



Cell Spring Rate Determination 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 Hybrid Electric Vehicle (HEV), 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 Spring Rate Determination for Soft Packaged Cells. This test shall be used to describe the procedure to generate the spring rate (stress-strain curve) of a soft-packaged prismatic automotive battery cell pouch that is substantially flat, i.e., rectangular solid with low height. The stress-strain curve of soft-packaged prismatic automotive battery cells is a necessary input in the design of automotive battery packs. Automotive battery packs have a mechanical structure that constrains these cells for the life of the pack. In particular, the structure provides the initial compression needed for proper cell functioning and the mechanical strength to hold the battery pack together as the cell thickness increases over cell life due to various degradation mechanisms. The design process of this mechanical structure relies on finite element modeling of the mechanical stresses in the battery pack. The stress-strain curve of the cell is a key input in this modeling process.

1.2 Applicability. This standard applies to all Rechargeable Energy Storage Systems (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 HEV, 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.

None

2.2 GM Standards/Specifications.

GMW3172

2.3 Additional References.

CG2762 Default Test Parameters

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3 Resources

3.1 Facilities. The test facilities and equipment shall be in good working order and shall have valid calibration. 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.

3.1.1 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. 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 methods. Data sources will include the items shown in Table 1. There may be additional data sources.

Table 1: Equipment Description and Specification

Description	Specification
Material Testing Machine with Automatic Drive and Data Acquisition Software	Electro-mechanical drive, minimum capacity 25 kN
Compression Load Cell	Compatible with Material Testing Machine. Maximum range 25 kN, linear response error < 0.5% of range
Compression Platen with Ball and Socket Joint	Capable of attaching under Load Cell
Linear Variable Differential Transducer (LVDT)	Quantity four (4), minimum range 5 mm, accuracy 0.001 mm
Compression Test Fixture	Two (2) flat plates (25 mm thick approximate), bottom plate with a post in each corner so that the top plate will slide up and down on linear bearings. Plate area large enough to cover entire test piece surface. One (1) LVDT insertion hole with retention screw near each corner of the top plate. The holes should be sufficiently wide apart and not interfere with test piece.
Zero Plate	Gage plate, similar to test piece size, flatness within 0.025 mm
Test Standard	Similar to test piece size, approximate compressive modulus 100 MPa

3.3 Test Vehicle/Test Piece. Prismatic soft packaged cells will be used as test pieces. Each test piece will have its cell tabs taped up with electrical insulating tape to prevent electrical shorting. The cell pouch should not contain gases which could cause the pouch seal to rupture and allow the internal gases to vent during the compression part of this standard. The presence of gas inside the cell pouch will be evident from the presence of bubbles under the surface of the cell pouch and will also be evidenced by looseness of the cell pouch content. If there are questions about the presence of gases, contact the cell Design Release Engineer (DRE) or cell manufacturer.

3.4 Test 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.

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3.6 Personnel/Skills. All personnel performing tests must have up-to-date training records in a high voltage training program. In addition, the following skills are needed:

- Material Testing Machine operation
- Data Acquisition Software operation

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.

4 Procedure

4.1 Preparation.

4.1.1 The test fixture plates used to hold the cells must be selected (material type and thickness) such that they will not deflect more than 0.1 mm with an applied pressure of 500 kPa over the electrode stack area. Twenty-five (25) mm thick aluminum (Al) plates are recommended.

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

4.1.3 All Devices Under Test (DUT) should be subjected to an initial inspection, as defined by the requestor.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless stated otherwise, the information in Table 2 defines the minimum test environment parameters and tolerances to be used for all testing. Meanwhile, the ambient environment for the DUT should be maintained in accordance with manufacturer specifications.

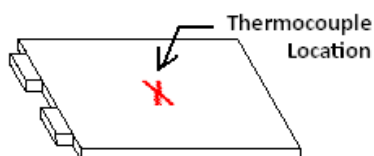
Table 2: Environmental Parameters and Tolerances

Parameter	Value	Tolerance
Lab Environment Temperature – Measure	25 °C	± 10 °C

4.2.1.1. Unless otherwise specified by the manufacturer, for cell level testing, if the change in temperature of the DUT reaches more than 20 °C with respect to the environment, the test must immediately enter a rest mode until the change in temperature of the DUT is less than 5 °C, with respect to the environment, and then continue. If the rest mode exceeds 1 h, halt test.

4.2.1.2 For cell level testing, temperature readings can be taken before and after the test (optional) with a thermocouple placed in the center of the largest exposed area of the cell (Figure 1). All thermocouples must be removed during the test when the cell is placed in a compression fixture.

Figure 1: Example of Thermocouple Location on a Cell



4.2.1.3 Cell Level DUTs. This test can be performed in the laboratory environmental conditions.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM department prior to the start of delivery of production level components or materials.

4.2.2.2 Any change to the component or material, e.g., design, function, properties, manufacturing process, and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier

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