be continued until

- the [RESS] (automatically) interrupts or limits the charging or
- external case temperature has stabilised, which means that the temperature varies by a gradient of less than [4℃ through 1 ho ur]

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 the [battery system] shall exhibit no evidence of

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

After the test, the isolation resistance shall not be less than 100 Ω/Volt.

3.6.3 Verification

The evidence of a) to d) of 3.5.2.2 shall be checked by inspection.

The isolation resistance shall be measured according to Annex 1.

3.7 Over-discharge Protection

3.7.1 Rationale

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

3.7.2 Requirement

3.7.2.1 Conditions

RESS which allow the possibility of SOC $\leq$ 0 are exempted from the requirement of the over-discharge protection test. The manufacturer shall 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.

For [RESS] which need an over-discharge protection the following test shall be conducted with the [RESS] [or with subsystem of the RESS].

The following test may be conducted with either the [RESS] [or with the subsystems] of the [RESS].

The [RESS] shall be tested under standard operating conditions as defined by the manufacturer.

At the beginning all relevant main contactors shall be closed.

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

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

- the [RESS] (automatically) interrupts or limits the discharging or
- external case temperature has stabilised, which means that the temperature varies by a gradient of less than [4℃ through 1 ho ur]

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

3.7.2.2 Acceptance criteria

During the test the [battery system] shall exhibit no evidence of

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

After the test, the isolation resistance shall not be less than 100 Ω/Volt.

3.7.3 Verification

The evidence of a) to d) of 3.5.2.2 shall be checked by inspection.

The isolation resistance shall be measured according to Annex 1.

3.8 Over-temperature Protection

3.8.1 Rationale

Simulates a breakdown of the thermal control/cooling of the DUT and internal overheating during operation. Validates function of protection measures against internal overheating.

3.8.2 Requirement

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

3.8.2.1 Conditions

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 until it reaches the maximum working temperature of the [RESS] specified by the manufacturer + 10℃. The over-temp erature shall be maintained until the DUT temperature saturates.

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 [T49]:
Comment Continental
Insert temperature

Comment [T50]:
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.

Comment [T51]:
Comment (Sweden) regarding requirements for interrupting the test
What is required to have the test requirement satisfied? A disconnection of the battery?

Comment [T52]:
Proposal Korea

Comment [T53]:
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.

3.8.3 Verification

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

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.]

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 [T54]:
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.

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 nominal ~~working~~ voltage of the RESS ~~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~~ nominal voltage of the RESS ~~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~~ nominal 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.

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

1.2.1. Test vehicle conditions

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

1.2.2. Measurement instrument

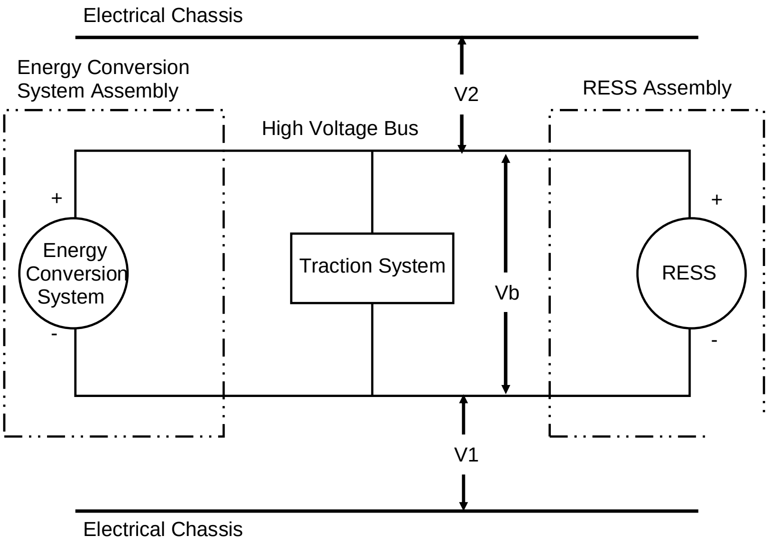
The voltmeter used in this test shall measure DC values and shall have an internal resistance of at least 10 MΩ.

1.2.3. Measurement method

1.2.3.1. First step

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

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


Electrical Chassis
Energy Conversion
System Assembly
V2
RESS Assembly
High Voltage Bus
+
Energy
Conversion
System
-
Traction System
Vb
+
RESS
-
V1
Electrical Chassis

1.2.3.2. Second step

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

1.2.3.3. Third step

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

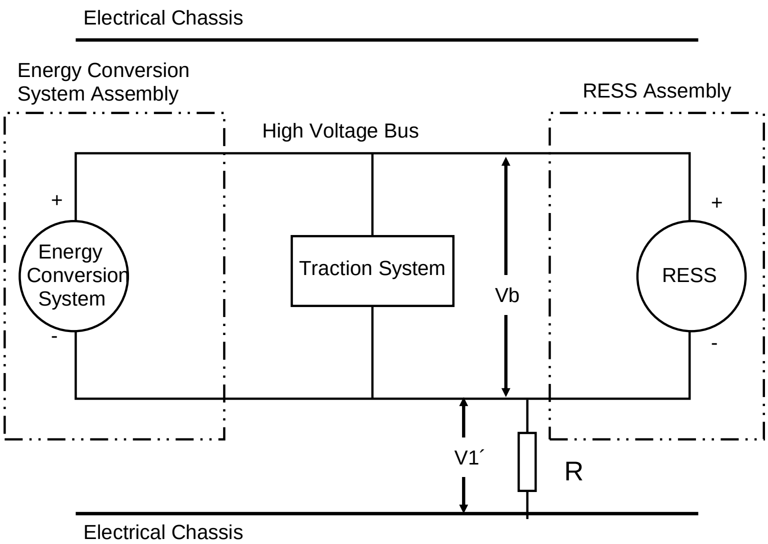
1.2.3.4. Fourth step

If V1 is greater than or equal to V2, insert a standard known resistance (Ro) between the negative side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V1') between the negative side of the high voltage bus and the electrical chassis (see Figure 2).

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

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

Figure 2 - Measurement of V1'

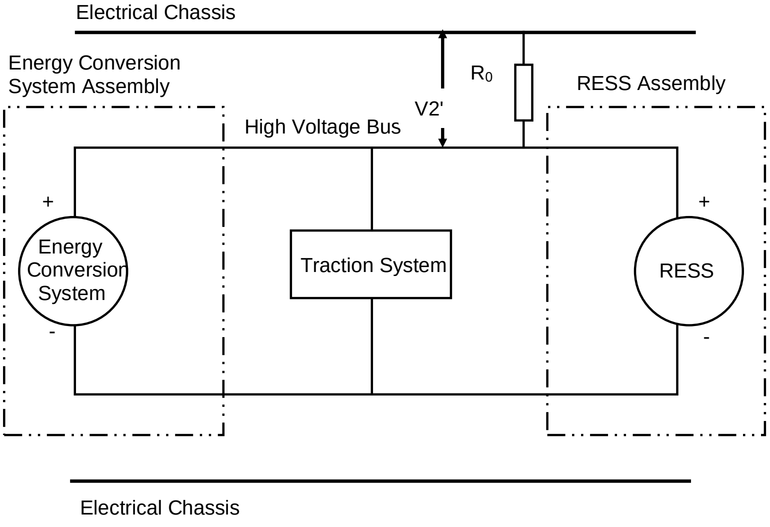


If V2 is greater than V1, insert a standard known resistance (Ro) between the positive side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V2') between the positive side of the high voltage bus and the electrical chassis. (See Figure 3). Calculate the electrical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

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

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

Figure 3 - Measurement of V2'

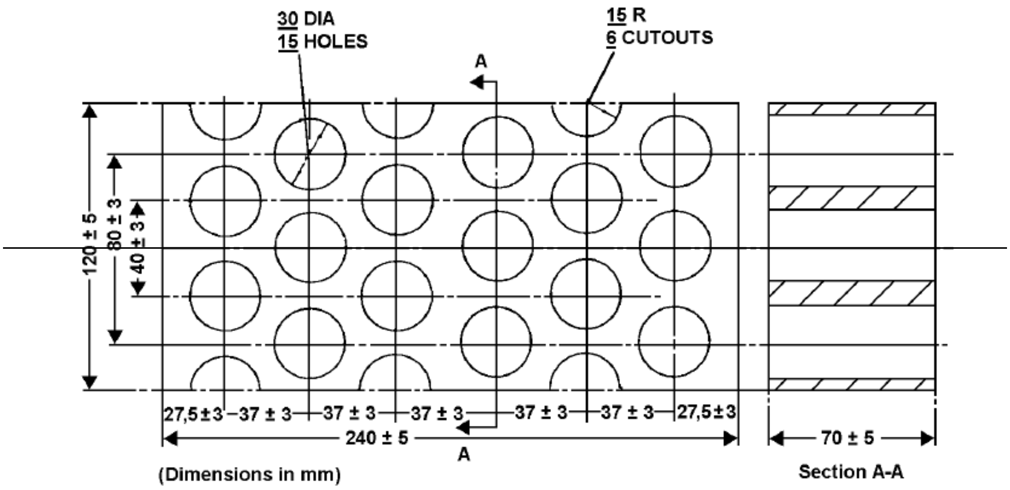


1.2.3.5. Fifth step

The electrical isolation value Ri (in Ω) divided by the nominal voltage ~~working voltage~~ of the RESS ~~high voltage bus~~ (in volts) results in the isolation resistance (in Ω/V).

NOTE 1: The standard known resistance Ro (in Ω) should be the value of the minimum required isolation resistance (in Ω/V) multiplied by the nominal ~~working~~ voltage of the RESS ~~vehicle~~ plus/minus 20 per cent (in volts). Ro is not required to be precisely this value since the equations are valid for any Ro; however, a Ro value in this range should provide good resolution for the voltage measurements.

ANNEX 2: DIMENSIONS AND TECHNICAL DATA OF FIREBRICKS



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

ANNEX 3: REQUIREMENTS FOR A STANDARD CYCLE

Conditions
The standard cycle is performed at RT (25 ± 5 ℃). 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

Comment [T55]: Proposal Sweden

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]

Page - 8 -: [1] Comment [T19]	Thomas	7/7/2011 10:45:00 AM

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

Page - 8 -: [2] Comment [T20]	Thomas	7/2/2011 2:46:00 PM

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.

Page - 8 -: [3] Comment [T21]	Thomas	7/3/2011 9:43:00 AM

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 - 8 -: [4] Comment [T24]	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 - 10 -: [5] Comment [TG32]	Thomas Goldbach	7/15/2011 12:57:00 PM

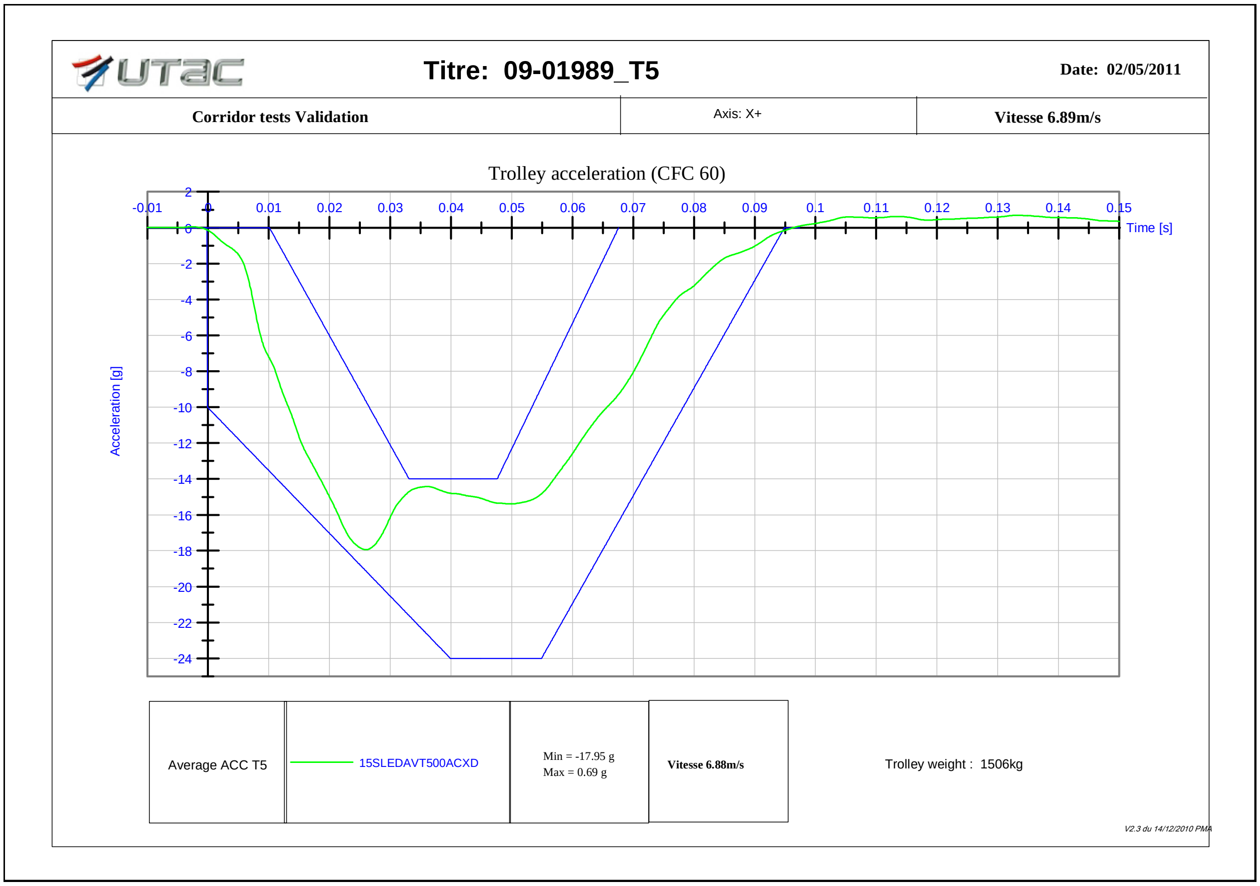
Comment Frontal Impact Informal Group & France

Side impact test for M1, N1

No existence of corridor corresponding to a R95 for component test.
We studied a corridor based on our experience of R95 impact tests (average of several tests).

Pulse proposal

The pulse into the corridor is a simulated pulse.



Page - 10 -: [6] Comment [TG33] Thomas Goldbach 7/15/2011 12:59:00 PM

Comment Frontal Impact Informal Group & France

<u>Corridor for M2, N2 and M3, N3 frontal and side impact tests</u>

We agree with values from RESS 3-3 rev 1 (which are the same values introduced in R110 and R67). Furthermore, we have to define a hold time, and we propose to apply the hold time from R80, which is 50ms, for the M2, N2, M3 and N3 categories.

Extract of R67:

« … The fuel container(s) must be mounted and fixed so that the following accelerations can be absorbed (without damage occurring) when the containers are full:

Vehicles of categories M1 and N1:

(a) 20 g in the direction of travel

(b) 8 g horizontally perpendicular to the direction of travel

Vehicles of categories M2 and N2:

(a) 10 g in the direction of travel

(b) 5 g horizontally perpendicular to the direction of travel

Vehicles of categories M3 and N3:

(a) 6. 6 g in the direction of travel

(b) 5 g horizontally perpendicular to the direction of travel

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