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Proposal for a new UN Regulation on the approval of vehicles, the safety of their High Voltage Systems, and Fuel Integrity in a Rear-End collision

Proposal for a new UN Regulation concerning the approval of vehicles with regard to the safety of their High Voltage Systems and with regard to Fuel Integrity in a Rear-End collision

Submitted by the expert from the European Commission on behalf of the drafting task force*

The text reproduced below was prepared by the experts of the drafting task force to align UN Regulations to the provisions of the revised General Safety Regulation of the European Union.

* In accordance with the programme of work of the Inland Transport Committee for 2018–2019 (ECE/TRANS/274, para. 123 and ECE/TRANS/2018/21/Add.1, Cluster 3.1), the World Forum will develop, harmonize and update UN regulations to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

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I. Proposal

New UN Regulation on uniform provisions concerning the approval of vehicles with regard to the safety of their High Voltage Systems and with regard to Fuel Integrity in a Rear-End collision

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1. Scope

This UN Regulation applies to vehicles of category M_1[1] with a total permissible mass not exceeding 3,500 kg and to vehicles of category N_1 with regard to fuel integrity and safety of high voltage systems in case of a rear-end collision.

2. Definitions

2.1. In defining the dimensions, the following simplified terminology is used:

2.1.1. a "*transverse plane*" is a vertical plane perpendicular to the median longitudinal plane of the vehicle.

2.1.2. a "*longitudinal plane*" is a vertical plane parallel to the median longitudinal plane of the vehicle.

2.1.3. the vehicle's "reference plane" is a plane related to the vehicle and horizontal when the vehicle in the state defined in paragraph 2.2.4. below rests on a horizontal plane.

2.2. For the purpose of this UN Regulation:

2.2.1. "*approval of a vehicle*" means the approval of a vehicle type with regard to the behaviour of the structure of the passenger compartment in a rear-end collision.

2.2.2. "*vehicle type*" means a category of power-driven vehicles which do not differ in such essential respects as:

2.2.2.1. the length and width of the vehicle in so far as they have an effect on the results of the impact test prescribed in this UN Regulation.

2.2.2.2. the structure, dimensions, lines and materials of the part of the vehicle rearward of the transverse plane through the "R" point of the rearmost seat.

2.2.2.3. the lines and inside dimensions of the passenger compartment in so far as they have an effect on the results of the impact test prescribed in this UN Regulation.

2.2.2.4. The siting (front, rear or centre) and the orientation (transversal or longitudinal) of the engine, in so far as they have a negative effect on the result of the impact test procedure as prescribed in this UN Regulation.

2.2.2.5 The unladen mass, in so far as there is a negative effect on the result of the impact test prescribed in this UN Regulation.

2.2.2.6. The locations of the REESS, in so far as they have a negative effect on the result of the impact test prescribed in this UN Regulation.

2.2.3. "*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 occupants from direct contact with high voltage live parts.

2.2.4. "*unladen kerb weight*" means the weight of the vehicle in running order, unoccupied and unladen but complete with fuel, coolant, lubricant, tools and a spare wheel (if provided as standard equipment by the vehicle manufacturer).

2.2.5. "*capacity of the fuel tank*" means the fuel-tank capacity as specified by the manufacturer.

[1] As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6, para. 2. – www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

2.2.6. "*High voltage*" means the classification of an electric component or circuit, if its working voltage is > 60 V and ≤ 1,500 V direct current (DC) or > 30 V and ≤ 1,000 V alternating current (AC) root – mean – square (rms).

2.2.7. "*Rechargeable electrical energy storage system (REESS)*" means the rechargeable electrical energy storage system which provides electrical energy for propulsion.

2.2.8. "*Electrical protection barrier*" means the part providing protection against any direct contact to the high voltage live parts.

2.2.9. "*Electrical power train*" means the electrical circuit which includes the traction motor(s), and may also include the REESS, the electrical energy conversion system, the electronic converters, the associated wiring harness and connectors, and the coupling system for charging the REESS.

2.2.10. "*Live parts*" means conductive part(s) intended to be electrically energized in normal use.

2.2.11. "*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. This includes parts under a cover that can be removed without using tools.

2.2.12. "*Direct contact*" means the contact of persons with high voltage live parts.

2.2.13. "*Indirect contact*" means the contact of persons with exposed conductive parts.

2.2.14. "*Protection degree IPXXB*" means protection from contact with high voltage live parts provided by either an electrical protection barrier or an enclosure and tested using a Jointed Test Finger (degree IPXXB) as described in paragraph 4. of Annex 4.

2.2.15. "*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.

2.2.16. "*Coupling system for charging the rechargeable electrical energy storage system (REESS)*" means the electrical circuit used for charging the REESS from an external electrical power supply including the vehicle inlet.

2.2.17. "*Electrical chassis*" means a set made of conductive parts electrically linked together, whose electrical potential is taken as reference.

2.2.18. "*Electrical circuit*" means an assembly of connected high voltage live parts which is designed to be electrically energized in normal operation.

2.2.19. "*Electrical energy conversion system*" means a system (e.g. fuel cell) that generates and provides electrical energy for electrical propulsion.

2.2.20. "*Electronic converter*" means a device capable of controlling and/or converting electrical power for electrical propulsion.

2.2.21. "*Enclosure*" means the part enclosing the internal units and providing protection against any direct contact.

2.2.22. "*High Voltage Bus*" means the electrical circuit, including the coupling system for charging the REESS that operates on a high voltage.

2.2.23. "*Solid insulator*" means the insulating coating of wiring harnesses, provided in order to cover and prevent the high voltage live parts from any direct contact. This includes covers for insulating the high voltage live parts of connectors; and varnish or paint for the purpose of insulation.

2.2.24. "*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.

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

3. Application for Approval

3.1. The application for approval of a vehicle type for the behaviour of the structure of the passenger compartment in a rear-end collision shall be submitted by the vehicle manufacturer or by their duly accredited representative.

3.2. It shall be accompanied by the undermentioned documents in triplicate, and by the following particulars:

3.2.1. a detailed description of the vehicle type with respect to its high voltage system, fuel system, dimensions, lines and constituent materials;

3.2.2. drawings of the vehicle showing the vehicle type in front, side and rear elevation and design details of the rear part of the structure; and

3.2.3. particulars of the vehicle's unladen kerb weight.

3.2.4. The lines and inside dimensions of the passenger compartment;

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

3.3. The applicant for approval shall be entitled to present any data and results of tests carried out which make it possible to establish that compliance with the requirements can be achieved with a sufficient degree of confidence.

3.4. A vehicle representative of the type to be approved shall be submitted to the technical service responsible for conducting the approval tests.

3.4.1. A vehicle not compromising all the components proper to the type may be accepted for test provided that it can be shown that the absence of the components omitted has no detrimental effect on the results of the test, so far as the requirements of this UN Regulation are concerned.

3.4.2. It shall be the responsibility of the applicant for approval to show that acceptance of the variants referred to in paragraph 3.4.1. is compatible with compliance with the requirements of this UN Regulation.

4. Approval

4.1. If the vehicle submitted for approval pursuant to this UN Regulation meets the requirements of this UN Regulation, approval of that vehicle type shall be granted.

4.1.1. The Technical Service appointed in accordance with paragraph 11. below shall check whether the required conditions have been satisfied.

4.1.2. In case of doubt, account shall be taken, when verifying the conformity of the vehicle to the requirements of this UN Regulation, of any data or test results provided by the manufacturer which can be taken into consideration in validating the approval test carried out by the Technical Service.

4.2. An approval number shall be assigned to each type approved. Its first two digits shall indicate the series of amendments incorporating the most recent major technical amendments made to the UN Regulation at the time of issue of the approval. The same Contracting Party may not assign the same approval number to another vehicle type.

4.3. Notice of approval or of extension or of refusal or withdrawal of approval or production definitely discontinued of a vehicle type pursuant to this UN Regulation shall be communicated to the Parties to the Agreement which apply this UN Regulation by means of a form conforming to the model in annex 1 to this UN Regulation.

4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this UN Regulation.

4.4.1. an international approval mark consisting of:

4.4.1.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval[2];

4.4.1.2. the number of this UN Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.1.

4.5. If the vehicle conforms to a vehicle type approved, under one or more other UN Regulations annexed to the Agreement, in the country which has granted approval under this UN Regulation, the symbol prescribed in paragraph 4.4.1.1. need not be repeated; in such a case the additional numbers and symbols of all the UN Regulations under which approval has been granted in the country which has granted approval under this UN Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.1.

4.6. The approval mark shall be clearly legible and be indelible.

4.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.

4.8. Annex 2 to this UN Regulation gives examples of arrangements of approval marks.

5. Requirements

5.1. When the vehicle has undergone the test referred to in paragraph 6 below, the provisions in paragraph 5.2 shall be fulfilled.

A vehicle with all parts of the fuel system in front of the midpoint of the wheelbase is deemed to fulfil the provisions in paragraph 5.2.1.

A vehicle with all parts of the high voltage system in front of the midpoint of the wheelbase is deemed to fulfil the provisions in paragraph 5.2.2.

5.2. Following the test conducted in accordance with the procedure laid down in Annex 4 to this UN Regulation, following provisions with regard to fuel integrity and safety of high voltage systems shall to be fulfilled:

5.2.1. In the case of a vehicle propelled by liquid fuel, compliance with paragraphs 5.2.1.1 to 5.2.1.2 has to be shown.

5.2.1.1. No more than slight leakage of liquid from the fuel feed installation shall occur on collision.

5.2.1.2. If there is continuous leakage of liquid from the fuel-feed installation after the collision, the rate of leakage shall not exceed 30 g/min; if the liquid from the fuel-feed system mixes with liquids from the other systems and the various liquids cannot easily be separated and identified, all the liquids

[2] The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev. 6, Annex 3- www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html.

collected shall be taken into account in evaluating the continuous leakage.

5.2.2. In case of a vehicle equipped with a high voltage system, the electrical power train operating on high voltage, and the high voltage components and systems, which are galvanically connected to the high voltage bus of the electric power train, shall meet the requirements in paragraphs 5.2.2.1. to 5.2.2.3.:

5.2.2.1. Protection against electrical shock

After the impact at least one of the four criteria specified in paragraph 5.2.2.1.1. through paragraph 5.2.2.1.4.2. below shall be met.

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

However, criteria defined in 5.2.2.1.4. below 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 degree IPXXB.

If 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 paragraph 5.2.2.1.3. or paragraph 5.2.2.1.4. for the relevant part(s).

For the coupling system for charging the REESS, which is not energized during driving conditions, at least one of the four criteria specified in paragraphs 5.2.2.1.1. to 5.2.2.1.4. shall be met.

5.2.2.1.1. Absence of high voltage

The voltages Vb, V1 and V2 of the high voltage buses shall be equal or less than 30 VAC or 60 VDC as specified in paragraph 2. of Annex 4.

5.2.2.1.2. Low electrical energy

The total energy (TE) on the high voltage buses shall be less than 2.0 joules when measured according to the test procedure as specified in paragraph 3. of Annex 4 with the formula (a). Alternatively, the Total Energy (TE) may be calculated by the measured voltage Vb of the high voltage bus and the capacitance of the X-capacitors (Cx) specified by the manufacturer according to formula (b) of paragraph 3. of Annex 4.

The energy stored in the Y-capacitors (TEy1, TEy2) shall also be less than 2.0 joules. This shall be calculated by measuring the voltages V1 and V2 of the high voltage buses and the electrical chassis, and the capacitance of the Y-capacitors specified by the manufacturer according to formula (c) of paragraph 3. of Annex 4.

5.2.2.1.3. Physical protection

For protection against direct contact with 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 ampere.

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

5.2.2.1.4. Isolation resistance

The criteria specified in the paragraphs 5.2.2.1.4.1. and 5.2.2.1.4.2. below shall be met.

The measurement shall be conducted in accordance with paragraph 5. of Annex 4.

5.2.2.1.4.1. 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 paragraph 5. of Annex 4) shall have a minimum value of 100 Ω/V of the working voltage for DC buses, and a minimum value of 500 Ω/V of the working voltage for AC buses.

5.2.2.1.4.2. 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 paragraph 5. of Annex 4) shall have a minimum value of 500 Ω/V 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, the isolation resistance between the high voltage bus and the electrical chassis (Ri, as defined in paragraph 5. of Annex 4) shall have a minimum value of 100 Ω/V of the working voltage.

5.2.2.2. Electrolyte spillage

In the period from the impact until 30 minutes after no electrolyte from the REESS shall spill into the passenger compartment and no more than 7 per cent of electrolyte shall spill from the REESS 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 litres shall spill outside the passenger compartment.

The manufacturer shall demonstrate compliance in accordance with paragraph 6. of Annex 4.

5.2.2.3. REESS retention

REESS located inside the passenger compartment shall remain in the location in which they are installed and REESS components shall remain inside REESS boundaries.

No part of any REESS that is located outside the passenger compartment for electric safety assessment shall enter the passenger compartment during or after the impact test.

The manufacturer shall demonstrate compliance in accordance with paragraph 7. of Annex 4.

6. Test

6.1. The vehicle's compliance with the requirements of paragraph 5. above shall be checked by the method set out in Annex 3 and Annex 4 to this UN Regulation

7. Modifications and Extension of Approval of the Vehicle Type

7.1. Every modification of the vehicle type shall be notified to the administrative department which approved that vehicle type. The department may then either:

7.1.1. consider that the modifications made are unlikely to have appreciable adverse effects, and that in any case the vehicle still meets the requirements; or

7.1.2. require a further test report from the technical service responsible for conducting the tests.

7.2. Without prejudice to the provisions of paragraph 7.1. above, a variant of the vehicle whose unladen kerb weight is lower than the weight of the vehicle submitted for approval shall not be regarded as a modification of the vehicle type.

7.3. Confirmation or refusal of approval, specifying the alterations shall be communicated by the procedure specified in paragraph 4.3. above to the Parties to the Agreement which apply this UN Regulation.

7.4. The competent authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this UN Regulation by means of a communication form conforming to the model in annex 1 to this UN Regulation.

8. Conformity of Production

The conformity of production procedures shall comply with those set out in the Agreement, Schedule 1 (E/ECE/TRANS/505/Rev.3), with the following requirements:

8.1. Every vehicle bearing an approval mark as prescribed under this UN Regulation shall conform to the vehicle type approved, more particularly as regards features affecting the behaviour of the structure of the passenger compartment in a rear-end collision.

8.2. In order to verify conformity as prescribed in paragraph 8.1. above, a sufficient number of serially produced vehicles bearing the approval mark required by this UN Regulation shall be subjected to random checks.

8.3. As a general rule, the checks aforesaid shall be confined to the taking of measurements. However, the vehicles shall if necessary be subjected to the checks prescribed in paragraph 6. above.

9. Penalties for non-conformity of production

9.1. The approval granted in respect of a vehicle type pursuant to this UN Regulation may be withdrawn if the requirements laid down in paragraph 8.1. above is not complied with or if the vehicle has failed to pass the tests prescribed in paragraph 6. above.

9.2. If a Party to the Agreement which applies this UN Regulation withdraws an approval it has previously granted, it shall forthwith notify the other Parties to the Agreement which apply this UN Regulation by means of a communication form conforming to the model in annex 1 to this UN Regulation.

10. Production definitely discontinued

If the holder of the approval completely ceases to manufacture the type approved in accordance with this UN Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication that authority shall inform thereof the other Parties to the 1958 Agreement applying this UN Regulation by means of a communication form conforming to the model in annex 1 to this UN Regulation.

11. Names and addresses of technical services conducting approval tests, and of administrative departments

The Parties to the Agreement which apply this UN Regulation shall communicate to the Secretariat of the United Nations the names and addresses of the technical services conducting approval tests and of the administrative departments which grant approval and to which forms certifying approval or refusal or withdrawal of approval, issued in the other countries, are to be sent.

Annex 1

Communication

(Maximum format: A4 (210 x 297 mm)

issued by: Name of administration:
.....
.....
.....

Concerning: [2] Approval granted
Approval extended
Approval refused
Approval withdrawn
Production definitively discontinued

of a vehicle type with regard to the safety of their High Voltage Systems and with regard to Fuel Integrity in a Rear-End collision, pursuant to UN Regulation XX

Approval No.: ..... Extension No.: .....

1. Trade name or mark of the power-driven vehicle .....
2. Vehicle type .....
3. Manufacturer's name and address .....
   .....
4. If applicable, name and address of manufacturer's representative
   .....
   .....
5. Brief description of the vehicle type as regards its structure, dimensions, lines and constituent materials .....
   .....
5.1. Description of the fuel system installed in the vehicle.....
   .....
5.2. Description of the electrical power source .....
   .....
6. Site of engine: forward/rear/central[2]
7. Drive: front-wheel/rear-wheel[2]
8. Mass of vehicle submitted for testing:
   Front axle: .....
   Rear axle: .....
   Total:.....
9. Vehicle submitted for approval on .....
10. Technical Service responsible for conducting approval tests .....

[1] Distinguishing number of the country which has granted/extended/refused/withdrawn an approval (see approval provisions in the Regulation).
[2] Strike out what does not apply

11. Date of report issued by that Service .....

12. Number of reports issued by that Service .....

13. Approval granted/refused/extended/withdrawn[2]

14. Position of approval mark on vehicle .....

15. Place .....

16. Date .....

17. Signature .....

18. The following documents, bearing the approval number shown above, are annexed to this communication: .....

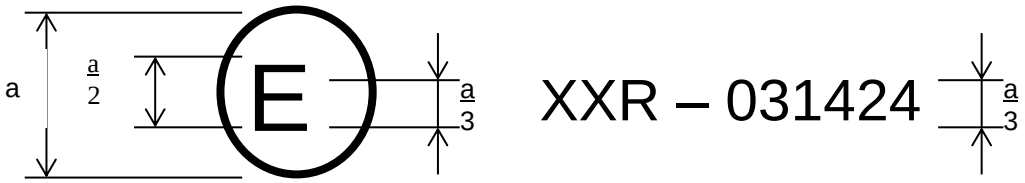
(Photographs and/or diagrams and drawings permitting the basic identification of the type(s) of vehicle and its possible variants which are covered by the approval)

Annex 2

Arrangements of approval marks

Model A

(See paragraph 4.4. of this UN Regulation)

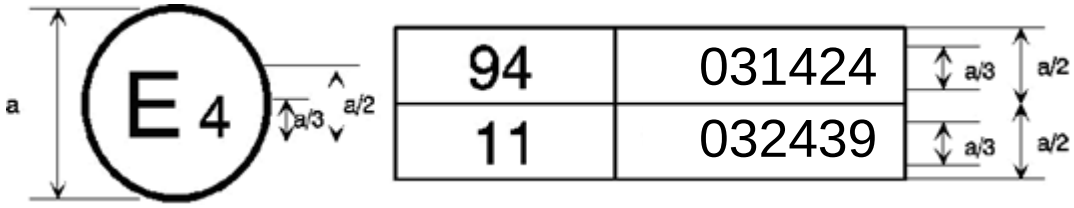


a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the protection of the occupants in the event of a frontal collision, been approved in the Netherlands (E 4) pursuant to UN Regulation No. XX under approval number 031424. The approval number indicates that the approval was granted in accordance with the requirements of UN Regulation No. XX as amended by the 03 series of amendments.

Model B

(See paragraph 4.5. of this UN Regulation)



a = 8 mm min.

The first two digits of the approval numbers indicate that, at the dates when the respective approvals were granted, UN Regulation No. 94 incorporated the 03 series of amendments and UN Regulation No. 11 incorporated the 03 series of amendments

Annex 3

Procedure for rear-end impact test

1. Purpose

1.1. The purpose of the test is to simulate the conditions of rear-end impact by another vehicle in motion.

2. Installations, Procedures and measuring instruments

2.1. Testing ground

The test area shall be large enough to accommodate the impactor (striker) propulsion system and to permit after-impact displacement of the vehicle impacted and installation of the test equipment. The part of which vehicle impact and displacement occur shall be horizontal, flat and smooth and representative of a normal, dry, uncontaminated road surface.

2.2. Impactor (striker)

2.2.1. The impactor shall be of steel and of rigid construction.

2.2.2. The impacting surface shall be flat, not less than 2,500 mm wide, and 800 mm high, and its edges shall be rounded to a radius of curvature of between 40 and 50 mm. It shall be covered with plywood boards 20 ± 2 mm thick.

2.2.3. At the moment of impact, the following requirements shall be met:

2.2.3.1. the impacting surface shall be vertical and perpendicular to the median longitudinal plane of the impacted vehicle;

2.2.3.2. the direction of movement of the impactor shall be substantially horizontal and parallel to the median longitudinal plane of the impacted vehicle;

2.2.3.3. the maximum lateral deviation tolerated between the median vertical line of the surface of the impactor and the median longitudinal plane of the impacted vehicle shall be 300 mm. In addition, the impacting surface shall extend over the entire width of the impacted vehicle;

2.2.3.4. the ground clearance of the lower edge of the impact surface shall be 175 ± 25 mm.

2.3. Propulsion of the impactor

The impactor may either be secured to a carriage (moving barrier) or form part of a pendulum.

2.4. Special provisions applicable where a moving barrier is used

2.4.1. If the impactor is secured to a carriage (moving barrier) by a restraining element, the latter must be rigid and be incapable of being deformed by the impact; the carriage shall at the moment of impact be capable of moving freely and no longer be subject to the action of the propelling device.

2.4.2. The velocity of the impact shall be between 48.0 km/h and 52.0 km/h.

2.4.3. The aggregate mass of carriage and impactor shall be 1,100 ± 20 kg.

2.5. Special provisions applicable where a pendulum is used

2.5.1. The distance between the centre of the impacting surface and the axis of rotation of the pendulum shall not be less than 5 m.

2.5.2. The impactor shall be freely suspended by rigid arms rigidly secured to it. The pendulum so constituted shall be substantially incapable of being deformed by

the impact.

2.5.3. Arresting gear shall be incorporated in the pendulum to prevent any secondary impact by the impactor on the test vehicle.

2.5.4. At the moment of impact, the velocity of the centre of percussion of the pendulum shall be as defined in paragraph 2.4.2.

2.5.5. The reduced mass "mr" at the centre of percussion of the pendulum is defined as a function of the total mass "m", of the distance "a"* between the centre of percussion and the axis of rotation, and of the distance "1" between the centre of gravity and the axis of rotation, by the following equation:

$$mr = m\frac{1}{a}$$

2.5.6. The reduced mass "mr" shall be 1,100 ± 20 kg.

2.6. General Provisions on the mass and velocity of the impactor

If the test has been conducted at an impact velocity higher than those prescribed in paragraphs 2.4.2. and 2.5.4. and/or with a mass greater than those prescribed in paragraphs 2.4.3. or 2.5.6. and the vehicle has met the requirements prescribed, the test shall be considered satisfactory.

2.7. State of vehicle under test

2.7.1. The vehicle under test shall either be fitted with all the normal components and equipment including in its unladen kerb weight or be in such condition as to fulfil this requirement so far as the components and equipment of concern to the passenger compartment and the distribution of the weight of the vehicle as a whole, in running order, are concerned.

2.7.2. The fuel tank shall be filled to at least 90 per cent of its capacity either with a liquid having density close to that of the fuel normally used. All other systems (break-fluid, header tanks, radiator, etc.) may be empty.

The fuel tank shall be filled to at least 90 per cent of its capacity either with fuel or with a non-inflammable liquid having a density and a viscosity close to those of the fuel normally used. All other systems (brake-fluid header tanks, radiator, Selective Catalytic Reduction reagents, etc.) may be empty.

This requirement does not apply to hydrogen fuel tanks.

2.7.3 The parking brake is disengaged and the transmission/gear lever is in neutral.

2.7.4. If the manufacturer so requests, the following derogations shall be permitted:

2.7.4.1. The technical service responsible for conducting the test may allow the same vehicle as is used for test prescribed by other UN Regulations (including tests capable of affecting its structure) to be used for the tests prescribed by this UN Regulation.

2.7.4.2. The vehicle may be weighted to an extent not exceeding 10 per cent of its unladen kerb weight with additional weights rigidly secured to the structure in such a way as not to affect the behaviour of the structure of the passenger compartment during the test.

2.7.5. Electrical power train adjustment

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

2.7.5.2. The electrical power train shall be energized with or without the operation of the original electrical energy sources (e.g. engine-generator, REESS or electric energy conversion system), however:

2.7.5.2.1. 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 insofar as there is no negative influence on the test result. For parts of the electrical power train not energized, the protection against electrical shock shall be proved by either physical protection or isolation resistance and appropriate additional evidence.

2.7.5.2.2. 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.

2.8. Measuring Instruments

The instruments used to record the speed referred to in paragraphs 2.4.2. and 2.5.4. above shall be accurate to within 1 per cent.

3. Results

3.1. To measure the residual longitudinal space, the amount of longitudinal displacement of the vertical projection on the floor of the "R" point of the vehicle's rearmost seat in relation to a reference point on a non-deformed part of the vehicle structure shall be determined.

4. Equivalent test methods

4.1. Rear impact tests are seen as equivalent if they are conducted

(a) with a moving deformable barrier having a weight of 1.368 kg, and

(b) with an impact speed between 78.5 km/h and 80.1 km/h

(c) and with overlapping between car and barrier of 70 per cent.

4.2 If a method other than that described in paragraph 2 or paragraph 4.1 above is used, its equivalence must be demonstrated.

Annex 4

Test procedures for the protection of the occupants of vehicles operating on electrical power from high voltage and electrolyte spillage

This annex describes test procedures to demonstrate compliance to the electrical safety requirements of paragraph 5.2.3. of this UN Regulation. 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.

Before the vehicle impact test conducted, the high voltage bus voltage (Vb) (see Figure 1 below) shall be measured and recorded to confirm that it is within the operating voltage of the vehicle as 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 REESS or the energy conversion system and the high-voltage bus of the REESS or the energy conversion system is protected according to protection degree IPXXB following the impact test, measurements may only be taken between 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.

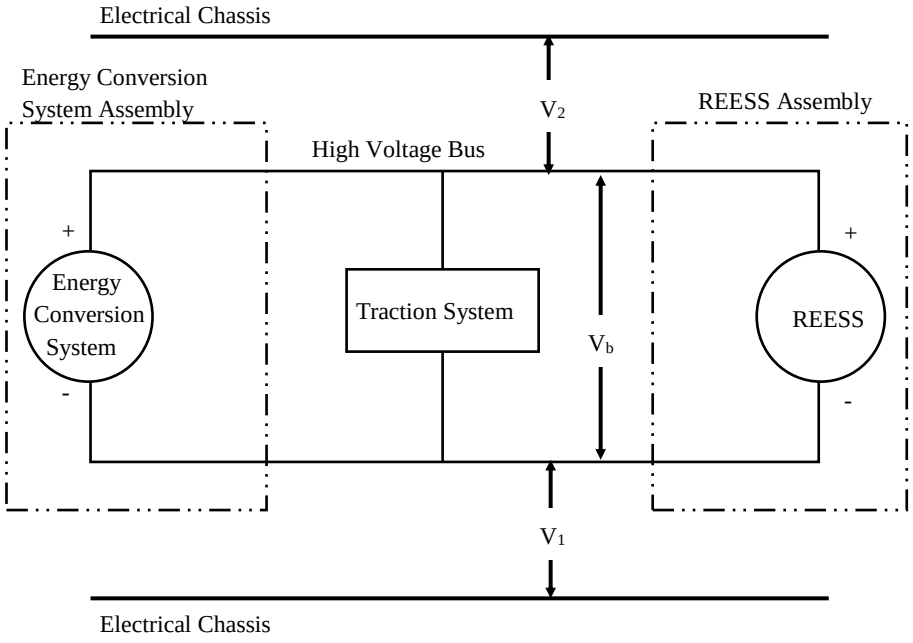
2. The following instructions may be used if voltage is measured.

   After the impact test, determine the high voltage bus voltages (Vb, V1, V2) (see Figure 1 below).

   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 electric power train is not energized.

Figure 1
Measurement of V_b, V_1, V_2



3. Assessment procedure for low electrical energy

Prior to the impact a switch S1 and a known discharge resistor Re is connected in parallel to the relevant capacitance (ref. Figure 2 below).

Not earlier than 5 seconds and not later than 60 seconds after the impact the switch S1 shall be closed while the voltage Vb and the current Ie are measured and recorded. The product of the voltage Vb and the current Ie shall be integrated over the period of time, starting from the moment when the switch S1 is closed (tc) until the voltage Vb falls below the high voltage threshold of 60 V DC (th). The resulting integration equals the Total Energy (TE) in joules.

(a) $$TE = \int_{tc}^{th} V_b \times I_e dt$$

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) $TE = 0.5 \times C_x \times (V_b^2 - 3{,}600)$

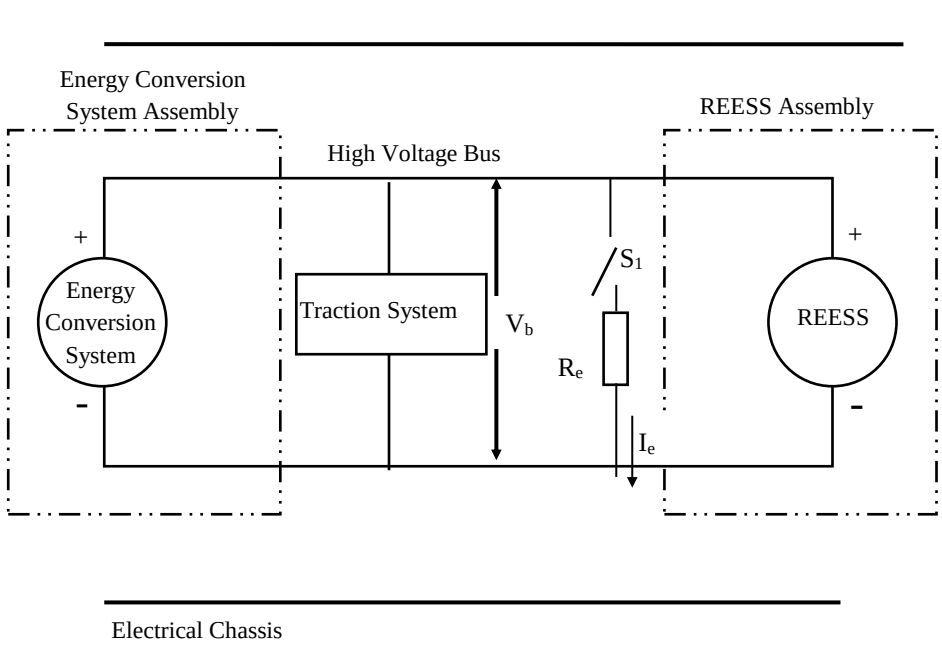
When V_1 and V_2 (see Figure 1 above) are measured at a point in time between 5 seconds and 60 seconds after the impact and the capacitances of the Y-capacitors (C_{y1}, C_{y2}) are specified by the manufacturer, Total Energy (TE_{y1}, TE_{y2}) shall be calculated according to the following formulas:

(c) $TE_{y1} = 0.5 \times C_{y1} \times (V_1^2 - 3{,}600)$

$TE_{y2} = 0.5 \times C_{y2} \times (V_2^2 - 3{,}600)$

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

Figure 2
E.g. measurement of high voltage bus energy stored in X-capacitors



4. Physical protection

Following the vehicle impact test any parts surrounding the high voltage components shall be, without the use of tools, opened, disassembled or removed. All remaining surrounding parts shall be considered part of the physical protection.

The jointed test finger described in Figure 1 of Appendix 1 shall be inserted into any gaps or openings of the physical protection with a test force of 10 N ± 10 per cent for electrical safety assessment. If partial or full penetration into the physical protection by the jointed test finger occurs, the jointed test finger shall be placed in every position as specified below.

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

Internal electrical protection 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 5.2.8.1.3. of this UN Regulation shall be considered to be met if the jointed test finger described in Figure 1 of Appendix 1, is unable to contact high voltage live parts.

If necessary, a mirror or a fiberscope may be used to inspect whether the jointed test finger touches the high voltage buses.

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 be used if the isolation resistance is demonstrated by measurement.

Measure and record the voltage (Vb) between the negative and the positive side of the high voltage bus (see Figure 1 above);

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

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

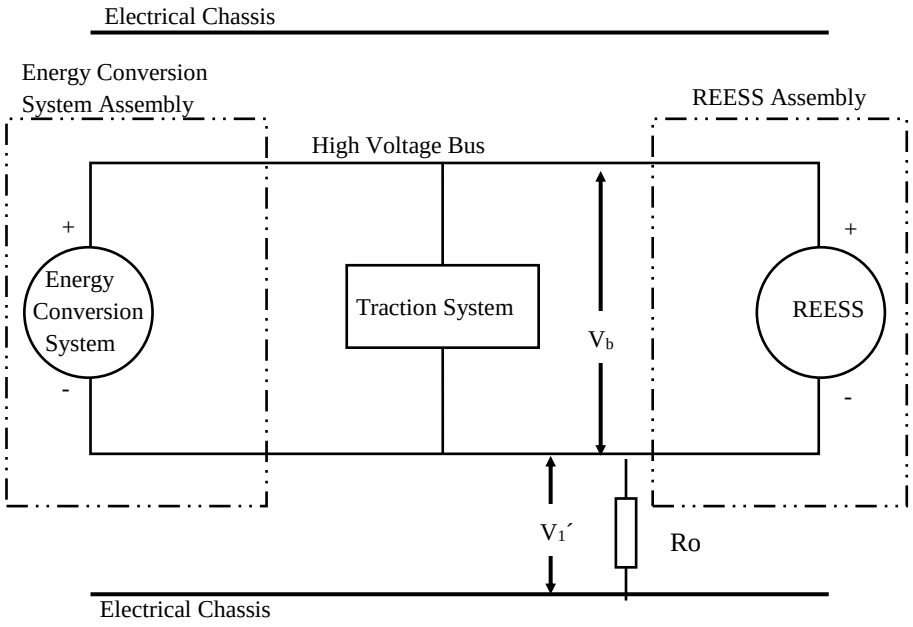
If V1 is greater than or equal to V2, insert a standard known resistance (Ro) between the negative side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V1') between the negative side of the high voltage bus and the vehicle electrical chassis (see Figure 3 below). Calculate the isolation resistance (Ri) according to the formula shown below.

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

Divide the result Ri, which is the electrical isolation resistance value in ohm (Ω), by the working voltage of the high voltage bus in volt (V).

Ri (Ω / V) = Ri (Ω) / Working voltage (V)

Figure 3
Measurement of V_1'



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 below).

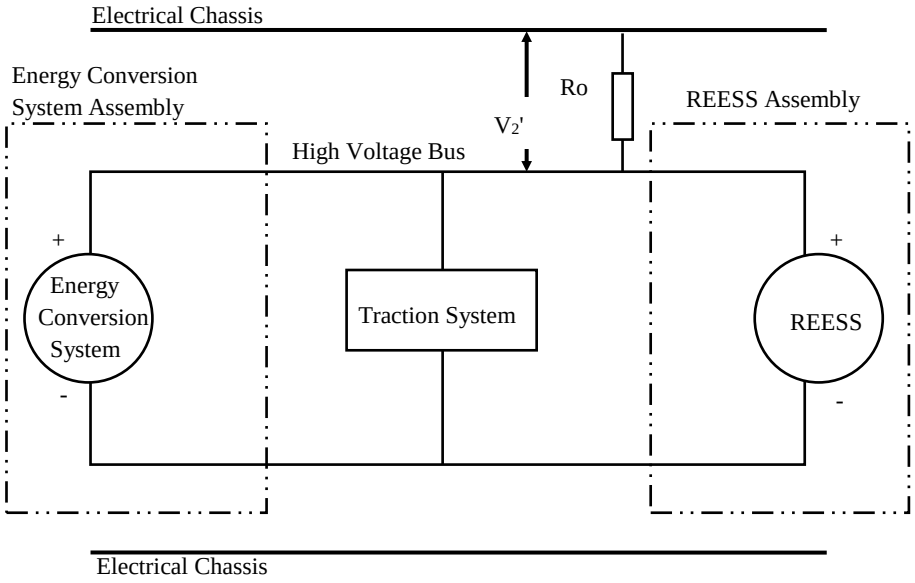
Calculate the isolation resistance (Ri) according to the formula shown below.

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

Divide the result Ri, which is the electrical isolation resistance value in ohm (Ω), by the working voltage of the high voltage bus in volt (V).

Ri (Ω / V) = Ri (Ω) / Working voltage (V)

Figure 4
Measurement of V_2'



Note: The standard known resistance Ro (in Ω) should be the value of the minimum required isolation resistance (Ω/V) multiplied by the working voltage (V) of the vehicle plus/minus 20 per cent. 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 a good resolution for the voltage measurements.

6. Electrolyte spillage

Appropriate coating shall be applied, if necessary, to the physical protection in order to confirm any electrolyte leakage from the REESS after the impact test.

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

7. REESS retention

Compliance shall be determined by visual inspection.

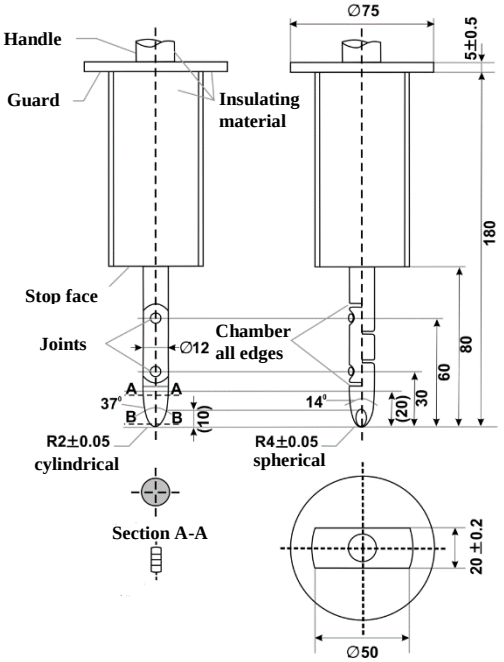
Annex 4 - Appendix

Jointed test finger (degree IPXXB)

Figure 1
Jointed test finger

Access probe
(Dimensions in mm)

IPXXB **Jointed text finger**



Material: metal, except where otherwise specified

Linear dimensions in millimetres

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.