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**Reliability Test Methods of Drive Motor System for Electric
Vehicles**

电动汽车用驱动电机系统可靠性试验方法

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Reliability Test Methods of Drive Motor System for Electric Vehicles

1 Scope

This Document specifies the test conditions, test procedures, test methods, inspection and maintenance, arrangement of test results, reliability evaluation and test report for bench reliability tests of drive motor systems for electric vehicles.

This Document is applicable to the drive motor system for electric vehicles, and the vehicle motor system with only auxiliary drive function or power generation function shall be implemented as a reference.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in 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 Document.

GB/T 2900.13 Electrotechnical terminology - Dependability and quality of service

GB/T 18488.1 Drive motor system for electric vehicles - Part 1: Specification

GB/T 18488.2 Drive motor system for electric vehicles - Part 2: Test methods

GB/T 19596 Terminology of electric vehicles

QC/T 893 Failure Classification and Assessment of Electrical Machine System for Electric Vehicle

QC/T 1022-2015 Technical specification for reduction gearbox of battery electric passenger cars

3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB/T 2900.13, GB/T 18488.1, GB/T 19596 and QC/T 893 apply.

3.1 Rated voltage

The nominal voltage value of the DC bus declared by the manufacturer.

3.2 Continuous torque

Under the conditions specified by the manufacturer, the maximum mechanical torque that the drive motor system can work continuously for a long time.

3.3 Rated speed

Under the conditions specified by the manufacturer, the maximum speed at which the drive motor system can output continuous torque.

4 Test Conditions

4.1 General requirements

4.1.1 The device under test shall be a drive motor system that complies with the provisions of product technical documentation.

4.1.2 Unless otherwise specified, the test conditions shall meet the test preparation requirements specified in GB/T 18488.2.

4.2 Cooling

The cooling equipment or cooling conditions during the test shall meet the following requirements:

- For the air-cooled drive motor system, the air-cooled motor in the actual loading shall be included in the test process;
- For the natural-cooled drive motor system, an external fan can be added to cool the drive motor system;
- For the liquid-cooled or oil-cooled drive motor system, the coolant or lubricating oil specified by the manufacturer shall be used; and shall be replaced regularly during the test according to the manufacturer's provisions;
- The cooling conditions of the drive motor system shall simulate its actual use conditions in the vehicle. The model of the drive motor system cooling device, the type of coolant, the flow rate (or pressure) and the temperature shall be recorded in the test report.

5 Test Procedures

5.1 Preparation before the test

5.1.1 The connection line between the controller and the motor shall be consistent with the actual vehicle, and the monitoring system shall be installed at the same time. In order to ensure that the system can work normally, the necessary associated signals shall be simulated or shielded by other methods.

5.1.2 The working status of power supply, test bench and monitoring system shall be normal.

5.1.3 When the drive motor system under test includes a reducer, it shall be run-in according to the requirements of 6.2.3 in QC/T 1022-2015 or the manufacturer's provisions before the test; and the lubricating oil shall be replaced after the run-in.

5.1.4 When the drive motor system under test includes a reducer, the setting of the preliminary test of performance, performance retest and reliability test conditions shall be converted according to the reduction ratio of the reducer.

5.2 Preliminary test of the performance

The preliminary test of performance shall be conducted in accordance with the requirements of GB/T 18488.2 for insulation resistance test, peak torque test at rated speed and maximum operating speed.

5.3 Reliability test

The reliability test shall be carried out in accordance with the provisions of Clause 6.

5.4 Performance retest

After the reliability test is completed, perform a performance retest in accordance with the provisions of 5.2.

6 Test Methods

6.1 Test sample

The reliability test in this Document consists of two parts, as shown in Table 1, and each part shall be tested with separate samples a and b.

7 Inspection and Maintenance

7.1 General requirements

The inspection and maintenance shall be carried out in accordance with the requirements of 7.2~7.5; but the content and period may be appropriately increased or decreased; and the inspection results and maintenance conditions shall be recorded in detail.

7.2 Inspection at any time

7.2.1 Use fault diagnostic devices, instruments, and computers to monitor the operating data at any time. When the limit value is exceeded, an alarm or emergency shutdown will be issued, and handling will be carried out according to the severity of the fault. If it belongs to the failure of the drive motor system under test, it shall be regarded as a failure shutdown. Record downtime, reasons and handling of failures.

7.2.2 Monitor the running sound of the drive motor system under test. When there is obvious abnormal noise, stop the machine to check the fasteners, mechanical connectors and the state of the drive motor system under test; check and confirm the noise source; and judge whether to continue the test further according to the actual situations.

7.3 Inspection every hour

Record, in a timely manner within 1 hour, the torque and speed of the motor under test, the DC bus voltage and current of the motor controller, cooling conditions, and the operating temperature of the power components of the motor controller. If the motor is equipped with a temperature sensor, check the working temperature of the motor windings together; and observe and monitor through the temperature-time relationship curve. If the drive motor system under test includes a reducer, the oil temperature of the reducer shall also be monitored and must not exceed the maximum allowable temperature.

7.4 Inspection every 24 hours

7.4.1 It is allowed to stop for one time, inspect the test equipment, and check the fasteners, mechanical connectors and pipelines, especially the hoses; and check the connecting cables and interfaces.

7.4.2 Check the liquid level of the coolant, whether there is leakage in the cooling system circuit, etc., and replenish the coolant when there is a shortage of liquid.

7.4.3 The shutdown inspection time shall not exceed 1h at most.

7.5 Handling of failure and Shutdown

7.5.1 Record the reason and operation content of each shutdown.

10 Test Report

The test report shall at least include the following:

- a) foreword: explain the source of the test task;
- b) test basis;
- c) the purpose of the test;
- d) test object: indicate the main parameters of the drive motor system under test, and attach graphics, photos and necessary descriptions;
- e) test equipment and instruments: the name, manufacturer, model, accuracy and other basic parameters of the main equipment and instruments, as well as the effective date of calibration and the measurement position shall be stated;
- f) differences between test conditions and standards;
- g) test results:
 - 1) sorting out the original data should be represented by a curve, and important data can be listed;
 - 2) calculation results of reliability evaluation indicators;
 - 3) failure and maintenance statistics;
 - 4) adjustment and replacement records during the test;
 - 5) performance test results.
- h) conclusions and recommendations:
 - 1) describe the mode, type and number of failures;
 - 2) describe the mean time to first failure, the number of failure shutdowns and the mean time between failures;
 - 3) when necessary, according to the reliability test results, put forward suggestions for improvement and supplementary tests.
- i) test date.

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