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Intelligent Safety Index
Electrical Safety Test Protocol

(Version 2023)

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Electrical Safety Test Protocol

1 Scope

This document specifies the test methods of IVISTA China Intelligent Vehicle Index - Intelligent Safety Index - Electrical Safety.

This document is applicable to new energy vehicles with battery packs arranged at the bottom of the vehicle.

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute indispensable provisions of this document. For dated references, only the dated edition applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB 11551-2014 The Protection of the Occupants in the Event of a Frontal Collision for Motor Vehicle

GB 18352.6-2016 Limits and Measurement Methods for Emissions from Light-duty Vehicles (CHINA 6)

GB 18384-2020 Electric Vehicles Safety Requirements

GB/T 18385-2005 Electric Vehicles - Power Performance - Test Method

GB/T 18386-2017 Electric Vehicles - Energy Consumption and Range - Test Procedures

GB/T 19596-2017 Terminology of Electric Vehicles

GB 38031-2020 Electric Vehicles Traction Battery Safety Requirements

3 Test Methods

This Electrical Safety Test Protocol includes the bottom collision tests. See Annex A for detailed rules for bottom collision tests.

Annex A
Detailed Rules for Bottom Collision Tests

A.1 Test preparation

A.1.1 Vehicle inspection

After the vehicle arrives at the test room, first check and confirm whether the vehicle is in good condition (such as whether vehicle parts are complete, whether vehicle state indicators are normal, and whether charging is normal). In case of any abnormalities, record the abnormal state and position in detail. If such abnormalities are directly related to the test, the vehicle shall be repaired or replaced.

A.1.2 Vehicle preparation

Vehicle tires, lubricating oil, energy storage system, lighting, signaling devices and auxiliary equipment shall be set as required in GB/T 18386-2017.

The vehicle under test (VUT) shall be able to reflect the characteristics of the series of products, including all equipment normally installed, and shall be in a normal operating state. Some parts and components may be replaced with parts of the same mass, but such replacement shall not affect the test results. The VUT shall be provided with all accessories that have an impact on the test results.

A.1.3 Test photos

Record the state of the VUT before and after the test. See Table 1 for detailed photos to be taken.

Table 1 Test Photos

No.	Shooting Angle	Before Test	During Test	After Test
1	Front view photo of the vehicle	√		
2	Photo taken at 45° in the right front of the vehicle	√		
3	Photo of the vehicle nameplate	√		
5	Photo of the bottom scraping test process		√	
6	Photo of the bottoming test process		√	
7	Photo of the bottom of the vehicle	√		√
8	Photo of other abnormalities	√		√

A.2 Test conditions

A.2.1 General conditions

The test site shall be large enough to accommodate the test equipment including the VUT and drive system. The ground of the site where the vehicle is subjected to bottom scraping shall be level, flat and dry.

Unless otherwise specified, the tests shall be carried out at an ambient temperature above 0 °C, a relative humidity of 10%~90% and an atmospheric pressure of 86 kPa ~ 106 kPa.

A.2.2 Test mass

Adjust the vehicle to its normal operating state without driver, passengers and goods, but with on-board tools and spare tires (if provided as standard equipment by the vehicle manufacturer). Measure and record the vehicle mass and front and rear axle loads in this condition, and the vehicle mass is the curb mass.

The vehicle test mass shall be measured after all test equipment is installed, and it shall include

the mass of all test equipment and two dummies in the front row of seats. Refer to GB 11551-2014 for the type and arrangement of dummies. The vehicle test mass shall be 160 kg ~ 200 kg larger than the measured curb mass. If the vehicle test mass does not reach this range, place counterweights in the trunk of the vehicle. If the vehicle test mass exceeds this range, remove some parts at the rear part of the vehicle that do not affect the test results.

A.2.3 Pre-conditioning before test

The vehicle SOC shall not be less than 50%.

The bottom collision tests shall be carried out within 24 h after the vehicle is charged.

If the vehicle is equipped with a standard battery guard, the original state of the vehicle shall be maintained.

A.3 Adjustment of measurement parameters

Test instruments shall be inspected or calibrated regularly, generally, every 12 months. The accuracy of all instruments and meters shall at least meet the following requirements:

The accuracy of measuring instruments and meters shall at least meet the following requirements:

a) Voltage measuring device: ±0.5% FS;

b) Current measuring device: ±0.5% FS;

c) Temperature measuring device: ±0.5 °C;

d) Time measuring device: ±0.1% FS;

e) Size measuring device: ±0.1% FS;

f) Mass measuring device: ±0.1% FS;

g) Acceleration measuring device: ±2% FS.

Unless otherwise stated in some specific test items, the recording interval of test data (such as time, temperature, current and voltage) shall not be greater than 100 ms.

A.4 Test methods

A.4.1 Bottom scraping test of the vehicle

A.4.1.1 Test the vehicle as per the following conditions:

a) Form of bottom scraping tooling: The bottom scraping tooling is shown in Fig. 1. The impact surface is a φ150 mm solid hemisphere made of #45 steel;

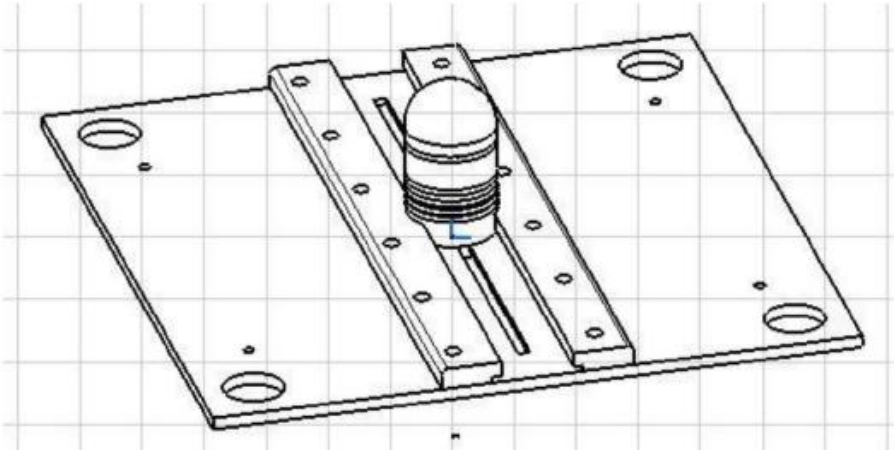

Fig. 1 Schematic Diagram of Bottom Scraping Tooling

b) Direction of bottom scraping test: along the X direction (once in the positive direction and once in the negative direction, with an interval of more than 2 h) in the three-dimensional reference system of the vehicle, as shown in Fig. 3;

c) Initial alignment position of bottom scraping: Randomly select weak points as the initial alignment position of bottom scraping, and select these points to start the bottom scraping test along the X direction:

For point selection in the bottom scraping test area, randomly select 2 weak points (such as orange/red points) as the initial alignment position of bottom scraping according to the schematic diagram of battery pack or vehicle and system layout/simulation prediction diagram of structural strength of battery pack provided by the vehicle manufacturer (divide from the longitudinal centerline of the battery to both sides at a grid size ≤ 100 mm*100 mm, from the front end to the rear end of the battery until the battery boundary) and the Z-direction simulation deformation/displacement prediction diagram of the battery pack (mark these points in different colors according to the displacement: green (Z-direction deformation ≤ 5 mm), yellow (10 mm ≥ Z-direction deformation > 5 mm), orange (15 mm ≥ Z-direction deformation > 10 mm) or red (Z-direction deformation > 15 mm)). Select these points to start the front/rear scraping test along the X direction, as shown in Fig. 2.

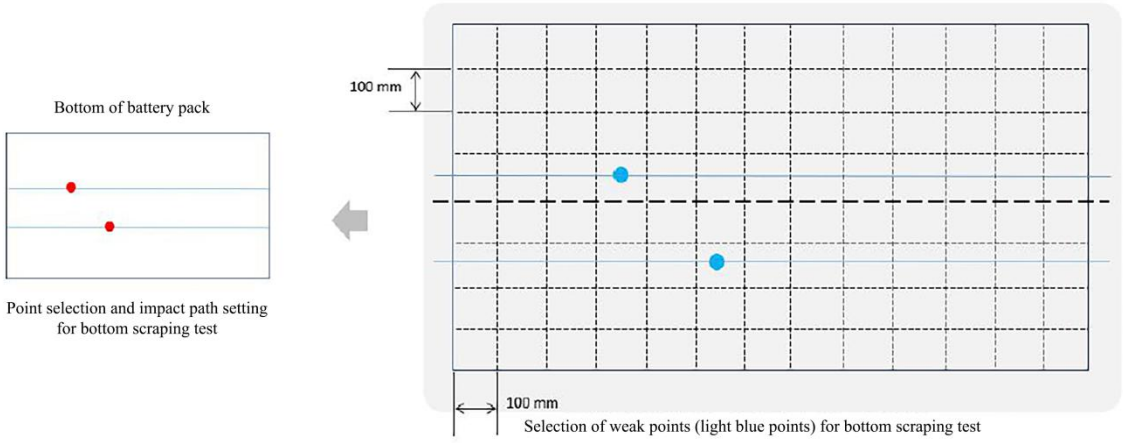

Fig. 2 Bottom Scraping Test Points

d) Bottom scraping overlap: The overlap of the highest point on the top of the bottom scraping tooling is 30 mm (+0 ~ +6 mm) in the Z direction relative to the projection point of the initial alignment position of bottom scraping under the vehicle test mass along the Z direction on the bottom of the battery pack or system;

e) Bottom scraping speed: The VUT runs forward at 30 ± 1 km/h or backward at 5 + (0~1) km/h.

f) Vehicle monitoring:

1) X-direction acceleration signal at the lower end of B-pillar of the vehicle;

2) Acceleration signal at the bottom of battery pack or system;

3) Battery pack or system bottom enclosure temperature;

4) High-speed camera at the bottom of battery pack or system.

A.4.1.2 After the above test steps are completed, observe the battery pack or system for leakage at the test ambient temperature for 2 h. After the observation, measure the deformation of the bottom.

Fig. 3 Schematic Diagram of Bottom Scraping Test

A.4.2 Vehicle bottoming test

A.4.2.1 Test the vehicle as per the following conditions:

a) Impactor form: As shown in Fig. 5, the impactor has a Φ25 mm hemisphere at its front end, weighs 10 kg and is made of #45 steel;

b) Impact direction: vertically upward along the Z direction;

c) Impact position: Randomly select weak points for impact according to the schematic diagram of battery pack or system layout provided by the vehicle manufacturer:

For point selection in the bottoming test area, randomly select 2 weak points (such as orange/red points) as the initial alignment position of bottoming according to the schematic diagram of battery pack or vehicle and system layout/simulation prediction diagram of structural strength of battery pack provided by the vehicle manufacturer (divide from the longitudinal centerline of the battery to both sides at a grid size ≤ 100 mm*100 mm, from the front end to the rear end of the battery until the battery boundary) and the Z-direction simulation deformation/displacement prediction diagram of the battery pack (mark these points in different colors according to the displacement: green, yellow, orange or red). Select these points to start the bottoming test along the Z direction, as shown in Fig. 4.

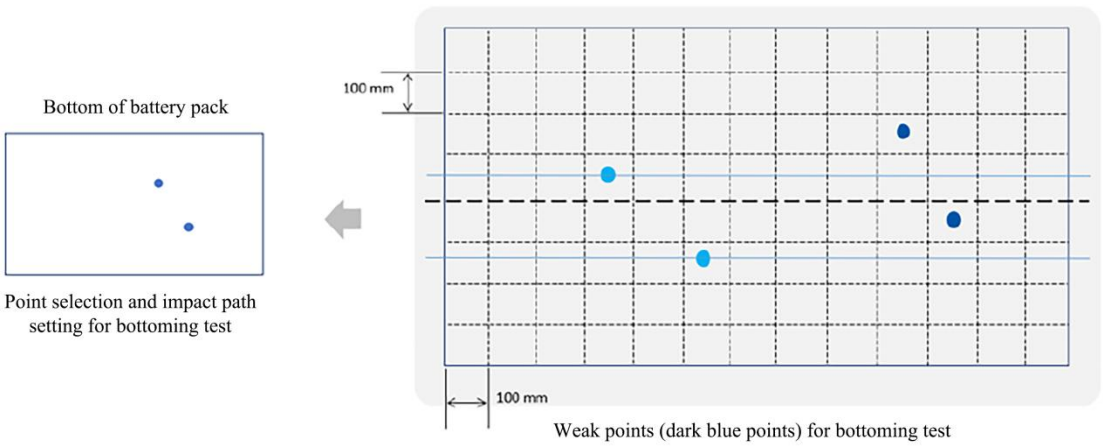

Fig. 4 Bottoming Test Points

d) Impact energy: 120 ± 3 J;

e) Vehicle monitoring: battery pack or system bottom enclosure temperature.

A.4.2.2 After the above test steps are completed, observe the battery pack or system for leakage at the test ambient temperature for 2 h. After the observation, measure the deformation of the bottom.

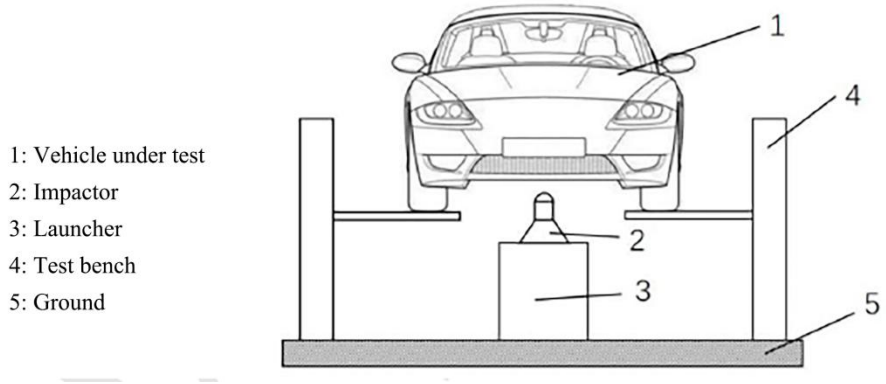

Fig. 5 Schematic Diagram of Impact Bench

A.4.3 Vehicle wading test

A.4.3.1 Test the vehicle as per the following conditions:

a) Wading pool conditions: The wading test site shall be designed according to 6.3.2 of GB 18384-2020. Namely, the wading pool for the test shall have an adjustable level from 0 m to 0.5 m and a width of not less than 4 m. The length of the effective straight section at the bottom shall not be less than 100 m, so as to fully simulate the situation where an electric vehicle passes through a flooded street or a puddle;

b) Test mass: The vehicle test mass shall be measured after all test equipment is installed, and it shall include the mass of all test equipment and test personnel. Load the test mass according to 3.2 of GB/T 18385-2005;

c) Wading depth: 300 mm;

d) Wading speed: The vehicle runs at a wading speed of 8 km/h ± 3 km/h

e) Test procedure: Confirm that the VUT has no fault or electrolyte/coolant leakage before the test. Drive/reverse the vehicle back and forth in the wading site by driving, towing, etc. The test ends after the vehicle runs for at least 10 min in a 300 mm deep pool.

A.4.3.2 After the bottom scraping, bottoming and wading tests are completed, the insulation

resistance of the traction battery shall be measured immediately according to the method described in 6.2.1 of GB 18384-2020 *Electric Vehicles Safety Requirements*. After the bottom collision tests are completed and the vehicle is parked for 24 h, measure the insulation resistance of the traction battery again.