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**Traction batteries for electric earth-moving machinery - Part 2:
Electrical performance requirements**

电动土方机械用动力电池 第2部分：电性能要求

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1 Scope

Part 2 of China's national standard for the traction batteries of electric earth-moving machinery, covering electrical performance. The performance a construction machine demands of a battery differs from a vehicle's in ways that determine the cell chemistry. The average power is high and sustained - an excavator digging is at substantial load continuously, not cruising - and the peaks are severe, with regenerative charging pulses every time the boom drops. The energy is consumed within a shift rather than over days, so the pack is cycled fully once or twice daily and its calendar life matters less than its cycle life. And the machine may charge at high rate during a break, which imposes its own stress. The requirements accordingly specify capacity and power at the rates and temperatures the application uses, rather than at the benign conditions that flatter a datasheet.

This document specifies the electrical performance requirements for power battery cells, battery packs or battery systems for electric earth-moving machinery; describes the relevant test methods. This document is applicable to the manufacture of power lithium-ion batteries for electric earth-moving machinery. The manufacture of other types of power batteries is implemented with reference to it.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. Among them, for dated references, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies to this document.

GB/T 10592 Specifications for high/low temperature testing chambers

GB/T 44254 Electric earth-moving machinery - Terminology

3 Terms and definitions

The terms and definitions as defined in GB/T 44254, as well as the following terms and definitions, apply to this document.

3.1 Electric earth-moving machinery; EEMM Earth-moving machinery whose operating energy is fully or partially provided by electric energy.

Note 1: Operating energy refers to the energy required for earth-moving machinery operations, including energy input, energy output, intermediate energy conversion processes.

Note 2: Electric energy comes from onboard rechargeable energy storage systems, fuel cells, generator devices, external wiring networks or other external energy storage devices.

Note: The range is the difference between the maximum and minimum values of all samples.

5.1.4 Room temperature rate discharge capacity The battery cell shall be tested according to 7.1.5; the discharge capacity shall not be less than 95% of the initial capacity.

5.1.5 Room temperature rate charging performance The battery cell shall be tested according to 7.1.6; the discharge capacity shall not be less than 85% of the initial capacity.

5.1.6 Low temperature rate discharge capacity The battery cell shall be tested according to 7.1.7; the discharge capacity shall not be less than 70% of the initial capacity.

5.1.7 High temperature discharge capacity The battery cell shall be tested according to 7.1.8; the discharge capacity shall not be less than 95% of the initial capacity.

5.1.8 Charge retention and capacity recovery The lithium-ion battery cell shall be tested according to 7.1.9; the room temperature and high temperature charge retention capacity shall not be less than 90% of the initial capacity; the recovery capacity shall not be less than 95% of the initial capacity.

5.1.9 Storage The battery cell shall be tested according to 7.1.10; the recovery capacity shall not be less than 95% of the initial capacity. At the same time, the range of the recovery capacity and energy efficiency of all test objects shall not be greater than 5% of the average value.

5.1.10 Cycle life The battery cell shall be tested according to 7.1.11. When the number of cycles reaches 500, the discharge capacity shall not be less than 90% of the initial capacity.

5.2 Battery pack or battery system

5.2.1 Appearance The battery pack or battery system shall be tested according to 7.2.1. The appearance shall be free of deformation and cracks. The surface shall be dry, free of burrs, external injuries and dirt. It shall also have clear and correct markings.

5.2.2 Dimensions and mass The battery pack or battery system shall be tested according to 7.2.2. The dimensions and mass shall comply with the product technical requirements provided by the manufacturer.

5.2.3 Room temperature discharge capacity The battery pack or battery system shall be tested according to 7.2.4. The initial capacity shall not be less than the rated capacity and shall not exceed 110% of the rated capacity. The room temperature discharge energy shall not be less than the rated energy.

5.2.4 Energy efficiency The battery pack or battery system shall be tested according to 7.2.4. The energy efficiency shall not be less than 90%.

6.1 General conditions

6.1.1 Unless otherwise specified, the test shall be conducted in an environment at a temperature of $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, a relative humidity of 10% ~ 90%, an atmospheric pressure of 86 kPa ~ 106 kPa.

6.1.2 When the test target ambient temperature changes, the environmental adaptation process shall be completed before the test: the difference between the battery cell temperature and the target ambient temperature shall not exceed $2\text{ }^{\circ}\text{C}$; the battery cell temperature change rate shall be less than $1\text{ }^{\circ}\text{C/h}$ within at least 30 min.

6.1.3 The high and low temperature test chamber shall meet the requirements of GB/T 10592; or refer to Appendix A to use the test fixture.

6.1.4 Before the test, the manufacturer shall provide parameters such as rated capacity, rated energy, discharge termination voltage.

6.1.5 During the test, the thermal management system of the battery pack or battery system works according to the manufacturer's requirements or the instructions of the battery management system; the on or off status of the thermal management system shall be clearly stated in the test report.

6.1.6 The test procedure and the number of samples required refer to Table B.1 in Appendix B.

6.2 Accuracy of measuring instruments and meters The accuracy of measuring instruments and meters shall meet the following requirements: If the manufacturer does not provide a charging method, charge at a constant current of no less than 1I₃ specified by the manufacturer to the charging termination voltage, which is specified by the manufacturer.

Switch to constant voltage charging, until the charging current drops to 0.15I₃. After charging, let it stand for 1 hour (or a standing time of no more than 1 hour provided by the manufacturer).

7.1.4 Room temperature discharge capacity The room temperature discharge capacity is carried out according to the following steps:

- a) Charge the battery cell according to the method in 7.1.3;
- b) At room temperature, discharge the high-energy batteries at a current of 1I₃ and high-power batteries at a current of 1I₁, until the discharge reaches the discharge termination voltage specified by the manufacturer;
- c) Measure the discharge capacity (Ah); calculate the discharge energy (Wh) and discharge specific energy (Wh/kg);
- c) for 5 times. When the range of the results of 3 consecutive tests is less than 3% of the rated capacity, the test can be terminated in advance; take the average of the last 3 test results as the initial capacity.

7.1.5 Room temperature rate discharge performance

7.1.5.1 High energy batteries 7.1.5.1.1 The data recording interval of the room temperature rate discharge capacity test shall not exceed 100 ms. 7.1.5.1.2 The room temperature rate discharge capacity test is carried out according to the following steps:

- a) Charge the battery cell according to the method in 7.1.3;
- b) At room temperature, discharge the battery cell at a current of 3I₃, until it reaches the discharge termination voltage specified by the manufacturer;
- c) Measure the discharge capacity (Ah).

7.1.5.2 High-power batteries 7.1.5.2.1 The data recording interval of the room temperature rate discharge capacity test shall not exceed 100 ms. 7.1.5.2.2 The room temperature rate discharge capacity test is carried out according to the following steps:

- a) Charge the battery cell according to the method of 7.1.3;
- b) At room temperature, discharge the battery cell at a current of 10I₁ (maximum current not exceeding 800 A), until it is discharged to the discharge termination voltage specified by the manufacturer;
- c) Measure the discharge capacity (Ah).

7.1.6 Room temperature rate charging performance Test the room temperature rate charging performance according to the following steps:

- a) At room temperature, discharge the high energy type batteries at a current of 1I₃ and