

*For Comments Only*

**BUREAU OF INDIAN STANDARDS**

**DRAFT FOR COMMENTS ONLY**

*(Not to be reproduced without the permission of BIS or used as an Indian Standard)*

*भारतीय मानक मसौदा*

**स्वचल वाहन – स्टीयरिंग नियंत्रण प्रणाली – संघट्ट सुरक्षा  
अपेक्षाएं एवं मापन पद्धतियां**

*( दूसरा पुनरीक्षण )*

*Draft Indian Standard*

**AUTOMOTIVE VEHICLES - STEERING CONTROL SYSTEMS - IMPACT PROTECTION  
REQUIREMENTS AND METHODS OF MEASUREMENT**

*( Second Revision )*

ICS 43.040

**Passive Safety Crash Protection Systems Sectional  
Committee, TED 29**

**Last date for receipt of comments is  
XX/XX/2024**

Passive Safety Crash Protection Systems Sectional Committee, TED 29

## FOREWORD

*(Formal Clause to be added later)*

This standard was first published in 1987. The present revision is necessary to incorporate the latest changes made in ECE and FMV standards. It is a known fact that in the case of accidents the eventualities are due to chest, neck and facial injuries as a result of the impact on collision.

This standard aims at the impact protection of the driver under the effect of the following three forces:

- a) Those due to the driver's body inertia in the event of an impact against the steering control in a frontal collision.
- b) Those resulting from a frontal collision which may produce rearward displacement of the steering column.
- c) Those due to the drivers head inertia in the event of an impact against the steering control in a frontal collision.

While preparing the standard, considerable assistance has been derived from the following EEC directive and UN ECE standard:

EEC directive 91/662/EEC *'The behavior of the steering wheel and column in an impact'*

EEC Directive 70/156/EEC *'On the approximation of the laws of the Member States relating to the Type Approval of Motor Vehicles and their Trailers'*

UN R12 - *Uniform provisions concerning the approval of vehicles with regard to the protection of the driver against the steering mechanism in the event of impact*

While formulating the standard, assistance has also been obtained from the following Indian Standards:

AIS 096: Requirements for Behavior of Steering Mechanism of a Vehicle in a Head-on Collision

The composition of the Committee responsible for the formulation of this standard is given at **Annex B (Will be added later)**.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (second revision)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Draft Indian Standard*

**AUTOMOTIVE VEHICLES – STEERING CONTROL SYSTEMS – IMPACT PROTECTION  
REQUIREMENTS AND METHODS OF MEASUREMENT**  
(*Second Revision*)

**1 SCOPE**

**1.1** This standard applies to the behavior 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 N1 with maximum permissible mass < 1500 kg and of vehicles of category M1, with regard to the protection of the occupants in a frontal collision.

**1.2** This standard shall not apply to multi-stage built vehicles produced in quantities not exceeding 500 vehicles in any period of 12 months' duration.

**1.3** This standard is not applicable for vehicles with forward control; for such vehicles an appropriate seat belt assembly preferably shoulder type shall be provided for the driver.

**1.4** This standard also applies to the behavior of steering mechanism of Quadricycles of category L7 vehicles

**2 REFERENCE**

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS/ ISO/ Others</i>	<i>Title</i>
IS 13749	Automotive vehicles - Procedure for determining the "H" point and the torso angle for 50 <sup>th</sup> percentile adult male in seating positions of motor vehicles
IS 15223	Automotive Vehicles - Interior Fittings - Specification
ISO 6487 :1987	Road Vehicles – Measurement Techniques in Impact Tests – Instrumentation
EEC Directive 70/156/EEC	On the approximation of the laws of the Member States relating to the Type Approval of Motor Vehicles and their Trailers
UN ECE R12	Uniform provisions concerning the approval of vehicles with regard to the protection of the driver against the steering mechanism in the event of impact
AIS-098	Requirements for the Protection of the Occupants in the event of an Offset Frontal Collision
AIS-096	Requirements for Behavior of Steering Mechanism of a Vehicle in a Head-on Collision

**3 TERMINOLOGY**

For the purpose of this standard, the following definitions shall apply.

**3.1 Air Bag** — Air bag means a flexible bag that is designed to be inflated with a gas under pressure, by a device actuated in case of vehicle's impact, in order to protect the driver against steering control.

**3.2 Body Block** — The torso shaped standardized body form used for carrying out the impact test.

**3.3 Boss** — The part of the steering control, usually at the center, that joins the steering control to the steering shaft and transmits the torque from the steering control to the steering shaft.

**3.4 Centre of the Boss** — The point on the surface of the steering control boss which is in line with axis of the steering shaft.

**3.5 Forward Control** — A configuration in which more than half of the engine length is rearward of the foremost point of the windshield base and the steering wheel hub is in the forward quarter of the vehicle length.

**3.6 General steering control** — A steering control which can be fitted to more than one approved vehicle type where differences in the attachment of the steering control to the steering column do not affect the impact performance of the steering control.

**3.7 Impactor** — The rigid hemi-spherical head form 165 mm in diameter with a mass of 6.8 kg, in accordance with 8.3.3.

**3.8 Passenger Compartment**

**3.8.1** Passenger compartment with regard to occupant's 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 seat back support.

**3.8.2** 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 occupants from direct contact with high voltage live parts.

**3.9 Plane of the Steering Control** — The case of the steering wheel, the flat surface that splits the steering wheel rim equally between the driver and front of the vehicle.

**3.10 R point or Seating reference point** — Seating reference point as defined in 2.4 of IS 13749. Tolerance (4) (*see* Fig.1)

- ± 5 mm
- ± 5 mm
- ± 1.2 kg

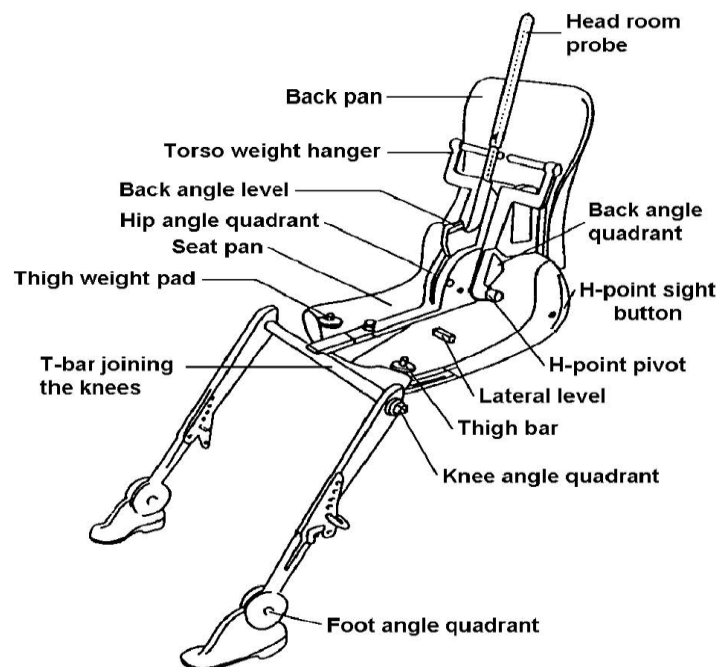


FIG. 1 DIMENSIONS AND MASS OF MANIKIN

**Mandatory Dimensions for the 3 DH Machine**

SI No.	Parameter	Dimension	Tolerance
--------	-----------	-----------	-----------

(1)	(2)	(3)	(4)
i)	H-point to knee point	432 mm	± 5mm
ii)	Knee point to ankle point	417 mm	± 5mm
iii)	T-bar length	108-424 mm (Adjustable)	

**Mandatory weight of the 3 DH machine**

SI No.	Parameter	Weight	Tolerance
(1)	(2)	(3)	(4)
i)	Weight of the complete 3 DH manikin	76 kg	± 1.2 kg

**Non-Mandatory Values of Select 3 DH Machine Dimensions**

SI No.	Parameter	Dimension
(1)	(2)	(3)
i)	Width across shoulders at widest location	395 mm
ii)	Distance across outside of H-point apertures	393 mm
iii)	Horizontal distance from H-point to rear of buttock section	134 mm
iv)	Vertical distance above seat base of h-point	97.5 mm
v)	Ankle pivot to heel point	107 mm

**Non-Mandatory Weights of 3 DH Machine Sub-systems**

Sl. No.	Parameter	Recommended Minimum weight
(1)	(2)	(3)
i)	Components simulating back and seat of the body	16 kg
ii)	Torso weights (8 no's)	31 kg
iii)	Seat weights (2 no's)	8 kg
iv)	Thigh weights (2 no's)	7 kg
v)	Leg weight	13 kg
<b>Total</b>		<b>75 kg</b>

**3.11 Spoke** — A bar connecting the steering control rim to the boss.

**3.12 Steering Column** — Housing enclosing the steering shaft.

**3.13 Steering Control** — The steering device, usually the steering wheel, which is actuated by the driver.

**3.14 Steering control type** — A category of steering controls which do not differ in such essential respects as:  
a) The structure, dimensions, lines and constituent materials

**3.15 Steering Control Rim** — The quasi-toroidal outer ring in the case of the steering wheel usually gripped by the driver's hand during driving.

**3.16 Steering Mechanism** — Aggregate comprising the steering control, the steering column, the assembly accessories, the steering shaft, the steering gear housing, and all other components such as those designed to contribute to the absorption of energy in the event of impact against the steering control

**3.17 Steering Shaft** — The component that transmits steering torque from steering control to the steering gear.

**3.18 Mass of the vehicle in running order**- 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 REESS.

**3.19 Maximum Permissible Mass** — Maximum permissible mass means the maximum mass declared by the vehicle manufacturer to be technically permissible.

**3.20 Vehicle type** - A category of motor vehicles which do not differ in such essential respects as:

- a) Vehicle powered by an internal combustion engine:
  - 1) The structure, dimensions, lines and constituent materials of that part of the vehicle forward of the steering control; and
  - 2) The mass of vehicle in running order, as defined in **3.18**.
- b) Vehicle powered by an electric motor:
  - 1) The structure, dimensions, lines and constituent materials of that part of the vehicle forward of the steering control;
  - 2) The locations of the Rechargeable Energy Storage Systems (REESS), in so far as they have a negative effect on the result of the impact test prescribed in this Standard; and
  - 3) Mass of the vehicle in running order as defined in **3.18**.

**3.21 High voltage** — The classification of an electric component or circuit, if its working voltage is as follows:

60 V < working voltage (DC) ≤ 1500 V; or  
30 V < working voltage (AC) rms ≤ 1000 V.

**3.22 Rechargeable Energy Storage System (REESS)** — Rechargeable energy storage system that which provides electrical energy for electrical propulsion.

A battery whose primary use is to supply power for starting the engine and/or lighting and/or other vehicle auxiliaries' systems is not considered as a REESS.

The REESS may include the necessary systems for physical support, thermal management, electronic controls and casing.

**3.23 Electrical Protection Barrier** — Part providing protection against any direct contact to the high voltage live parts.

**3.24 Electrical Power Train** — 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.

**3.25 Live Parts** — Conductive part(s) intended to be electrically energized in normal use.

**3.26 Exposed Conductive Part** — 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.

**3.27 Direct Contact** — The contact of persons with high voltage live parts.

**3.28 Indirect Contact** — The contact of persons with exposed conductive parts.

**3.29 Protection IPXXB** — 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 (IPXXB) as described in **A-5**.

**3.30 Working Voltage** — The highest value of an electrical circuit voltage root-mean-square (rms), specified by the vehicle 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.

**3.31 Coupling System for Charging the Rechargeable Energy Storage System (REESS)** — The electrical circuit used for charging the REESS from an external electrical power supply including the vehicle inlet.

**3.32 Electrical Chassis** — A set made of conductive parts electrically linked together, whose electrical potential is taken as reference.

**3.33 Electrical Circuit** — An assembly of connected high voltage live parts which is designed to be electrically energized in normal operation.

**3.34 Electric Energy Conversion System** — A system that generates and provides electrical energy for electrical propulsion.

**3.35 Electronic Converter** — A device capable of controlling and/or converting electrical power for electrical propulsion.

**3.36 Enclosure** — Physical part enclosing the internal units and providing protection against any direct contact.

**3.37 High Voltage Bus** — Electrical circuit, including the coupling system for charging the REESS that operates on a high voltage.

Where electric circuits are galvanically connected to each other and fulfil the specific voltage condition, only the components or parts of the electric circuit that operate on high voltage are classified as high voltage bus.

**3.38 Solid Insulator** — 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.

**3.39 Automatic Disconnect** — A device that when triggered, galvanically separates the electrical energy sources from the rest of the high voltage circuit of the electrical power train.

**3.40 Open Type Traction Battery** — A type of battery requiring filling with liquid medium and generating hydrogen gas that is released to the atmosphere.

**3.41 Aqueous electrolyte** — An electrolyte based on water solvent for the compounds (e.g. acids, bases) providing conducting ions after its dissociation.

**3.42 Electrolyte leakage** — The escape of electrolyte from REESS in the form of liquid.

**3.43 Non-aqueous electrolyte** — An electrolyte not based on water as the solvent.

**3.44 Normal operating conditions** — Operating modes and conditions that can reasonably be encountered during typical operation of the vehicle including driving at legally posted speeds, parking and standing in traffic, as well as, charging using chargers that are compatible with the specific charging ports installed on the vehicle. It does not include, conditions where the vehicle is damaged, either by a crash, road debris or vandalization, subjected to fire or water submersion, or in a state where service and or maintenance is needed or being performed.

**3.45 Specific voltage condition** — Condition that the maximum voltage of a galvanically connected electric circuit between a DC live part and any other live part (DC or AC) is  $\leq 30$  V AC (rms) and  $\leq 60$  V DC.

Notes: When a DC live part of such an electric circuit is connected to electrical chassis and the specific voltage condition applies, the maximum voltage between any live part and the electrical chassis is  $\leq 30$  V AC (rms) and  $\leq 60$  V DC.

For pulsating DC voltages (alternating voltages without change of polarity) the DC threshold shall be applied.

**3.46 State of Charge (SOC)** — The available electrical charge in a REESS expressed as a percentage of its rated capacity.

**3.47 Fire** — The emission of flames from the vehicle. Sparks and arcing shall not be considered as flames.

**3.48 Explosion** — The sudden release of energy sufficient to cause pressure waves and/or projectiles that may cause structural and/or physical damage to the surrounding of the vehicle.

**3.49 Sharp Edge** — An edge of a rigid material having radius of curvature of less than 2.5 mm except in case of projections of less than 3.2 mm, measured from the panel according to the procedure described in Annex C of IS 15223 as amended from time to time. If the height of projection is less than 3.2 mm, the minimum radius of curvature shall not apply provided the height of the projection is not more than half its width and its edges are blunted. (See ANNEX F, explanatory notes, **3.14** of IS 15223 as amended from time to time)

**3.50 Behaviour of the steering mechanism in the event of an impact** — Behaviour of this mechanism under the effect of three types of forces, i.e.:

**3.50.1** Those resulting from a frontal collision which may produce displacement of the steering column towards the rear;

**3.50.2** Those due to the driver's head inertia in the event of an impact against the steering control in a frontal collision;

**3.50.3** Those due to the driver's body inertia in event of an impact against the steering control in a frontal collision.

**3.51 Multistage type approval** — Procedure whereby one or more testing agencies certify that depending on the state of completion, an incomplete or completed vehicle type satisfies the relevant technical requirements of the standard.

**3.52 Multi-stage build** — Procedure whereby two or more manufacturers separately and sequentially participate in the construction of a vehicle.

## 4 SPECIFICATIONS

**4.1** When the vehicle, in running order, without a manikin, is collision-tested against a barrier at a speed of 35 km/h in case quadricycle of category L7 and 48.3km/h for other vehicles as per **7**.

**4.1.1** During the test, the top of the steering and its shaft shall not move backwards by more than 127mm and upwards by more than 127mm when measured as per **7.3.1** and corrected as per **7.4.2** of this standard.

A vehicle other than quadricycle of category L7, which has been certified as complying to **5.2.2** the offset frontal collision test requirements of AIS-098 as amended from time to time shall be deemed to have met the requirements of **4.1.1** of this standard.

**4.1.2** Additionally vehicles equipped with electrical power train shall meet requirements of **4.6**. This could be demonstrated in a separate frontal impact test, at the request of the vehicle manufacturer, after validation by the Test Agency, given that the electric components do not influence the driver's protection performance of the vehicle type as defined in this Standard.

**4.2** When the steering control is struck by a body block released against this control at a relative speed of 17.5 km/h in case quadricycle of category L7 and 24.1 km/h for other vehicles, the force applied to the body block by the steering control shall not exceed 1 111 daN.

**4.3** If the steering control is fitted with a steering wheel airbag, specifications of **4.2** above are deemed to be met if the vehicle equipped with such a steering system complies with the specifications of **5.2.1.4** and **5.2.1.5** of AIS-098 as amended from time to time.

**4.4** When the steering control is struck by an impactor released against this control at a relative speed of 17.5 km/h in case quadricycle of category L7 and of 24.1 km/h for other vehicles, in accordance with the procedures in paragraph 8 of this standard, the deceleration of the impactor shall not exceed 80 g cumulative for more than 3 milliseconds. The deceleration shall always be lower than 120 g with Channel Frequency Class 600 Hz of ISO 6487.

**4.5** The steering control shall be designed, constructed and fitted in such a way that:



**4.5.1** Before the impact tests prescribed in **4.2** and **4.4** above no part of the steering control surface, directed towards the driver, which can be contacted by a sphere of 165 mm in diameter shall present any roughness or sharp edges with a radius of curvature of less than 2.5 mm.

In the case of a steering control equipped with an airbag, this requirement shall be deemed satisfactory if no part, which can be contacted by a sphere of 165 mm diameter, contains any dangerous sharp edges, as defined in **3.49** likely to increase the risk of serious injury to the occupants.

**4.5.1.1** After any impact tests prescribed in **4.2** and **4.4** the part of the steering control surface directed towards the driver shall not present any sharp or rough edges likely to increase the danger of severity of injuries to the driver. Small surface cracks and fissures shall be disregarded.

**4.5.1.2** In the case of a projection consisting of a component made of non-rigid material of less than 50 Shore A hardness mounted on rigid support, the requirement of **4.5.1.1** shall only apply to the rigid support.

**4.5.2** The steering control shall be so designed, constructed and fitted as not to embody components or accessories, including the horn control and assembly accessories, capable of catching in the driver's clothing or jewelry in normal driving movements.

**4.5.3** In the case of steering controls not intended to form part of the original equipment they shall be required to meet the specification when tested in accordance with **6.5.6** and **8.3.1**.

**4.5.4** In the case of "general steering controls", the requirements shall be met over:

**4.5.4.1** The full range of column angles, it being understood that the tests shall be performed at least for the maximum and minimum column angles for the range of approved vehicle types for which the controls are intended;

**4.5.4.2** The full range of possible impactor and body block positions in relation to the steering control, it being understood that the test shall be performed at least for the mean position for the range of approved vehicle types for which the controls are intended. Where a steering column is used, it shall be of a type corresponding to the "worst case" conditions.

**4.5.4.3** Where adaptors are used to adapt a single type of steering control to a range of steering columns, and it can be demonstrated that with such adaptors the energy-absorbing characteristics of the system are the same, all the tests may be performed with one type of adaptor.

**4.6** Following the test, conducted in accordance with the procedure defined in **7** of this Standard, 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 electrical power train, shall meet the following requirements:

#### **4.6.1 Protection against electrical shock**

After the impact, the high voltage buses shall meet at least one of the 4 criteria specified in **4.6.1.1** to **4.6.1.4** shall be met.

If the vehicle has an automatic disconnect function or device(s) that galvanically conductively 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 circuit individually after the disconnect function is activated.

However, criteria defined in **4.6.1.4** 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 degree IPXXB.

In the case that the test is performed under the condition that part(s) of the high voltage system is not energized and with the exception of any coupling system for charging the REESS which is not energized during driving conditions, the protection against electrical shock shall be proved by either paragraph **4.6.1.3** or paragraph **4.6.1.4** below for the relevant part(s).

#### 4.6.1.1 Absence of high voltage

The voltages  $V_b$ ,  $V_1$  and  $V_2$  of the high voltage buses shall be  $< 30 V_{AC}$  or  $60 V_{DC}$  within 60 s after the impact when measured in accordance with paragraph 2 of Annex B of this standard.

#### 4.6.1.2. Low electrical energy

The total energy (TE) on the high voltage buses shall be  $< 2.0$  J when measured according to the test procedure as specified in **A-4**. 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 vehicle manufacturer in **A-4**.

The energy stored in the Y-capacitors ( $TE_{y1}$ ,  $TE_{y2}$ ) shall also be  $< 2.0$  J. 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 vehicle manufacturer according to formula (c) in **A-4**.

#### 4.6.1.3. Physical protection

For protection against direct contact with high voltage live parts, the protection degree IPXXB shall be provided. The assessment shall be conducted in accordance with **A-5**.

In addition, for protection against electrical shock, which could arise from indirect contact, the resistance between all exposed conductive parts of electrical protection barriers/enclosures and the electrical chassis shall be  $< 0.1 \Omega$  and the resistance between any two simultaneously reachable exposed conductive parts of electrical protection barriers/enclosures that are less than 2.5 m from each other shall be less than  $0.2 \Omega$  when there is current flow of at least 0.2 Amp. This resistance may be calculated using the separately measured resistances of the relevant parts of electric path.

These requirements are satisfied if the galvanic connection has been made by welding. In case of doubt or if the connection is established by mean other than welding, measurements shall be made by using one of the test procedures described in **A-5.1**.

#### 4.6.1.4. Isolation Resistance

The criteria specified in the **4.6.1.4.1** and **4.6.1.4.2** below shall be met. The measurement shall be conducted in accordance with **A-6**.

##### 4.6.1.4.1. 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 **A-6**) shall have a minimum value of  $100 \Omega/\text{volt}$  of the working voltage for DC buses, and a minimum value of  $500 \Omega/\text{volt}$  of the working voltage for AC buses.

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

If the AC high voltage buses and the DC high voltage buses are conductively connected, they shall meet one of the following requirements:

- a) Isolation resistance between the high voltage bus and the electrical chassis shall have a minimum value of  $500 \Omega/\text{V}$  of the working voltage;
- b) Isolation resistance between the high voltage bus and the electrical chassis shall have a minimum value of  $100 \Omega/\text{V}$  of the working voltage and the AC bus meets the physical protection as described in **4.6.1.3**;
- c) Isolation resistance between the high voltage bus and the electrical chassis shall have a minimum value of  $100 \Omega/\text{V}$  of the working voltage and the AC bus meets the absence of high voltage as described in **4.6.1.1**.

#### 4.6.2 Electrolyte leakage

**4.6.2.1** In case of aqueous electrolyte REESS.

For a period from the impact until 60 minutes after the impact, there shall be no electrolyte leakage from the REESS into the passenger compartment and no more than 7 percent by volume of the REESS electrolyte with a maximum of 5.0 l leaked from the REESS to the outside of the passenger compartment. The leaked amount of electrolyte can be measured by usual techniques of determination of liquid volumes after its collection. For containers containing Stoddard, coloured coolant and electrolyte, the fluids shall be allowed to separate by specific gravity then measured.

#### 4.6.2.2 In case of non-aqueous electrolyte REESS.

For a period from the impact until 60 minutes after the impact, there shall be no liquid electrolyte leakage from the REESS into the passenger compartment, luggage compartment and no liquid electrolyte leakage to outside the vehicle. This requirement shall be verified by visual inspection without disassembling any part of the vehicle.

#### 4.6.3 REESS retention

REESS shall remain attached to the vehicle by at least one component anchorage, bracket, or any structure that transfers load from REESS to the vehicle structure, and REESS located outside the passenger compartment shall not enter the passenger compartment.

#### 4.6.4 REESS fire hazard

4.7 Specifications of 4.6 to 4.6.4 above are deemed to be met if the vehicle equipped with an electrical power train operating on high voltage complies with the relevant specifications of AIS-098, as amended from time to time.

## 5 TESTS

The following tests shall be carried out to determine the impact of steering control system on the driver in the event of any frontal collision:

- a) Body block test (*see 6*);
- b) Frontal impact test (*see 7*); and
- c) Head form test (*see 8*).

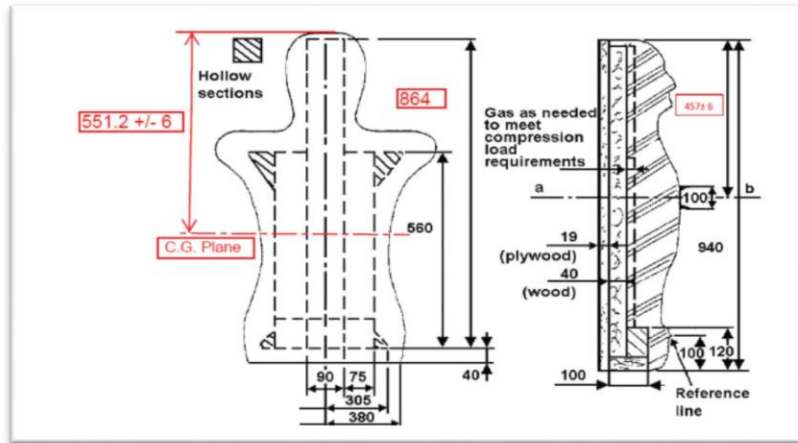
## 6 BODY BLOCK TEST

6.1 When the steering control is struck by a body block released against this control at a relative speed of 17.5 km/h (+1.2, 0) in case of quadricycle of category L7 and 24.1 km/h (+1.2, 0) for other vehicles, in accordance with the following procedure and the force applied to the body by the steering control shall not exceed 1111 daN.

If the steering control is fitted with a steering wheel airbag, specifications of 6 are deemed to be met if the vehicle equipped with such a steering system complies with the specifications of 5.2.1.4 and 5.2.1.5 of AIS-098 as amended from time to time.

### 6.2 Body Block

6.2.1 The body block shall have the shape, dimensions, mass and characteristics shown in Fig. 2.



All dimensions in millimetres.

FIG. 2 MASS 34-36 KG, 50<sup>TH</sup> PERCENTILE TORSO-SHAPED BODY BLOCK

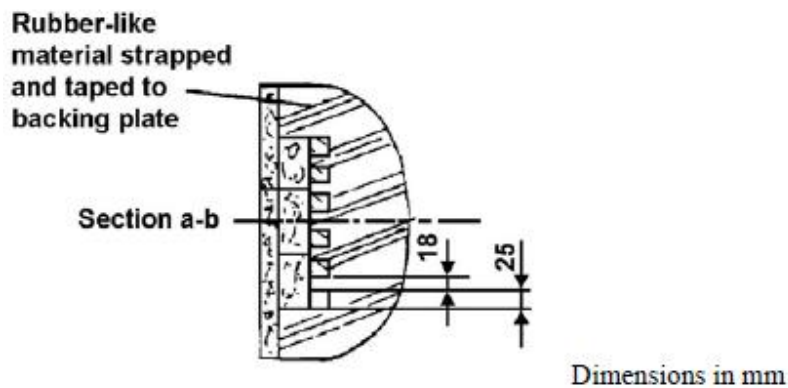


FIG. 3 BAKING PLATE

Spring Rate: 107 kgf/cm — 143 kgf/cm

Following are non mandatory additional guidelines for mechanical properties of the body block:

- Rate of loading during stiffness measurement:  $250 \pm 50$  mm/min;
- Centre of gravity:  $551.2 \pm 6$  mm from top of the body block;
- Moment of inertia about lateral axis through centre of gravity:  $2.26 \pm 0.23$  kg.m<sup>2</sup>.

The chest is loaded with a 100 mm beam as shown, 90° to the longitudinal axis of the block and parallel to the backing plate. The load is measured when the beam has moved 12.7 mm in to the body block.

### 6.3 Mounting of Steering Control

**6.3.1** The control shall be mounted on the front section of the vehicle obtained by cutting the body transversely at the level of front seats and possibly eliminating the roof, windscreen and doors. This section shall be fixed rigidly to the test bench so that it does not move under the impact of the body block.

The tolerance on the control mounting angle shall be  $\pm 2$  degrees of the design angle.

**6.3.2** However, at the request of the manufacturer and with the agreement of the testing agency, the steering control may be mounted on a framework simulating the mounting of the steering mechanism, provided that, as compared with the real "front body section/steering mechanism" assembly the "framework/steering mechanism" assembly has:

- 6.3.2.1 the same geometrical layout,
- 6.3.2.2 greater rigidity.

**6.3.3** Mounting of the steering control when seeking steering control approval only. The steering control shall be tested complete with trim. The steering control shall have a minimum collapsing space of 100 mm between the steering control and the test bench. The steering shaft shall be firmly attached to the test bench so that the steering shaft does not move under impact (*see* Figure 3a and 3b).

#### **6.4 Setting of Steering Mechanism**

**6.4.1** During the first test, the steering control shall be turned so that its most rigid spoke is perpendicular to the first point of contact with body block; if the steering control is a steering wheel, the test shall be repeated with the most flexible part of the steering wheel perpendicular to the point of contact. In the case of an adjustable steering control, both tests shall be carried out with the wheel adjusted to the normal position indicated by the manufacturer or, failing that, midway between the limits of its range(s) of adjustment.

**6.4.2** If the vehicle is equipped with a device to adjust the slope and position of the steering wheel, the test shall be performed with the latter in the normal position of use indicated by the manufacturer and regarded by the laboratory as representative from the standpoint of energy absorption.

#### **6.5 Propulsion of Body Block**

**6.5.1** Any method of propulsion may be used, provided that when the body block strikes the steering control, it shall be free from all connections with the propelling device, the body block shall strike the control after an approximately straight trajectory parallel to the longitudinal axis of this vehicle.

**6.5.2** The H point of the body block, indicated by a special mark, shall be so adjusted that before the impact it is in the horizontal plane passing through the R point as indicated by the manufacturer of the vehicle.

#### **6.6 Speed**

The body block shall strike the steering control at a speed of 17.5 km/h (+1.2, 0) in case of quadricycle of category L7 and 24.1 km/h (+1.2, 0) i.e 15mph, (+0.8, 0) for other vehicles. However, if the test has been carried out at a higher impact speed and the control has met the requirements laid down, the test shall be considered satisfactory.

#### **6.7 Measurements of Forces**

##### **6.7.1 Force**

**6.7.1.1** Measurements shall be made of the maximum force, acting horizontally and parallel to the longitudinal axis of the vehicle, applied to the body block as a result of impact against the steering control. This force may be measured directly or indirectly or may be calculated from values recorded during the test.

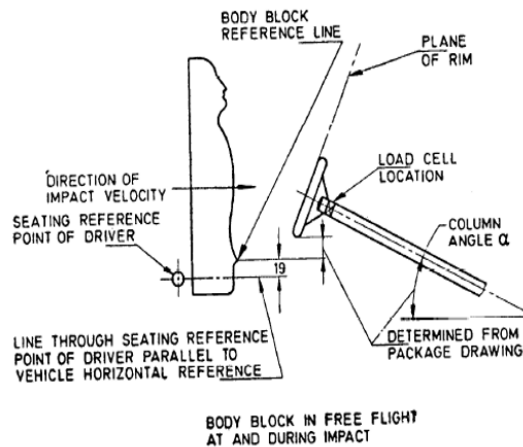


FIG. 3C STEERING WHEEL-BODY BLOCK RELATIONSHIP

6.7.1.2 The test shall be carried out as per the method indicated by manufacturer as specified in 6.8.1.d.1) or 6.8.1.d.2).

## 6.8 Measuring Instruments

6.8.1 The accuracy of instruments used to record parameters specified in 6.1 shall be such that the measurements made shall have the accuracies indicated below:

- a) Speed of body block: within 2 percent;
- b) Recording time: within 1/1 000s; and
- c) The beginning of the impact (zero point) at the moment of first contact of the body block with the steering control shall be identified on the recordings and films used for analyzing the results of the test.
- d) **Measurement of Force** — The instrumentation used shall comply with ISO 6487: 1987 unless otherwise specified in this standard.
  - 1) With load transducers inserted on the steering system:  
The channel amplitude class shall be 1 960 daN (2000 kg) and the channel frequency class 600.
  - 2) With accelerometers or load transducers inserted on the body block:  
Two unidirectional accelerometers shall be placed symmetrically in the transverse plane of the centre of gravity of the body block. The channel amplitude class shall be 60 g and the channel frequency class 180. Other methods with regard to the number and positioning of the measuring accelerometers shall be allowed, such as by dividing the test apparatus in separate parts at the centre of gravity of which accelerometers are placed to measure the acceleration horizontally and parallel to the longitudinal axis of the vehicle.

The resultant force shall be the force corresponding to the maximum of the sum of forces calculated or measured directly for each part of the body block.

6.9 Ambient temperature: stabilised at  $(20 \pm 5)$  °C.

## 6.10 Result

6.10.1 After the test, the damage sustained by the steering mechanism shall be ascertained and recorded in a test report, at least one side-view and one front-view photograph of the steering control/steering column/instrument panel area shall be taken.

6.10.2 The maximum value of force shall be measured or calculated as indicated in 6.8.1, and it shall be reported.

## 7 FRONTAL IMPACT TEST (AGAINST A BARRIER)

**7.1** When the vehicle, in running order, without a manikin, is collision-tested against a barrier at a speed of 35 km/h in case quadricycle of category L7 and 48.3 km/h, in accordance with the following procedure, the top of the steering column and its shaft shall not move backwards, horizontally or vertically by not more than 12.7 cm in the plane parallel to the longitudinal axis of the vehicle in relation to a point of the vehicle not affected by the impact.

**7.1.1** Additionally vehicles, equipped with electrical power train, shall meet requirements specified in Annex A of this standard. This could be demonstrated in a separate frontal impact test at the request of the vehicle manufacturer after validation by the Test Agency, given that the electric components do not influence the driver's protection performance of the vehicle type as defined in this standard.

## **7.2 Installation Procedure and Measuring Instrument**

### **7.2.1 Testing Ground**

**7.2.1.1** 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 (slope less than 3 percent measured over a length of one metre), flat and smooth.

### **7.2.2 Barrier**

**7.2.2.1** The barrier shall consist of a block of reinforced concrete not less than 3 m wide in front and not less than 1.5 m high. The barrier shall be of such thickness that its mass is at least 70 metric tons. The front face shall be flat, vertical and perpendicular to the axis of the run-up track. It shall be covered with plywood board  $20 \pm 2$  mm thick, in good condition. A structure on a steel plate at least 25 mm thick may be placed between the plywood board and the barrier.

A barrier with different characteristics may likewise be used, provided that the area of the impact surface is greater than the frontal crash area of the vehicle being tested and also would give equivalent results.

### **7.2.3 Propulsion of Vehicle**

**7.2.3.1** At moment of impact, the vehicle shall no longer be subject to the action of any additional steering or propelling device. It shall reach the obstacle on a course perpendicular to the barrier; the maximum lateral misalignment permissible between the vertical median line of the front of the vehicle and the vertical median line of the barrier is  $\pm 30$  cm.

### **7.2.4 State of Vehicle**

**7.2.4.1** For the test the vehicle shall either be fitted with all the normal components and equipment included in its unladen (kerb) mass or be in such a condition as to satisfy this requirement so far as the components and equipment of concern to the passenger compartment and the distribution of the mass of the vehicle as a whole, in running order, are concerned.

At the request of the manufacturer, by derogation from **4.1**, the test may be carried out with manikins in position, provided they do not at any time hinder the movement of the steering mechanism. The mass of the manikins shall not be taken into account for the purposes of the test.

**7.2.4.2** If the vehicle is driven by an external means, the fuel feed systems shall be filled to at least 90 percent of its capacity with a non-flammable liquid having a specific gravity ranging between 0.7 and 1 and all the other systems (brake-fluid reservoir, radiator etc) may be left empty.

**7.2.4.3** If the vehicle is driven by its own engine, the fuel tank shall be filled to at least 90 percent of its capacity. All other reservoirs shall be filled to their capacity. If the manufacturer so desires and the testing agency agrees, the fuel feed to the engine may be provided from an auxiliary tank of small capacity. In such case, the fuel tank shall be filled to not less than 90 percent of its capacity with a non-flammable liquid having a specific gravity ranging between 0.7 and 1.

**7.2.4.4** If the manufacturer so requests, the testing agency responsible for conducting the tests may allow the same vehicle as is used for tests specified by other Indian Standards (including tests capable of affecting its structure) to be used also for the tests specified in this standard.

#### **7.2.4.5** *Electrical power train adjustment*

##### **7.2.4.5.1** Procedures for SOC adjustment

**7.2.4.5.1.1** The adjustment of SOC shall be conducted at an ambient temperature of  $20 \pm 10$  °C.

**7.2.4.5.1.2** The SOC shall be adjusted according to one of the following procedures as applicable. Where different charging procedures are possible, REESS shall be charged using the procedure which yields the highest SOC:

For a vehicle with a REESS designed to be externally charged, the REESS shall be charged to the highest SOC in accordance with the procedure specified by the manufacturer for normal operation until the charging process is normally terminated.

For a vehicle with a REESS designed to be charged only by an energy source on the vehicle, the REESS shall be charged to the highest SOC which is achievable with normal operation of the vehicle. The manufacturer shall advise on the vehicle operation mode to attain this SOC.

**7.2.4.5.1.3** When the vehicle is tested, SOC shall be no less than 95 per cent of SOC according to **7.2.4.5.1.1** and **7.2.4.5.1.2** for REESS designed to be externally charged and shall be no less than 90 per cent of SOC according to **7.2.4.5.1.1** and **7.2.4.5.1.2** for REESS designed to be charged only by an energy source on the vehicle. SOC will be confirmed by a method provided by the manufacturer.

**7.2.4.5.2** The electrical power train shall be energized with or without the operation of the original electrical energy sources (for example engine-generator, REESS or electric energy conversion system), however;

**7.2.4.5.3** By the agreement between Test Agency and vehicle 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. 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.

**7.2.4.5.4** In the case where an automatic disconnect is provided, at the request of the vehicle 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.'

**7.2.4.6** 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.

#### **7.2.5** *Speed on Impact*

**7.2.5.1** The speed on impact shall be between 48.3 km/h and 53.1 km/h in case of vehicle other than quadricycle of category L7. For quadricycles of category L7, the speed on impact shall be between 32 km/h and 35 km/h. However, if the test has been carried out at a higher impact speed and the vehicle has met the requirements laid down, the test shall be considered satisfactory.

#### **7.2.6** *Measuring Instruments*

**7.2.6.1** The instruments used for recording the speed specified in **7.2.5.1** above shall be accurate to within 1 percent.

### **7.3 Results**

**7.3.1** To determine the rear- and upward movement of the steering control, a recording shall be made, during the collision, of the variation in the distance - measured horizontally and parallel to the longitudinal axis of the vehicle,



and vertically, in the direction perpendicular to that axis - between the top of the steering column (and shaft) and a point on the vehicle which is not affected by the impact. The largest value of this variation, taken from the recording, shall be taken as the rear- and upward movement.

**7.3.2** After the test the damage sustained by the vehicle shall be recorded in a test report; one photograph at least shall be taken of each of the following views of the vehicle:

- a) Side (right and left);
- b) Front;
- c) Bottom; and
- d) Affected area inside the passenger compartment.

## 7.4 Correction Factors

### 7.4.1 Notation

Recorded speed in km/h;

- $v$  = Recorded speed in km/hr  
 $m_0$  = Mass of prototype in the state defined in **7.2.4**  
 $m_1$  = Mass of prototype with testing apparatus;  
 $D_0$  = Variation in the distance measured during the impact, as defined in **7.3.1**  
 $D_1$  = Variation in the distance used to determine the results of the test;  
 $K_1$  = the greater of  $(48.3/v)^2$  and 0.83 for vehicles other than quadricycle of category L7;  
K1 the greater of  $(32/v)^2$  and 0.83 for quadricycle of category L7  
 $K_2$  = the greater of  $(m_0/m_1)$  and 0.8;

**7.4.2** The corrected variation  $D_1$  used to check the conformity of the prototype with the requirements of this standard shall be calculated by the following formula:

$$D_1 = D_0 \times K_1 \times K_2$$

**7.4.3** A frontal impact test against a barrier is not needed in the case of a vehicle, which is identical with the prototype considered as regards the characteristics specified in **3.19** of this standard but whose mass  $m_1 > m_0$ , if  $m_1 < 1.25 m_0$ , if  $m_1$  is not more than  $1.25 m_0$  and if the corrected variation  $D_2$  obtained from the variation  $D_1$  by the formula

$$D_2 = (m_1 \times D_1)/m_0$$

is such as to show that the new vehicle still meets the requirements of **4** of this standard.

## 7.5 EQUIVALENT PROCEDURES

**7.5.1** Alternative tests may be permitted at the discretion of the Approval Authority provided equivalence can be demonstrated. A report shall be attached to the approval documentation describing the method used and the results obtained or the reason for not carrying out the test.

**7.5.2** Responsibility for demonstrating the equivalence of the alternative method shall rest with the manufacturer or his agent wishing to use such a method.

## 8 HEAD FORM TEST

**8.1** When the steering control is struck by an impactor released against this control at a relative speed of 17.5 km/h (+1.2, 0) in case of quadricycle of category L7 and 24.1 km/h (+1.2, 0) for other vehicles, in accordance with the following procedure, the deceleration of the impactor shall not exceed 80 g cumulative for more than 3 milliseconds. The deceleration shall always be lower than 120 g with channel frequency class 600 Hz of ISO 6487.

**8.2** The steering control shall be tested complete with trim.

**8.2.1** If the steering control is fitted with a steering wheel air-bag, the test shall be carried out with the air-bag inflated. At the request of the manufacturer and with the consent of the testing agency the test may be carried out without the air-bag inflated.

### **8.3 Installation Procedure and Measuring Instrumentat**

#### **8.3.1 Mounting of Steering Control**

##### **8.3.1.1 Mounting of the Steering Control when seeking Steering Control Approval related to Vehicle Approval**

**8.3.1.1.1** The control shall be mounted on the front section of the vehicle obtained by cutting the body transversely at the level of the front seats and possibly eliminating the roof, windscreen and doors. This section shall be fixed rigidly to the test bench, so that it does not move under the impact of the head form.

**8.3.1.1.2** However, at the request of the manufacturer and with the agreement of the testing agency, the steering control may be mounted on a framework simulating the mounting of the steering mechanism, provided that, as compared with the real "front body section/steering mechanism" assembly, the "framework/steering mechanism" assembly has:

**8.3.1.1.2.1** the same geometric layout.

**8.3.1.1.2.2** greater rigidity.

**8.3.1.1.3** The tolerance on the control mounting angle shall be  $\pm 2^{\circ}$  of the design angle.

##### **8.3.1.2 Mounting the Steering Control when seeking Steering Control Approval only**

**8.3.1.2.1** The steering control shall be tested complete with trim. The steering control shall have a minimum collapsing space of 100 mm between the steering control and the test bench. The steering shaft shall be firmly attached to the test bench so that the steering shaft does not move under impact (*see* Fig. 3A & 3B).

**8.3.1.2.2** However, at the request of the manufacturer the test may be carried out under the conditions specified in **8.3.1** above. In such case the approval will only be valid for the specified type(s) of vehicle(s).

#### **8.3.2 Test Apparatus**

**8.3.2.1** This apparatus consists of a fully guided linear impactor, rigid, with a mass of 6.8 kg. Its impact surface is hemispherical with a diameter of 165 mm.

**8.3.2.2** The head-form shall be fitted with two accelerometers capable of measuring values in the impact direction.

#### **8.3.3 Speed of Impactor**

**8.3.3.1** The impactor shall strike the steering control at a velocity of 17.5 km/h (+1.2, 0) in case of quadricycle of category L7 and 24.1 km/h (+1.2, 0) for other vehicles; this velocity shall be achieved either by mere energy of propulsion or by using an additional propelling device.

#### **8.3.4 Instrumentation**

The measuring instruments used shall comply with ISO 6487. In addition, they shall have the following characteristics:

- a) Acceleration
  - 1) Channel amplitude class: 150 g; and
  - 2) Channel frequency class: 600 Hz CFC
- b) Speed Accuracy to within 1percent; and
- c) Time recording: The instrumentation shall enable the action to be recorded throughout its duration and the readings to be made with the accuracy to one-thousandth of a second. The beginning of the impact at

the moment of first contact between the impactor and the steering control shall be noted on the recordings used for analyzing the test.

## 8.4 Test Procedure

**8.4.1** The plane of the steering control shall be set up perpendicular to the direction of impact.

**8.4.2** A maximum of four and a minimum of three positions on each steering control wheel type shall be impacted. A new steering control shall be used for each impact. On successive impacts the axial axis of the impactor shall be in line with one of the following points:

**8.4.2.1** The centre of the steering control boss;

**8.4.2.2** The joint of the stiffest or most supported spoke to the inner edge of the steering control rim;

**8.4.2.3** The mid-point of the shortest unsupported area of the steering control rim that does not include a spoke when hit by the head form;

**8.4.2.4** At the discretion of the type approving authority, the "worst case" position on the steering control.

## 8.5 Results of Test

In the tests carried out according to the above procedure, the deceleration rate of the impactor shall be taken as the average of the simultaneous readings of the two accelerometers.

## 8.6 Equivalent Procedures

**8.6.1** Alternative tests may be permitted at the discretion of the Approval Authority provided equivalence can be demonstrated. A report shall be attached to the approval documentation describing the method used and the results obtained or the reason for not carrying out the test.

**8.6.2** Responsibility for demonstrating the equivalence of the alternative method shall rest with the manufacturer or his agent wishing to use such a method.

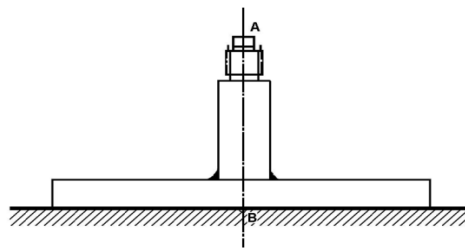


FIG 3A TESTING SETUP

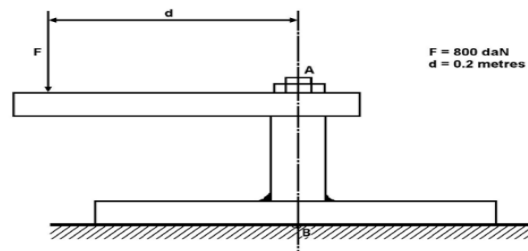


FIG 3B MEASURING OF THE TEST SETUP RIGIDITY

## 8.7 Measurement of the Testing Set-up Rigidity

Under a load of 800 daN producing a couple of 160 m.daN in relation to the Point "B", the displacement in any direction of the Point "A" shall be lower than 2 mm.

## 9 APPLICATION FOR APPROVAL

### 9.1 Vehicle Type

**9.1.1** The application for approval of a vehicle type with regard to the protection of the driver against the steering mechanism in the event of impact shall be submitted by the vehicle manufacturer or by his duly accredited representative.

**9.1.2** It shall be accompanied by the under mentioned documents in triplicate and the following particulars:

- a) A detailed description of the vehicle type with respect to the structure, dimensions, lines and constituent materials of that part of the vehicle forward of the steering control;
- b) Drawings, on an appropriate scale and in sufficient detail, of the steering mechanism and of its attachment to the vehicle chassis and body;
- c) A technical description of that mechanism;
- d) An indication of the mass of the vehicle in running order;

**9.1.3** The following shall be submitted to the testing agency responsible for conducting approval tests:

- a) A vehicle, representative of the vehicle type to be approved, for the test referred to in **5**;
- b) At the manufacturer's discretion, with the agreement of the testing agency, either a second vehicle, or those parts of the vehicle regarded by him as essential for the test referred to in **6** and **8**.
- c) The testing agency shall verify the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type approval is granted.

### 9.2 Steering Control Type

**9.2.1** The application for approval of a steering control type with regard to the protection of the driver against the steering mechanism in the event of impact shall be submitted by the steering control manufacturer or by his duly accredited representative.

**9.2.2** It shall be accompanied by the under mentioned documents in triplicate and the following particulars:

- a) A detailed description of the steering control type with respect to the structure, the dimensions and the constituent materials of the steering control;
- b) Drawings on an appropriate scale and in sufficient detail, of the steering mechanism and of its attachment to the vehicle chassis and body.

**9.2.3** A steering control representative of the steering control type to be approved plus, at the manufacturer's discretion, with the agreement of the testing agency, those parts of the vehicle regarded by him as essential for the test, shall be submitted to the testing agency responsible for conducting approval tests for the test referred to in **4.2** and **4.3**.

### 9.3 Approval

**9.3.1** *Vehicle Type* — If the vehicle submitted for approval pursuant to this standard meets the requirements of **4**, **6**, **7** and **8**, approval of that vehicle type shall be granted.

**9.3.2** *Steering Control Type* — If the steering control submitted for separate approval pursuant to this standard meets the applicable requirements of **4** and **5** as well as **6**, **7** and **8**, approval of that steering control type shall be granted. This is only applicable to steering controls, which do not include an airbag.

### 9.4 Criteria for Extension of Approval

**9.4.1** The approval accorded under this standard to a vehicle may be extended to:

**9.4.1.1** A variant whose mass in running order is same as or less than the mass in running order of the vehicle.

**9.4.1.2** A variant whose mass in running order is more than the mass in order of the vehicle subjected to the defined approval test but less than the actual test mass (defined as  $m_1$  **7.4.1**) of the vehicle subjected to the approval test.

**9.4.1.3** For the purposes of **9.4.1.1** and **9.4.1.2** variant shall be considered to be that vehicle whose layout of parts ahead of the bulkhead (firewall) and of the steering system is similar to but not more adverse (for the intents of this standard) than the vehicle subjected to the approval test.

**9.4.1.4** In the case of reduction in the mass of the steering wheel, tests as per **7** (crash test) and **6** (body block impact test) are not required for proving compliance to this standard.

**9.4.1.5** In the case of reduction in the inclination of the steering column axis with respect to horizontal plane, test as per **6** (bodyblock impact test) is not required for proving compliance to this standard.

**9.4.1.6** In the case of change in steering column inclination, test as per **8** (head form impact test) is not required for proving compliance to this standard.

**9.4.1.7** In the case of increase in the height of the seat R point from the floor, no test is required to prove the compliance with this standard.

**9.4.2** An approval accorded to vehicle type may be extended to another version of same type where the difference of mass is within the criterion specified in **7.4.3**.

**9.4.3** The approval accorded to a vehicle of category M1 may be extended to a vehicle of category N1 whose design/construction has been derived from approved M1 vehicle and which has substantially similar characteristics.

ANNEX A

(Clause 4.5.1.1, 4.5.1.2, 4.5.1.3, 4.5.1.4, 4.5.1.4.1, A-1.1.1.1, A-1.1.1.2, A-1.1.1.2, A-1.1.1.3, A-1.1.1.4, A-1.1.1.4.1 and A-1.1.1.4.2)

**TEST PROCEDURES FOR THE PROTECTION OF THE OCCUPANTS OF VEHICLES EQUIPPED WITH ELECTRIC POWER TRAINS OPERATING ON ELECTRICAL POWER FROM HIGH VOLTAGE AND ELECTROLYTE SPILLAGE**

**A-1** This Annex describes test procedures to demonstrate compliance to the electrical safety requirements of 4.5 of this standard. 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 ( $V_b$ ) (see Fig. 4) shall be measured and recorded to confirm that it is within the operating voltage of the vehicle as specified by the vehicle manufacturer.

**A-2 TEST SET UP 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 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 d.c. values and have an internal resistance of at least 10 MΩ.

**A-3 THE FOLLOWING INSTRUCTIONS MAY BE USED, IF VOLTAGE IS MEASURED:**

After the impact test, determine the high voltage bus voltages ( $U_b, U, U_2$ ) (see Fig. 4). The voltage measurement shall be made not earlier than 10 seconds but not later than 60 s after the impact. This procedure is not applicable, if the test is performed under the condition where the electrical power train is not energized.

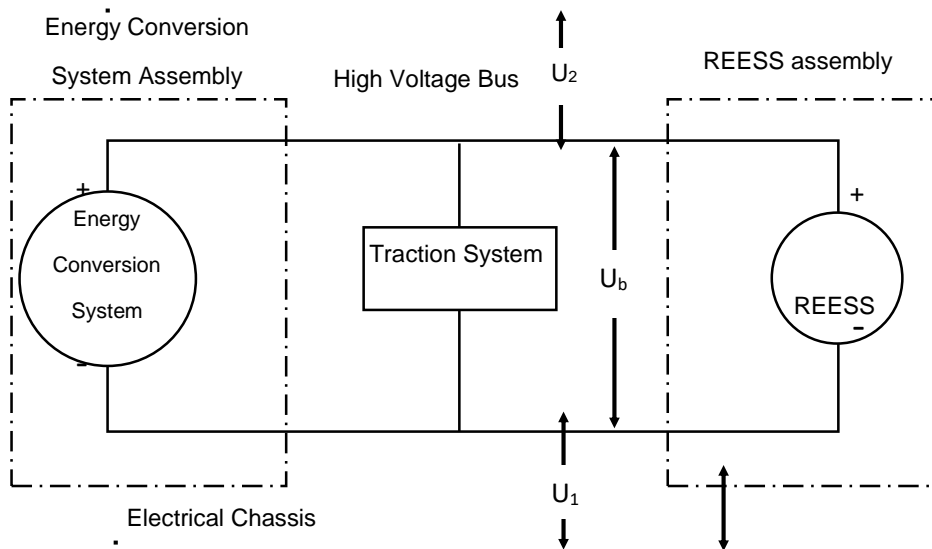


FIG. 4 MEASUREMENT OF  $U, U_1, U_2$

**A-4 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 (see Fig. 5).

- a) Not earlier than 10 seconds and not later than 60 seconds after the impact the switch S1 shall be closed while the voltage  $U_b$  and the current  $I_e$  are measured and recorded. The product of the voltage  $U_b$  and the current  $I_e$  shall be integrated over the period of time, starting from the moment when the switch S1 is closed ( $t_c$ ) until the voltage  $U_b$  falls below the high voltage threshold of 60 V DC ( $t_h$ ). The resulting integration equals the Total Energy (TE) in joules:

$$TE = \int_{t_c}^{t_h} U_b \times I_e dt$$

- b) When  $U_b$  is measured at a point in time between 10 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:

$$TE = 0.5C_x \times (U_b)^2$$

- c) When  $U_1$  and  $U_2$  (see figure 1 above) are measured at a point in time between 10 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:

$$TE_{y1} = 0.5 \times C_{y1} \times U_1^2$$

$$TE_{y2} = 0.5 \times C_{y2} \times U_2^2$$

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

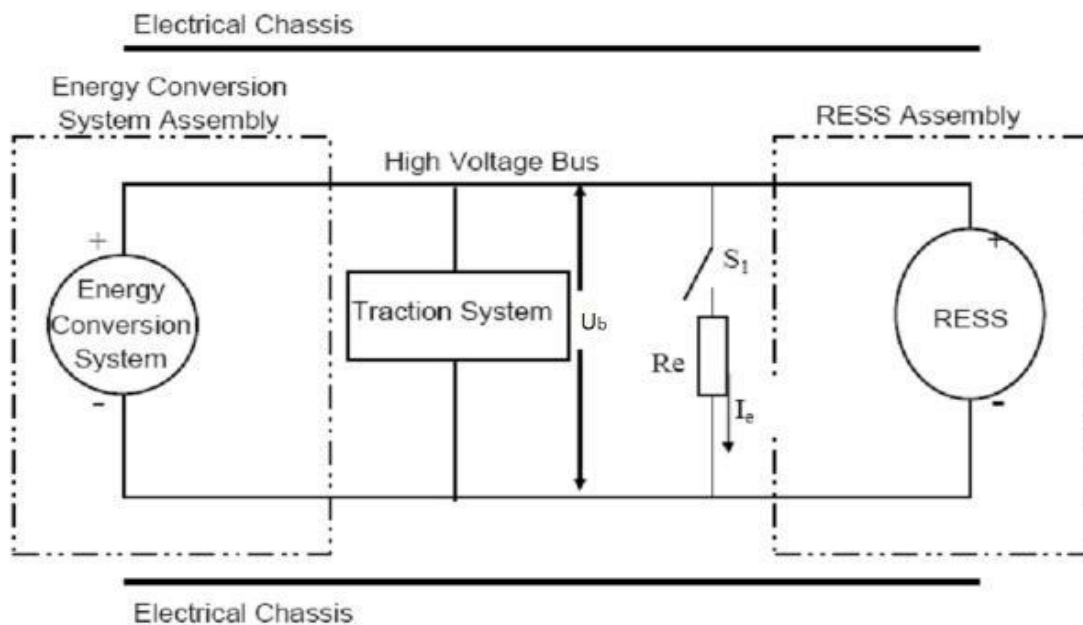


FIG. 5 E.G MEASUREMENT OF HIGH VOLTAGE BUS ENERGY STORED IN X-CAPACITORS

## A-5 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 (JTF) described in Fig. 8 shall be inserted into any gaps or openings of the physical protection with a test force of 10 N ±10 percent 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 (> 40 V and < 50 V) in series with a suitable lamp should be connected, between the JTF and high voltage live parts inside the electrical protection barrier or enclosure.

#### A-5.1 Test method for measuring electric resistance:

- a) Test method using a resistance tester.

The resistance tester is connected to the measuring points (typically, electrical chassis and electro conductive enclosure/electrical protection barrier) and the resistance is measured using a resistance tester that meets the specification as follows:

- 1) Resistance tester: Measurement current at least 0.2 A;
- 2) Resolution: 0.01 Ω or less;
- 3) The resistance R shall be less than 0.1 Ω.

- b) Test method using DC power supply, voltmeter and ammeter.

The DC power supply, voltmeter and ammeter are connected to the measuring points (Typically, electrical chassis and electro conductive enclosure/electrical protection barrier).

The voltage of the DC power supply is adjusted so that the current flow becomes at least 0.2 A.

The current "I" and the voltage "U" are measured

The resistance "R" is calculated according to the following formula:

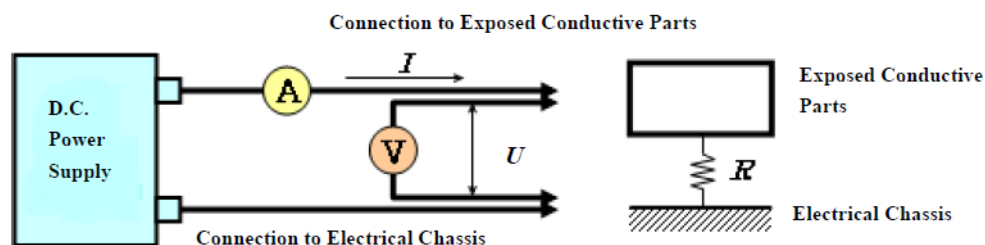
$$R = U / I$$

The resistance R shall be less than 0.1 Ω.

**Note:** If lead wires are used for voltage and current measurement, each lead wire shall be independently connected to the electrical protection barrier/enclosure/electrical chassis. Terminal can be common for voltage measurement and current measurement.

An example of the test method using DC power supply, voltmeter and ammeter is shown below.

#### Example of test method using DC power supply



### A-6 ISOLATION RESISTANCE

#### A-6.1 General

The isolation resistance for each high voltage bus of the vehicle is measured or shall be determined by calculating the measurement values of each part or component unit of a high voltage bus.



All measurements for calculating voltage(s) and electrical isolation are made after a minimum of 10 s after the impact.

### **A-6.2 Measurement method**

The isolation resistance measurement is conducted by selecting an appropriate measurement method from among those listed in **A-6.2.1** to **A-6.2.2**, depending on the electrical charge of the live parts or the isolation resistance.

The range of the electrical circuit to be measured is clarified in advance, using electrical circuit diagrams. If the high voltage buses are conductively isolated from each other, isolation resistance shall be measured for each electrical circuit.

Moreover, modifications 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 and change in software.

In cases where the measured values are not stable due to the operation of the on-board isolation resistance monitoring system, necessary modifications for conducting the measurement may be carried out by stopping the operation of the device concerned or by removing it. Furthermore, when the device is removed, a set of drawings will be used to prove that the isolation resistance between the live parts and the electrical chassis remains unchanged.

These modifications shall not influence the test results.

Utmost care shall be exercised to avoid short circuit and electric shock since this confirmation might require direct operations of the high-voltage circuit.

**A-6.2.1** Measurement method using DC voltage from external sources:

#### **A-6.2.1.1** *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.

#### **A-6.2.1.2** *Measurement method*

An isolation resistance test instrument is connected between the live parts and the electrical chassis. The isolation resistance is subsequently 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 conductively 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 components disconnected.

**A-6.2.2** Measurement method using the vehicle's own REESS as DC voltage source:

#### **A-6.2.2.1** Test vehicle conditions

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

#### **A-6.2.2.2** Measurement instrument

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

#### **A-6.2.2.3** *Measurement method:*

- a) The voltage is measured as shown in Figure 1 and the high voltage bus voltage ( $U_b$ ) is recorded.  $U_b$  shall be equal to or greater than the nominal operating voltage of the REESS and/or energy conversion system as specified by the vehicle manufacturer.
- b) The voltage ( $U_1$ ) between the negative side of the high voltage bus and the electrical chassis is measured and recorded (*see* Figure 5).
- c) The voltage ( $U_2$ ) between the positive side of the high voltage bus and the electrical chassis is measured and recorded (*see* Figure 5).
- d) If  $U_1$  is greater than or equal to  $U_2$ , a standard known resistance ( $R_o$ ) is inserted between the negative side of the high voltage bus and the electrical chassis. With  $R_o$  installed, the voltage ( $U_1'$ ) between the negative side of the high voltage bus and the electrical chassis is measured (*see* Figure 7).

The electrical isolation ( $R_i$ ) is calculated according to the following formula:

$$R_i = R_o \times U_b \times (1/U_1' - 1/U_1)$$

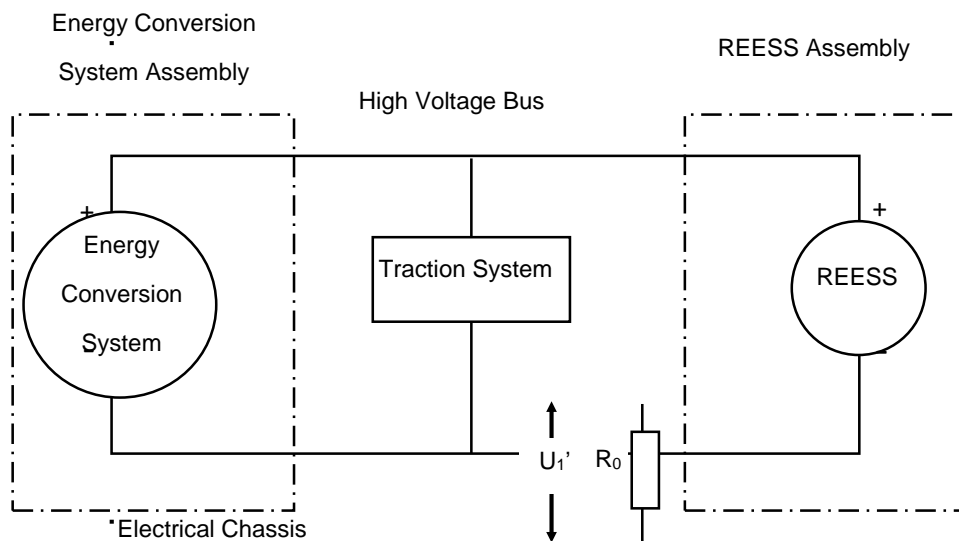


FIG. 6 MEASUREMENT OF  $U_1$

If  $U_2$  is greater than  $U_1$ , insert a standard known resistance ( $R_o$ ) between the positive side of the high voltage bus and the electrical chassis. With  $R_o$  installed, measure the voltage ( $U_2'$ ) between the positive side of the high voltage bus and the electrical chassis (*see* Figure 8 below). The electrical isolation ( $R_i$ ) is calculated according to the following formula:

$$R_i = R_o \times U_b \times (1/U_2' - 1/U_2)$$

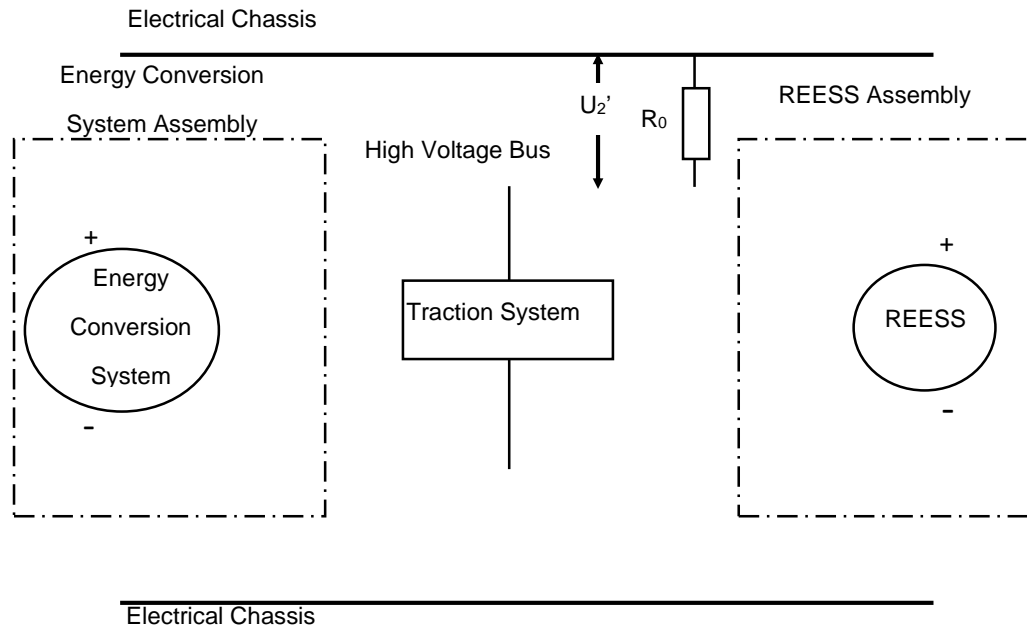


FIG. 7 MEASUREMENT OF  $U_2$

The electrical isolation value  $R_i$  (in  $\Omega$ ) divided by the working voltage of the high voltage bus (in V) results in the isolation resistance (in  $\Omega/V$ ).

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

#### A-7 ELECTROLYTE LEAKAGE

An appropriate coating if necessary may be applied, to the physical protection (casing) in order to confirm if there is any electrolyte leakage from the REESS resulting from the test.

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



ANNEX B

*(Foreword)*

COMMITTEE COMPOSITION

Passive Safety Crash Protection Systems Sectional Committee, TED 29

Will be added later