GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW16937

Cell Charge Depleting Cycle Life for Rechargeable Energy Storage Systems

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard specifies the test procedure for evaluating the performance for Plug-in Hybrid Electric Vehicle (PHEV), Extended Range Electric Vehicle (EREV) and Electric Vehicle (EV) batteries that are used in a vehicle environment.

1.1.1 Cell Charge Depleting (CD) Cycle Life Test. This test shall be used to evaluate the ability to meet vehicle rechargeable energy storage systems (RESS) performance metrics. The cell CD cycle life test evaluates cell life using a charge depleting profile with relevant aging factors, i.e., energy throughput, temperature, power, state of charge (SOC) swing, appropriate to the vehicle targets. This test is also important to obtain reliable and significant data for battery life prediction.

1.2 Applicability. This standard applies to all RESS for passenger or commercial vehicles and trucks. General Motors shall approve all changes to the format and/or content of this test standard.

Hybrid controllers, battery disconnect units (BDU), and other internal electrical/electronic components are required to meet GMW3172.

1.3 Remarks. This document provides the standard technical requirements for PHEV, EREV and EV batteries. A program-specific technical specification that is used in conjunction with this document may include additional program-specific requirements that are not referenced in this document and may supercede any requirements included in this document. In the case of any conflicts between this document and the program-specific technical specification, the program-specific technical specification takes precedence.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

IEC 60068-2-14 ISO 16750-4

2.2 GM Standards/Specifications.

GMW3172

2.3 Additional References.

- CG2762 Default Test Parameters
- QF1009B
- Battery and/or Cell Manufacturer Specifications and/or DUT SSTS or CTS
- Customer Requests and/or Requirements, i.e., Test Request
- Program-specific Technical Specification

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3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Environment Chamber. Sized for DUT being tested

3.2.2 Voltage and Current Cycler.

3.2.3 Coolant Conditioner. Liquid cooled RESS only.

3.2.4 Fan. Air cooled RESS only.

3.2.5 Data Acquisition System (DAQ). Appropriate equipment is required to complete the test procedure defined in Section 4 to acquire and store all necessary data. Data must be recorded using appropriate software for the battery cycler in use. Data sources will include data measured by the battery cycler and any external process indicators, i.e., flow meters. There may be additional data sources.

3.2.6 Equipment Parameters. Unless stated otherwise, the information in Table 1: Equipment Parameters and Tolerances defines the minimum test equipment parameters and tolerances to be used for all testing.

Table 1: Equipment Parameters and Tolerances

Parameter	Range	Tolerance
Direct Current (DC) Voltage: Cell Level: Generate and Measure	0.25 V above maximum specified device under test (DUT) voltage. 0.25 V below minimum specified device under test (DUT) voltage. 0 V to 18 V	± 20 mV
DC Current: Cell Level: Generate and Measure	0 A to 5 A 5 A to 500 A	± 50 mA ± 1% of reading
DC Power: Cell Level: Generate and Measure	0 W to 90 W 90 W to 9000 W	± 1% of reading ± 1% of reading

3.3 Test Vehicle/Test Piece. All cell level RESS.

3.4 Test Time.

Calendar time:	See CG2762
Test time:	See CG2762
Coordination time:	See CG2762

3.5 Test Required Information. All limits imposed by the battery manufacturer shall be observed over the course of testing. Power, current, voltage, and temperature restrictions provided in written documentation by the manufacturer take precedence over any instructions given in this document.

3.6 Personnel/Skills. All personnel performing tests must have up to date training in a high voltage training program and be familiar with IEC 60068-2-14 and ISO 16750-4

3.7 Personal Protection Equipment (PPE). PPE, such as high voltage gloves, face shields, fire extinguishers, etc., shall be in good working order and available in the immediate area used in the execution of the testing.

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4 Procedure

4.1 Preparation. Soft-packaged prismatic cells must be tested under a minimum external pressure of 28 kPa (4 psig) and metal can prismatic cells must be tested under a minimum external pressure of 69 kPa (10 psig).

4.1.1 Additional customer requests or requirements must be provided in writing prior to start of test.

4.1.2 All devices under test (DUT) should be subjected to an initial inspection as defined by QF1009B.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless stated otherwise, the information in Table 2: Environmental Parameters and Tolerances defines the minimum test environment parameters and tolerances to be used for all testing. The test tolerances for temperature are ± 3 °C, or as defined by the requestor.

Table 2: Environmental Parameters and Tolerances

Parameter	Range	Tolerance
Temperature Sensor: Measure	-40 °C to 85 °C	± 3 °C
Chamber Temperature: Generate and Measure	-40 °C to 60 °C	± 3 °C
Chamber Humidity: Generate and Measure	20% to 80% Relative Humidity (RH)	± 5% RH
Lab Environment Temperature: Generate	25 °C	± 10 °C
Lab Environment Temperature: Measure	Not applicable	± 3 °C
Lab Environment Humidity: Measure	10% to 85% RH	± 5% RH

4.2.1.1 Unless otherwise specified by the test requestor, all testing should be conducted using environmental chambers and the humidity level should be set according to the requirements specified in Table 2: Environmental Parameters and Tolerances. The ambient temperature for the DUT should be maintained in accordance with manufacturer specifications.

4.2.1.2 Unless otherwise specified by the manufacturer, for cell level testing, if the temperature of the DUT is > 20 °C with respect to the ambient temperature, the test must immediately enter a safety rest mode until the difference in temperature is < 5 °C, and then continue. If the rest mode exceeds 1 h, halt test.

4.2.1.3 Thermocouple locations on a cell. See Figure 1 for Thermistor Location Examples

4.2.1.3.1 Test Requester must discuss thermocouple locations on cells with a team that should at least include a representative from the Test Lab and from Design. The Team must determine the optimal locations that will provide input to confirm any thermal analysis and for definition of thermistor locations for RESS testing.

4.2.1.3.2 For cell level testing, a thermocouple must be placed in the center of the largest exposed area of the cell (Figure 1). At least one thermocouple must be placed in the area near the terminals. In addition, thermocouples should be placed near the location that the thermistor will be placed in the production design Cell Module.

4.2.1.3.3 If the cell is constrained in a compression fixture, the thermocouple should not be compressed within the fixture. In this case, a thermocouple must be placed near the positive terminal and if the terminals are side by side, the thermocouple must be placed in an area near either terminal. Caution must be taken if the thermocouple is place between adjacent electrodes. Another thermocouple must be placed nearby the cell to monitor environmental temperature.

4.2.1.3.4 At least one cell should be tested with thermocouples in multiple locations to determine the propagation of thermal energy across the surface of the cell.

4.2.1.3.5 To improve the fidelity of the thermal reading from the thermocouple, add either a second layer over the Kapton tape (a polyimide film) used to hold the thermocouple in place, or any other type of thermal tape.

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