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NATIONAL STANDARD OF THE
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ICS 43.120

CCS T 47

GB 38031-2025

Replacing GB 38031-2020

Electric vehicles traction battery safety requirements

电动汽车用动力蓄电池安全要求

Issued on: 2025-03-28

Implemented on: 2026-07-01

**Issued by: State Administration for Market Regulation;
National Standardization Administration.**

Table of Contents

Foreword	3
Introduction	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols and abbreviations	11
4.1 Symbols	11
4.2 Abbreviations	11
5 Safety requirements	12
5.1 Safety requirements for battery cells	12
5.2 Safety requirements for battery pack or system	12
6 Test conditions	14
6.1 General conditions	14
6.2 Accuracy of measuring instruments and meters	16
6.3 Test process error	16
6.4 Data recording and recording interval	17
7 Test preparation	17
7.1 Preparation for battery cell test	17
7.2 Preparation for battery pack or system test	18
8 Test methods	19
8.1 Test methods for battery cell safety	19
8.2 Battery pack or system safety test method	22
9 Determination of the same type	40
10 Implementation of the standard	43
Appendix A (Informative) Examples of typical structures of battery packs and systems	44
Appendix B (Normative) Test method for battery pack or system insulation resistance	47
Appendix C (Normative) Thermal diffusion analysis and verification report	49
References	57

Foreword

This document was drafted in accordance with the provisions of GB/T 1.1-2020 "Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents".

This document replaces GB 38031-2020 "Electric vehicles traction battery safety requirements". Compared with GB 38031-2020, in addition to structural adjustments and editorial changes, the main technical changes are as follows:

- CHANGE the scope (see Chapter 1; Chapter 1 of the 2020 edition);
- ADD the definition of battery subsystem (see 3.5);
- CHANGE the definition of leakage (see 3.14; 3.13 of the 2020 edition);
- ADD the definition of thermal events (see 3.15);
- ADD the safety requirements and test methods for battery cells after fast charging cycles (see 5.1.7 and 8.1.8);
- CHANGE the safety requirements and test methods for battery pack or system vibration (see 5.2.1 and 8.2.1; 5.2.1 and 8.2.1 of the 2020 edition);
- CHANGE the safety requirements for mechanical shock of battery packs or systems (see 5.2.2; 5.2.2 of the 2020 edition);
- CHANGE the safety requirements for simulated collision of battery packs or systems (see 5.2.3; 5.2.3 of the 2020 edition);
- CHANGE the safety requirements and test methods for extrusion of battery packs or systems (see 5.2.4 and 8.2.4; 5.2.4 and 8.2.4 of the 2020 edition);
- CHANGE the safety requirements for damp heat cycling of battery packs or systems (see 5.2.5; 5.2.5 of the 2020 edition);
- CHANGE the safety requirements for water immersion of battery packs or systems (see 5.2.6; 5.2.6 of the 2020 edition);
- CHANGE the safety requirements and test methods for thermal stability of battery packs or systems (see 5.2.7, 8.2.7 and Appendix C; 5.2.7, 8.2.7 and Appendix C of the 2020 edition);
- CHANGE the safety requirements and test methods for temperature shock of battery packs or systems (see 5.2.8 and 8.2.8; 5.2.8 and 8.2.8 of the 2020 edition);
- CHANGE the safety requirements and test methods for battery pack or system salt

Electric vehicles traction battery safety requirements

1 Scope

This document specifies the safety requirements and test methods for power batteries (hereinafter referred to as batteries) for electric vehicles, battery packs or systems.

This document applies to power batteries for electric vehicles.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB/T 2423.4 Environmental testing for electric and electronic products - Part 2: Test method - Test Db: Damp heat, cyclic (12 h + 12 h cycle)

GB/T 2423.17-2024 Environmental testing - Part 2: Test methods - Test Ka: Salt mist

GB/T 2423.43 Environmental testing for electric and electronic products - Part 2: Test methods - Mounting of specimens for vibration, impact and similar dynamic tests

GB/T 2423.56 Environmental testing - Part 2: Test methods - Test Fh: Vibration, broadband random and guidance

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

GB/T 19596 Terminology of electric vehicles

GB/T 28046.4-2011 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 4: Climatic loads

3 Terms and definitions

The terms and definitions defined in GB/T 19596, as well as the following terms and definitions, apply to this document.

3.1

5 Safety requirements

5.1 Safety requirements for battery cells

5.1.1 The battery cells shall not catch fire or explode, when subjected to the over-discharge test in accordance with 8.1.2.

5.1.2 The battery cells shall not catch fire or explode, when subjected to the over-charge test in accordance with 8.1.3.

5.1.3 The battery cells shall not catch fire or explode, when subjected to the external short-circuit test in accordance with 8.1.4.

5.1.4 The battery cells shall not catch fire or explode, when subjected to the heating test in accordance with 8.1.5.

5.1.5 The battery cell shall not catch fire or explode, when subjected to temperature cycle test in accordance with 8.1.6.

5.1.6 The battery cell shall not catch fire or explode, when subjected to extrusion test in accordance with 8.1.7.

5.1.7 The battery cell shall not catch fire or explode, when subjected to fast charge cycle in accordance with 8.1.8.

5.2 Safety requirements for battery pack or system

5.2.1 The battery pack or system shall be subjected to vibration test in accordance with 8.2.1; it shall not have leakage, housing crack, fire or explosion. The insulation resistance after the test shall be not less than 100 Ω/V . If there is an AC circuit, the insulation resistance shall be not less than 500 Ω/V .

5.2.2 The battery pack or system shall be subjected to mechanical impact test in accordance with 8.2.2; it shall not have leakage, housing crack, fire or explosion. The insulation resistance after the test shall be not less than 100 Ω/V . If there is an AC circuit, the insulation resistance shall be not less than 500 Ω/V .

5.2.3 The battery pack or system shall be subjected to a simulated collision test in accordance with 8.2.3; there shall be no leakage, housing crack, fire or explosion. The insulation resistance after the test shall be no less than 100 Ω/V . If there is an AC circuit, the insulation resistance shall be no less than 500 Ω/V .

5.2.4 The battery pack or system shall be subjected to an extrusion test in accordance with 8.2.4; there shall be no fire or explosion. The insulation resistance after the test

shall be no less than 100 Ω/V . If there is an AC circuit, the insulation resistance shall be no less than 500 Ω/V .

5.2.5 The battery pack or system shall be subjected to a damp heat cycle test in accordance with 8.2.5; there shall be no leakage, housing crack, fire or explosion. The insulation resistance within 30 minutes after the test shall be no less than 100 Ω/V . If there is an AC circuit, the insulation resistance shall be no less than 500 Ω/V .

5.2.6 The battery pack or system shall be subjected to water immersion test in accordance with 8.2.6; it shall meet one of the following requirements:

- a) According to method 1, no fire or explosion shall occur;
- b) According to method 2, after the test, it shall meet the IPX7 requirements of GB/T 4208-2017, and there shall be no leakage, housing crack, fire or explosion. The insulation resistance after the test shall not be less than 100 Ω/V . If there is an AC circuit, the insulation resistance shall not be less than 500 Ω/V .

5.2.7 Thermal stability test shall be carried out in accordance with 8.2.7 (except for nickel-metal hydride battery packs or systems). The requirements are as follows:

- a) The battery pack or system shall be subjected to external fire test in accordance with 8.2.7.1 and shall not explode;
- b) The battery pack or system or the whole vehicle shall be subjected to thermal diffusion analysis and verification in accordance with 8.2.7.2; it shall:
 - 1) Be no fire or explosion;
 - 2) Provide a thermal event alarm signal, meanwhile the alarm signal shall be issued no later than 5 minutes after the thermal runaway of the battery cell is triggered;
 - 3) For battery pack or system level tests, provide technical description documents that smoke does not cause danger to the passenger compartment before and within 5 minutes after the thermal event alarm signal is issued; for vehicle level tests, no smoke enters the passenger compartment before and within 5 minutes after the thermal event alarm signal is issued.

5.2.8 The battery pack or system shall be subjected to temperature shock test in accordance with 8.2.8; there shall be no leakage, housing crack, fire or explosion. The insulation resistance after the test shall be no less than 100 Ω/V . If there is an AC circuit, the insulation resistance shall be no less than 500 Ω/V .

5.2.9 The battery pack or system shall be subjected to salt spray test in accordance with 8.2.9; there shall be no leakage, housing crack, fire or explosion. The insulation resistance after the test shall be no less than 100 Ω/V . If there is an AC circuit, the

3% of the rated capacity for 3 consecutive times, the battery cell is deemed to have completed the pretreatment; the pretreatment cycle can be terminated; the average of the last 3 test results is taken as the actual capacity.

7.2 Preparation for battery pack or system test

7.2.1 Confirmation of working status

Before the formal test begins, the battery electronic components or BCU shall be in normal working condition.

7.2.2 Pretreatment

7.2.2.1 Before the formal test begins, the battery pack or system shall be preconditioned. The steps are as follows:

- a) Charge at a current of not less than $1 I_3$ or according to the charging method recommended by the manufacturer to the end-of-charge condition specified by the manufacturer;
- b) Let it stand for 30 min or the time specified by the manufacturer;
- c) Discharge at a current specified by the manufacturer and not less than $1 I_3$ to the end-of-discharge condition specified by the manufacturer;
- d) Let it stand for 30 min or the time specified by the manufacturer;
- e) Repeat steps a) ~ d) no more than 5 cycles.

7.2.2.2 If the discharge capacity change of the battery pack or system for 2 consecutive times is not higher than 3% of the rated capacity, the battery pack or system is considered to have completed the pretreatment; the pretreatment cycle can be terminated; the average of the last 2 test results is taken as the actual capacity.

7.2.2.3 Unless otherwise specified, if the time interval between the completion of the pretreatment cycle and adjustment to the highest working state of charge and a new test item is greater than 24 h, a supplementary charge shall be performed: charge at a current of not less than $1 I_3$ to the end-of-charge condition specified by the manufacturer or charge according to the charging method recommended by the manufacturer; let it stand for 30 min or the time specified by the manufacturer.

8.1.8.2 Test according to the following steps:

- a) Adjust to 20% SOC according to the method provided by the manufacturer;
- b) Let it stand for 30 minutes or the time specified by the manufacturer;
- c) Charge to 80% SOC according to the charging method provided by the manufacturer; the charging time shall not exceed 15 minutes;
- d) Let it stand for 30 minutes or the time specified by the manufacturer;
- e) Repeat steps a) ~ d) 300 times;
- f) Perform external short-circuit test according to 8.1.4.

8.2 Battery pack or system safety test method**8.2.1 Vibration****8.2.1.1** The test object is a battery pack or system.

8.2.1.2 Install the test object on the vibration table according to the installation position and fixing method of the test object vehicle and the requirements of GB/T 2423.43. Random and fixed frequency vibration loads are applied in each direction; the loading sequence shall be z-axis random, z-axis fixed frequency, y-axis random, y-axis fixed frequency, x-axis random, x-axis fixed frequency (the direction of vehicle travel is the x-axis direction; the other horizontal direction perpendicular to the travel direction is the y-axis direction). The testing agency can also choose the sequence by itself to shorten the conversion time. The test process is carried out in accordance with GB/T 2423.56.

8.2.1.3 For battery packs or systems loaded on vehicles other than categories M_1 and N_1 , the vibration test parameters are set according to Table 2 and Figure 2, where the RMS of the x-axis, y-axis, z-axis are 0.52 g, 0.57 g, 0.73 g, respectively. Where there are multiple installation directions (x/y/z) for the test object, the test is carried out in the installation direction with the largest RMS. For battery packs or systems installed on the top of the vehicle, vibration tests shall be carried out according to the vibration test parameters provided by the manufacturer that are not less than those in Table 2 and Figure 2.

8.2.1.4 For battery packs or systems installed on categories M_1 and N_1 vehicles, the vibration test parameters shall be set according to Table 3 and Figure 3, where the RMS of the x-axis, y-axis, z-axis are 0.50 g, 0.45 g, and 0.64 g, respectively.

temperature determined according to a) or b) (as applicable) is reached; then maintained at or above this temperature until the end of the test.

- a) If the battery system is equipped with internal overheating protection measures, the temperature shall be increased to the operating temperature threshold corresponding to the overheating protection measures of the battery system, to ensure that the temperature of the test object is increased in accordance with 8.2.11.3.
- b) If the battery system is not equipped with any internal overheating protection measures, the temperature shall be increased to the maximum operating temperature specified by the battery system manufacturer.

8.2.11.5 The test is terminated when any of the following conditions are met:

- a) The test object automatically terminates or limits charging or discharging;
- b) The test object sends a signal to terminate or limit charging or discharging;
- c) The temperature of the test object is stable; the temperature change is less than 4 °C within 2 hours.

8.2.11.6 After completing the above test steps, observe for 1 hour at the test environment temperature.

8.2.12 Overcurrent protection

8.2.12.1 The test object is a battery system that can be powered by an external DC power supply.

8.2.12.2 The test conditions are as follows:

- a) The test shall be carried out at an ambient temperature of 20 °C ± 10 °C;
- b) According to the normal operation recommended by the battery system manufacturer (such as using external charging and discharging equipment), adjust the SOC of the test object to the middle part of the normal operating range. As long as the battery system can operate normally, precise adjustment is not required;
- c) Negotiate with the battery system manufacturer, to determine the overcurrent that can be applied (assuming the failure of the external DC power supply equipment) and the maximum voltage (within the normal range).

8.2.12.3 Perform the overcurrent test according to the instructions provided by the battery system manufacturer in the following steps:

- a) Connect the external DC power supply device and change or disable the charging control communication, to allow the overcurrent level determined by negotiation

with the battery system manufacturer;

- b) Start the external DC power supply device and charge the battery system to the highest normal charging current specified by the battery system manufacturer. Then, increase the current from the highest normal charging current to the overcurrent level described in c) of 8.2.12.2 within 5 s and continue charging.

8.2.12.4 The test ends when any of the following conditions are met:

- a) The test object automatically terminates the charging current;
- b) The test object sends a signal to terminate the charging current;
- c) The temperature of the test object is stable; the temperature change is less than 4 °C within 2 h.

8.2.12.5 After completing the above test steps, observe at the test environment temperature for 1 h.

8.2.13 External short-circuit protection

8.2.13.1 The test object is a battery system.

8.2.13.2 The test conditions are as follows:

- a) The test shall be conducted at an ambient temperature of 20 °C ± 10 °C or a higher temperature required by the manufacturer;
- b) At the beginning of the test, all protective devices that affect the function of the test object and are related to the test results shall be in normal operation.

8.2.13.3 The external short-circuit process is as follows:

- a) At the beginning of the test, the main contactors for charging and discharging shall be closed (such as the relevant relays in the battery system circuit), to represent the driving mode and the mode that allows external charging. If it cannot be completed in a single test, two or more tests shall be performed;
- b) The positive and negative terminals of the test object are connected to each other. The short-circuit resistance does not exceed 5 mΩ.

8.2.13.4 The short-circuit state is maintained until any of the following conditions are met, then the test is terminated:

- a) The protection function of the test object works and the short-circuit current is terminated;
- b) After the temperature of the test object's shell is stable (the temperature change is

less than 4 °C within 2 hours), continue the short circuit for at least 1 hour.

8.2.13.5 After completing the above test steps, observe for 1 hour at the test ambient temperature.

8.2.14 Overcharge protection

8.2.14.1 The test object is a battery system.

8.2.14.2 The test conditions are as follows:

- a) The test shall be carried out at an ambient temperature of $20\text{ °C} \pm 10\text{ °C}$ or a higher temperature required by the manufacturer;
- b) According to the normal operation recommended by the battery system manufacturer (such as using an external charging and discharging device), adjust the SOC of the test object to the middle part of the normal operating range. As long as the test object can operate normally, precise adjustment is not required;
- c) At the beginning of the test, all protection devices that affect the function of the test object and are related to the test results shall be in normal operation.

All relevant main contactors for charging shall be closed (such as relevant relays in the battery system circuit).

8.2.14.3 The charging process is as follows:

- a) The external charging device shall be connected to the main terminals of the test object. The charging control limit of the external charging device shall be disabled;
- b) The test object shall be charged by the external charging device under the shortest charging strategy as permitted by the battery system manufacturer.

8.2.14.4 Charging shall continue until any of the following conditions are met, then the test is terminated:

- a) The test object automatically terminates the charging current;
- b) The test object sends a signal to terminate the charging current;
- c) When the overcharge protection control of the test object does not work, or if there is no function described in a) of 8.2.14.4, charging shall continue until the temperature of the test object exceeds 10 °C above the maximum operating temperature specified by the manufacturer;
- d) When the charging current is not terminated and the temperature of the test object is lower than 10 °C above the maximum operating temperature, charging shall continue for 12 h.

8.2.14.5 After completing the above test steps, observe at the test environment temperature for 1 h.

8.2.15 Over-discharge protection

8.2.15.1 The test object is a battery system.

8.2.15.2 The test conditions are as follows:

- a) The test shall be conducted at an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$ or a higher temperature required by the manufacturer;
- b) According to the normal operation method recommended by the battery system manufacturer (such as using an external charging and discharging device), adjust the SOC of the test object to a lower level within the normal operating range. As long as the test object can operate normally, no precise adjustment is required;
- c) At the beginning of the test, all protective devices that affect the function of the test object and are related to the test results shall be in normal operation.

All relevant main contactors for discharge shall be closed (such as relevant relays in the battery system circuit).

8.2.15.3 The discharge process is as follows:

- a) The external discharge device shall be connected to the main terminals of the test object;
- b) The discharge shall be carried out at a stable current within the specified normal operating range in consultation with the battery system manufacturer.

8.2.15.4 The discharge shall continue until any of the following conditions are met, then the test is terminated:

- a) The test object automatically terminates the discharge current;
- b) The test object sends a signal to terminate the discharge current;
- c) When the automatic interruption function of the test object does not work, or there is no function described in a) of 8.2.15.4, the discharge shall continue until the test object is discharged to 25% of its rated voltage;
- d) The temperature of the test object is stable; the temperature change is less than $4\text{ }^{\circ}\text{C}$ within 2 hours.

8.2.15.5 After completing the above test steps, observe for 1 hour at the test environment temperature.

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