Regulation No. 94

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE PROTECTION OF THE OCCUPANTS IN THE EVENT OF A FRONTAL COLLISION

UNITED NATIONS

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CONTENTS

CONTENTS (continued)

1. SCOPE

This Regulation applies to vehicles of category M_1 1/ of a total permissible mass not exceeding 2.5 tonnes; other vehicles may be approved at the request of the manufacturer.

2. DEFINITIONS

For the purposes of this Regulation:

2.1. "Protective system" means interior fittings and devices intended to restrain the occupants and contribute towards ensuring compliance with the requirements set out in paragraph 5. below;

2.2. "Type of protective system" means a category of protective devices which do not differ in such essential respects as:

Their technology;
Their geometry;
Their constituent materials;

2.3. "Vehicle width" means the distance between two planes parallel to the longitudinal median plane (of the vehicle) and touching the vehicle on either side of the said plane but excluding the rear-view mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mud-guards and the deflected part of the tyre side-walls immediately above the point of contact with the ground;

2.4. "Overlap" means the percentage of the vehicle width directly in line with the barrier face;

2.5. "Deformable barrier face" means a crushable section mounted on the front of a rigid block;

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

2.6.1. The length and width of the vehicle, in so far as they have a negative effect on the results of the impact test prescribed in this Regulation,

2.6.2. The structure, dimensions, lines and materials of the part of the vehicle forward of the transverse plane through the "R" point of the driver's seat, in so far as they have a negative effect on the results of the impact test prescribed in this Regulation,

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1/ As defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), (TRANS/WP.29/78/Rev.1/Amend.2 as last amended by its Amendment 4).

2.6.3. The lines and inside dimensions of the passenger compartment and the type of protective system, in so far as they have a negative effect on the results of the impact test prescribed in this Regulation,

2.6.4. The siting (front, rear or centre) and the orientation (transversal or longitudinal) of the engine,

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

2.6.6. The optional arrangements or fittings provided by the manufacturer, in so far as they have a negative effect on the result of the impact test prescribed in this Regulation,

[2.6.7. The place of the RESS.]

2.7. Passenger compartment 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,

[2.7.1 For vehicles with electric powertrain, passenger compartment 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, or rear gate, as well as by the barriers and enclosures provided for protecting from direct contact with high voltage live parts.]

2.8. ""R" point" means a reference point defined for each seat by the manufacturer in relation to the vehicle's structure, as indicated in Annex 6;

2.9. ""H" point" means a reference point determined for each seat by the testing service responsible for approval, in accordance with the procedure described in Annex 6;

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

2.11. "Airbag" means a device installed to supplement safety belts and restraint systems in power-driven vehicles, i.e. systems which, in the event of a severe impact affecting the vehicle, automatically deploy a flexible structure intended to limit, by compression of the gas contained within it, the gravity of the contacts of one or more parts of the body of an occupant of the vehicle with the interior of the passenger compartment.

2.12. "Passenger airbag" means an airbag assembly intended to protect occupant(s) in seats other than the driver's in the event of a frontal collision.

2.13. "Child restraint" means an arrangement of components which may comprise a combination of straps or flexible components with a securing buckle, adjusting devices, attachments, and in some cases a supplementary chair and/or an impact shield, capable of being anchored to a power driven vehicle. It is so designed as to diminish the risk of injury to the wearer, in the event of a collision or of abrupt deceleration of the vehicle by limiting the mobility of the wearer's body.

2.14. "Rearward-facing" means facing in the direction opposite to the normal direction of travel of the vehicle.

2.15. "Electric power train" means the electrical circuit which includes the traction motor(s), and may include the RESS, the electric energy conversion system, the electronic converters, the associated wiring harness and connectors, and the coupling system for charging the RESS.

2.16. "RESS" means rechargeable energy storage system that provides the electric energy for propulsion.

2.17. "Electric Energy-conversion system" means a system (e.g. fuel cell) that generates and provides electric energy for electric propulsion.

2.18. "Electronic converter" means a device capable of controlling and/or converting electric power for electric propulsion.

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

2.20. "Direct contact" means the contact of persons with live parts.

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

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

2.23. "Protection degree" means the Protection provided by a barrier/enclosure related to the contact with live parts by a test probe, such as a test finger (IPXXB) as defined in Appendix 1 of Annex 11.

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.

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

2.26. **"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.**

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

2.28. **["Protection Barrier / Protection Shielding / Shielding / Barrier-el/ High Voltage Protection]" means the part providing protection against direct contact to the live parts from any direction of access."**

2.29. **Enclosure" means the part enclosing the internal units and providing protection against direct contact from any direction of access.**

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

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

3. APPLICATION FOR APPROVAL

3.1. The application for approval of a vehicle type with regard to the protection of the occupants of the front seats in the event of a frontal collision shall be submitted by the vehicle manufacturer or by his duly accredited representative.

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

3.2.1. A detailed description of the vehicle type with respect to its structure, dimensions, lines and constituent materials;

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

3.2.3. Particulars of the vehicle's unladen kerb mass;

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

3.2.5. A description of the interior fittings and protective systems installed in the vehicle.

3.2.6 General description of the RESS type, [location] and the electric powertrain (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 which is 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 comprising 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 in so far as the requirements of this Regulation are concerned.

3.4.2. It shall be the responsibility of the applicant for approval to show that the application of paragraph 3.4.1. is compatible with compliance with the requirements of this Regulation.

4. APPROVAL

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5. SPECIFICATIONS

5.1. General specifications applicable to all tests

5.1.1. The "H" point for each seat shall be determined in accordance with the procedure described in Annex 6.

5.1.2. When the protective system for the front seating positions includes belts, the belt components shall meet the requirements of Regulation No. 16.

5.1.3. Seating positions where a dummy is installed and the protective system includes belts, shall be provided with anchorage points conforming to Regulation No. 14.

5.2. Specifications

The test of the vehicle carried out in accordance with the method described in Annex 3 shall be considered satisfactory if all the conditions set out in paragraphs 5.2.1. to **5.2.8.** below are all satisfied at the same time.

5.2.1. The performance criteria recorded, in accordance with Annex 8, on the dummies in the front outboard seats shall meet the following conditions:

5.2.1.1. The head performance criterion (HPC) shall not exceed 1000 and the resultant head acceleration shall not exceed 80 g for more than 3 ms. The latter shall be calculated cumulatively, excluding rebound movement of the head;

5.2.1.2. The neck injury criteria (NIC) shall not exceed the values shown in Figures 1 and 2 2/;

Figure 1

Neck tension criterion

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Figure 2

Neck shear criterion

……..

5.2.1.3. The neck bending moment about the y axis shall no exceed 57 Nm in extension 3/;

5.2.1.4. The thorax compression criterion (ThCC) shall not exceed 50 mm;

5.2.1.5. The viscous criterion (V * C) for the thorax shall not exceed 1,0 m/s;

5.2.1.6. The femur force criterion (FFC) shall not exceed the force-time performance criterion shown in Figure 3;

Figure 3

Femur force criterion

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5.2.1.7. The tibia compression force criterion (TCFC) shall not exceed 8 kN;

5.2.1.8. The tibia index (TI), measured at the top and bottom of each tibia, shall not exceed 1,3 at either location;

5.2.1.9. The movement of the sliding knee joints shall not exceed 15 mm.

2/ Until 1 October 1998, the values obtained for the neck shall not be pass/fail criteria for the purposes of granting approval. The results obtained shall be recorded in the test report and be collected by the Approval Authority. After this date, the values specified in this paragraph shall apply as pass/fail criteria unless or until alternative values are adopted.

5.2.2. Residual steering wheel displacement, measured at the centre of the steering wheel hub, shall not exceed 80 mm in the upwards vertical direction and 100 mm in the rearward horizontal direction.

5.2.3. During the test no door shall open.

5.2.4. During the test no locking of the locking systems of the front doors shall occur.

5.2.5. After the impact, it shall be possible, without the use of tools, except for those necessary to support the weight of the dummy:

5.2.5.1. To open at least one door, if there is one, per row of seats and, where there is no such door, to move the seats or tilt their backrests as necessary to allow the evacuation of all the occupants; this is, however, only applicable to vehicles having a roof of rigid construction;

5.2.5.2 To release the dummies from their restraint system which, if locked, shall be capable of being released by a maximum force of 60 N on the centre of the release control;

5.2.5.3. To remove the dummies from the vehicle without adjustment of the seats.

5.2.6. In the case of a vehicle propelled by liquid fuel, no more than slight leakage of liquid from the fuel feed installation shall occur on collision.

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

5.2.8. The electric power train, the high voltage components and systems which are galvanically connected to the high voltage bus of the electric power train meet the following conditions:

5.2.8.1. Not more than [5.0] litres of liquid except coolant from RESS shall spill outside the passenger compartment, and no visible trace of liquid except coolant from RESS shall spill into the passenger compartment, within 30 minutes after a barrier impact test. Compliance may be demonstrated by test or analysis.

If the spilled liquid cannot clearly be identified as coolant, the entire amount of liquid should be considered.

5.2.8.2. RESS located inside the passenger compartment must remain in the installed location and RESS components shall remain inside RESS.
No part of any RESS that is located outside the passenger compartment shall enter the passenger compartment during the test procedures, as determined by visual inspection.

5.2.8.3. After the test, at least one of the following criteria specified in paragraph 5.2.8.3.1 thorough paragraph 5.2.8.3.4 shall be met.
If the vehicle has an automatic disconnect function, the criteria shall be applied to each divided portion individually.

5.2.8.3.1. Isolation Resistance:
If the electrical circuit divided by the disconnect function includes AC circuit, this part of the high voltage bus/portion shall be considered as an AC high voltage bus/portion.
If the electrical circuit divided by the disconnect function doesn't include AC circuit, this part of the high voltage bus/portion shall be considered as a DC high voltage bus/portion.

If there is any live part of the high voltage system which does not meet the requirements under the provision of IPXXB

- **for AC high voltage buses/portions, isolation resistance between the high voltage bus/portion and the electrical chassis shall have minimum value of 500 ohms/volt of working voltage;**
- **for DC portion of the high voltage buses/portions after crash, isolation resistance between the high voltage bus/portion and the electrical chassis shall have minimum value of 100 ohms/volt of working voltage.**

5.2.8.3.2. Voltage
For AC high voltage buses/portions, voltage of the bus/portion shall be equal to or less than 30 VAC.
For DC high voltage buses/portions, voltage of the bus/portion shall be equal to or less than 60 VDC

5.2.8.3.3. Energy
Energy on the high voltage bus/portion shall be less than 0.2 Joules.

5.2.8.3.4. Physical Protection
5.2.8.3.4.1 For protection of live parts, the protection degree IPXXB shall be provided.

5.2.8.3.4.2 For protection against indirect contact with live parts, all exposed conductive parts shall be securely connected to the electrical chassis such that no dangerous potentials are produced.
The requirements shall be considered to be fulfilled if the resistance between the electrical chassis and all exposed conductive parts shall be less than 0.1 ohm, which is measured when there is a current flow of at least 0.2 amps.

The said resistance shall be regarded as lower than 0.1 ohm when it is clearly evident that the DC electrical connection has been established adequately and securely by welding.

6. INSTRUCTIONS FOR USERS OF VEHICLES EQUIPPED WITH AIRBAGS

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7. MODIFICATION AND EXTENSION OF APPROVAL OF THE VEHICLE TYPE

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8. CONFORMITY OF PRODUCTION

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9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

……

10. PRODUCTION DEFINITELY DISCONTINUED

……

11. TRANSITIONAL PROVISIONS

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12. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

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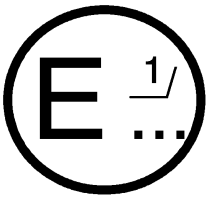
Annex 1

COMMUNICATION

(Maximum format: A4 (210 x 297 mm))



issued by : Name of administration:
.....
.....
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concerning: 2/ APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard to the protection of the occupants in the event of a frontal collision, pursuant to Regulation No. 94

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 protective system installed in the vehicle.....
.....

5.2. Description of interior arrangements or fittings that might affect the tests
……..

5.3 RESS localisation……

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 .....

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

12. Number of report 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)

1/ Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

2/ Strike out what does not apply.

Annex 2

ARRANGEMENTS OF THE APPROVAL MARK

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Annex 3

TEST PROCEDURE

1. INSTALLATION AND PREPARATION OF THE VEHICLE

1.1. Testing ground

The test area shall be large enough to accommodate the run-up track, barrier and technical installations necessary for the test. The last part of the track, for at least 5 m before the barrier, shall be horizontal, flat and smooth.

1.2. Barrier

The front face of the barrier consists of a deformable structure as defined in Annex 9 of this Regulation. The front face of the deformable structure is perpendicular within ± 1° to the direction of travel of the test vehicle. The barrier is secured to a mass of not less than 7×10^4 kg, the front face of which is vertical within ± 1°. The mass is anchored in the ground or placed on the ground with, if necessary, additional arresting devices to restrict its movement.

1.3. Orientation of the barrier

The orientation of the barrier is such that the first contact of the vehicle with the barrier is on the steering-column side. Where there is a choice between carrying out the test with a right-hand or left-hand drive vehicle, the test shall be carried out with the less favourable hand of drive as determined by the Technical Service responsible for the tests.

1.3.1. Alignment of the vehicle to the barrier

The vehicle shall overlap the barrier face by 40 per cent ± 20 mm.

1.4. State of vehicle

1.4.1. General specification

The test vehicle shall be representative of the series production, shall include all the equipment normally fitted and shall be in normal running order. Some components may be replaced by equivalent masses where this substitution clearly has no noticeable effect on the results measured under paragraph 6.

1.4.2. Mass of vehicle

1.4.2.1. For the test, the mass of the vehicle submitted shall be the unladen kerb mass;

1.4.2.2. The fuel tank shall be filled with water to mass equal to 90 per cent of the mass of a full as specified by the manufacturer with a tolerance of ± 1 per cent;

1.4.2.3. All the other systems (brake, cooling, ...) may be empty in this case, the mass of the liquids shall be carefully compensated;

1.4.2.4. If the mass of the measuring apparatus on board the vehicle exceeds the 25 kg allowed, it may be compensated by reductions which have no noticeable effect on the results measured under paragraph 6. below.

1.4.2.5. The mass of the measuring apparatus shall not change each axle reference load by more than 5 per cent, each variation not exceeding 20 kg.

1.4.2.6. The mass of the vehicle resulting from the provisions of paragraph 1.4.2.1. above shall be indicated in the report.

1.4.3. Passenger compartment adjustments

1.4.3.1. Position of steering wheel

The steering wheel, if adjustable, shall be placed in the normal position indicated by the manufacturer or, failing that, midway between the limits of its range(s) of adjustment. At the end of propelled travel, the steering wheel shall be left free, with its spokes in the position which according to the manufacturer corresponds to straight-ahead travel of the vehicle.

1.4.3.2. Glazing

The movable glazing of the vehicle shall be in the closed position. For test measurement purposes and in agreement with the manufacturer, it may be lowered, provided that the position of the operating handle corresponds to the closed position.

1.4.3.3. Gear-change lever

The gear-change lever shall be in the neutral position.

1.4.3.4. Pedals

The pedals shall be in their normal position of rest. If adjustable, they shall be set in their mid position unless another position is specified by the manufacturer.

1.4.3.5. Doors

The doors shall be closed but not locked.

1.4.3.6. Opening roof

If an opening or removable roof is fitted, it shall be in place and in the closed position. For test measurement purposes and in agreement with the manufacturer, it may be open.

1.4.3.7. Sun-visor

The sun-visors shall be in the stowed position.

1.4.3.8. Rear-view mirror

The interior rear-view mirror shall be in the normal position of use.

1.4.3.9. Arm-rests

Arm-rests at the front and rear, if movable, shall be in the lowered position, unless this is prevented by the position of the dummies in the vehicles.

1.4.3.10. Head restraints

Head restraints adjustable for height shall be in their uppermost position.

1.4.3.11. Seats

1.4.3.11.1. Position of front seats

Seats adjustable longitudinally shall be placed so that their "H" point, determined in accordance with the procedure set out in Annex 6 is in the middle position of travel or in the nearest locking position thereto, and at the height position defined by the manufacturer (if independently adjustable for height). In the case of a bench seat, the reference shall be to the "H" point of the driver's place.

1.4.3.11.2. Position of the front seat-backs

If adjustable, the seat-backs shall be adjusted so that the resulting inclination of the torso of the dummy is as close as possible to that recommended by the manufacturer for normal use or, in the absence of any particular recommendation by the manufacturer, to 25° towards the rear from the vertical.

1.4.3.11.3. Rear seats

If adjustable, the rear seats or rear bench seats shall be placed in the rearmost position.

1.4.4. Electric powertrain adjustments

[1.4.4.1. The high voltage system shall be energized.]

1.4.4.2. The RESS shall be at a state of charge which allows the normal operation of the power train recommended by the manufacturer.

2. DUMMIES

2.1. Front seats

2.1.1. A dummy corresponding to the specifications for Hybrid III 1/ fitted with a 45° ankle and meeting the specifications for its adjustment shall be installed in each of the front outboard seats in accordance with the conditions set out in Annex 5. The dummy shall be equipped for recording the data necessary to determine the performance criteria with measuring systems corresponding to the specifications in Annex 8. The ankle of the dummy shall be certified in accordance with the procedures in Annex 10.

2.1.2. The car will be tested with restraint systems, as provided by the manufacturer.

3. PROPULSION AND COURSE OF VEHICLE

3.1. The vehicle shall be propelled either by its own engine or by any other propelling device.

1/ The technical specifications and detailed drawings of Hybrid III, corresponding to the principal dimensions of a fiftieth percentile male of the United States of America, and the specifications for its adjustment for this test are deposited with the Secretary-General of the United Nations and may be consulted on request at the secretariat of the Economic Commission for Europe, Palais des Nations, Geneva, Switzerland.

3.2. At the moment of impact the vehicle shall no longer be subject to the action of any additional steering or propelling device.

3.3. The course of the vehicle shall be such that it satisfies the requirements of paragraphs 1.2. and 1.3.1.

4. TEST SPEED

Vehicle speed at the moment of impact shall be 56 -0/+1 km/h. However, if the test was performed at a higher impact speed and the vehicle met the requirements, the test shall be considered satisfactory.

5. MEASUREMENTS TO BE MADE ON DUMMY IN FRONT SEATS

5.1. All the measurements necessary for the verification of the performance criteria shall be made with measurement systems corresponding to the specifications of Annex 8.

5.2. The different parameters shall be recorded through independent data channels of the following CFC (Channel Frequency Class):

5.2.1. Measurements in the head of the dummy

The acceleration (a) referring to the centre of gravity is calculated from the triaxial components of the acceleration measured with a CFC of 1000.

5.2.2. Measurements in the neck of the dummy

5.2.2.1. The axial tensile force and the fore/aft shear force at the neck/head interface are measured with a CFC of 1000.

5.2.2.2. The bending moment about a lateral axis at the neck/head interface are measured with a CFC of 600.

5.2.3. Measurements in the thorax of the dummy

The chest deflection between the sternum and the spine is measured with a CFC of 180.

5.2.4. Measurements in the femur and tibia of the dummy

5.2.4.1. The axial compressive force and the bending moments are measured with a CFC of 600.

5.2.4.2. The displacement of the tibia with respect to the femur is measured at the knee sliding joint with a CFC of 180.

6. MEASUREMENTS TO BE MADE ON THE VEHICLE

6.1. To enable the simplified test described in Annex 7 to be carried out, the deceleration time history of the structure shall be determined on the basis of the value of the longitudinal accelerometers at the base of the "B" pillar on the struck side of the vehicle with a CFC of 180 by means of data channels corresponding to the requirements set out in Annex 8;

6.2. The speed time history which will be used in the test procedure described in Annex 7 shall be obtained from the longitudinal accelerometer at the "B" pillar on the struck side.

Annex 4

DETERMINATION OF PERFORMANCE CRITERIA

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Annex 5

ARRANGEMENT AND INSTALLATION OF DUMMIES AND ADJUSTMENT OF RESTRAINT SYSTEMS

……..

Annex 6

PROCEDURE FOR DETERMINING THE "H" POINT AND THE ACTUAL TORSO ANGLE FOR SEATING POSITIONS IN MOTOR VEHICLES

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Annex 7

TEST PROCEDURE WITH TROLLEY

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Annex 8

TECHNIQUE OF MEASUREMENT IN MEASUREMENT TESTS: INSTRUMENTATION

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Annex 9

DEFINITION OF DEFORMABLE BARRIER

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Annex 10

CERTIFICATION PROCEDURE FOR THE DUMMY LOWER LEG AND FOOT

……..

Annex 11

ELECTRIC SAFETY – TEST PROCEDURES

This section describes test procedures. Alternative test and analysis methods may also be used. For example, oscilloscope or megohmmeter measurements are an appropriate alternative to the procedure described below for measuring isolation resistance.
Well-established calculation methods also exist to determine electrical energy on high voltage buses.

1 Test setup and equipment

If a high voltage disconnect function is used, measurements are 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 fully enclosed within a physical barrier or enclosure that maintains protection class IPXXB after crash test, measurements may be taken only downstream of the device performing the disconnect function.

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

2 Bus voltage

The following instructions may be used if voltage is measured.
Prior to the vehicle crash test measure and record the high voltage bus voltage (V_b) (see Figure 1). If V_b is high voltage, conduct the specified vehicle crash test. After the crash test, determine the high voltage bus voltages (V_b, V_1, V_2) (see Figure 1).
[The measurement shall be made after 5 seconds of the vehicle coming to rest after each crash test.]

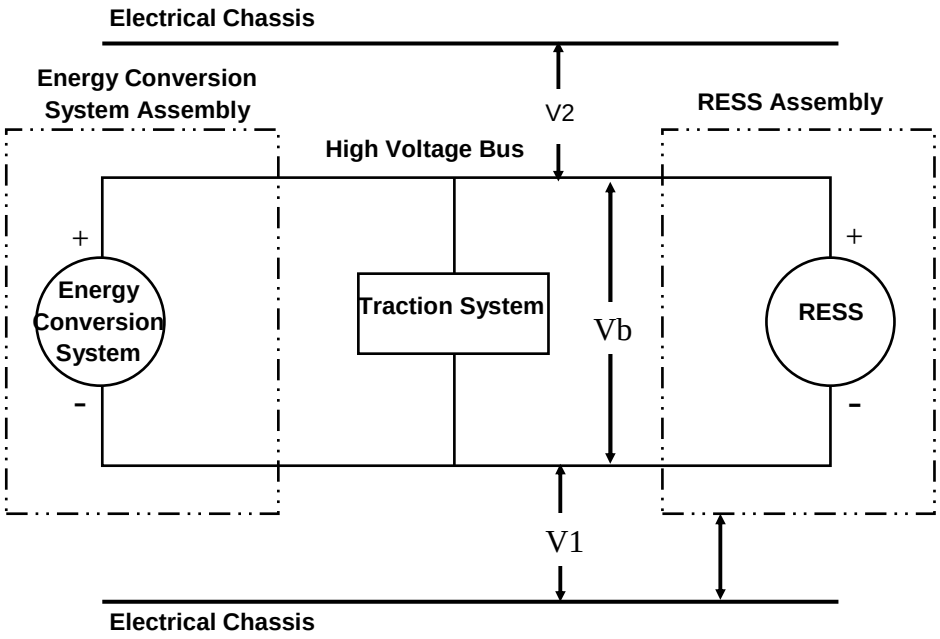


Figure 1: Measurement of Vb, V1, V2

3 Isolation resistance measurement method

3.1 General

The isolation resistance for each high voltage bus of the vehicle shall be measured or shall be determined by calculation using measurement values from each part or component unit of a high voltage bus (hereinafter referred to as the "divided measurement").

3.2 Measurement Method.

The isolation resistance measurement shall be conducted by selecting an appropriate measurement method from among those listed in Paragraphs 3.2.1. through 3.2.2., depending on the electrical charge of the live parts or the isolation resistance, etc.

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

Moreover, modification necessary for measuring the isolation resistance may be carried out, such as removal of the cover in order to reach the live parts, drawing of measurement lines, change in software, etc.

In cases where the measured values are not stable due to the operation of the on-board isolation resistance monitoring system, etc., necessary modification for conducting the measurement may

be carried out, such as stopping of the operation of the device concerned or removing it. Furthermore, when the device is removed, it shall be proven, using drawings, etc., that it will not change the isolation resistance between the live parts and the electrical chassis.

Utmost care shall be exercised as to short circuit, electric shock, etc., for this confirmation might require direct operations of the high-voltage circuit.

3.2.1. Measurement method using DC voltage from off-vehicle sources
3.2.1.1. Measurement instrument

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

3.2.1.2. Measurement method

An insulator resistance test instrument shall be connected between the live parts and the electrical chassis. Then, the isolation resistance shall be measured by applying a DC voltage at least half of the working voltage of the high voltage bus.
If the system has several voltage ranges (e.g. because of boost converter) in galvanically connected circuit and some of the components cannot withstand the working voltage of the entire circuit, the isolation resistance between those components and the electrical chassis can be measured separately by applying at least half of their own working voltage with those component disconnected.

3.2.2.Measurement method using the vehicle's own RESS as DC voltage source
3.2.2.1. Test vehicle conditions

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

3.2.2.2 Measurement instrument

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

3.2.2.3 Measurement method
3.2.2.3.1 First step

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

3.2.2.3.2. Second step

Measure and record the voltage (V_1) between the negative side of the high voltage bus and the electrical chassis (see Figure 1):

3.2.2.3.3. Third step

Measure and record the voltage (V_2) between the positive side of the high voltage bus and the electrical chassis (see Figure 1):

3.2.2.3.4. Fourth step

If V1 is greater than or equal to V_2, insert a standard known resistance (R_o) between the negative side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage ($V_{1'}$) between the negative side of the high voltage bus and the electrical chassis (see Figure 2).
Calculate the electrical isolation (R_i) according to the following formula:

$$Ri = Ro*(V_b/V_{1'} - V_b/V_1) \quad or \quad R_i = R_o*V_b*(1/V_{1'} - 1/V_1)$$

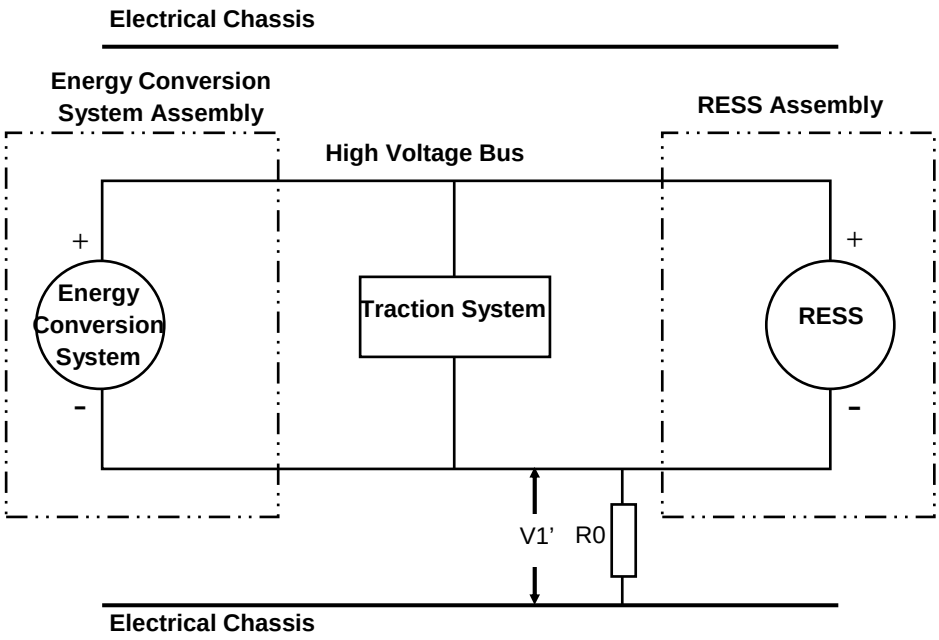


Figure 2: Measurement of V1'

If V_2 is greater than V_1, insert a standard known resistance (R_o) between the positive side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage ($V_{2'}$) between the positive side of the high voltage bus and the electrical chassis. (See Figure 3).Calculate the electrical isolation (R_i) according to the formula shown. Divide this electrical isolation value (in ohms) by the nominal operating voltage of the high voltage bus (in volts).

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

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

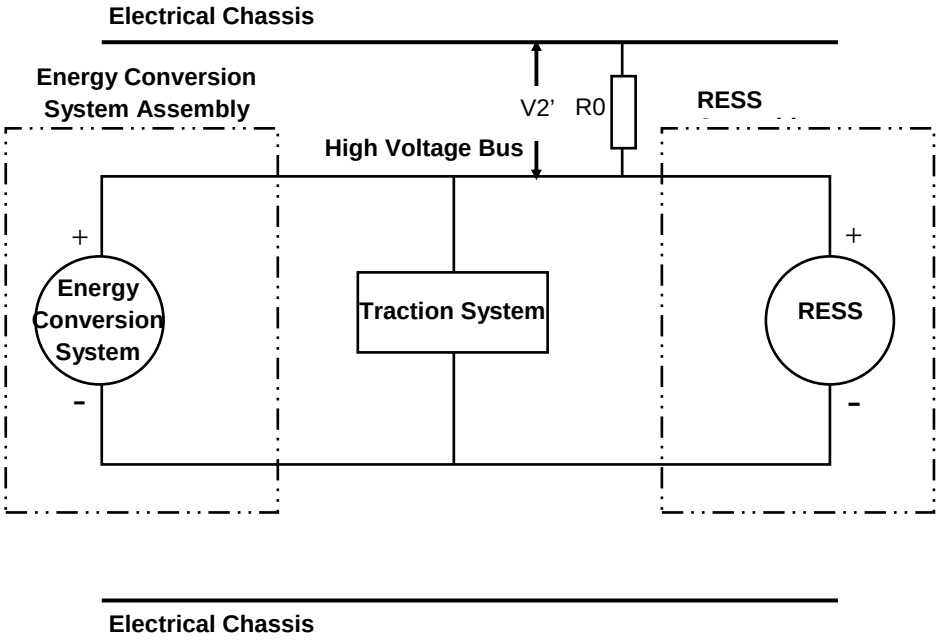


Figure 3: Measurement of V2'

3.2.2.3.5 Fifth step

The electrical isolation value R_i (in ohms) divided by the working voltage of the high voltage bus (in volts) results in the isolation resistance (in ohms/volt).

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

4 Electrical Energy

The following procedure may be used if energy is measured.
After the vehicle crash determine the high voltage bus energy (see Figure 4). Install switch S_1 and known resistance R_e. Close switch S_1 and measure and record voltage V_b and current I_e. Integrate the product of these two measurements with respect to time as shown below to obtain total energy.

$$\int_{t_0}^{t_1} V_b \times I_e \, dt$$ **[t_0 = closing S1 after 5 seconds of the vehicle coming to rest t_1= ???]**

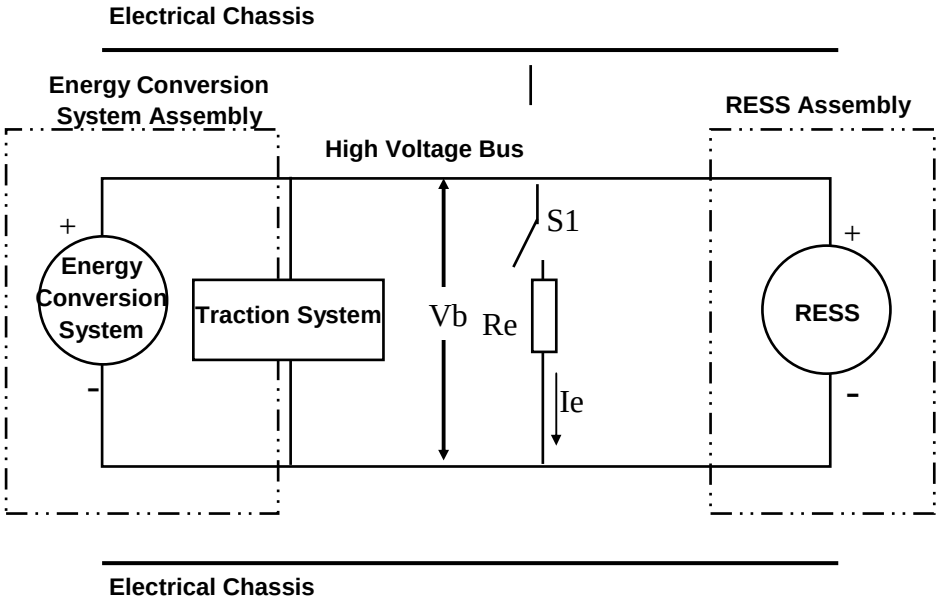


Figure 4: Measurement of high voltage bus energy

5 Physical Barrier

The following procedure may be used if physical protection is tested.

5-1 Test conditions

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

Any surrounding parts of the high voltage components that can be opened, disassembled or removed without the use of tools after crash test shall be opened, disassembled or removed.
Surrounding parts that cannot be opened, disassembled or removed without the use of tools are considered as a part of the physical barrier.

The access probe is pushed against any openings of the physical barrier with the force 10 N ± 10 %. If it partly or fully penetrates into the original physical protection, it is placed in every possible position.

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.

5-2 Acceptance conditions

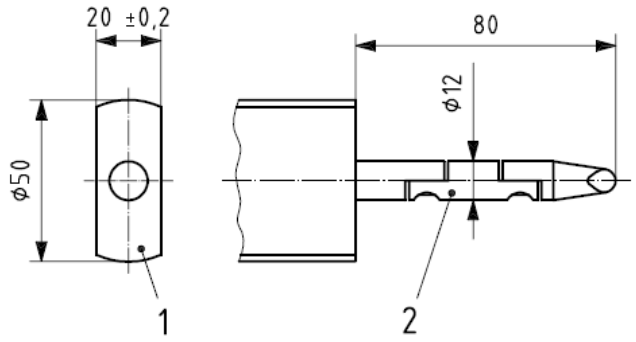
The access probe shall not touch live parts.

A mirror or a fiberscope may be used in order to inspect whether the access probe touches the high voltage buses, if necessary.

Annex 11 – Appendix 1 - Protection degrees

1 IPXXB

Jointed test finger diameter 12; 80 length Dimensions in millimetres



Key

1 stop face (diameter 50 × 20) (insulating material)

2 jointed test finger (metal)

The jointed test finger may penetrate over its full length of 80 mm but shall not contact the hazardous parts, even when its joints are bent at any optional angle (up to 90° from its axis) and are brought into any possible position. The stop face (Ø50 mm x 20 mm) shall not pass through the opening.