



Rechargeable Energy Storage Systems (RESS) Pressure Variation at Temperature (PVT) Test Procedure

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. The purpose of this standard is to evaluate the sealing capability of Rechargeable Energy Storage System (RESS) coolant hose connections and evaluate individual components of the hose connections by subjecting coolant hoses and their attachments to a thermal aging process and a pressure cycle.

1.2 Applicability. This standard applies to all liquid cooled RESS for passenger or commercial vehicles and trucks.

1.3 Remarks. This standard describes methods for evaluating RESS liquid cooled systems in their intended subsystem assembly using coolant as a circulating medium. Test fixtures are cycled through hot and cold temperature extremes with varying pressure for 10 cycles. The performance measure is determined by test completion with zero leakage (successful test). See also GMW16390.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW16390

2.3 Additional References.

- Battery Specifications and/or Device Under Test (DUT) Subsystem Technical Specification (SSTS) or Component Technical Specification (CTS)
- Customer Requests and/or Requirements, i.e., Test Request
- Program Specific Technical Specification

3 Resources

3.1 Facilities. A complete Pressure Variation at Temperature (PVT) facility to enclose the coolant joints and related fixtures. The system employed coolant system should consist of a "closed loop" system. The facility shall include but is not limited to the equipment listed in 3.2.1 thru 3.2.8.

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 An environmental chamber capable of maintaining operating temperatures ranging from $-30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ to $+65\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($-22\text{ }^{\circ}\text{F} \pm 3\text{ }^{\circ}\text{F}$ to $+149\text{ }^{\circ}\text{F} \pm 3\text{ }^{\circ}\text{F}$).

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3.2.2 A variable displacement coolant circulation pump capable of flowing coolant through the hoses at a rate of 5.0 L/minute to 19.0 L/minute at laboratory ambient temperature.

3.2.3 The flow meter capable of measuring and operating within the pressure, temperature, and flow parameters outlined in Section 4 or the Customer Requests and/or Requirements, i.e., Test Request. **Note:** The flow meter shall be fitted in-line with the inlet of the RESS. The flow meter shall have an accuracy of ± 0.5 L/minute or lower of measured value.

3.2.4 A pressurization system capable of pressurizing the coolant at 0 kPa, 50% of the maximum pressure requirement, and 100% of the maximum pressure requirement defined in the Battery Specifications and/or Device Under Test (DUT) Subsystem Technical Specification (SSTS) or Component Technical Specification (CTS) or the Program Specific Technical Specification at a rate of approximately 8 kPa/s (1 psig/s) at laboratory ambient temperature. **Note:** Pressure transducers shall be fitted as close as possible to the coolant inlet and outlet ports of the RESS. The pressure transducers shall have an accuracy of $\pm 0.5\%$ or lower.

3.2.5 A coolant heater capable of heating the coolant to a maximum of $+65\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($+149\text{ }^{\circ}\text{F} \pm 3\text{ }^{\circ}\text{F}$).

3.2.6 A coolant chiller capable of chilling the coolant to a minimum of $-30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($-22\text{ }^{\circ}\text{F} \pm 3\text{ }^{\circ}\text{F}$).

3.2.7 An operating system (automatic or manual), with instrumentation, to control the test parameters listed in 3.2.1 through 3.2.6. **Note:** To obtain the required system pressures outlined in Section 4 or the Customer Requests and/or Requirements, i.e., Test Request, the coolant pressure must be controlled at the inlet of the DUT, as shown in Figure 1. To accomplish this, the chiller and/or test control system shall utilize a Proportional Integral Derivative (PID) control method. The chiller and/or test control system shall calculate an error value by comparing the pressure set point provided by the test script to the measured inlet pressure from the pressure transducer. The chiller output pressure shall then be varied to minimize the error value and obtain the correct inlet pressure.

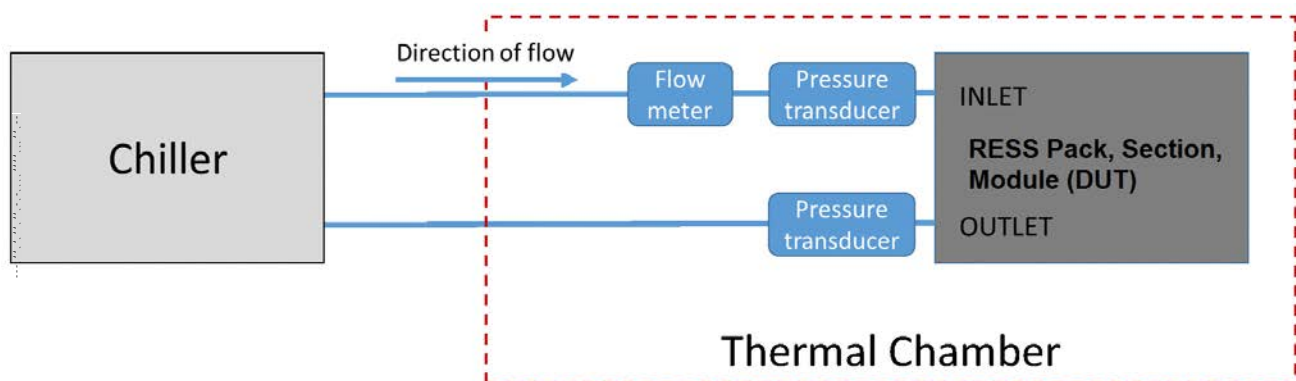


Figure 1: Schematic of PVT Test Setup

3.2.8 Miscellaneous fixtures, fasteners, manifolds, and other mounting provisions to accommodate the DUT.

3.2.9 Cameras, liquid detection sensors, etc. see 4.1.2, if applicable.

3.2.10 Air regulator and orifice or flow control valve. See 4.1.3.

3.3 Test Vehicle/Test Piece. Test material includes all hoses and attachments required to recreate/simulate the DUT in-RESS installation.

3.3.1 Hoses/Assemblies. Complete hoses or hose assemblies including clamps and/or quick connects. For validation testing, these should be certified hoses provided by the Hose Supplier, unless otherwise specified in the Customer Requests and/or Requirements, i.e., Test Request. For development testing, the Requestor should specify hose conditions required/allowed.

3.3.2 Attachments. All attaching hardware, including retaining clips, brackets, etc., which constrain hose movement.

3.3.3 Fittings. One set of fittings for each hose/assembly to be tested simultaneously in the chamber.

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3.3.4 Coolant. Coolant mixture should be 50% ethylene glycol and 50% distilled water by volume, or as defined in the Program Specific Technical Specification.

3.3.5 Lubricant. Some fittings may require lubrication, per direction from the Requestor. If required, apply the lubricant as specified by the Requestor, e.g., approximately 6 ml per fitting. Record the lubricant part number in the test report.

3.4 Test Time. Per sample.

Calendar time: 5 days/cycle

Test time: 80 h/cycle

Coordination time: 8 h

3.5 Test Required Information. All limits imposed by the Battery Specifications and/or DUT SSTs or CTS shall be observed over the course of testing. Power, current, voltage and temperature restrictions provided in the Battery Specifications and/or DUT SSTs or CTS take precedence over any instructions given in this standard.

3.6 Personnel/Skills. All personnel performing tests must have up to date training in a high voltage training program.

4 Procedure

4.1 Preparation.

4.1.1 Connect the RESS Pack, Section, Module (DUT) to the test equipment as shown in Figure 1.

4.1.2 Visually inspect all hoses for evidence of bloom, cuts/damage or residual oils or other residue from the manufacturing process. Record all observations. Discard any hoses that appear to be damaged and are not good candidates for use. If hoses and other sealing components are obstructed by covers or any other components, the obstructions must be moved or otherwise accommodated prior to start of testing. If this is unreasonable, alternatives such as cameras or liquid detection sensors may be used.

4.1.3 Pressure check the system at laboratory ambient temperature using an air regulator and orifice or flow control valve installed at the inlet of the DUT, upstream of the flow meter as follows:

- Ramp the pressure from 0 kPa to 150 kPa (0 psig to 15 psig) in 15 s.
- Ramp the pressure from 150 kPa (15 psig) to 50% of the maximum pressure requirement defined in the Battery Specifications and/or DUT SSTs or CTS or the Program Specific Technical Specification in 15 s.
- Ramp the pressure from 50% of the maximum pressure requirement to 100% of the maximum pressure requirement defined in the Battery Specifications and/or DUT SSTs or CTS or the Program Specific Technical Specification in 15 s.
- Hold the pressure 100% of the maximum pressure requirement for 15 s then release the pressure.

4.1.3.1 Examine the test setup for any of the following:

- Coolant leakage or seepage. Report pressure setting and amount of leakage (in drops/second).
- Hose movement. Report approximate amount of hose displacement (in millimeters).
- Separation of hose from fitting. Report hose and location where separation occurred.
- Any other observations or areas of potential concern.

4.1.3.2 Review pressure check results with the Requestor.

Note: If any parts are replaced or repaired, the pressure check described in 4.1.3 must be repeated.

4.2 Conditions.

4.2.1 Environmental Conditions. Ambient laboratory temperature and humidity.

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.

4.3 Instructions. Execute the eight (8) segments of the PVT cycle as described in 4.3.1 thru 4.3.8 and summarized in Table 1 and Figure 2 a total of ten (10) times. Monitor cameras, liquid detection sensors, etc. if applicable. Examine the test setup for any of the following:

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