

## Supplement to the proposal for 04 series of amendments to Regulation No. 12

The text reproduced below was prepared by the expert from France in order to extend the scope of the present Regulation to all kinds of power train systems above a certain working voltage level. The modifications to the existing text of the Regulation R 12 are based on informal document No. GRSP- 46-04, distributed during the forty sixth session of the Working Party on Passive Safety (GRSP) and discussions made at the 3<sup>rd</sup> EVPC adhoc group meeting held in Bonn, 11-12 march 2010. This informal document supersedes document ECE/TRANS/WP.29/GRSP/2010/19 distributed as an official document for the forty-seventh session of the Working Party on Passive Safety (GRSP). The modifications to the existing text of Regulation No. 12 are originally marked in bold or strikethrough characters and the modifications resulting form the EVPC meeting are highlighted in grey colour.

Additional amendments and corrections were introduced for clarification to take into account remarks received, in order to have one consolidated document. Modifications to the existing text GRSP 47-02/Rev.1 are deleted or marked in italic characters and highlighted in grey colour. Additional justifications are provided at the end of the document.

### I. Proposal

Contents, insert a new Annex 7, to read:

“... ”

**Annex 7 - Test Procedures for the protection of the occupants of vehicles operating on electrical power from high voltage and electrolyte spillage.**

~~Appendix 1 – Protection against direct contacts of parts under voltage”~~

Appendix 1 – Jointed Test Finger (IPXXB) ”

Modify the paragraph 1 Scope, to read:

“1. SCOPE

1.1. This Regulation applies to the behaviour of the steering mechanism and to the electrical power train operating on high voltage as well as the high voltage components and systems which are galvanically connected to the high voltage bus of the electric power train, of motor vehicles of category M1, and vehicles of category N1, with a maximum permissible mass less than 1,500 kg, with regard to the protection of the occupants in a frontal collision.”

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Modify paragraph 2.2.2.1., to read:

“2.2.2.1. The structure, dimensions, lines and constituent materials of that part of the vehicle forward of the steering control.”; ~~Dimensions, mass, structure of the~~

~~vehicle, forms and constituent materials, place of the components of the electric power train propulsion system, place of the battery or of the parts of propulsion battery the rechargeable energy storage system (RESS).~~

Insert a new paragraph 2.2.2.2., to read:

“2.2.2.2. The locations of the RESS, in so far as they have a negative effect on the result of the impact test prescribed in this Regulation,”

Renumbered 2.2.2.2. as 2.2.2.3.

“2.2.2.3. Mass of the vehicle in running order, as defined in paragraph 2.18. below.”

Paragraph 2.16., amend to read:

“2.16. ~~“Passenger compartment with regard to driver protection” means the space for occupant accommodation, bounded by the roof, floor, side walls, doors, outside glazing, front bulkhead, and the plane of the rear compartment bulkhead or the plane of the rear seat back support, and if necessary any partition of the tray(s) containing the monoblocs of the electric vehicle's propulsion battery; For the sake of protection of occupants from high voltage and electrolyte spillage according to Annex 7 a different definition (see paragraph 2.36.) is applied.”~~

“2.16. Passenger compartment”

Insert new paragraphs 2.16.1. and 2.16.2., to read:

“2.16.1. “Passenger compartment with regard to occupant protection” means the space for occupant accommodation, bounded by the roof, floor, side walls, doors, outside glazing and front bulkhead and the plane of the rear compartment bulkhead or the plane of the rear-seat back support.

2.16.2. “Passenger compartment for electric safety assessment” means the space for occupant accommodation, bounded by the roof, floor, side walls, doors, outside glazing, front bulkhead and rear bulkhead, or rear gate, as well as by the electrical protection barriers and enclosures provided for protecting the power train from direct contact with high voltage live parts.”

Paragraph 2.18., amend to read:

“2.18. “Mass of the vehicle in running order” means the mass of the vehicle unoccupied and unladen but complete with fuel, coolant, lubricant tools and spare wheel, if provided as standard equipment by the vehicle manufacturer, and RESS. ~~propulsion battery tray(s) including the monoblocs of the electric vehicle's propulsion battery.~~”

Paragraphs 2.19. to 2.21., shall be deleted.

Insert new paragraphs 2.19. to 2.38. as renumbered, to read:

- ~~2.34.2.19.~~ “High Voltage” means the classification of an electric component or circuit, if its working voltage is > 60 V and < 1500 V direct current (DC) or > 30 V and < 1000 V alternating current (AC) root – mean – square (rms).
- 2.20. “Rechargeable energy storage system (RESS)” means rechargeable energy storage system that which provides the electrical energy for propulsion.
- ~~2.32.2.21.~~ “Electrical Protection Barrier” – / Protection Shielding / Shielding Barrier el/ High Voltage Protection” means the part providing protection against any direct contact to the high voltage live parts, from any direction of access.
- ~~2.19.2.22.~~ “Electrical power train” means the electrical circuit which includes the traction motor(s), and may also include the RESS, the electrical energy conversion system, the electronic converters, the associated wiring harness and connectors, and the coupling system for charging the RESS,
- ~~2.25.2.23.~~ “Live parts” means conductive part(s) intended to be electrically energized in normal use.
- ~~2.28.2.24.~~ “Exposed conductive part” means the conductive part which can be touched under the provisions of the protection degree IPXXB, and which becomes electrically energized under isolation failure conditions.
- ~~2.24.2.25.~~ “Direct contact” means the contact of persons with high voltage live parts.
- 2.26. ”Indirect contact” means the contact of persons with exposed conductive parts.
- 2.27. “Protection IPXXB-degree” means the protection from contact with high voltage live parts provided by either an electrical protection barrier or an enclosure related to the contact with live parts by a test probe, such as a and tested using a Jointed Test Finger (IPXXB) as defined described in paragraph 4 Appendix 1 of Annex 7.
- ~~2.30.2.28.~~ “Working voltage” means the highest value of an electrical circuit voltage root-mean-square (rms), specified by the manufacturer, which may occur between any conductive parts in open circuit conditions or under normal operating conditions. If the electrical circuit is divided by galvanic isolation, the working voltage is defined for each divided circuit, respectively.
- ~~2.23.2.29.~~ “Coupling system for charging the rechargeable energy storage system (RESS)” means the electrical circuit used for charging the RESS from an external electrical power supply including the vehicle inlet.
- ~~2.31.2.30.~~ “Electrical chassis” means a set made of conductive parts electrically linked together, whose electrical potential is taken as reference.
- ~~2.29.2.31.~~ “Electrical circuit” means an assembly of connected high voltage live parts which is designed to be electrically energized in normal operation.

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~~2.21-2.32.~~ “**Electrical energy conversion system**” means a system (e.g. fuel cell) that generates and provides electrical energy for electrical propulsion,

~~2.22-2.33.~~ “**Electronic converter**” means a device capable of controlling and/or converting electrical power for electrical propulsion,

~~2.33-2.34.~~ “**Enclosure**” means the part enclosing the internal units and providing protection against any direct contact, ~~from any direction of access,~~

~~2.35.~~ “**High Voltage Bus**” means the electrical circuit, including the coupling system for charging the RESS that operates on a high voltage,

~~2.36.~~ “**Passenger compartment for electric safety assessment**” means the space for occupant accommodation, bounded by the roof, floor, side walls, doors, window glass, front bulkhead and rear bulkhead, or rear gate, as well as by the barriers and enclosures provided for protecting the power train from direct contact with high voltage live parts,

~~2.37-2.36.~~ “**Solid insulator**” means the insulating coating of wiring harnesses provided in order to cover and prevent protect the high voltage live parts from any against direct contact, ~~from any direction of access.~~ This includes covers for insulating the high voltage live parts of connectors, and varnish or paint for the purpose of insulation,

~~2.37.~~ “**Automatic disconnect**” means a device that when triggered, galvanically separates the electrical energy sources from the rest of the high voltage circuit of the electrical power train,”

**2.38. "Open type traction battery" means a type of battery requiring liquid and generating hydrogen gas released to the atmosphere."**

Paragraphs 3.1.2.6. and 3.1.2.7., amend to read:

“3.1.2.6. evidence that the steering mechanism complies with the specifications of paragraph 5.2.2. of Regulation No. 94 if the application for approval is submitted by the applicant pursuant paragraph 5.1.2. below.

3.1.2.7. evidence that the steering control complies with the specifications of paragraphs 5.2.1.4. and 5.2.1.5. of Regulation No. 94, if the application for approval is submitted by the applicant pursuant paragraph 5.2.1. below.”

Insert a new paragraph 3.1.2.8., to read:

“3.1.2.8. A general description of the RESS electric power source type, and location and the electrical power train (e.g. hybrid, electric).”

Paragraph 3.2.2.3., amend to read:

Deleted: 2.20. “**Rechargeable energy storage system (RESS)**” means rechargeable energy storage system that which provides the electrical energy for propulsion,¶

Deleted: ~~2.23-2.29.~~ “**Coupling system for charging the rechargeable energy storage system (RESS)**” means the electrical circuit used for charging the RESS from an external electrical power supply including the vehicle inlet,¶

Deleted: ~~2.24-2.25.~~ “**Direct contact**” means the contact of persons with high voltage live parts,¶

~~2.25-2.23.~~ “**Live parts**” means conductive part(s) intended to be electrically energized in normal use,¶

2.26. “**Indirect contact**” means the contact of persons with exposed conductive parts,¶

2.27. “**Protection IPXXB degree**” means the protection from contact with high voltage live parts provided by either an electrical protection barrier or an enclosure related to the contact with live parts by a test probe, such as a and tested using a Jointed Test Finger (IPXXB) as defined described in paragraph 4 Appendix 1 of Annex 7,¶

~~2.28-2.24.~~ “**Exposed conductive part**” means the conductive part which can be touched under the provisions of the protection degree IPXXB, and which becomes electrically energized under isolation failure conditions,¶

~~2.29-2.31.~~ “**Electrical circuit**” means an assembly of connected high voltage live parts which is designed to be electrically ... [1]

Deleted: ~~2.34-2.19.~~ “**High Voltage**” means the classification of an electric component or circuit, if its working voltage is > 60 V and ≤ 1500 V direct current (DC) or > 30 V ... [2]

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“3.2.2.3. evidence that the steering control complies with the specifications of paragraphs 5.2.1.4. and 5.2.1.5. of Regulation No. 94, if the application for approval is submitted by the applicant pursuant paragraph 5.2.1. below.”

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Paragraph 4.2.2., amend to read:

“4.2.2. An approval number shall be assigned to each type approved. Its first two digits (at present 0304 corresponding to the 0304 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to the same vehicle type equipped with another type of steering mechanism, or to another vehicle type, as defined in paragraph 2.2. above.”

Deleted: , entered into force on 24 August 199303 [...]

Paragraph 4.3.2., amend to read:

“4.3.2. An approval number shall be assigned to each type approved. Its first two digits (at present 0304 corresponding to the 0304 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another steering control type as defined in paragraph 2.4. above.”

Deleted: , entered into force on 24 August 199303 [...]

Paragraph 4.3.4.3., amend to read:

“4.3.4.3. the symbol R94-0102 in the case of an approval pursuant paragraph 5.2.1. below.”

Paragraph 5.1.1., amend to read:

“5.1.1. ~~Additionally, vehicles equipped with electrical power train shall meet paragraph 5.5. in addition. This could be demonstrated in a separate frontal impact crash test at the request of the manufacturer after validation by the Technical Service, given that the electric components do not influence the driver's protection performance of the vehicle type as defined in this Regulation.~~”

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Paragraphs 5.1.1.1 and 5.1.1.2., shall be deleted.

Modify paragraph 5.1.2., to read:

“5.1.2. Specifications of paragraph 5.1. above are deemed to be met if the vehicle equipped with such a steering system complies with the specifications of paragraph 5.2.2. of Regulation No. 94.”

Deleted: , 0102 series of amendments

Modify paragraph 5.2.1., to read:

“5.2.1. If the steering control is fitted with a steering wheel airbag, specifications of paragraph 5.2. above are deemed to be met if the vehicle equipped with such a steering system complies with the specifications of paragraphs 5.2.1.4. and 5.2.1.5. of Regulation No. 94.”

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Insert new paragraphs 5.5. to 5.6. to read:

“5.5. Following the test conducted in accordance with the procedure defined in Annex 3 to this Regulation the electrical power train operating on high voltage ~~as well as~~ and the high voltage components and systems which are galvanically connected to the high voltage bus of the electrical power train shall meet the following requirements:

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5.5.1. Protection against electrical shock

After the impact at least one of the ~~four following~~ criteria specified in paragraph 5.5.1.1. to paragraph 5.5.1.4.2. shall be met.

If the vehicle has an automatic disconnect function or device(s) that galvanically divide the electrical power train circuit during driving condition, at least one of the following criteria shall apply to the disconnected circuit or to each divided ~~portion~~ circuit individually after the disconnect function is activated.

However criteria defined in 5.5.1.4. shall not apply if more than a single potential of a part of the high voltage bus is not protected under the conditions of protection IPXXB.

In the case that the test is performed under the condition that part(s) of the high voltage system are not energized, the protection against electrical shock shall be proved by either 5.5.1.3. or 5.5.1.4. for the relevant part(s).

5.5.1.1. Absence of high voltage

The voltages  $V_b$ ,  $V_1$  and  $V_2$  of the high voltage buses shall be equal or less than 30 VAC or 60 VDC as specified in Annex 7 paragraph 2.

5.5.1.2. Low electrical energy

The total energy ~~Energy~~ (TE) on the high voltage buses shall be less than ~~2.0 Joules~~ when measured according to the test procedure as specified in Annex 7 paragraph 3 formula (a). Alternatively the total energy (TE) may be calculated by the measured voltage  $V_b$  of the high voltage bus and the capacitance of the X-capacitors ( $C_x$ ) specified by the manufacturer ~~according~~ to Annex 7 paragraph 3 formula (b).

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The energy stored in the Y-capacitors ( $TE_{Y1}$ ,  $TE_{Y2}$ ) shall also be less than ~~2.0~~ Joules. This shall be calculated by measuring the voltages  $V_1$  and  $V_2$  of the high voltage buses and the electrical chassis, and the capacitance of the Y-capacitors specified by the manufacturer ~~according to~~ Annex 7 paragraph 3 formula (c).

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5.5.1.3. Physical protection

For protection against direct contact with ~~of~~ high voltage live parts, the protection ~~degree~~ IPXXB shall be provided.

In addition, for protection against electrical shock which could arise from indirect contact, the resistance between all exposed conductive parts and the electrical chassis shall be lower than 0.1 ohm when there is current flow of at least 0.2 amperes.

This requirement is satisfied if the galvanic connection has been made established by welding.

#### 5.5.1.4. Isolation resistance

The criteria specified in the paragraphs 5.5.1.4.1. and 5.5.1.4.2. below shall be met.

The measurement shall be conducted in accordance with to Annex 7 paragraph 5.

##### 5.5.1.4.1. Electrical power train consisting of separate DC- or AC-buses

If the AC high voltage buses and the DC high voltage buses are galvanically isolated from each other, isolation resistance between the high voltage bus and the electrical chassis ( $R_i$ , as defined in annex 7 paragraph 5) shall have a minimum value of 100  $\Omega$ /volt of the working voltage for DC buses, and a minimum value of 500  $\Omega$ /volt of the working voltage for AC buses.

##### 5.5.1.4.2. Electrical power train consisting of combined DC- and AC-buses

If the AC high voltage buses and the DC high voltage buses are galvanically connected isolation resistance between the high voltage bus and the electrical chassis ( $R_i$ , as defined in annex 7 paragraph 5) shall have a minimum value of 500  $\Omega$ /volt of the working voltage.

However, if the protection degree IPXXB is satisfied for all AC high voltage buses or the AC voltage is equal or less than 30 V after the vehicle impact-crash, the isolation resistance between the high voltage bus and the electrical chassis ( $R_i$ , as defined in annex 7 paragraph 5) shall have a minimum value of 100  $\Omega$ /volt of the working voltage.

#### 5.5.2. Electrolyte spillage

In the period from the impact until 30 minutes after no electrolyte from the RESS shall spill into the passenger compartment, and no more than 7 per cent with a maximum of 5.0 liters of electrolyte shall spill from the RESS except open type traction batteries outside the passenger compartment. For open type traction batteries no more than 7 per cent with a maximum of 5.0 liters shall spill outside the passenger compartment. The manufacturer shall demonstrate compliance in accordance with Annex 7 paragraph 6.

Deleted: In the period from the impact until 30 minutes after, no electrolyte from the [RESS] shall spill into the passenger compartment, and no more than [7 per cent with a maximum of / 5.0 liters] of electrolyte shall spill from the [RESS] outside the passenger compartment. If the electrolyte spillage mixes with other fluids leaking from the vehicle and the liquids cannot be clearly distinguished the total leakage shall be considered electrolyte spillage.

#### 5.5.3. [RESS] retention

**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 electrical safety assessment shall enter the passenger compartment during or after the impact test procedures.

The manufacturer shall demonstrate compliance in accordance with Annex 7 paragraph 7.

5.6. Specifications of Paragraphs 5.5.1 to 5.5.3. above are deemed to be met if the vehicle equipped with an electrical power train operating on high voltage complies with the specifications of Paragraphs 5.2.8.1 to 5.2.8.3. of Regulation No. 94, 02 series of amendments.”

Paragraph 6.1., amend to read:

“6.1. Compliance with the requirements of paragraphs 5.1. to 5.4. above shall be checked in accordance with the methods set out in Annexes 3, 4 and 5 to this Regulation. **Compliance with the requirements of paragraph 5.5 above shall be checked in accordance with the methods set out in annex 3 to this Regulation.** All measurements should be done on the basis of ISO 6487-1987.”

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Paragraph 13. TRANSITIONAL PROVISION, amend to read:

#### “13. TRANSITIONAL PROVISIONS

##### 13.1 General

13.1.1. As from the official date of entry into force of the 03 series of amendments to this Regulation, no Contracting Party shall refuse an application for approval submitted in accordance with this Regulation as amended by the 03 series of amendments.

13.1.2. As from the official date of entry into force of the 04 series of amendments to this Regulation, no Contracting Party shall refuse an application for approval submitted in accordance with this Regulation as amended by the 04 series of amendments.

##### 13.2. Approvals of vehicle type

13.2.1 Upon the expiration of a period of 36 months following the official date of entry into force referred to in Paragraph 13.1.1 above, Contracting Parties applying this Regulation shall grant approval for Category M1 forward-control vehicles and Category N1 vehicles of less than 1.5 t only if the vehicle type satisfies the requirements of this Regulation as amended by the 03 series of amendments, with the exception of the provisions laid down in Paragraph 5.1. of this Regulation concerning the maximum vertical displacement of the steering column, which shall apply to new approvals only after a further period of 12 months.

13.2.2 Upon the expiration of a period of 48 months following the official date of entry into force referred to in Paragraph 13.1.1 above, Contracting Parties applying this Regulation shall grant approval to Category M1 vehicles other than forward-control vehicles only if the vehicle type satisfies the requirements of this Regulation as amended by the 03 series of amendments.

13.2.3 Upon the expiration of a period of 60 months following the official date of entry into force referred to in Paragraph 13.1.1 above, Contracting Parties applying this Regulation may refuse to recognize approvals of the vehicle type which have not been granted in accordance with the 03 series of amendments to this Regulation.

~~13.2.4. Upon the expiration of a period of [...]~~ months following the official date of entry into force referred to in paragraph 13.1.2 above, Contracting Parties applying this Regulation shall grant approval for category M<sub>1</sub> forward control vehicles and category N<sub>1</sub> vehicles of less than 1.5 tonnes only if the vehicle type satisfies the requirements of this Regulation as amended by the 04 series of amendments.

~~13.2.5. Upon the expiration of a period of [...]~~ months following the official date of entry into force referred to in paragraph 13.1.2 above, Contracting Parties applying this Regulation shall grant approval to category M<sub>1</sub> vehicles other than forward control vehicles only if the vehicle type satisfies the requirements of this Regulation as amended by the 04 series of amendments.

13.2.4. As from [...] months, Contracting Parties applying this Regulation shall grant ECE approvals only to those types of vehicles which comply with the requirements of this Regulation as amended by the 04 series of amendments.

13.2.5. Contracting Parties applying this Regulation shall not refuse to grant extensions of approval to the preceding series of amendments to this Regulation.

~~13.2.6. Contracting Parties applying this Regulation shall continue to grant approvals to those types of vehicles which comply with the requirements of this Regulation as amended by the preceding series of amendments during the 36 months' period which follows the date of entry into force of the 04 series of amendments.~~

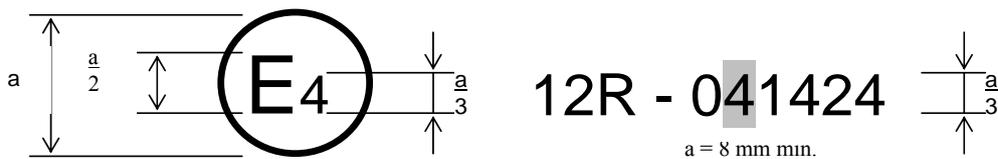
13.2.6 Contracting Parties may continue to apply the requirements with regard to electrical safety in the event of a frontal collision already in force at the time of acceding to 04 series of amendments.”<sup>1</sup>

Annex 2, amend to read:

“ARRANGEMENTS OF THE APPROVAL MARK

Model A

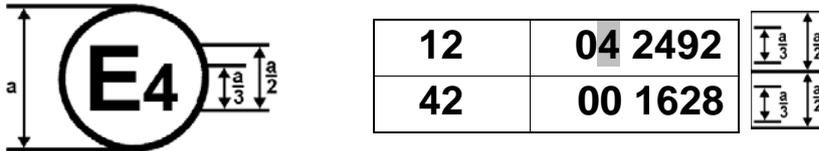
(See paragraph 4.2.4. of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the protection of the driver against the steering mechanism in the event of impact, been approved in the Netherlands (E4) pursuant to Regulation No. 12. The approval number indicates that the approval was granted according to the requirements of Regulation No. 12 as amended by the 03 04 series of amendments.

Model B

(See paragraph 4.2.5. of this Regulation)

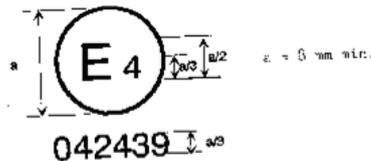


a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E4) pursuant to Regulations Nos. 12 and 3942.<sup>1/</sup> The approval numbers indicate that, at the dates when the respective approvals were given, Regulation No. 12 included the 0304 series of amendments and Regulation No. 3942 the 0400 series of amendments.

Model C

(See paragraph 4.3.4 of this Regulation)



The above approval mark affixed to a steering control shows that the steering control type concerned has, with regard to the protection of the driver against the steering mechanism in the event of impact, been approved in the Netherlands (E4) pursuant to the relevant part of Regulation No. 12 as amended by the 0304 series of amendments.”

Annex 3,

Paragraph 2.4.2., amend to read:

“2.4.2. If the vehicle is driven by external means, the fuel feed system shall be filled to at least 90 per cent, of its capacity with a non-inflammable liquid having a density between 0.7 and 1.

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<sup>1/</sup> The second number is given merely as an example.

This requirement does not apply for Hydrogen as fuel.

All the other systems (brake-fluid reservoirs, radiator, etc.) may be empty.”

~~At the request of the manufacturer it shall be allowed to perform the test with the engine or electric energy conversion system running and to allow for the fuel system to be modified in such a way that an appropriate amount of fuel can be used.~~

~~It shall be allowed by agreement between manufacturer and Technical Service to modify the fuel system so that an appropriate amount of fuel can be used to run the engine or the electrical energy conversion system.~~

~~This requirement does not apply to Hydrogen fuel tanks.~~

~~Alternative gas (i.e. helium gas) or alternative liquid (i.e. liquid nitrogen (LN2)) can be used instead of hydrogen gas or liquid hydrogen.~~

~~However the requirement of paragraph 5.2.8.1.3. shall be satisfied for the hydrogen conversion system disconnected by its automatic disconnect when this alternative is used.~~

Paragraph 2.4.3. amend to read:

“2.4.3. If the vehicle is driven by its own engine, the fuel tank shall be at least 90 **per cent** of a full load of fuel. All other reservoirs shall be filled to capacity.

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~~If the manufacturer so desires and the technical service agrees, the fuel feed to the engine may be provided from an auxiliary tank of small capacity.~~

~~It shall be allowed by agreement between manufacturer and Technical Service to modify the fuel system so that an appropriate amount of fuel can be used to run the engine or the electrical energy conversion system.~~

In such case, the fuel tank shall be filled to not less than 90 **per cent of mass of a full load of fuel** with a non-flammable liquid of a density between 0.7 and 1.

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~~This requirement does not apply to Hydrogen fuel tanks.”~~

Insert new paragraphs 2.4.4. to 2.4.4.2.2. to read:

“2.4.4. **Electrical power train adjustment**

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

2.4.4.2. ~~{The high voltage system shall be energized.}~~The electrical power train shall be energized with or without the operation of the original electrical energy sources (e.g. engine-generator, RESS or electric energy conversion system), however:

2.4.4.2.1. by the agreement between Technical Service and manufacturer it shall be permissible to perform the test with all or parts of the electrical power train

not being energized in so far as there is no negative influence on the test result. ~~In this case~~ For parts of the electrical power train not energized, the protection against electrical shock shall be proved by either physical protection or isolation resistance for relevant part(s) and appropriate additional evidence.

- 2.4.4.2.2. in the case where an automatic disconnect is provided, at the request of the manufacturer it shall be permissible to perform the test with the automatic disconnect being triggered. In this case it shall be demonstrated that the automatic disconnect would have operated during the impact test. This includes the automatic activation signal as well as the galvanic separation considering the conditions as seen during the impact.”

Paragraphs 2.4.4. and 2.4.5.(former), renumber as paragraphs 2.4.5. and 2.4.6, respectively.

Insert a new Annex 7 and Appendix 1, to read:

**“Annex 7**

**Test Procedures for the Protection of the occupants of vehicles operating on electrical power [against/ from] high voltage and electrolyte spillage**

This section describes test procedures to demonstrate compliance to the electrical safety requirements of paragraph 5.5. For example, megohmmeter or oscilloscope measurements are an appropriate alternative to the procedure described below for measuring isolation resistance. *In this case it may be necessary to deactivate the on-board isolation resistance monitoring system.*

~~The following procedures should be performed for each of the specified crash tests.~~

~~Before the vehicle impact crash test conducted, measure and record the high voltage bus voltage (Vb) (see figure 1) shall be measured and recorded to and confirm that it is within the operating voltage of the vehicle as defined specified by the vehicle manufacturer.~~

**1. Test setup and equipment**

If a high voltage disconnect function is used, measurements are to be taken from both sides of the device performing the disconnect function.

However, if the high voltage disconnect is integral to the RESS or the energy conversion system and the high-voltage bus of the RESS or the energy conversion system is protected according to class protection IPXXB following the impact ~~after crash test~~, measurements may be taken only be taken between the ~~downstream of the~~ device performing the disconnect function and the electrical loads.

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

~~Before the vehicle impact crash test, measure and record the high voltage bus voltage (Vb) (see figure 1) shall be measured and recorded to and~~

confirm that it is within the operating voltage of the vehicle as defined specified by the vehicle manufacturer.

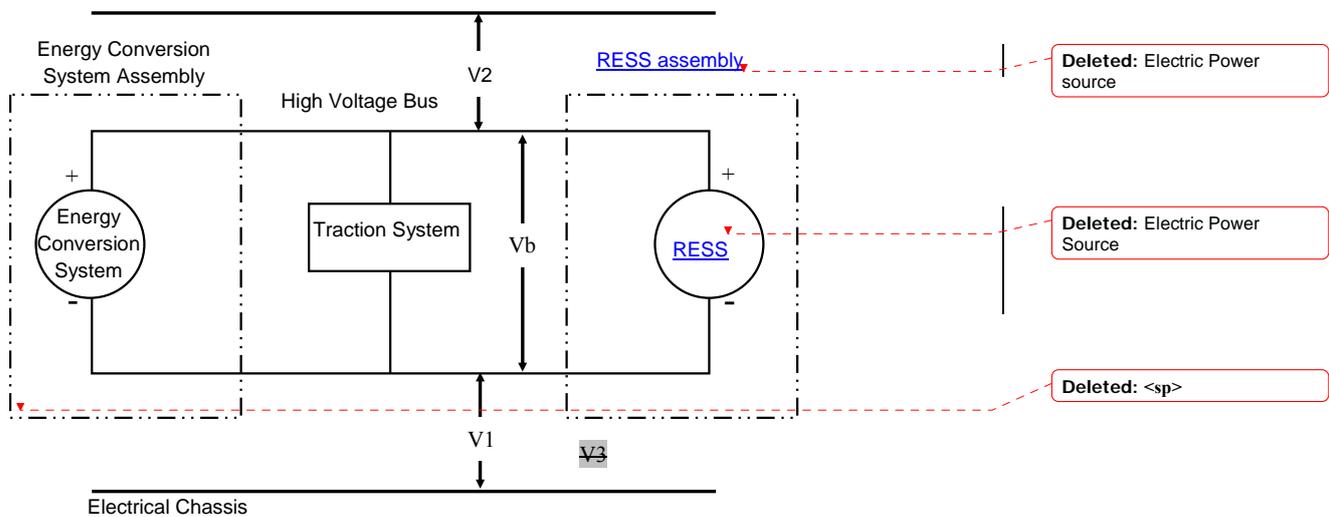
2. The following instructions may be used if voltage is measured.

After the impact ~~crash~~-test, determine the high voltage bus voltages ( $V_b$ ,  $V_1$ ,  $V_2$ ) (see figure 1). ~~If the RESS has exposed conductive parts, measure the voltage  $V_3$  between any exposed conductive parts of it and the electrical chassis.~~

~~The measurement shall be made at 5 seconds after the impact.~~

The voltage measurement shall be made not earlier than 5 seconds but not later than 60 seconds after the impact.

This procedure is not applicable if the test is performed under the condition where the electrical power train is not energized.



**Figure 1:** Measurement of  $V_b$ ,  $V_1$ ,  $V_2$ ,  $V_3$

3. Assessment procedure for low electrical energy

Prior to the impact a switch  $S_1$  and a known discharge resistor  $R_e$  is connected in parallel to the relevant capacitance (ref. figure 2). ~~installed according to figure 2.~~

Not earlier than 5 seconds and not later than 60 seconds ~~At 5 seconds~~ after the impact the switch  $S_1$  shall be ~~is~~ closed while the voltage  $V_b$  and the current  $I_e$  are ~~is~~ measured and recorded. The product of the voltage  $V_b$  and the current  $I_e$  shall be ~~is~~ integrated over the period of time, starting from the moment when the switch  $S_1$  is closed ( $t_c$ ) until the voltage  $V_b$

falls below the high voltage threshold of 30 V AC or 60 V DC ( $t_h$ ). The resulting integration equals in the total energy (TE) in joules:

$$(a) \quad TE = \int_{t_c}^{t_h} V_b \times I_e dt$$

When  $V_b$  is measured at a point in time between 5 seconds and 60 seconds after the impact and the capacitance of the X-capacitors ( $C_x$ ) is specified by the manufacturer, total energy (TE) shall be calculated according to the following formula:

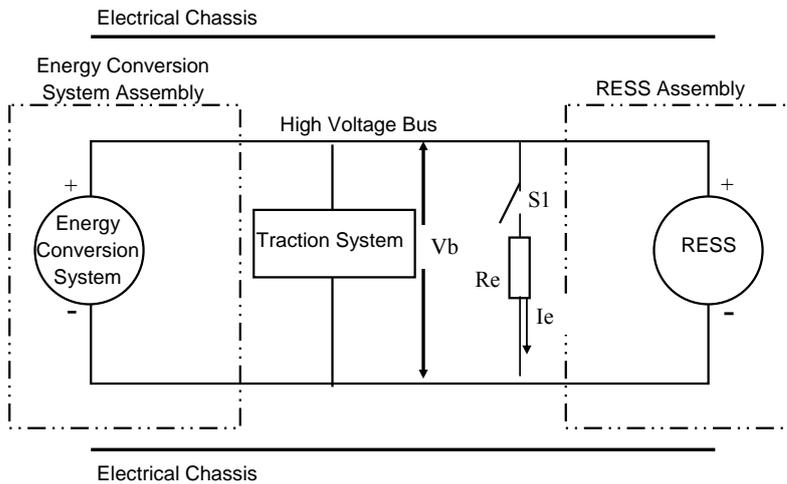
$$(b) \quad TE = 0.5 \times C_x \times (V_b^2 - 3600 \text{ Volt}^2)$$

When  $V_1, V_2$  (see figure 1) are measured at a point in time between 5 seconds and 60 seconds after the impact and the capacitances of the Y-capacitors ( $C_{y1}, C_{y2}$ ) are specified by the manufacturer, total energy ( $TE_{y1}, TE_{y2}$ ) shall be calculated according to the following formulas:

$$(c) \quad TE_{y1} = 0.5 \times C_{y1} \times (V_1^2 - 3600 \text{ Volt}^2)$$

$$TE_{y2} = 0.5 \times C_{y2} \times (V_2^2 - 3600 \text{ Volt}^2)$$

This procedure is not applicable if the test is performed under the condition where the electrical power train is not energized.



**Figure 2:** E.g. Measurement of high voltage bus energy stored in X-capacitors

#### 4. Physical protection

The manufacturer shall define the physical barriers, enclosures and solid insulators that protect the human from the direct contact with the high voltage bus in use (hereinafter referred to as the 'original physical protection').

~~After crash~~ Following the vehicle impact test any ~~surrounding parts~~ surrounding ~~of the high voltage components~~ shall be, without the use of tools, ~~that can be opened, disassembled or removed, without the use of tools shall be opened, disassembled or removed.~~ Only All remaining surrounding parts that cannot be opened, disassembled or removed without the use of tools are shall be considered as a part of the ~~original~~ physical protection.

The Jointed Test Finger ~~access probe~~ described in Appendix 1 figure 1 is ~~pushed against~~ shall be inserted into any gaps or openings of the ~~original~~ physical protection with a ~~the~~ test force of  $10\text{ N} \pm 10\text{ per cent}$  for electrical safety assessment. If partial or full penetration ~~it partly or fully penetrates~~ into the ~~original~~ physical protection by the Jointed Test Finger occurs, ~~it is~~ the Jointed Test Finger shall be placed in every ~~possible~~ position as specified below.

Starting from the straight position, both joints of the test finger shall be rotated progressively ~~successively bent~~ through an angle of up to 90 degrees with respect to the axis of the adjoining section of the finger and shall be placed in every possible position.

Internal barriers are considered part of the enclosure.

If appropriate a low-voltage supply (of not less than 40 V and not more than 50 V) in series with a suitable lamp should be connected, between the Jointed Test Finger and high voltage live parts inside the electrical protection barrier or enclosure.

#### 4.1. Acceptance conditions

The requirements of paragraph 5.5.1.3 shall be considered to be met if the Jointed Test Finger ~~access probe~~ described in Appendix 1, figure 1 ~~shall not~~ is unable to contact ~~touch~~ high voltage live parts.

If necessary a ~~A~~ mirror or a fiberscope may be used in order to inspect whether the Jointed Test Finger touches the high voltage buses, ~~if necessary.~~

If this requirement is verified by a signal circuit between the Jointed Test Finger and high voltage live parts, the lamp shall not light.

#### 5. Isolation resistance

The isolation resistance between the high voltage bus and the electrical chassis may be demonstrated either by measurement or by a combination of measurement and calculation.

The following instructions should ~~may~~ be used if the isolation resistance is demonstrated by measurement.

~~[Before the vehicle crash test, measure and record the high voltage bus voltage (Vb) (see figure 1). Vb must be equal to or greater than the nominal operating voltage as defined by the vehicle manufacturer.]~~

~~[The vehicle manufacturer is allowed to calculate or simulate this value instead of measuring this after the crash.]~~

Measure and record the voltage (Vb) between the negative and the positive side of the high voltage bus (see figure 1):

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

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

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 vehicle electrical chassis (see Figure 3). Calculate the isolation resistance (Ri) according to the formula shown below.

$$R_i = R_o * (V_b / V1' - V_b / V1) \quad \text{or} \quad R_i = R_o * V_b * (1 / V1' - 1 / V1)$$

Divide the result Ri, which is the ~~this~~ electrical isolation resistance value ( $\Omega$ ) by the working voltage of the high voltage bus (in volts Volt).

$$R_i (\Omega / V) = R_i (\Omega) / \text{Working voltage (V)}$$

$$R_i = R_o * (V_b / V1' - V_b / V1) \quad \text{or} \quad R_i = R_o * V_b * (1 / V1' - 1 / V1)$$

Electrical Chassis

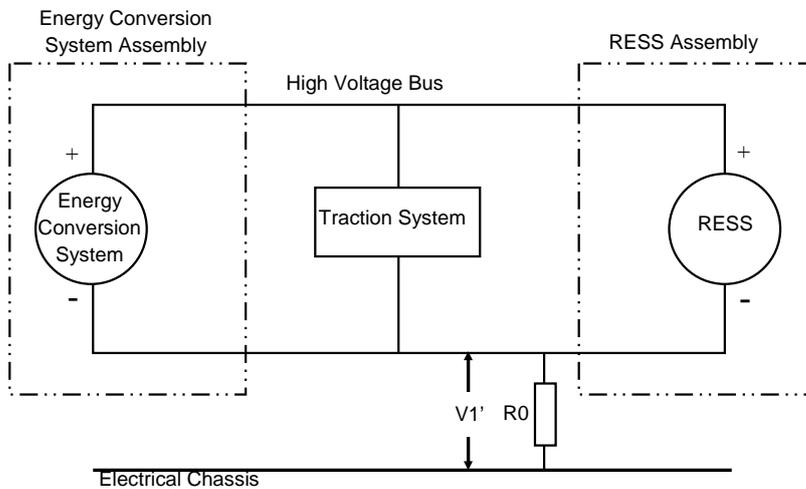


Figure 3: Measurement of V1'

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 4).

Calculate the isolation resistance (Ri) according to the formula shown below. Divide the result, which is the ~~this~~ electrical isolation value (in  $\Omega$ ) by the working voltage of the high voltage bus (in volts).

$$R_i = R_o * (V_b / V2' - V_b / V2) \quad \text{or} \quad R_i = R_o * V_b * (1 / V2' - 1 / V2)$$

Divide the result Ri, which is the electrical isolation resistance value ( $\Omega$ ) by the working voltage of the high voltage bus (Volt).

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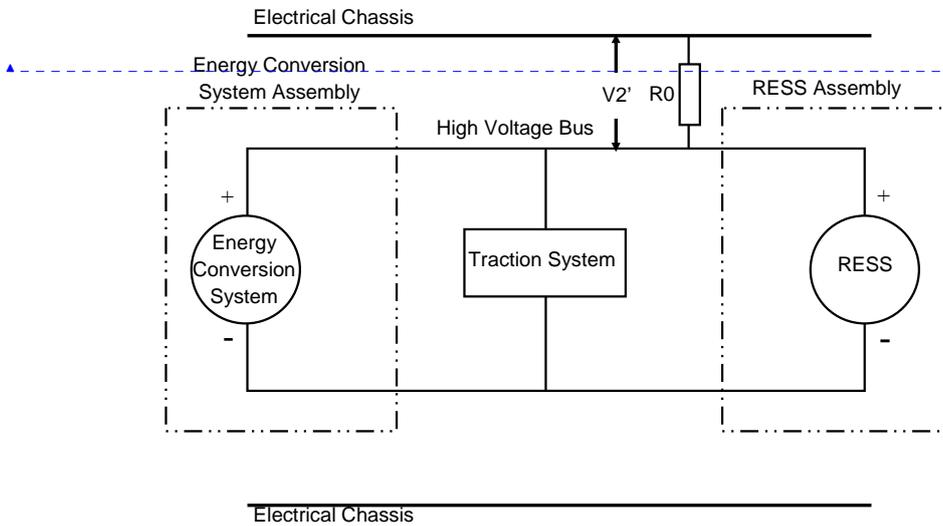
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$$R_i (\Omega / V) = R_i (\Omega) / \text{Working voltage (V)}$$

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**Figure 4:** Measurement of  $V_2'$

**Note 1:** The standard known resistance  $R_0$  ( $\Omega$ ) should be approximately 500 times the working voltage of the vehicle the value of the minimum required isolation resistance ( $\Omega/V$ ) multiplied by the working voltage of the vehicle plus/minus 20 per cent (in volts/Volt).  $R_0$  is not required to be precisely this value since the equations are valid for any  $R_0$ ; however, an  $R_0$  value in this range should provide a good resolution for the voltage measurements.

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The isolation resistance between the high voltage bus and the electrical chassis may be demonstrated by calculation, measurement or a combination of both.

#### 6. Electrolyte spillage

Appropriate coating paint shall be applied, if necessary, to the original physical protection in order to confirm the any electrolyte leakage is leaking from the RESS after the collision impact test.

Add color to other liquid (such as coolant, oil, fuel, etc.), if necessary, so that the electrolyte and other liquid can be classified or separated.

If the electrolyte cannot be clearly identified from the other leaking liquids, all liquid shall be considered as the electrolyte.

Unless the manufacturer provides means to differentiate between the leakage of different liquids, all liquid leakage shall be considered as the electrolyte.

7. RESS retention  
Compliance shall be determined by visual inspection.

Appendix 1

JOINTED TEST FINGER (IPXXB)

Protection against direct contacts of parts under voltage

1. Access probes

Access probes to verify the protection of persons against access to live parts are given in figure 1.

2. Test conditions

The access probe is pushed against any openings of the enclosure with the force specified in paragraph 4 of this annex. If it partly or fully penetrates, it is placed in every possible position, but in no case shall the stop face fully penetrate through the opening.

Internal barriers are considered part of the enclosure

A low-voltage supply (of not less than 40 V and not more than 50 V) in series with a suitable lamp should be connected, if necessary, between the probe and live parts inside the barrier or enclosure.

The signal circuit method should also be applied to the moving live parts of high-voltage equipment.

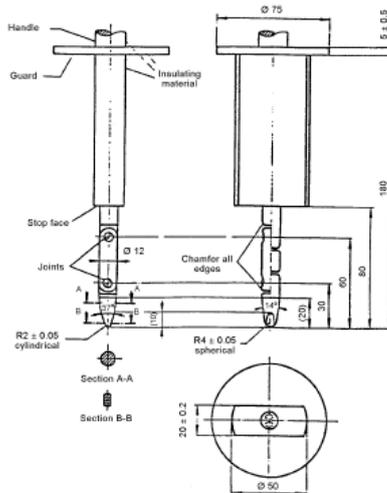
Internal moving parts may be operated slowly, where this is possible.

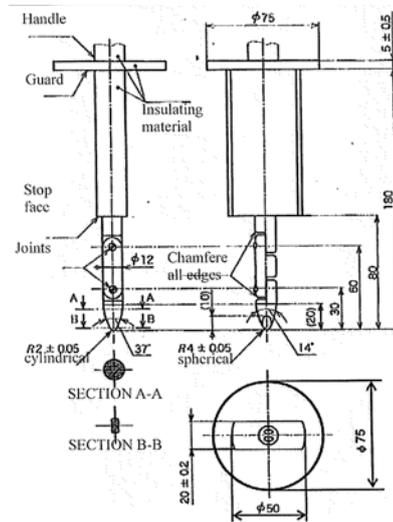
3. Acceptance conditions

The access probe shall not touch live parts.

If this requirement is verified by a signal circuit between the probe and live parts, the lamp shall not light.

In the case of the test for IPXXB, the jointed test finger may penetrate to its 80 mm length, but the stop face (diameter 50 mm x 20 mm) shall not pass through the opening. Starting from the straight position, both joints of the test finger shall be successively bent through an angle of up to 90 degree with respect to the axis of the adjoining section of the finger and shall be placed in every possible position.





**Figure 1: Jointed test finger**

**Material: metal, except where otherwise specified**

**Linear dimensions in millimeters**

**Tolerances on dimensions without specific tolerance:**

- (a) on angles: 0/-10°
- (b) on linear dimensions: up to 25 mm: 0/-0.05 mm over 25 mm: ± 0.2 mm

**Both joints shall permit movement in the same plane and the same direction through an angle of 90° with a 0 to +10° tolerance.”**

## II. Justification

Regulation No. 12 already includes prescriptions regarding vehicles powered by electric motor(s). This amendment is to propose to align the text of the Regulation 12 with those amendments proposed for Regulations Nos. 94 and 95.

This proposal incorporates provisions in order to ensure that M<sub>1</sub> and N<sub>1</sub> vehicles, as defined in the scope of Regulation No. 12, with power train systems above a certain working voltage level, comply with general requirements on the electrical safety, for the

protection of the driver and other occupants, after an impact test. The electrical safety requirements are based on the 01 series of amendments to Regulation No. 100, Informal document No.GRSP-46-04 distributed during the forty-sixth session of GRSP and of the results at the EVPC informal group meetings held in Paris on 13-14 January 2010, and on 11-12 March in Bonn. Justifications on Rev A are given at the end of this document.

*Contents,*

*New Annex 7,*

A new annex is inserted to cover electrical safety requirements based on the 01 series of amendments to Regulation No. 100.

*New paragraph 2.2.2.1.:*

The place of the electrical source(s) has been introduced in the vehicle type definition as a new parameter to take into account.

*Paragraphs 2.16. to 2.18.*

The proposed amendment is needed with regard to the new prescriptions introduced for the passenger compartment for pure electrical safety aspects which is different from the original protection of the driver.

*New paragraphs 2.19. to 2.37.:*

The proposed amendment to this paragraph is needed with regard to the new provisions introduced for the passenger compartment for pure electrical safety aspects which are different from the original protection of occupants.

*New paragraph 3.1.2.8., to read:*

“Application for approval” is modified to include information on the rechargeable energy storage system (RESS) type and the location of the electrical power train.

Insert a new paragraph 5.1.1., to read:

In this paragraph the new paragraph 5.1.1 is mentioned to provide electrical requirements to fulfil the electrical vehicle safety. It also introduces the possibility for the manufacturer to perform a separate impact test for the assessment of the electrical safety of electric vehicles.

*New paragraphs 5.5. to 5.5.3.*

These paragraphs deal with:

- (a) Electrical safety requirements;
- (b) Spillage requirements for RESS;
- (c) Cells and RESS locations and retention.

Control of electrical safety prescriptions is satisfied if at least one the four following requirements is met:

- (a) Absence of high voltage;
- (b) Energy on high voltage bus less than 0.2 j;
- (c) Physical barrier protection IPXXB and resistance between the electrical chassis and all exposed conductive parts shall be less than 0.1 ohm;
- (d) Isolation resistance.

This proposal refers to the 01 series of amendments to Regulation No. 100, considering separate or combined DC-AC buses to specify the minimum insulation resistance to achieve.

Modifications introduced reflect the state of discussions in the EVPC informal group.

*Annexe 2: update the example for the marking*

*Annex 3,*

*Paragraph 2.4.2.:*

This paragraph has been revised to allow performing tests with the fuel system modified to have the engine running (e.g. with an additional small fuel tank) or the electrical energy conversion system running.

*Paragraph 2.4.3.:*

Hydrogen storage systems initially introduced have to be taken into account in another regulation.

*New paragraphs 2.4.4 to 2.4.5.:*

These paragraphs describe the test conditions of the electrical power train.

*Insert a new Annex 7:*

This annex describes the test setup, measuring equipment and the different test procedure that can be used for validation of the different options mentioned in paragraph 5.5.3.

- (a) Bus voltage
- (b) Isolation resistance
- (c) Electrical energy
- (d) Physical barrier

Isolation resistance measurement and physical barrier protection requirements are in line with the 01 series of amendments to Regulation No. 100. Accordingly, Appendix 1 introduces the jointed test finger for the protection against direct contacts of parts under voltage.

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#### Justifications for additional amendments marked in italic

*Paragraph 5.5.1.2. Low electrical energy*

The first amendment clarifies that the determination of energy with the X-capacitors value, together with Vb, is an alternative to test procedure mentioned in Annex 11. Furthermore, it was not described how the TE has to be calculated on the basis of the X-capacitors and Vb. A formula is also added to the annex and a hint to this is necessary here.

The second modification is to clarified that, in addition to TE, the total energy of the Y-capacitors has also to be checked whether it is below 0,2 Joule. This has to be checked for both voltages V1 and V2. It is also here necessary to add two formulas in annex 11 and to make here a hint to the formula in the annex.

*New paragraph 5.6*

A clause is necessary to address the situation that a vehicle already approved under R94 has not to do it again under R12 for electrical safety, as it is already made for ICE vehicle in paragraph 3.2.2.3.

*Modify paragraph 13.2.4. to 13.2.5 to update them according to R 94 and R 95*

*Paragraph 13, modify 13.2.6*

*13.2.6 Contracting Parties may continue to apply the requirements with regard to electrical safety in the event of a frontal collision already in force at the time of acceding to 04 series of amendments.”*

As the proposed 13.2.6 is not really necessary, we proposed to replace it by the above proposal to take into account a proposal from Japan.

*Annex 3, modify paragraph 5.11.2.1.*

These prescriptions allow that only parts of the system are not energized. Therefore it is possible that other parts are energized and it will not be possible to use for these parts the “voltage- or energy-option», according to the second part of the paragraph. Furthermore, in Annex 7, at the end of the test procedure for both dynamic measures, it is mentioned that this procedure is not applicable if the test is performed under the condition where the electric power train is not energized. Therefore, the second sentence has to be modified to allow this possibility.

*Annex 7*

It is likely that an active onboard isolation resistance monitoring system will not allow conducting the measurements. Therefore it is necessary to allow deactivating the system. This is also allowed in the new ECE R100.

*Annex 7, paragraph 1*

The measurement of  $V_b$ , which is showing that the right vehicle was crashed, should not be mentioned under the following topic “Test setup and equipment”. It is the understanding of the crash-experts that when it is mentioned there, it is not possible to conduct the test with the systems not energized but this is an allowed possibility. In addition, to make it clear that this requirement has to be checked before the impact test the word “conducted” is added.

*Annex 7, paragraph 3*

When after the impact test, no energy will be produce (e.g. recuperation), no AC V will be in the system. Therefore, when this is the case only DC Voltage has to be considered.  
(delete 30 VAC)

Formulas are those already mentioned under 5.5.1.2. The  $3\ 600\ \text{Volt}^2$  are expressing the agreement that only the energy above 60 V has to be considered.

- ~~2.24~~.2.25. **“Direct contact”** means the contact of persons with high voltage live parts,
- ~~2.25~~.2.23. **“Live parts”** means conductive part(s) intended to be electrically energized in normal use,
- 2.26. **“Indirect contact”** means the contact of persons with exposed conductive parts,
- 2.27. **“Protection IPXXB-degree”** means the protection from contact with high voltage live parts provided by either an electrical protection barrier or an enclosure related to the contact with live parts by a test probe, such as a and tested using a Jointed Test Finger (IPXXB) as defined-described in paragraph 4 Appendix 1 of Annex 7,
- ~~2.28~~.2.24. **“Exposed conductive part”** means the conductive part which can be touched under the provisions of the protection-degree IPXXB, and which becomes electrically energized under isolation failure conditions,
- ~~2.29~~.2.31. **“Electrical circuit”** means an assembly of connected high voltage live parts which is designed to be electrically energized in normal operation,
- ~~2.30~~.2.28. **“Working voltage”** means the highest value of an electrical circuit voltage root-mean-square (rms), specified by the manufacturer, which may occur between any conductive parts in open circuit conditions or under normal operating conditions. If the electrical circuit is divided by galvanic isolation, the working voltage is defined for each divided circuit, respectively,
- ~~2.31~~.2.30. **“Electrical chassis”** means a set made of conductive parts electrically linked together, whose electrical potential is taken as reference,
- ~~2.32~~.2.21. **“Electrical Protection Barrier” / Protection Shielding / Shielding / Barrier el/ High Voltage Protection”** means the part providing protection against any direct contact to the high voltage live parts, from any direction of access,

- ~~2.34~~.2.19. **“High Voltage”** means the classification of an electric component or circuit, if its working voltage is  $> 60 \text{ V}$  and  $\leq 1500 \text{ V}$  direct current (DC) or  $> 30 \text{ V}$  and  $\leq 1000 \text{ V}$  alternating current (AC) root – mean – square (rms),