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Safety requirement for electric bicycles electrical

电动自行车电气安全要求

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1 Scope

This document specifies the requirements for electrical safety signs, warnings, wiring, wires, connections, voltage, insulation resistance, electric strength, heat generation, protection, temperature and humidity resistance, vibration and shock. It describes the corresponding test methods.

This document applies to electric vehicles (hereinafter referred to as the vehicle) included in power-assisted bicycles defined in QB/T 1714.

This document does not apply to vehicles with an on-board charger.

2 Normative references

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

GB/T 2423.1, *Environmental testing for electric and electronic products - Part 2: Test methods - Tests A: Cold*

GB/T 2423.2, *Environmental testing for electric and electronic products - 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 3956-2008, *Conductors of insulated cables*

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

GB 4706.1-2005, *Household and similar electrical appliances - Safety - Part 1: General requirements*

GB/T 16842-2016, *Protection of persons and equipment by enclosures - Probe for verification*

GB 17761, *Safety technical specification for electric bicycle*

GB/T 22199.1-2017, *Valve-regulated lead-acid batteries for moped - Part 1: Technical conditions*

4.3 Wiring, wires and connections

4.3.1 Wiring

Vehicle wiring shall meet the following requirements.

a) The main circuit cables and secondary circuit cables are classified and wired, and the lines are neat and smooth. Avoid burrs, fins or similar sharp edges that could cause insulation damage. There is a sheath at the joint part of the conducting wire and the conductor and it is fixed.

b) The inside of the flexible metal tube is smooth. Avoid wire insulation damage. If an open coil spring is used to protect the conductor, it must be properly installed and insulated. For the metal hole through which the insulated wire passes, its surface is smooth, or it is equipped with a sleeve.

c) Avoid contact with moving parts when routing. If the wire contacts moving parts or bends during normal use or maintenance, the part where the wire contacts the moving parts or bends has an insulating sheath. If the movable part moves back and forth, the wire shall bend and stretch within the maximum angle allowed by its structure.

d) The connecting wires in the battery box do not cross and overlap. If there is cross overlap, it shall avoid being squeezed by external pressure. There are insulating sheaths at the crossovers.

4.3.2 Wires

Wires with a maximum operating current greater than 200 mA in the vehicle circuit shall be copper conductor wires. The technical requirements shall meet the requirements of the fifth conductor in Chapter 6 of GB/T 3956-2008.

For wires used in vehicles, the minimum nominal cross-sectional area of single-core wires is based on the maximum operating current of the circuit (take the larger value between the actual measured value and the upper limit value of the current-limiting protection specified by the manufacturer). It shall meet the requirements of the nominal cross-sectional area corresponding to Table 1.

The minimum nominal cross-sectional area of the wires (except communication and signal wires) connected inside or between batteries shall not be less than the nominal cross-sectional area of the single-core wires of the main circuit cables.

NOTE: If the batteries are connected in parallel or between the batteries, the requirement for the minimum cross-sectional area of the connecting wires at the parallel connection is excluded.

4.8 Protection

4.8.1 Protection against access to contacting live parts

The protection of the vehicle battery system against contacting live parts shall meet the requirements of Chapter 8 of GB 4706.1-2005. The protection level of the battery system shall meet the requirements of IP33B specified in GB/T 4208.

4.8.2 Electric shock protection for exposed conductive parts

For circuits with a vehicle voltage higher than 35.0 V (DC) and 16.0 V (AC), all exposed conductive parts shall be connected. The connection methods are as follows:

a) Wire connection;

b) Connection of screws to the metal frame;

c) The mobile battery system (metal box) can be connected with metal reeds.

The contact resistance connected by metal reed shall be measured by the method described in 5.3.4. Its value shall meet the requirements of 4.3.4b).

4.8.3 Short circuit protection

Carry out a short-circuit test between the input port and the output port of the battery system according to the method described in 5.8.3. The short-circuit current shall not exceed 200 mA. The circuit cut-off time shall not be greater than 500 μs.

4.8.4 Charging protection

4.8.4.1 Main circuit protection under charging state

When the battery system of the vehicle is in the charging state, its output terminal and the main circuit shall be cut off. The voltage of its output port (connected with the main circuit) shall be 0 V (DC) and 0 V (AC).

4.8.4.2 Charging overvoltage protection

The vehicle battery system shall have a charging overvoltage protection function. When the charging voltage of the battery system is greater than the charging overvoltage protection value specified by the manufacturer, it shall cut off the charging circuit within 1 s. The accuracy error of the battery system judging the charging overvoltage shall be ±1%.

4.8.4.3 Charging overcurrent protection

The vehicle battery system shall have a charging overcurrent protection function. When the charging current value of the battery system is greater than the charging current-limiting protection specified by the manufacturer, it shall cut off the charging circuit

within 1 s. The accuracy error of the battery system judging the charging overcurrent shall be ±5%.

4.8.4.4 Misconnection protection of charging port

The charging port of the vehicle battery system shall have misconnection protection function. When the positive and negative electrodes of the input port of the battery system are connected incorrectly with the positive and negative electrodes of the output port of the charger, the charging circuit shall have no current output. After being connected correctly, the battery system shall be able to charge normally.

4.8.5 Discharge protection

The vehicle battery system shall have discharge overcurrent protection function. During the discharge process of the battery system, when the total discharge current (main circuit current plus secondary circuit current) reaches 105% of the maximum operating current of the vehicle (the larger value between the actual measured value and the upper limit value of the current limiting protection indicated by the manufacturer), it shall cut off all discharge circuits within 1 s. The accuracy error of the battery system in judging the discharge overcurrent shall be ±5%.

The current-limiting protection indicated by the vehicle manufacturer shall be less than 95% of the maximum discharge current indicated by the battery it is equipped with.

4.8.6 Temperature protection

The vehicle battery system shall have a temperature protection function. When the charging operating temperature of the battery system is higher than the maximum charging operating temperature or lower than the manufacturer's expressly indicating minimum charging operating temperature, and when the discharge operating temperature of the battery system is higher than the maximum discharge operating temperature or lower than the minimum discharge operating temperature indicated by the manufacturer, it shall cut off the charging or discharging circuit within 30 s.

4.8.7 Abnormal temperature alarm

The vehicle shall have an alarm function for abnormal temperature of the battery system. When the internal temperature of the battery system or the temperature of a single battery reaches the limit value, the vehicle or the battery system shall send out an alarm sound not lower than 85 dB(A) within 30 s.

4.8.8 Power failure of protective device

When the protective device fails in any state of the vehicle using the lithium-ion battery system, it shall be able to immediately cut off the internal connection of the battery, and the connection cannot be automatically restored.

4.8.9 Mutual recognition and collaborative charging

current-limiting protection of the vehicle's main circuit or secondary circuit indicated by the manufacturer with the larger value of the measured value.

Measure and calculate the cross-sectional area of connecting wires (except communication and signal wires) inside or between batteries. Compare the nominal cross-sectional area of the single-core conductor of the main circuit conductor.

5.3.3 Connection test

The vehicle wire connection test method is as follows:

a) Connector connection: test with tensioner;

b) Terminal connection: visual inspection and torque wrench test.

5.3.4 Contact resistance measurement

Use a low resistance tester with an accuracy of ±0.2% to test vehicle contact resistance. Measure as follows:

a) For contact resistance measurement with terminal connections. Connect the low resistance tester to both ends of the post. Under the current intensity of 5.0 A/mm^2, after reaching thermal equilibrium, measure the contact resistance value. Compare with the resistance value of the wire of the same length in the contact part of the wiring.

b) For contact resistance measurement connected with plug-in components or switch components. After the connector has been plugged and unplugged 10 times or the switch has been closed 10 times, connect the low resistance tester to both ends of the connector or switch. Under the current intensity of 5.0 A/mm^2, after reaching thermal equilibrium, measure the contact resistance value.

5.4 Voltage measurement

The vehicle voltage is measured with a voltage measuring instrument according to the following method:

a) Take the main metal parts of the vehicle (such as the frame, handlebars, hangers and other parts that the human body may come into contact with) as the reference point. Measure and record the voltage value of any circuit other than the main circuit and the circuit directly connected with the battery.

b) Turn on the electric door lock. Measure and record the voltage value of the battery system output port (connected to the main circuit). Turn off the electric door lock. Measure and record the voltage value of the battery system output port (connected with the main circuit).

5.5 Insulation resistance measurement

Use an insulation resistance meter with a DC voltage of 500 V to measure the insulation resistance value of the electrical components of the vehicle. Measure the insulation resistance value of each electrical component as follows.

a) Battery system. Connect one test lead of the insulation resistance meter to the positive and negative electrodes of the input terminal and output terminal of the battery system, respectively. For the other test lead, if the test piece is movable, connect with its case. If the test piece is immovable, it shall be connected to the frame, handlebar and motor casing, respectively.

b) Protective device. Connect one test lead of the insulation resistance meter to the positive and negative electrodes of the input terminal and output terminal of the protective device, respectively. The other test lead is connected with its case.

c) Electric motor. Connect a test-lead of the insulation resistance meter to the casing of the motor. The other test lead is connected with its armature winding and Hall line, respectively.

d) Controller. Short connect all leads of the controller. Connect a test lead of an insulation resistance meter to its case or heat sink. The other test lead is connected with its shorted lead.

e) Power-off brake handles, switches and electric door locks. Connect a test lead of the insulation resistance meter to the terminal of the tested object. For the other test lead, if the test piece is measured separately, connect with its case or heat sink. If the test piece is installed on the vehicle, it is connected to the frame, handlebar and motor casing, respectively. When the switch of the test piece is off, connect the two test leads of the insulation resistance meter to the positive and negative electrodes of the input terminal and the output terminal of the test piece, respectively.

f) Speed control handle, instrument, lamp, flasher, anti-theft device, sounding device. Connect a test-lead of the insulation resistance meter to the terminal of the tested object. For the other test lead, if the test piece is measured separately, it shall be connected to its casing or heat sink. If the test piece is installed on the vehicle, it is connected to the frame, handlebar and motor casing, respectively.

5.6 Electric strength test

After each electrical component of the vehicle has passed the constant heat and humidity test, conduct the electric strength test at the following test points (non-metallic components covered with metal foil) according to the values shown in Table 3:

a) Electric motor: between the winding and the casing, between the auxiliary line and the casing, between the auxiliary line and the winding;

voltage of the converter), measure its load under the rated power. Then work continuously for 2 h under the highest working voltage and rated load. Measure and record the meter shell temperature.

c) Lamps. Connect to the circuit (or analog circuit) of the adapted vehicle. Power it on. Work continuously for 2 h at the highest working voltage (if using a converter, use the output voltage of the converter). Measure and record the lamp shell temperature.

d) Protective devices. Connect to the circuit of the battery system of the adapted vehicle (or a simulated load with the same power consumption). Power it on. Under the highest working voltage, the main circuit works continuously for 2 h with the load of 90% of the maximum working current, and the secondary circuit works with the maximum load (turn on the front and rear lighting, horn device, turn signal, etc. at the same time). Measure and record the temperature of the protective device shell.

Immediately after the heating test is completed, measure and record the heating insulation resistance value of the electrical components according to the method described in 5.5.

5.8 Protection test

5.8.1 Protection test against contacting live parts

Put the battery system in every possible position. Apply an inconspicuous force to the Type B test probe described in GB/T 16842-2016. Insert through its openings to any depth permitted. Also, turn or bend the probe before, during and after insertion into either location. If the probe cannot be inserted into the opening, apply a force of 20 N to the probe in the vertical direction. If the probe can now be inserted into the opening, the test is repeated with the test probe at an angle, probing for contact with live parts.

Apply an inconspicuous force to the No. 13 test probe described in GB/T 16842-2016. Through openings in Class II appliances or Class II structures, explore and touch live parts.

The protection level of the battery system shall be tested according to the method described in GB/T 4208.

NOTE: For Class II appliances and Class II structures, see the definitions in 3.3.10 and 3.3.11 of GB 4706.1-2005.

5.8.2 Protection against electric shock of exposed conductive parts

Visually inspect connections of exposed conductive parts on circuits with voltages higher than 35.0 V (DC) and 16.0 V (AC).

5.8.3 Short circuit protection test

Before the test, according to the manufacturer's express requirements, the specimen battery system shall be fully charged and left for 2 h before the test of this item is carried out.

Take a plug that matches your vehicle's charging port. Use a wire with a cross-sectional area greater than 1 mm^2 (short-circuit resistance is less than 50 mΩ) between the positive and negative poles of the plug. Connect a current recorder in series and connect it to the charging port of the vehicle. Check and record the charging circuit cut-off time and short-circuit current value of the battery system.

When the motor stops rotating, between the positive and negative electrodes of the output port of the battery system, use a wire with a cross-sectional area greater than 1 mm^2 (short-circuit resistance is less than 100 mΩ) to connect a current recorder in series and make a short-circuit connection. Check and record the output circuit cut-off time and short-circuit current value of the battery system.

5.8.4 Charging protection test

5.8.4.1 Main circuit protection in charging state

Connect a voltmeter to the output port of the vehicle battery system (connected to the main circuit). Connect the output of the charger to the input of the vehicle battery system. After the input terminal is connected to the mains, it charges the battery system whose remaining capacity is less than 50% of the rated capacity. Unlock the vehicle electric door lock. Record the reading of the voltmeter. After charging is completed (the charger has no current output, but is still connected to the mains), record the reading of the voltmeter. When the output terminal of the charger is disconnected from the input terminal of the vehicle battery system (the electric door lock is unlocked), record the reading of the voltmeter.

5.8.4.2 Charging overvoltage protection

Before the test, according to the manufacturer's indicated requirements, the specimen battery system shall be fully charged and left for 2 h before the test of this item is carried out.

As shown in Figure 2, connect the voltmeter, ammeter, battery system, adjustable voltage source, and oscilloscope to the charging circuit. Replace battery with diode D1 in series with stabilized power supply. The output of the regulated power supply is set to the rated voltage of the battery system. Close the switch K1 to make it work normally. Gradually increase the adjustable voltage source from 0 V. Record voltmeter voltage measurements. When the voltage value reaches 105% of the upper limit of the charging overvoltage protection value specified by the battery manufacturer, record the time when the current measurement value of the oscilloscope is 0 A.

specified by the manufacturer, record the time when the ammeter readings are all 0 A.

c) Put the battery system with remaining capacity less than 30% of the rated capacity into the center of the test chamber at a temperature 5°C higher than the minimum charging temperature indicated by the manufacturer. Connect an ammeter in series with the input port of the battery system. Connect it with a suitable charger to make it work normally. Gradually lower the chamber temperature. When the internal temperature of the battery system or the temperature of a single battery reaches the minimum charging temperature specified by the manufacturer, record the time when the ammeter reading becomes 0 A.

d) Put the battery system with a remaining capacity greater than 90% of the rated capacity into the center of the test chamber at a temperature 5°C higher than the minimum discharge temperature indicated by the manufacturer. Connect an ammeter in series with the output port of the battery system. Connect the simulated load to make it work normally. Gradually lower the chamber temperature. When the internal temperature of the battery system or the temperature of a single battery reaches the minimum discharge temperature specified by the manufacturer, record the time when the ammeter reading becomes 0 A.

5.8.7 Abnormal temperature alarm test

Before the test, according to the manufacturer's indicated requirements, the specimen battery system shall be fully charged and then put aside for 1 h before carrying out the test of this item.

Fix the detection end of the spot thermometer with the temperature sensor of the battery system. Measuring instruments and other electrical components connected to the battery system are placed outside the test chamber to work through wire connections.

Put the battery system with a remaining capacity greater than 80% of the rated capacity into a test box at a temperature of 65°C (45°C for a lead-acid battery system). Gradually increase the temperature in the test chamber. When the internal temperature of the container (battery box) containing the battery system or the temperature of a single battery reaches 80°C (the temperature of the lead-acid battery reaches 60°C), use a stopwatch to record the time when the battery system emits an alarm sound.

The sound pressure level measurement method of the alarm sound is as follows.

a) Measurement environment

The requirements for the alarm sound measurement environment are as follows:

1) The measurement site is flat and open (the indoor height is not less than 3.0 m). In a measurement area with a radius of 5.0 m drawn from the measurement

point as the center, there are no reflectors (such as walls, etc.).

2) Except for the testing personnel, there is no other person in the measurement area during the measurement. The position of the measuring personnel does not affect the meter reading.

3) The measurement is carried out under the climatic conditions of no rain, no snow and wind speed not greater than 3 m/s. The influence of gusts on the readings of the sound level meter shall be excluded during measurement.

4) The sound pressure level of the background noise is more than 10 dB(A) lower than the sound pressure level of the alarm sound of the tested vehicle.

b) Measurement method

The method of measuring the alarm sound is as follows:

1) Place the vehicle under test in the center of the test field. On the left and right sides of the vehicle at a distance of 2 m perpendicular to the center of the vehicle body and at a height of 1.2 m, place a sound level meter with a first-class accuracy.

2) Turn on the circuit at room temperature. Trigger buzzer alarm sound. Read the minimum readings of the left and right sound level meters, respectively. Take the minimum of the two sets of readings as the measured value.

5.8.8 Power failure test of protective device

Connect the voltmeter to the positive and negative poles of the lithium-ion battery in parallel. It reads the total voltage of the Li-ion battery. Connect the wires in any of the following ways and record the readings of the voltmeter. Record the voltmeter reading after removing the lead.

a) Connect the positive terminal of the input port of the lithium-ion battery system to the positive terminal of the lithium-ion battery; or

b) Connect the positive pole of the output port (connected to the main circuit) of the lithium-ion battery system with the positive pole of the lithium-ion battery; or

c) Connect the positive pole of the output port of the lithium-ion battery system (connected to the secondary circuit) with the positive pole of the lithium-ion battery.

If the protective device is connected to the negative pole, all negative pole connections shall be tested according to the above method.

5.8.9 Mutual recognition and collaborative charging test

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