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**Cycle life requirements and test methods for traction battery of
electric vehicle**

电动汽车用动力蓄电池循环寿命要求及试验方法

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1 Scope

This standard specifies the requirements, the test methods and the inspection rules for the standard cycle life of traction batteries for electric vehicles, and the test methods and the inspection rules for the operating-condition cycle life.

This standard applies to traction batteries fitted to electric vehicles, referred to below as batteries.

2 Normative references

The following documents are indispensable for the application of this document. For dated references, only the dated version applies to this document. For undated references, the latest version, including all amendments, applies to this document.

GB/T 2900.41 Electrotechnical terminology - Primary and secondary cells and batteries.
GB/T 19596 Terminology of electric vehicles.

3 Terms and definitions

The terms and definitions given in GB/T 2900.41 and GB/T 19596 and the following apply to this document.

3.1 secondary cell. The basic unit device that converts chemical energy directly into electrical energy, comprising electrodes, separator, electrolyte, case and terminals, and designed to be rechargeable.

3.2 battery module. An assembly of more than one secondary cell connected in series, in parallel or in series-parallel, having only one pair of positive and negative output terminals, and used as a power source.

3.3 battery pack. A unit that normally includes battery modules, a battery management module not including the BCU, a battery case and the corresponding accessories, and that is able to take in electrical energy from outside and to deliver electrical energy outward.

3.4 battery system. An energy storage device made up of one or more battery packs together with the corresponding accessories, that is the management system, the high-voltage circuit, the low-voltage circuit, the thermal management equipment and the mechanical assembly.

3.5 rated capacity. The capacity in ampere hours released by a fully charged battery discharged at room temperature at a current of one times I_1 in amperes until the cut-off voltage is reached.

3.6 rated energy. The energy in watt hours released by a fully charged battery discharged at room temperature at a current of one times I_1 in amperes until the cut-off voltage is reached.

3.7 initial capacity. The capacity in ampere hours released by a newly delivered traction battery which, at room temperature and after being fully charged, is discharged at a current of one times I_1 in amperes to the discharge cut-off condition specified by the manufacturer.

3.8 initial energy. The energy in watt hours released by a newly delivered traction battery which, at room temperature and after being fully charged, is discharged at a current of one times I_1 in amperes to the discharge cut-off condition specified by the manufacturer.

3.9 state of charge, SOC. The percentage of the initial capacity represented by the currently available capacity.

4 Symbols

The following symbols apply to this document.

C_1 is the one-hour-rate rated capacity in ampere hours. I_1 is the one-hour-rate discharge current, numerically equal to C_1 , in amperes. C_{n1} is the one-hour-rate actual discharge capacity in ampere hours. I_{n1} is the one-hour-rate actual discharge current, numerically equal to C_{n1} , in amperes.

5 Requirements

Room-temperature discharge capacity, that is initial capacity. When a cell is tested in accordance with 6.2, its discharge capacity shall be not lower than the rated capacity and not higher than 110 % of the rated capacity, and the range of initial capacity across all test samples shall not be greater than 5 % of the mean initial capacity.

When a module or a system is tested in accordance with 6.2, its discharge capacity shall be not lower than the rated capacity and not higher than 110 % of the rated capacity, and

the range of initial capacity across all test samples shall not be greater than 7 % of the mean initial capacity.

Standard cycle life. When test samples are subjected to the standard cycle life test in accordance with 6.4, the discharge capacity at 500 cycles shall be not lower than 90 % of the initial capacity, or the discharge capacity at 1 000 cycles shall be not lower than 80 % of the initial capacity.

Operating-condition cycle life. For power-type batteries for hybrid passenger cars tested in accordance with 6.5.1 and for power-type batteries for hybrid commercial vehicles tested in accordance with 6.5.2, the discharge capacity and the five-second discharge power shall be measured when the ratio of the total discharged energy to the initial energy of the battery reaches 500.

For energy-type batteries for battery-electric passenger cars tested in accordance with 6.5.3 and for energy-type batteries for battery-electric commercial vehicles tested in accordance with 6.5.4, the discharge capacity shall be measured when the ratio of the total discharged energy to the initial energy of the battery reaches 500.

Batteries for plug-in hybrid and range-extended electric vehicles shall be tested by reference to 6.5.3 or 6.5.4, and the discharge capacity shall be measured when the ratio of the total discharged energy to the initial energy reaches 500.

6 Test methods

General conditions. Unless otherwise specified, the tests shall be carried out at a temperature of 25 degrees Celsius plus or minus 5 degrees Celsius, a relative humidity of 15 % to 90 % and an atmospheric pressure of 86 kPa to 106 kPa. Room temperature as used in this standard means 25 degrees Celsius plus or minus 2 degrees Celsius.

The test samples shall be delivered together with the operating documents that are needed and with the interface parts required for connection to the test equipment, such as connectors and plugs, including cooling interfaces. The supplier shall provide the working limits of the battery pack or system so that the whole test can be carried out safely.

Charging method. At room temperature the battery shall be charged by the method specified by the manufacturer. If the manufacturer gives no charging method, then a lithium-ion battery shall be charged at constant current of I_1 in amperes up to the charge cut-off voltage specified by the manufacturer, then at constant voltage until the charging current falls to 0.05 times I_1 in amperes, and left to stand for 1 h after charging, or for the standing time not longer than 1 h specified by the manufacturer; a nickel metal hydride battery shall be charged at constant current of one times I_1 in amperes for 1 h, then at 0.2 times I_1 for 1 h, and left to stand for 1 h after charging, or for the standing time not longer than 1 h specified by the manufacturer.

Capacity and energy measurement. Discharge at one times I_1 in amperes to the discharge cut-off condition specified by the manufacturer; stand for not less than 30 min, or for the standing time specified by the manufacturer, which shall not be longer than 60 min; charge by the method above; stand again for not less than 30 min and not more than 60 min; discharge at one times I_1 in amperes to the discharge cut-off condition specified by the manufacturer; and calculate the discharge capacity in ampere hours and the discharge energy in watt hours of that last discharge step.

Method for adjusting the state of charge to the target value of n per cent. Charge as above; stand for not less than 30 min and not more than 60 min; then discharge at a constant current of one times I_{n1} in amperes for the number of hours obtained by subtracting n from 100 and dividing by 100.

Power measurement. Adjust the state of charge of the test sample to 50 %; stand for 30 min; discharge for 5 s at the maximum current specified by the manufacturer and afterwards discharge at one times I_1 in amperes to the discharge cut-off condition specified by the manufacturer; and calculate the power in watts at the last data acquisition point of that discharge step.

The room-temperature capacity and energy test and the room-temperature power test apply to cells, modules or systems; the standard cycle life test applies to cells or modules; the operating-condition cycle life test applies to modules or systems. Discharge current carries a positive sign and charge current a negative sign.

Accuracy of measuring instruments. Voltage measuring device not lower than class 0.5; current measuring device not lower than class 0.5; temperature measuring device plus or minus 0.5 degrees Celsius; time measuring device plus or minus 0.1 %; dimension measuring device plus or minus 0.1 %; mass measuring device plus or minus 0.1 %.

Room-temperature capacity and energy, that is initial capacity and energy. At room temperature the capacity and the energy are measured five times by the method above; when the range of three consecutive results is less than 3 % of the rated capacity the test may be ended early, and the mean of the last three results is taken.

Room-temperature power, that is initial power, is measured at room temperature by the power measurement method.

Standard cycle life is measured as follows. Discharge at one times I_1 in amperes to the discharge cut-off condition specified by the manufacturer; stand for not less than 30 min or for the standing condition specified by the manufacturer; charge by the specified method; stand again; discharge at one times I_1 in amperes to the discharge cut-off condition and record the discharge capacity; repeat the standing, charging, standing and discharging steps for 500 consecutive cycles, and if the discharge capacity is above 90 % of the initial capacity end the test, otherwise continue for a further 500 cycles; then measure the room-temperature discharge capacity and discharge energy.