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General requirements for swappable battery pack of electric vehicles

电动汽车快速更换电池箱通用要求

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Table of Contents

General requirements for swappable battery pack of electric vehicles

1 Scope

This document specifies the basic composition, general requirements, test methods, transportation and storage requirements of the swappable battery pack of electric vehicles (referred to as “swappable battery pack”).

This document applies to the swappable battery pack of electric vehicles using battery replacement mode.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the version corresponding to that date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB/T 2423.1, Environmental testing - Part 2: Test methods - Tests A: Cold

GB/T 2423.2, Environmental testing - Part 2: Test methods - Tests B: Dry heat

GB/T 2423.3, Environmental testing - Part 2: Testing method - Test Cab: Damp heat, steady state

GB/T 2423.17, Environmental testing for electric and electronic products - Part 2: Test method - Test Ka: Salt mist

GB/T 2423.34, Environmental testing - Part 2: Test methods - Test Z/AD: Composite temperature/humidity cyclic test

GB/T 4208-2017, Degrees of protection provided by enclosure (IP code)

GB/T 17626.2-2018, Electromagnetic compatibility - Testing and measurement techniques - Electrostatic discharge immunity test

GB/T 17626.3-2016, Electromagnetic compatibility - Testing and measurement techniques - Radiated radio-frequency electromagnetic field immunity test

GB/T 17626.4-2018, Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test

GB/T 17626.6-2017, Electromagnetic compatibility - Testing and measurement techniques - Immunity to conducted disturbances induced by radio-frequency fields

GB/T 17626.8-2006, Electromagnetic compatibility (EMC) - Part 8: Testing and measurement techniques - Power frequency magnetic field immunity test

GB/T 17626.10-2017, Electromagnetic compatibility - Testing and measurement techniques - Damped oscillatory magnetic field immunity test

GB/T 17626.12-2013, Electromagnetic compatibility - Testing and measurement techniques - Ring wave immunity test

GB 18384, Electric vehicles safety requirements

GB/T 19596, Terminology of electric vehicles

GB/T 19666, General rules for flame retardant and fire resistant electric wires and cables or optical fiber cables

GB/T 29317, Terminology of electric vehicle charging/battery swap infrastructure

GB/T 31466, Voltage ratings of electric vehicles high voltage electricity system

GB/T 32879, General technical requirements for battery box connectors for replacement of electric vehicles

GB 38031, Electric vehicles traction battery safety requirements

NB/T 10436-2020, General requirements for swapping battery pack cooling connector of electric vehicle

QC/T 413-2002, Basic technical requirements for automotive electric equipment

QC/T 1023-2015, General requirement of traction battery system for electric vehicles

QC/T 1067.1, Connector used in automobile wire harness and electrical device - Part 1: Definition, test method and requirement

3 Terms and definitions

Terms and definitions determined by GB/T 19596 and GB/T 29317, as well as the following ones, are applicable to this document.

3.1

swappable battery pack

Battery pack which is suitable for the fixed installed traction battery pack, electronic control unit and corresponding auxiliary components, and can be disassembled and assembled on electric vehicles in a short period of time (not more than 5 minutes for passenger cars, and not more than 10 minutes for commercial vehicles) with human or mechanical assistance, and can charge the battery while off-board.

3.2

lock mechanism

Mechanism that fixes the swappable battery pack to the swappable battery pack frame or electric vehicle.

3.3

the guiding and positioning device

Device used for traveling guidance during the access process and positioning in a fixed position of the swappable battery pack.

3.4

battery pack coupler

Including the swappable battery pack electrical coupler and the swappable battery pack cooling connector.

The swappable battery pack electrical coupler, a special electrical coupler that realizes the conductive connection between the swappable battery pack and the electric vehicle, or between the swappable battery pack and the charging rack, is composed of an electric coupler plug and an electric coupler socket-outlet.

The swappable battery pack cooling connector, referred to as “cooling connector”, is a fluid coupler that realizes the conduction of coolant between the swappable battery pack and the electric vehicle, or between the swappable battery pack and the charging rack. It is composed of a cooling coupler plug and a cooling coupler socket-outlet.

3.5

thermal management system

It is provided with the functions of temperature measurement and alarm for the internal space, modules, and coupler poles of the battery pack, and the ability to intervene when the temperature exceeds the standard, so that the battery module always works within the set temperature range.

b) It shall be provided with the function of managing the charging and discharging parameters of the swappable battery pack.

c) It should be provided with the function of thermal management and control of the swappable battery pack.

d) It may have the function of balancing the battery cell or battery module.

e) It shall be provided with a CAN communication interface to realize data communication with other vehicle controllers or off-board chargers.

5.2 Functional requirements

5.2.1 Swappable battery pack coupler

The structure and performance of the swappable battery pack coupler shall meet the requirements of GB/T 32879; the structure and performance of the swappable battery pack cooling connector shall meet the requirements of NB/T 10436.

5.2.2 Electronic control unit

a) It shall be provided with the function of collecting data such as the total voltage or current of swappable battery pack, the voltage of battery cell or battery module, the temperature of battery (not less than 4 monitoring points), and the temperature of strong electrical contact of the swappable battery pack connector.

b) It shall be provided with the function of managing the charging and discharging parameters of the swappable battery pack.

c) It shall be provided with a CAN communication interface to realize data communication with the vehicle controller or the off-board charger.

d) It should be provided with the function of thermal management and control of the swappable battery pack.

e) It should be provided with the function of balancing the battery cell or battery module.

5.2.3 Lock mechanism

a) A mechanical or electronic lock mechanism shall be used for the fixation of the swappable battery pack. It shall be provided with the function of preventing locking failure, so as to realize the reliable connection between the swappable battery pack and the body of the electric vehicle and meet the needs of rapid battery replacement.

b) The lock mechanism shall be able to securely fix the swappable battery pack on the vehicle body or the bracket, so that there is no relative displacement or mechanical noise under the frequent vibration caused by the driving of the vehicle.

c) The unlocking and locking of the lock mechanism shall be operated in a controlled manner, and the working status of the lock mechanism shall be reliably detected.

d) The lock mechanism shall have a manual operation function. Under abnormal circumstances, it shall be manually unlocked so that the swappable battery pack can be taken out.

5.2.4 The guiding and positioning device

a) The guiding device shall be able to reliably correct the push-pull movement path.

b) The positioning device shall be able to reliably locate the locked position of the swappable battery pack.

5.2.5 Thermal management system

a) The swappable battery pack shall be provided with the temperature measurement and alarm functions, and should be equipped with the thermal management function.

b) The thermal management function shall ensure that the temperature field in the swappable battery pack is uniform, and the temperature difference of the temperature field of the modules inside the swappable battery pack should not be greater than 5 °C; for swappable battery pack system composed of multiple battery packs, the temperature difference of each battery pack should not be greater than 8 °C.

5.2.6 Identification

The swappable battery pack shall have a uniquely coded identification.

5.3 Requirements for electrical performance

5.3.1 Nominal voltage

The nominal voltage class of the swappable battery pack shall meet the requirements of the whole vehicle and should meet the requirements of GB/T 31466. The recommended voltage class is listed in Table 1.

The swappable battery pack shall be able to withstand the radiated radio-frequency electromagnetic field immunity test of level 3 specified in Chapter 5 of GB/T 17626.3-2016.

5.5.4 Electrical fast transient/burst immunity

The swappable battery pack shall be able to withstand the electrical fast transient/burst immunity of level 3 specified in Chapter 5 of GB/T 17626.4-2018.

5.5.5 Immunity to conducted disturbances induced by radio-frequency fields

The swappable battery pack shall be able to withstand the immunity test to conducted disturbances induced by radio-frequency fields of level 3 specified in Chapter 5 of GB/T 17626.6-2017.

5.5.6 Power frequency magnetic field immunity

The swappable battery pack shall be able to withstand the power frequency magnetic field immunity test of level 4 specified in Chapter 5 of GB/T 17626.8-2006.

5.5.7 Damped oscillatory magnetic field immunity

The swappable battery pack shall be able to withstand the damped oscillatory magnetic field immunity test of level 4 specified in Chapter 5 of GB/T 17626.10-2017.

5.6 Requirements for structure and process

5.6.1 Appearance

The appearance of the swappable battery pack must not have deformation or cracks; the surface shall be flat and dry, without external injuries; the marking shall be clear.

5.6.2 Non-electrical accessories

The non-electrical accessories of the swappable battery pack, such as the battery grouped framework, separators, heating materials, insulation materials, and corrugated tubes and cable ties for wire harness protection, shall have temperature resistance, wear resistance, waterproof, corrosion resistance, oxidation resistance, flame retardant and other characteristics.

5.6.3 Requirements for wire harness

a) The wire harness shall have the characteristics of temperature resistance, wear resistance, waterproof, corrosion resistance, oxidation resistance, and flame retardancy. The flame retardancy and fire resistance performance shall meet the requirements of GB/T 19666; the pressure welding and stretching resistance of the connector harness shall meet the requirements of QC/T 1067.1.

b) The power line shall be low-smoke, halogen-free multi-strand copper conductors or flexible copper bars. Its rated voltage shall not be lower than the rated voltage class of its circuit; the minimum shall not be less than 750 V and shall meet the charging safety requirements. The temperature resistance shall not be lower than 125 °C. The wire harness shall have clear marks, so that the positive and negative poles can be clearly distinguished.

c) If pressure welding is used to connect the internal modules of the swappable battery pack and the internal and external power line terminals of the swappable battery pack coupler, tin filling shall be adopted.

d) Power lines and control lines shall be bundled independently, with smooth wiring, and shall have measures to prevent vibration and friction.

e) The control line shall be made of multi-strand copper conductors. Its rated voltage shall not be lower than 300 V, and its temperature resistance shall not be lower than 200 °C.

f) The communication line shall be shielded twisted pair, and the shielding layer shall be grounded.

5.6.4 Process requirements

a) The coating layer, chemical processing layer and surface paint layer of the metal casing and parts of the swappable battery pack shall comply with the regulations in 3.15 of QC/T 413-2002.

b) The positive and negative poles of the battery module shall be clearly marked and be provided with corresponding protective measures.

c) The battery modules shall be grouped to facilitate heat dissipation, and an arrangement method to keep the thermal field uniform shall be adopted.

d) The installation of the battery module shall have measures to prevent vibration and friction, and firm positioning and clamping devices shall be used.

e) The installation of the electronic control unit shall be isolated from the battery module.

f) Mechanical and electrical connection points shall maintain sufficient pre-tightening force, and appropriate anti-loosening measures shall be adopted. For electrical connection points with risk of insulation reduction, insulation protection shall be strengthened as required.

5.6.5 Other requirements

a) The swappable battery pack shall be universal and interchangeable. Refer to Appendix A for the interchangeability requirements;

the negative electrode and the casing. The insulation resistance value shall not be less than 500 Ω/V.

6.2 Appearance, dimensions and mass of swappable battery pack

6.2.1 Appearance of swappable battery pack

Under good light, check the appearance of the swappable battery pack visually.

6.2.2 Dimensions and mass of swappable battery pack

Use measuring tools and weighing apparatus to measure the external dimensions and mass of the swappable battery pack.

6.3 Environmental adaptability test

6.3.1 High-temperature test

The test of high-temperature operation shall be carried out according to the provisions of "Test Bd: High-temperature test of gradual temperature change of heat-dissipating specimen – the specimen is not powered on during the temperature rise adjustment period" in GB/T 2423.2. In the test, the high-temperature test temperature is 55 °C, and the test duration is 16 hours.

6.3.2 Low temperature test

The test of low-temperature operation shall be carried out according to the provisions of "Test Ad: Low-temperature test of gradual temperature change of heat-dissipating specimen – the specimen is powered on after the temperature starts to stabilize" in GB/T 2423.1. In the test, the low-temperature test temperature is -20 °C, and the test duration is 24 hours.

6.3.3 Constant damp and hot test

Place the test swappable battery pack in a steady-state damp heat test box, and carry out the test according to the method specified in GB/T 2423.3. Carry out the test continuously for 48 hours in an environment with a temperature of 40 °C ± 2 °C and a relative humidity of (93±3) %. After the test, place the swappable battery pack in the environment specified in 6.1.1 for 2 hours.

6.4 Electrical performance test

6.4.1 Energy test of swappable battery pack

Charge the swappable battery pack according to the manufacturer's requirements. Connect the swappable battery pack to the discharge equipment; under the condition of 25 °C ± 5 °C, discharge the battery pack with 1 times the I_1 (A) current until the voltage of the battery cell reaches the end-of-discharge voltage specified by the manufacturer,

and stop discharging; let it stand for 1 hour; record the energy released by the swappable battery pack during the entire discharge process; retain 3 significant figures for the rated energy (kW·h) of the swappable battery pack. The test results shall meet the requirements of 5.3.2. If the specified value is not reached in the first test, the test can be repeated; if the specified value is still not reached in the fifth continuous charge-discharge cycle test, the test shall be stopped.

6.4.2 Capacity test of swappable battery pack

Carry out the test at the same time with the energy test of the swappable battery pack as specified in 6.4.1; according to the current value and discharge time data, calculate the capacity (in A·h) according to Formula (1).

C (capacity of swappable battery pack) = I (discharge current) × t (discharge time) …… (1)

6.4.3 Charge retention energy test

a) Charge the swappable battery pack according to the manufacturer's requirements.

b) Store the swappable battery pack at 25 °C ± 5 °C for 28 days.

c) Discharge the swappable battery pack at 20 °C ± 5 °C with 1 times the I_1 (A) current until the battery cell voltage reaches the end-of-discharge voltage specified by the manufacturer; stop discharging.

d) Calculate the capacity (in A·h) based on the current value and discharge time data; express the charge retention capacity as the percentage of the test capacity to the rated capacity.

6.5 Safety test

6.5.1 Protection test

a) Dustproof test: Carry out the dustproof test of the swappable battery pack according to the method specified in 13.4 of GB/T 4208-2017. If other protective casings are used outside the swappable battery pack, the swappable battery pack shall be tested together with the protective casing.

b) Waterproof test: Carry out the waterproof test of the swappable battery pack according to the method specified in Chapter 14 of GB/T 4208-2017. If other protective casings are used outside the swappable battery pack, the swappable battery pack shall be tested together with the protective casing.

6.5.2 Electrical insulation performance test

The connectors, terminals, electrical contacts, etc. inside the swappable battery pack shall be insulated to meet the requirements of GB 18384, and the equipment shall be

7.2 Exit-factory inspection

7.2.1 Before leaving the factory, each batch of products shall be randomly sampled for ex-factory inspection. For the capacity inspection item of the swappable battery pack, the swappable battery pack shall be discharged at 25 °C ± 5 °C with 1 times the I_1 (A) current, and the capacity difference shall not exceed ±5%.

7.2.2 In the ex-factory inspection, if one or more items are unqualified, the batch of products shall be returned to the production department for rework and general inspection, and then submitted for acceptance again. If there is still one or more unqualified items in the re-inspection, judge this batch of products as unqualified.

7.3 Type inspection

7.3.1 Type inspection shall be carried out in any of the following cases

a) when a new product is put into production or an old product is transferred to a factory for trial type identification.

b) after formal production, when there are major changes in structure, process or materials, which may affect product performance.

c) when the production, which has been suspended for one year or more, is resumed;

d) when the current factory inspection result is significantly different from the previous type inspection result.

e) when the national quality supervision institutions propose a requirement to carry out type inspection;

7.3.2 Judgment rules

The type test shall conform to the technical requirements of the product. If all of the items pass the test, judge it as qualified; if any item is unqualified, judge the product as unqualified.

8 Marking, transportation and storage

8.1 Marking

In the obvious positions of the swappable battery pack, there shall be safety graphic and signage and nameplate signs, which shall be clear, firm and reliable. Nameplate contents include:

a) the name and trademark of the manufacturer.

b) product name and model.

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