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**The protection of the occupants in the event of a lateral
collision**

汽车侧面碰撞的乘员保护

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The protection of the occupants in the event of a lateral collision

1 Scope

This document specifies the technical requirements, test methods and type identification for the protection of the occupants in the event of a lateral collision.

This document applies to M₁ and N₁ vehicles as well as multipurpose goods vehicles.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB 11551, The protection of the occupants in the event of a frontal collision for motor vehicle

GB 14166, Safety-belts and restraint systems for occupants of power-driven vehicles

GB 14167, Safety-belt anchorages and restraint systems anchorages for occupants of power-driven vehicles

GB 15086, Motor vehicles door locks and retention components performance requirements and test methods

GB/T 19596, Terminology of electric vehicles

GB/T 31498-2021, Post crash safety requirement for electric vehicle

ISO 6487, Road vehicles - Measurement techniques in impact tests - Instrumentation

ISO 15830, Road vehicles - Design and performance specifications for the WorldSID 50th percentile male side-impact dummy

4 Technical requirements

4.1 General

The vehicle is tested in accordance with the provisions of Chapter 5. The test shall be carried out on the driver's side, with a WorldSID 50th side-impact dummy or a EuroSID-2re side-impact dummy placed at the driver's position. After the test, the vehicle shall comply with the requirements of 4.2 ~ 4.4. If the vehicle body structure or protection system is asymmetrical and the difference affects the side impact performance, the test shall be carried out on the side that is most unfavorable for the side impact performance according to the most unfavorable principle, and the WorldSID 50th side-impact dummy or EuroSID-2re side-impact dummy shall be placed in the front impact side position.

4.2 Dummy performance index requirements

4.2.1 WorldSID 50th side-impact dummy

4.2.1.1 The head injury criterion (HIC₃₆) shall not be greater than 1 000. When no head contact occurs, the HIC value is not calculated and "no head contact" shall be recorded.

4.2.1.2 The peak lateral force on the shoulder shall not exceed 3 kN.

4.2.1.3 The chest rib deformation shall not exceed 50 mm.

4.2.1.4 The belly rib deformation shall not exceed 65 mm.

4.2.1.5 The peak force at the pubic symphysis shall not exceed 2.8 kN.

4.2.2 EuroSID-2re side-impact dummy

4.2.2.1 The head injury criterion (HIC₃₆) shall not be greater than 1 000. When no head contact occurs, the HIC value is not calculated and "no head contact" shall be recorded.

4.2.2.2 The chest rib deformation shall not exceed 44 mm.

4.2.2.3 The peak value of the resultant force on the belly shall not be greater than 2.5 kN of internal force.

4.2.2.4 The peak force at the pubic symphysis shall not exceed 6 kN.

4.3 Vehicle body safety requirements

4.3.1 During a collision, the vehicle doors (including the rear door or tailgate) shall not open.

4.3.2 After the collision test, the vehicle doors (including the rear door or tailgate) shall be in a latched state, and both the latch and the striker shall not be detached from the connection with the vehicle body; the door hinges shall not be separated from each other

4.3.6 Without increasing the risk of injury to occupants, the components inside the passenger compartment are only allowed to fall off due to permanent deformation.

4.3.7 After the collision test, if there is continuous leakage of liquid in the fuel supply system, the average leakage rate in the first 5 minutes after the collision shall not exceed 30 g/min; if the liquid leaked from the fuel supply system is mixed with the liquid leaked from other systems, and the different liquids cannot be separated and identified, the continuous leakage amount shall be evaluated based on all the collected liquids.

4.3.8 During the collision test and within 30 minutes after the collision test, the vehicle shall not catch fire (continued flame phenomenon).

4.3.9 After the collision test, the vehicle shall automatically turn on the hazard warning lights.

4.4 Electrical safety requirements

For battery electric vehicles and hybrid electric vehicles with Class B voltage circuits, after the collision test, the vehicle's high-voltage power system including the REESS and the high-voltage components connected to it shall comply with the anti-electric shock protection requirements (4.2 of GB/T 31498-2021), electrolyte leakage requirements (4.3 of GB/T 31498-2021) and REESS requirements (4.4 of GB/T 31498-2021) of GB/T 31498.

5 Test methods

5.1 Test site

The size of the test site shall be able to accommodate the collision device propulsion system, the movement of the collided vehicle after collision, and the installation of the test equipment. The site where vehicles collide and move shall be level and flat, and the road friction coefficient shall be no less than 0.5.

5.2 Test conditions

5.2.1 The test vehicle shall remain stationary.

5.2.2 The mobile deformable barrier shall comply with the characteristics specified in Appendix A. The mobile deformable barrier shall be equipped with appropriate devices to avoid secondary collision with the test vehicle.

5.2.3 When a collision occurs, the longitudinal mid-vertical plane of the mobile deformable barrier shall be perpendicular to the longitudinal mid-vertical plane of the collided vehicle.

5.2.4 The distance between the longitudinal mid-vertical plane of the mobile deformable barrier and the transverse vertical plane of the test vehicle passing through

R point of the front seat on the impact side shall be within ± 25 mm. At the moment of impact, it shall be ensured that the horizontal mid-plane defined by the vertical plane of the outer edge of the front surface of the deformable barrier is within ± 25 mm above and below the position determined before the test.

5.2.5 The instrument shall comply with the requirements of ISO 6487.

5.2.6 During the lateral collision test, the temperature of the side-impact dummy shall be stable at $20.6\text{ }^{\circ}\text{C} \sim 22.2\text{ }^{\circ}\text{C}$.

5.3 Test speed

At the moment of collision, the speed of the mobile deformable barrier shall be $50\text{ km/h} \pm 1\text{ km/h}$, and this speed shall remain stable for at least 1 m before collision. The accuracy of the instrument used to measure the speed of the mobile barrier shall not be less than 1%. If the test is carried out at a higher impact speed and the test results meet the technical requirements of Chapter 4, the test is valid.

5.4 Vehicle status

5.4.1 General requirements

The test vehicle shall include all equipment properly installed and shall be in normal operational state. Some parts may be replaced by parts of equal mass, but such replacement shall not affect the test results.

5.4.2 Vehicle equipment requirements

The test vehicle shall be equipped with all optional parts that may affect the test results.

5.4.3 Vehicle mass

5.4.3.1 The test mass of the vehicle shall be the reference mass, and its mass deviation shall be adjusted to within the range of $\pm 1\%$ of its reference mass.

5.4.3.2 The fuel tank (if any) shall be emptied and then filled with water or a non-flammable liquid with a density and viscosity similar to that of the fuel normally used. The mass of the water or non-flammable liquid filled shall be at least 90% of the mass of the full fuel specified by the manufacturer. All other systems (braking system, lubricating system, cooling system, etc.) may be drained, but the mass of the fluid reduced by draining shall be compensated.

5.4.3.3 If the mass of the on-board measuring equipment exceeds 25 kg, some components that have no significant effect on the test results shall be reduced to compensate.

5.4.3.4 The mass of the on-board measuring equipment shall be such that the change in the axle load of each axle shall not exceed 5% and shall not be greater than 20 kg.

5.5 Vehicle preparation

5.5.1 Before the collision test, at least the windows on the collision side shall be closed and the sunroof (if any) shall be in the fully closed position.

5.5.2 The doors shall be in the fully latched position but not latched; for vehicles equipped with an automatically activated door locking system, all doors shall be in the fully latched position and latched before testing.

5.5.3 The vehicle may be in neutral and the parking brake shall be in the braking position.

5.5.4 For externally rechargeable REESS devices, the REESS shall be charged to the maximum charge state in accordance with the manufacturer's specifications. The collision test shall be carried out within 24 hours after charging is completed.

5.5.5 If the dummy seat and its components are adjustable, they shall be adjusted to the following positions.

- a) Lumbar support and other support structures shall be in their lowest or retracted position, armrests shall be adjusted to the stowed position, and seat cushions with adjustable length and leg support systems shall be adjusted to their rearmost or retracted position. Other seat comfort adjustment systems shall be adjusted to the positions specified by the vehicle manufacturer.
- b) For seats with adjustable seat cushions, first mark the seat cushion reference points on the outer surface of the seat cushion support structure, and determine the seat cushion reference line through the seat cushion reference points; then adjust the seat cushion reference points to the highest and rearmost position, determine the seat cushion reference line angle range, and adjust the seat cushion reference line angle to the middle angle.

5.5.6 The dummy seat shall be adjusted to the following positions in the vertical and fore-and-aft directions.

- a) When using the WorldSID 50th side-impact dummy, adjust the seat cushion reference point to the lowest position in the vertical direction; adjust the seat cushion reference point to the position 20 mm rearward of the middle of its front and rear travel in the fore-and-aft direction. If this position cannot be latched, adjust it to the closest rearward position.
- b) When using the EuroSID-2re side-impact dummy, adjust the seat cushion reference point to the middle position or the design position in the vertical direction; adjust the seat cushion reference point to the middle position of its front and rear travel in the fore-and-aft direction. If this position cannot be latched, adjust it to the nearest rearward position.

5.5.7 The seat back angle shall be adjusted to the position designed by the manufacturer. If there is no designed position, it shall be adjusted to a position tilted 25° backward from the vertical plane.

5.5.8 The seat headrest shall be adjusted to a position where the upper surface and the center of gravity of the dummy's head are on the same height plane. If this cannot be achieved, adjust the upper surface of the headrest to a position closest to the height of the center of gravity of the dummy's head.

5.5.9 Other front seats shall be adjusted to the same position as the dummy's seat.

5.5.10 If the steering wheel is adjustable, it shall be adjusted to the middle position of the travel.

5.5.11 The tire pressure shall be adjusted to the pressure value specified by the vehicle manufacturer.

5.5.12 During the placement of the side-impact dummy and vehicle test preparation, the axle of the test vehicle shall be in a horizontal state.

5.5.13 The test vehicle shall comply with the requirements of 5.4.3. For vehicles equipped with a suspension system with adjustable ground clearance, the ground clearance shall be adjusted to the manufacturer's specified ground clearance for normal driving at a speed of 50 km/h. If necessary, the above ground clearance may be maintained by adding auxiliary supports, but this shall not affect the collision performance of the test vehicle.

5.6 Side-impact dummy and its placement

5.6.1 The side-impact dummy shall comply with the requirements of Appendix B or Appendix C and shall be placed on the front seat of the vehicle on the impact side in accordance with the requirements of Appendix B or Appendix C.

5.6.2 When the dummy cannot be placed, the seat can be adjusted appropriately. First adjust the seat cushion height. If it still does not meet the requirements, adjust the seat back angle again. The angle adjustment shall not exceed $\pm 5^\circ$. Finally, adjust the front and rear position of the seat until the dummy can be placed, leaving a 10 mm gap between the dummy's head and the vehicle ceiling.

5.6.3 The dummy shall use the seat belts and other restraint systems equipped on the vehicle model. Seat belts and seat belt fixing points shall comply with the requirements of GB 14166 and GB 14167.

5.6.4 According to the manufacturer's specifications, adjust the safety belt and other restraint systems to a position suitable for the dummy. If the manufacturer has no regulations, it shall be adjusted to the middle height position; if it cannot be adjusted to

Appendix A

(Normative)

Mobile deformable barrier

A.1 General requirements

A.1.1 The mobile deformable barrier consists of a trolley and a honeycomb aluminum barrier, in which the honeycomb aluminum barrier is installed at the front end of the trolley.

A.1.2 The mobile deformable barrier shall be equipped with a braking system to avoid secondary collision with the test vehicle.

A.1.3 The total mass of the mobile deformable barrier shall be $1\,400\text{ kg} \pm 20\text{ kg}$.

A.1.4 The center of gravity of the mobile deformable barrier shall be within 10 mm of the longitudinal mid-vertical plane, $1\,000\text{ mm} \pm 30\text{ mm}$ from the front axle, and $500\text{ mm} \pm 30\text{ mm}$ from the ground.

A.1.5 The distance from the front surface of the honeycomb aluminum barrier to the center of gravity of the mobile deformable barrier shall be $2\,000\text{ mm} \pm 30\text{ mm}$.

A.1.6 In the static state before collision, the height of the intersection of the upper and lower groups of honeycomb aluminum barriers from the ground plane shall be $550\text{ mm} \pm 5\text{ mm}$.

A.1.7 The front and rear wheel space of the trolley shall be $1\,500\text{ mm} \pm 10\text{ mm}$.

A.1.8 The wheel space of the trolley shall be $3\,000\text{ mm} \pm 10\text{ mm}$, and the tire pressure of all tires of the trolley shall be adjusted to the same.

A.2 Honeycomb aluminum barrier and mounting plate

A.2.1 Honeycomb aluminum barrier

A.2.1.1 Geometric characteristics

A.2.1.1.1 The honeycomb aluminum barrier consists of six parts (blocks A, B, C, D, E, and F) connected together. The shape and distribution of the parts are shown in Figures A.1 and A.2. The dimensions of blocks B and E in width and height are $(500 \pm 5)\text{ mm}$ and $(250 \pm 3)\text{ mm}$ respectively, and the dimensions of blocks A, C, D, and F in width and height are $(600 \pm 5)\text{ mm}$ and $(250 \pm 3)\text{ mm}$, respectively.

A.3.2.1 Install the ventilation device on the front panel of the trolley.

A.3.2.2 Ensure that a 0.5 mm thick standard feeler gauge cannot be inserted between the ventilation device and the trolley surface at any point. If a gap greater than 0.5 mm appears, the ventilation system frame needs to be replaced or adjusted so that the gap is no greater than 0.5 mm.

A.3.2.3 Remove the ventilation device from the front panel of the trolley.

A.3.2.4 Fix a 1.0 mm thick cork padding to the front panel of the trolley.

A.3.2.5 Reinstall the ventilation device on the front of the trolley and tighten it until there are no gaps.

A.4 Static test

A.4.1 For samples taken from each batch of processed aluminum honeycomb barriers (blocks A, B, C, D, E and F), the sample size shall be 250 mm × 500 mm × 440 mm.

A.4.2 The sample shall be compressed between two parallel loading plates, with the loading plates at least 20 mm beyond the edge of the cross-section of the honeycomb aluminum barrier aluminum block.

A.4.3 The compression speed is 100 mm/min ± 5 mm/min.

A.4.4 The minimum sampling frequency for static compressed data is 5 Hz.

A.4.5 Continue the static test until the compressibility of the honeycomb aluminum barrier samples (blocks A, B, C, D, E, and F) is at least 300 mm.

A.5 Dynamic test

A.5.1 Test site

The test site shall be large enough to accommodate the runway with a movable deformable barrier, the fixed barrier and the equipment necessary for the test. In the last part of the runway, there shall be at least 5 m of level, smooth road surface in front of the rigid barrier.

A.5.2 Rigid barrier and force measuring wall

A.5.2.1 The rigid barrier is made of reinforced concrete, with a front width of not less than 3 m and a height of not less than 1.5 m. Its thickness shall ensure that its mass is not less than 70 000 kg.

A.5.2.2 The front plane of the force measuring wall shall be vertical and perpendicular to the center axis of the runway. The surface shall be equipped with load sensors to measure the load on each aluminum block on the mobile deformable barrier at the moment of collision. The center of the force measuring wall shall be aligned with the

center of the mobile deformable barrier. The installation and surface of the sensor shall comply with ISO 6487.

A.5.2.3 For every 200 aluminum blocks of honeycomb aluminum barrier produced, the manufacturer shall conduct a dynamic test using a force measuring wall fixed on the rigid barrier. The load sensor of the force measuring wall shall consist of at least 6 force sensors, covering the blocks A, C, D and F of the honeycomb aluminum barrier. Among them, the surface area of the central load sensor is 500 mm × 250 mm, and the surface area of other load sensors is 600 mm × 250 mm.

A.5.2.4 The dimensions of the area surrounding the load sensor shall extend at least 150 mm above the impact surface of the force measuring wall. If the barrier is not perfectly aligned for impact, ensure that the honeycomb barrier surface is crushed evenly and does not wrap around the edge of the load sensor.

A.5.2.5 The load sensor surface is equipped with a protective device consisting of plywood with a thickness of 18 mm ± 5 mm to avoid reducing the sensitivity of the sensor.

A.5.2.6 The rigid barrier may be fixed or placed on the ground, but shall be fixed with additional fixing devices.

A.5.3 Driving of the mobile deformable barrier

At the moment of impact, the mobile deformable barrier shall not be affected by the steering and driving devices. The movable deformable barrier shall collide with the force measuring wall vertically, and the collision position deviation shall be within ±15 mm.

A.5.4 Measuring devices

A.5.4.1 Speed

The collision speed shall be 35 km/h ± 0.5 km/h, and the accuracy of the measuring device shall be no less than 1%.

A.5.4.2 Measurement channels

The measurement channel of the device shall comply with the provisions of ISO 6487, with a CFC of 60 and a CAC of 100 kN.

A.5.4.3 Acceleration

A.5.4.3.1 The acceleration shall be measured at three positions in the longitudinal direction of the trolley that are not easily deformed, one in the center and the other two on both sides.

A.5.4.3.2 The centrally located acceleration transducer shall be within 500 mm of the centre of gravity of the mobile deformable barrier and within ± 10 mm of the longitudinal vertical plane from the centre of gravity of the mobile deformable barrier.

A.5.4.3.3 The installation height of the acceleration transducers on both sides shall not differ by more than 10 mm, and the distance from the front surface of the mobile deformable barrier shall not differ by more than 20 mm.

A.5.4.3.4 The measurement channel of the acceleration sensor shall comply with the provisions of ISO 6487, with a CFC of 1 000 and a CAC of 50 g.

A.5.5 Mobile deformable barrier

The mobile deformable barrier shall comply with the provisions of A.1.

A.5.6 Honeycomb aluminum barrier

A.5.6.1 When the output signals of the six load sensors meet the requirements of A.2.1.5, the dynamic test of the honeycomb aluminum barrier shall meet the requirements.

A.5.6.2 Honeycomb aluminum barriers shall be marked with a serial number that can be traced back to their production date.

A.5.7 Data processing

A.5.7.1 Raw data

At the contact zero moment in the crash test, all bias in the data shall be eliminated. The method for eliminating the bias shall be recorded in the test report.

A.5.7.2 Filtering

A.5.7.2.1 Raw data shall be filtered before processing and calculation.

A.5.7.2.2 The data filter level for acceleration integration shall be CFC 180.

A.5.7.2.3 The data filter level for acceleration pulse calculation shall be CFC 60.

A.5.7.2.4 The filter level of the load data shall be CFC 60.

A.5.7.3 Calculation of surface deformation of mobile deformable barrier

A.5.7.3.1 The filtered acceleration data of the three acceleration transducers are integrated twice to obtain the deformation of the honeycomb aluminum barrier aluminum block.

A.5.7.3.2 Initial conditions for deformation calculation: At the initial contact moment of the collision, the corresponding speed is the speed measured by the speed measuring device, and the corresponding deformation is 0.

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