



Rechargeable Energy Storage Systems (RESS) Seal Aging 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. This standard specifies procedure to subject a module or sections of a liquid cooled Rechargeable Energy Storage System (RESS) to thermal aging of the sealing components within the Device Under Test (DUT). This is a module or section level test, where heating and cooling rates are based off modules or sections, and not full battery packs.

Note: Packs can be used if applicable, but must be tested without the cover to allow proper thermal exposure to the module/section. This test is used to verify RESS seal integrity after thermal aging.

Note: Typically for liquid cooled packs, multiple modules are assembled together to build a section.

1.2 Applicability. This procedure applies to all liquid cooled RESS modules or sections for passenger cars or commercial vehicles and trucks. RESS Cooling Code Letter B (liquid cooled).

Note: This test is intended to be conducted at the module or section level instead of the pack level. A minimum of three (3) modules or sections shall be tested for validation. Battery packs without covers may be used under unique circumstances and approved by the Requestor.

1.3 Remarks. This test procedure utilizes thermal shocks, short thermal soaks, and extreme temperatures to thermal age the seals used in the liquid cooled RESS modules and sections. A typical example of a sealing material is Ethylene Propylene Diene Monomer (EPDM). These thermal shocks and soaks decrease the test time for thermal aging by accelerating the aging of the seal. This test procedure can be used for any seal material whose material properties fall within the test temperature range of -40 °C to 60 °C. See also GMW16390.

Note: Typical EPDM has Glass Transition (Tg) at -52.5 °C, peak performance at +31.4 °C, and gassing at +98.6 °C from Erich NETZSCH GmbH & Co. Holding KG, Uniform Resource Locator (URL) <https://www.netzsch-thermal-analysis.com/us/materials-applications>.

Note: To verify the amount of aging done on the tested seals, ASTM E1641 and ASTM E1877 are utilized to determine the seal material activation energy and relative thermal index which can be compared to untested/baseline seals to determine the amount of aging. The tested seals should have lower activation energy and a lower relative thermal index than the baseline seals.

2 References

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

2.1 External Standards/Specifications.

ASTM E1641 ASTM E1877

2.2 GM Standards/Specifications.

GMW16390

2.3 Additional References.

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

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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 Environmental Chamber. The required temperature range is -40 °C to 60 °C with an accuracy of ± 3 °C of the measured value. The chamber should have portholes for coolant hose and thermocouple exit.

3.2.2 Coolant Conditioner. A coolant conditioner with temperature capabilities between -10 °C to 40 °C with an accuracy of ± 3 °C of the measured value.

3.2.3 Coolant Pump (Optional). An auxiliary pump should be utilized to increase the flow rate into the section(s) if a large pressure drop is seen and the coolant conditioning unit is not capable of meeting the desired coolant flow rate. The auxiliary pump should be placed in the coolant inlet line, upstream of the bypass valve assembly.

3.2.4 Solenoid Directional Valves. Electrically controlled solenoid valves to create a coolant bypass loop and control coolant flow to the section(s). Valves shall have an operating range of -10 °C to 40 °C and a maximum operating pressure exceeding the expected maximum coolant system pressure.

3.2.5 Coolant System Fluorescent Tracer Dye. Tracer dye and Ultraviolet (UV) lighting/eyewear to help show coolant leaks.

3.2.6 Instrumentation

3.2.6.1 Pressure Transducers. To measure coolant pressure. The pressure transducers should be chosen based on the expected measurement value with an accuracy of $\pm 2\%$ of the measured value. The recommended range is 0 kPa to 310 kPa. The measured reading is recommended to fall between half and full transducer range to achieve better accuracy. The operating temperature range shall be -40 °C to 60 °C to allow installation in the environmental chamber and as close to the DUT as possible.

3.2.6.2 Flow Meter. To measure coolant flow to the section(s) under test. The flow meter shall be rated for coolant (ethylene glycol) and have an operating range of 0.2 L/minute to 25 L/minute in the temperature range of -10 °C to 40 °C and a maximum operating pressure exceeding the expected maximum coolant system pressure.

3.2.6.3 Thermocouples. Type K probe style thermocouples with ± 3 °C required accuracy. The recommended range is 0 °C to 100 °C.

3.2.7 Test Stand Controller and Data Logger. System for controlling test equipment and recording instrumentation data.

3.3 Test Vehicle/Test Piece. Liquid cooled RESS section.

3.4 Test Time.

Calendar time: 53 d

Test time: 1260 h

Coordination time: 40 h

3.5 Test Required Information. All limits imposed by the Battery and/or Cell Manufacturer Specifications and/or DUT Subsystem Technical Specification (SSTS) or Component Technical Specification (CTS) shall be observed over the course of testing. In the case of any power, current, voltage and temperature conflicts between this standard and the Battery and/or Cell Manufacturer Specifications and/or DUT SSTS or CTS, the Battery and/or Cell Manufacturer Specifications and/or DUT SSTS or CTS take precedence.

3.6 Personnel/Skills. All personnel performing tests must have up to date training in a high voltage training program and be familiar with coolant leak testing.

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.

4.1.1 Review the Customer Requests and/or Requirements, i.e., Test Request.

Note: This is to be provided in writing prior to the start of the test.

4.1.2 Review the applicable Battery and/or Cell Manufacturer Specifications and/or DUT SSTS or CTS and/or Program Specific Technical Specification conditions for test parameters.

4.1.3 Perform RESS section initial inspection as defined by the Test Requestor.

4.1.4 Test Setup.

4.1.4.1 Environmental Chamber Setup. There will be no electrical monitoring, therefore fully discharged prepared sections are preferable. Figure 1 shows an example test setup in the environmental chamber. The sections are connected by quick connects which are then attached to coolant hoses leading out of the chamber. The sections are elevated above the chamber floor so leaks can be detected. The chamber floor should be wiped clean of any residual coolant before the start of test. Fluorescent tracer dye can be added to the coolant and matting can be placed under the sections to help with leak detection.



Figure 1: Environmental Chamber Test Set-up Example using Battery Electric Vehicle (BEV) Sections

4.1.4.2 Cooling System Setup. A set of valves is required for coolant flow control. The valves will keep the coolant isolated from the sections during soak periods via a bypass loop. Three direction solenoid valves can be used to create the bypass loop, a bypass valve, an inlet valve, and an outlet valve. The inlet and outlet valve should be wired together so that they are simultaneously controlled. A diagram of the valves and instrumentation is shown in Figure 2. An example setup is shown in Figure 3 and Figure 4.

If the flow meter reading is sensitive to flow meter orientation, or, if the flow meter needs to be isolated from the RESS system, set the flow meter orientation and pipe length as required by the flow meter manufacturer. For operating flow rate, refer to the Battery and/or Cell Manufacturer Specifications and/or DUT SSTS or CTS and/or Program Specific Technical Specification. Set the upper and lower flow limits, and voltage output to be compatible with the data acquisition hardware and software used.

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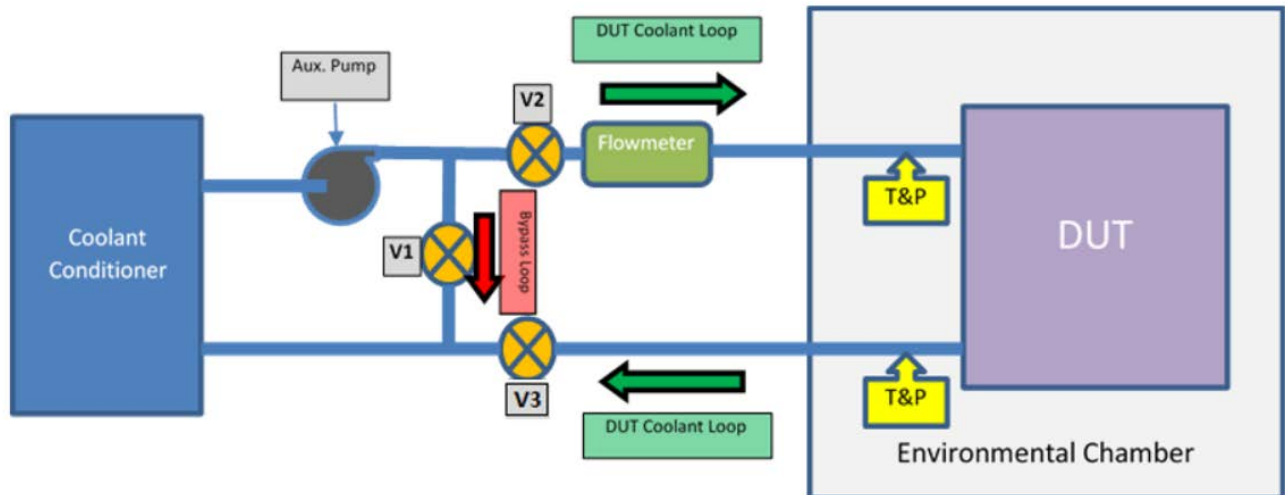
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Note: Aux. = Auxiliary, T&P = Temperature and Pressure (measuring location), V1 = Valve One (bypass valve), V2 = Valve Two (inlet valve), V3 = Valve Three (outlet valve).

Figure 2: Diagram of Valves and Instrumentation Setup

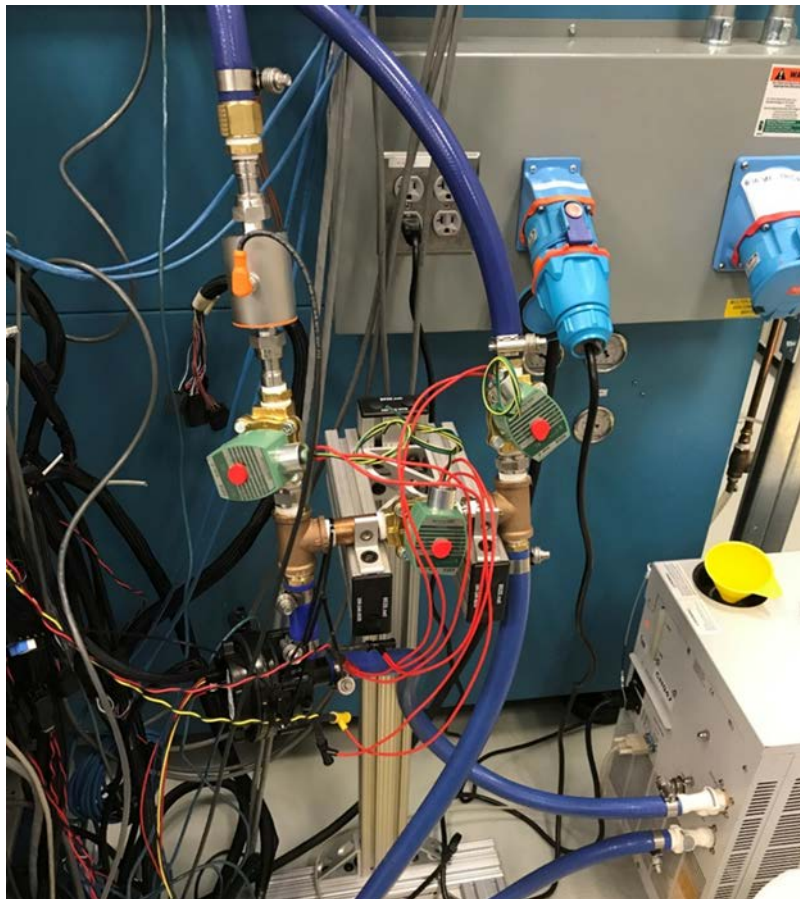


Figure 3: Cooling System Setup Example, Outside Chamber

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Figure 4: Cooling System Setup Example, Inside Chamber

4.1.4.3 Thermocouples. To monitor temperatures, thermocouples should be placed at the inlet and outlet of the section(s). Control coolant temperature to the target temperature set point.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless specified otherwise, the environment ranges and tolerances to be used for all testing are as shown in Table 1.

Table 1: Environmental Parameters and Tolerances

Parameter	Range	Tolerance
Chamber Temperature, Generate and Measure	-40 °C to 60 °C	± 3 °C
Chamber Humidity, Generate and Measure	Uncontrolled	Uncontrolled
Lab Environment Temperature, Measure	25 °C	± 10 °C
Lab Environment Humidity, Measure	10% to 85% Relative Humidity (RH)	± 5% RH
Coolant ^{Note 1}	-10 °C to 40 °C 0 kPa to 310 kPa 0.2 L/minute to 25 L/minute	± 3 °C ± 2% ± 2%

Note 1: As specified by the Test Requester

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.

4.3.1 Test Thermal Profile Description. This test procedure contains multiple steps that utilizes thermal soaks of -40 °C, -18 °C, 25 °C, 50 °C, and 60 °C and coolant cycling at -10 °C, 25 °C, and 40 °C. Figure 5 is an example of the first 4 days (96 h) of cycling during the first week. Table A1 in Appendix A is an example of the weekly profile will be repeated for a total test time of 7.5 weeks. The 7.5 weeks represent 15 years.

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