



Removable Roof Panel 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 procedure determines if a Removable Roof Panel (RRP) system meets the requirements as stated in the program specific Subsystem Technical Specifications (SSTS) or Component Technical Specification (CTS).

1.2 Applicability. This procedure applies to all passenger vehicles, Multipurpose Passenger Vehicles (MPV), and light duty trucks with a RRP.

1.3 Remarks. This document is the GM Worldwide Removable Roof Panel (RRP) Testing Standard. Its purpose is to establish a common test methodology for Removable Roof Panel (RRP) systems to ensure that a high quality world class system is consistently developed and produced. This is a living document and any suggestions or revisions will be reviewed and/or updated annually by the Roof Closure Global Subsystem Leadership Team (GSSLT).

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3059	GMW8518	GMW15308	GMW16300 (ID)
GMW3091	GMW14101 (ID)	GMW15332 (ID)	GMW16301 (ID)
GMW3172	GMW14284	GMW15443	GMW16302 (ID)
GMW3191	GMW14527	GMW15470 (ID)	GMW16303 (ID)
GMW3205	GMW14528	GMW15531	GMW16679
GMW3428	GMW14529 (ID)	GMW15576	GMW17039
GMW3600	GMW15016	GMW15730	GMW17145
GMW8463	GMW15264	GMW16185	

(ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References. The supplier shall work with the GM Design Responsible Engineer to comprehend these requirements.

- CG180 (ID) 5-Phase Document Template
- CG2999 (ID) Component Software Validation Requirements
- CG3000 (ID) Software Change Description Questionnaire Template
- Component EMc and ENvironmental Test Database (CEMENT)
- Component Technical Specification (CTS)
- Dimensional Technical Specifications (DTS)
- GM Research and Development Report AS-598 Hearing Acuity Standard for Squeak and Rattle Evaluators

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- GM Security Guidelines. (<https://gmweb.gm.com/HR/Security/Pages/FutureGuide.aspx>)
- GM1829 Analysis Development Validation Plan and Report (ADVP&R) which is located in the SSTs
- Subsystem Technical Specifications (SSTS)
- Vehicle Technical Specifications (VTS)

3 Resources

3.1 Facilities. Thermal Chamber large enough to minimally contain one (1) test buck the chamber should also meet the following:

- Temperature Range (-40 °C to +95 °C) and continuously adjustable
- Controlled humidity
- Recirculating air temperature cabinet
- Test room, suitable for the execution of the test
- Permissible temperature accuracy: ± 3 °C
- Explosion proof

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 A 9 V to 16 V power supply capable of 20 A.

3.2.2 Force gage with a minimum range of 0 N to 250 N. Suitable end effects to perform individual tests.

3.2.3 Load cell with minimum 1500 N capacities.

3.2.4 Stop watch.

3.2.5 Removable Roof Panel Holding Fixture. The fixture shall have provisions to attach to the RRP at the high stress points.

3.2.6 Digital camera.

3.2.7 Temperature measuring equipment.

3.2.8 Safety equipment.

3.2.9 Vehicle.

3.2.10 Vibration/Shock machine.

3.3 Test Vehicle/Test Piece.

3.3.1 Test samples shall be of production intent design and material for design validation (DV); or, production intent design and materials manufactured with production processes (home line) for product validation (PV). Any changes to the components or material, e.g., design, fit, form, function, properties, manufacturing process, and/or location of manufacture require revalidation. GM shall approve validation methods for product/process changes before the supplier is committed to the change. Refer to GMW3600.

3.3.2 Unless otherwise specified, three samples of components or systems shall be tested.

3.3.3 All components/systems used in testing shall be within drawing specifications and have supporting data prior to start of test.

3.4 Test Time. Test time varies for each procedure. See each procedure in 4.3 for more information.

3.5 Test Required Information.

3.5.1 Notification. GM Validation shall be notified of test failures within 24 h period of occurrence.

3.5.2 Five (5) Phase. Supplier to develop a five phase document for all test failures.

3.5.3 Product Security. Security protocol for the test vehicle must be followed per GM Security Guidelines.

3.6 Personnel/Skills. Prior experience in setting up and running similar tests. Experience in the use of the referenced test equipment.

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3.6.1 Sound Evaluators.

3.6.1.1 Hearing Requirements. It is recommended that all evaluators for customer actuated sound have a hearing test. Any professional hearing test is acceptable, but the following test is given as a reference: GM Research and Development Report AS-598, "Hearing Acuity Standard for Squeak and Rattle Evaluators."

3.6.1.2 Auditor Skill Level. Evaluators shall have completed 2 to 3 prior Customer Actuated Sounds (CAS) Vehicle Evaluations under the supervision of an experienced CAS Evaluator.

4 Procedure

4.1 Preparation.

4.1.1 Read the proper requirement from the SSTS.

4.1.2 Thoroughly read this GMW and any other associated GMWs.

4.1.3 Ensure that proper Personal Protection Equipment (PPE) is used during set up and testing.

4.1.4 Ensure that the materials are in compliance to GMW3059 and any regulatory requirements for country of sales.

4.1.5 Confirm Product Security Protocol for the vehicle tested by contacting the Vehicle Performance Manager (VPM). (Vehicles requiring camouflage, etc., must be carefully secured throughout the testing procedure so that no lapse in vehicle security occurs.)

4.2 Conditions. Deviations from the requirements of this standard shall have been agreed upon and approved by the GM Subsystem Validation Engineer (SVE) and Design Engineer (DE) and the supplier. Deviations shall be approved by the GM Validation Engineer and specified on the GM1829 Analysis Development and Validation Plan and Report and all effected test reports. The deviations to SSTS requirements shall be documented with the DE.

4.2.1 Environmental Conditions. Following are the default conditions:

- Ambient Temperature = $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.
- Humidity shall be 50% to 75% for all tests unless otherwise specified in the individual test procedure or in the program specific SSTS.
- $T_{\min}$ is $-40\text{ }^{\circ}\text{C}$ unless otherwise specified.
- $T_{\max}$ is $+85\text{ }^{\circ}\text{C}$ unless otherwise specified.
- Atmospheric pressure equivalent to the local barometric pressure (which is variable during any given day and from day to day).

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.

Following are the default conditions:

- Voltage: $V_{\text{nom}} \pm 0.3\text{ V}$ at motor terminals.

4.2.2.1 Unless otherwise specified, use a dynamic gun at 50 min^{-1} (rpm) to dynamically torque the fastener for all tests.

4.2.2.2 Part Orientation. Parts shall be tested in vehicle orientation unless otherwise specified.

4.2.2.3 Water Hardness. Verify that the hardness of the water does not exceed 205 mg/L (12 grains/gal). The water hardness certification may be obtained from the local water supplier. Otherwise, contractor shall obtain an equivalent certification or conduct such test within 60 d of beginning of compliance test run. A suitable water softener shall be used if required.

4.2.2.4 Emerging Market Environmental Conditions. Emerging markets are to use the following unless stated otherwise in the program specific SSTS.

- $T_{\min} = -20\text{ }^{\circ}\text{C}$ for India.
- $T_{\min} = -40\text{ }^{\circ}\text{C}$ for Russia.
- $T_{\min} = -15\text{ }^{\circ}\text{C}$ for South America only.

4.3 Instructions.

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4.3.1 Durability/Reliability. Unless stated otherwise in the program specific SSTs, one life of RRP operation shall be defined as 3760 total cycles of RRP operation under the following environmental conditions (see Table 1 and Figure 1). Segments may be run in any order. The body or test fixture shall soak for 4 h (minimum) in the environment before cycling starts in each new environmental segment.

Table 1: Removable Roof Panel Cycle and Environmental Conditions

Number of Cycles	Temperature	Relative Humidity
3200	23 °C ± 3 °C	30% to 50%
500	85 °C ± 3 °C	--
50	40 °C ± 3 °C	90% minimum
10	-5 °C ± 3 °C	--

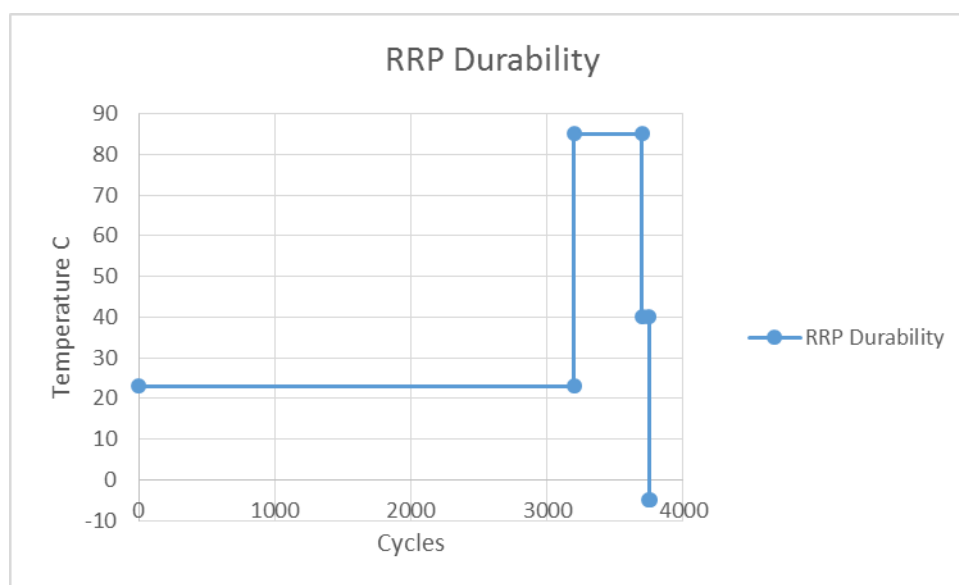


Figure 1: Removable Roof Panel Durability Profile

One cycle starts with the RRP installed and in the latched condition. The RRP is removed, as the customer would remove the panel, and stowed in the vehicle or in a fixture that simulates the vehicle environment. The RRP is then removed from the stowed position and reinstalled and latched to the vehicle. This constitutes one cycle. See Appendix A. An example of test schedule is provided in Figure 3 to meet an R95C50 requirement.

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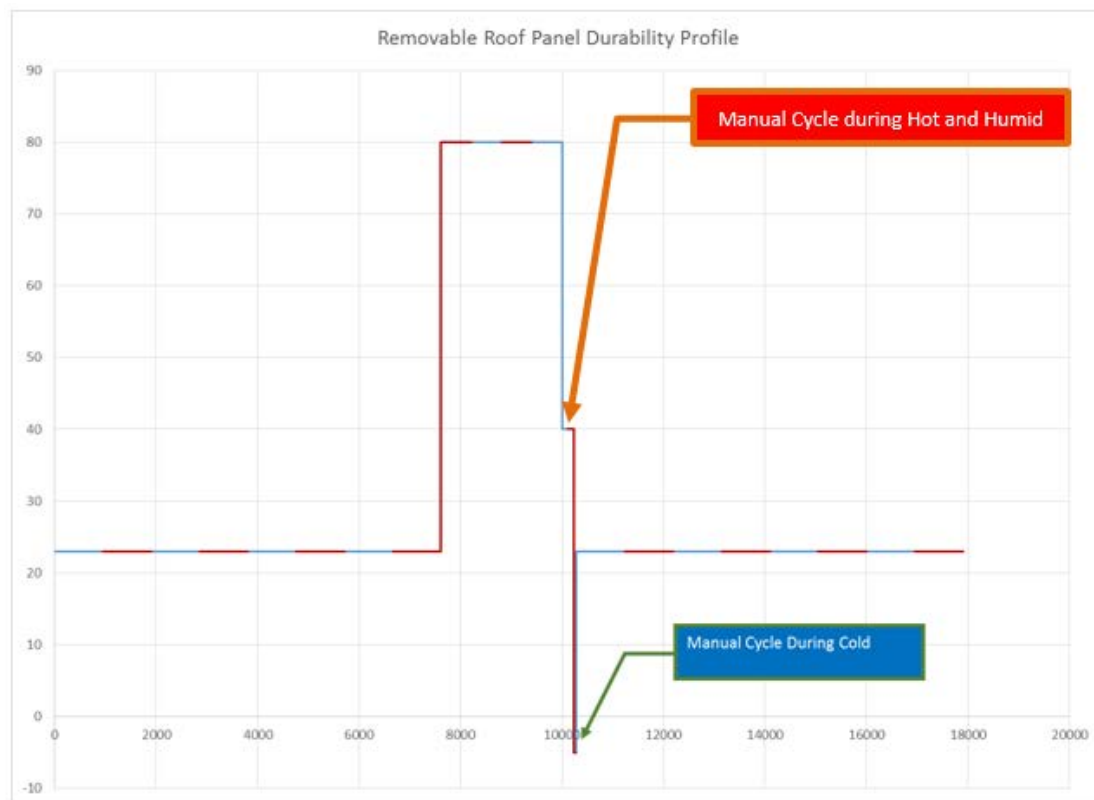


Figure 2: Durability Profile

Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop
23 C															
	952	1904		2856	3808		4760	5712		6664	7616				
0	952		1904	2856		3808	4760		5712	6664					
							</								

Figure 3: Durability Profile for R95C50

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4.3.1.1 Acceptance Criteria. Definition of failure during cycle testing:

Any of the following conditions constitute a failure during laboratory RRP durability cycle testing.

- a. Any disabled or deteriorated functions.
- b. Any broken or detached parts.
- c. Any visible cracks.
- d. Any operating efforts or latching characteristics that are outside of the specified limits.
- e. Any tears or customer-objectionable wear-marks.
- f. Movement in threaded fasteners. (Fastener position shall be marked after the fastener is installed before the start of test. Fastener position shall be audited during testing and rechecked at the end of test.)
- g. Any loss of alignment or loss of adjustment, which requires readjustment to restore normal function.
- h. Any damage to the tonneau panel, surrounding trim or body.

Premature wear or degradation shall be considered a failure. Functional surfaces are allowed to have gradual wear during the test. For example striker to handle wear is acceptable. Wear or degradation that is considered acceptable at the end of test, shall be considered a failure if it occurs early in testing.

4.3.2 Alternate Durability Testing.

4.3.2.1 Purpose. This is an alternate Durability Test (Refer to Figure 4 and Figure 5) when manual cycling cannot be done due to time or manpower concerns. This test breaks down the steps of the removal process into "components" (Refer to Figure 4). A combination of Component level testing, Vehicle Durability and Environmental Testing will be used to estimate a subsystem durability test. Alternate Testing MUST be approved by SMT and Validation.



Figure 4: Example of Breakdown of Removal Process

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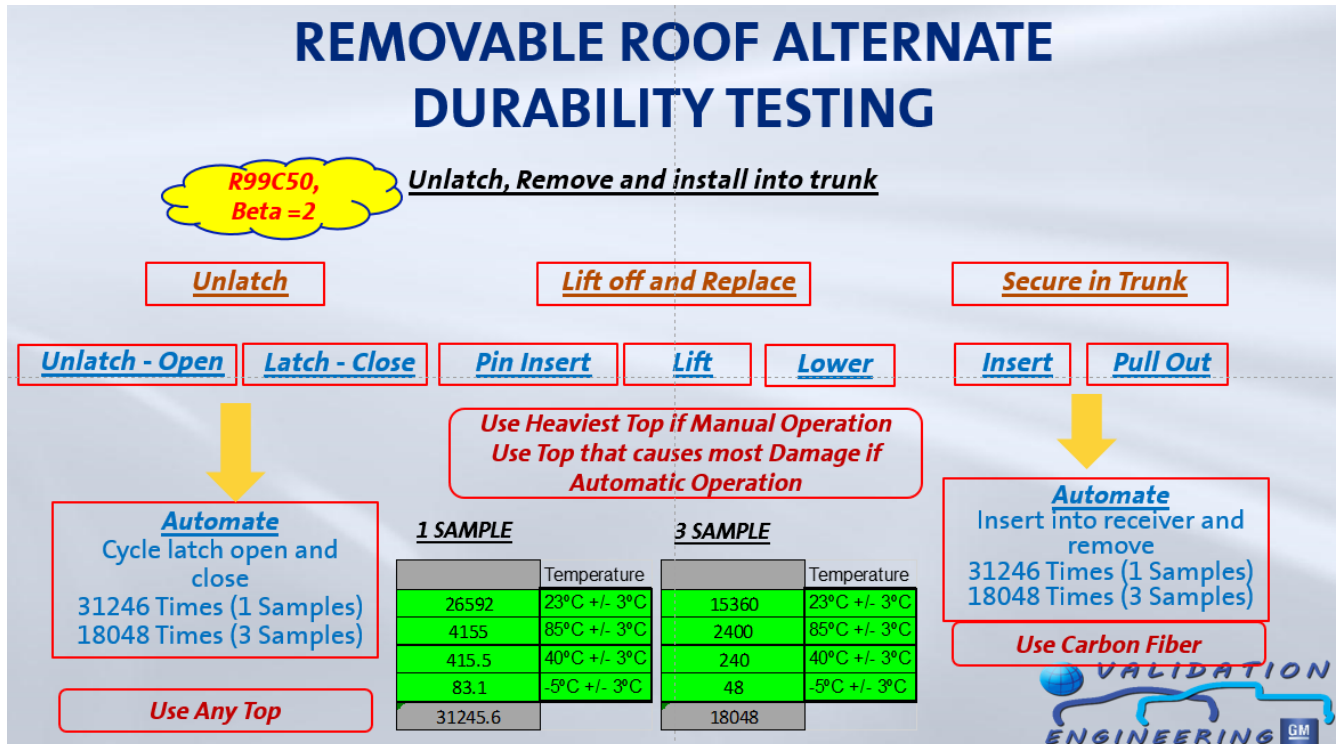


Figure 5: Example of Component Tests Required for Alternate Procedure

4.3.2.2 Test Equipment. Per 3.2.**4.3.2.2.1 Automation Equipment** for each component level test.**4.3.2.2.2 Force gage** with end effect.**4.3.2.3 Test Samples.** Per 3.3; 6 samples.**4.3.2.4 Test Preparation.** Per 4.1.**4.3.2.5 Test Conditions.** Per 4.2.**4.3.2.6 Test Procedure Stowage.**

4.3.2.6.1 Purpose. to ensure that when installing the RRP in its stowed position, the receivers will properly maintain the top long term.

4.3.2.6.2 Procedure.

4.3.2.6.2.1 Set up the test fixture with the pneumatic or similar piston to enable the stowage bracket to receive the RRP.

4.3.2.6.2.2 Using the profile provided in Figure 2 (or program specific profile), cycle the RRP into and out of the receivers. Ensure that the proper samples size and cycles are being used for the Reliability requirement.

4.3.2.7 Test Procedure - Lift Off and Reinstall.

4.3.2.7.1 Purpose. To ensure that after removal and reinstalling back to vehicle the top will meet program specific requirements.

4.3.2.7.2 Procedure. Evaluate this during the durability cycle. RRP is to be removed from the stowage area and placed on the vehicle.

4.3.2.7.3 Acceptance Criteria. Check program specific SSTs for acceptance criteria.

4.3.2.8 Test Procedure - Environmental.

4.3.2.8.1 Purpose. To ensure that after environmental exposure the top will meet program specific requirements.

4.3.2.8.2 Procedure.**GM Confidential**

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Note: The same tops shall be used for all the environmental testing and shall be the same top that does the durability.

4.3.2.8.2.1 Place the RRP and fixture in the thermal chamber.

4.3.2.8.2.2 Soak for 4 h at -30 °C or until top has reach temperature.

4.3.2.8.2.3 Manually cycle the top to meet the reliability and confidence requirement for the program.

4.3.2.8.2.4 Change the temperature to 40 °C and 95% humidity.

4.3.2.8.2.5 Soak for 4 h.

4.3.2.8.2.6 Manually cycle the top to meet the reliability and confidence requirement for the program.

4.3.2.8.2.7 Change temperature to 80 °C.

4.3.2.8.2.8 Soak for 4 h.

4.3.2.8.2.9 Manually cycle the top to meet the reliability and confidence requirement for the program.

4.3.2.8.3 Acceptance Criteria. Check program specific SSTs for acceptance criteria.

4.3.2.9 Test Procedure Durability Vehicles.

4.3.2.9.1 Purpose. To obtain "real" world cycling on the RRP.

4.3.2.9.2 Procedure. Confirm that the Durability Drivers can cycle the top on and off a minimum of 4 times per shift.

4.3.2.9.2.1 Drivers are to remove the top per the owner's manual instructions. If owner's manual is not available the Design Engineer (DE) or Validation Engineer (VE) shall provide proper technique for removing the top.

4.3.2.9.3 Acceptance Criteria. Check program specific SSTs for acceptance criteria.

4.3.2.10 Test Requirements. Must meet requirements from the program specific SSTs.

4.3.3 Latch System Requirements.

4.3.3.1 Purpose. This test is to verify that if the RRP latches meet the requirements in the program specific SSTs.

4.3.3.2 Test Equipment. Per 3.2.

4.3.3.2.1 Force gage with end effect.

4.3.3.3 Test Samples. Per 3.3; 6 samples.

4.3.3.4 Test Preparation. Per 4.1.

4.3.3.5 Test Conditions. Per 4.2.

4.3.3.6 Test Procedure.

4.3.3.6.1 Place the RRP in the holding fixture.

4.3.3.6.2 With the latch in the closed position, connect the force gage to the left handle at the middle of the hand grabbing surface.

4.3.3.6.3 Apply a constant increasing load until the latch disengages.

4.3.3.6.4 In the test report, record the peak force required to open the latch.

4.3.3.6.5 Apply a constant increasing load to close the latch.

4.3.3.6.6 In the test report, record the peak force to close the latch.

4.3.3.6.7 Calculate the average, standard deviation and maximum/minimum values.

4.3.3.6.8 Plot the test results.

4.3.3.6.9 Repeat 4.3.3.6.1 thru 4.3.3.6.8 for the right side.

4.3.3.7 Test Requirements. Per the program specific SSTs or CTS. The RRP latch must have an operating effort as specified in the program specific SSTs. Document test setup with photos. Document all test observations in the test report.

4.3.3.8 Apply the loads in Table 2.

4.3.3.8.1 Document the observations in the test report. The front latches shall meet the following performance requirements:

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- a. The latch system, including the handle, shall not release when subjected to a 40G acceleration in any direction. Friction shall not be included in the Computer Aided Engineering (CAE) model. Compliance to this requirement shall be demonstrated by CAE analysis. The mass of all latch components, including the latch handle mechanism shall be included in this analysis.
- b. The RRP latch shall withstand the following separating forces without loss of engagement of the latch to receiver or loss of attachment of the receivers to the body or the latches to the RRP.

Table 2: Removable Roof Panel Latch Loading Values

	Direction of Load	Static Load on Each Front of RRP Latch System	Static Load on the Rear Latch System
a.	+X	2.8 kN	3.5 kN
b.	$\pm Y$	1.63 kN	3.25 kN
c.	+Z	3.5 kN	7 kN

4.3.4 Hot Storage Testing.

4.3.4.1 Purpose. This test is to verify that if the RRP components are stored in a location which has high ambient temperatures it will not have any lasting effect on the RRP system's performance.

4.3.4.2 Test Equipment. Per 3.2.

4.3.4.3 Test Samples. Per 3.3; 3 samples.

4.3.4.4 Test Preparation. Per 4.1.

4.3.4.5 Test Conditions. Per 4.2.

4.3.4.5.1 Test Temperature. $90^{\circ}\text{C} \pm 3^{\circ}\text{C}$.

4.3.4.6 Test Procedure.

4.3.4.6.1 Place RRP components, as shipped to GM assembly plants, in an environmental chamber and set temperature to $90^{\circ}\text{C} \pm 3^{\circ}\text{C}$. Part orientation should represent shipping package orientation. Maintain temperature for 100 h.

4.3.4.6.2 Reduce temperature to $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ for 4 h to allow components to stabilize.

4.3.4.6.3 Examine parts for visible defects and fully assemble RRP and install on the fixture. Check the RRP for fit concerns and operating efforts.

4.3.4.7 Test Requirements. Per the program specific SSTS or CTS.

4.3.4.7.1 RRP shall meet the Dimensional Technical Specifications (DTS) fit requirements and handle operating efforts.

4.3.4.7.2 Document test setup with photos. Document all test observations in the test report.

4.3.5 Cold Storage Testing.

4.3.5.1 Purpose. This test is to verify that if the RRP components are stored in a location which has cold ambient temperatures it will not have any lasting effect on the RRP performance.

4.3.5.2 Test Equipment. Per 3.2.

4.3.5.3 Test Samples. From 3.3.

4.3.5.4 Test Preparation. Per 4.1.

4.3.5.5 Test Conditions. Per 4.2.

4.3.5.5.1 Test Temperature. $-40^{\circ}\text{C} \pm 3^{\circ}\text{C}$.

4.3.5.6 Place individual RRP components, as shipped to GM assembly plants, in an environmental chamber and set temperature to $-40^{\circ}\text{C} \pm 3^{\circ}\text{C}$. Part orientation should represent shipping package orientation.

Note: Maintain temperature for 100 h.

4.3.5.6.1 Increase temperature to $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ for 4 h to allow components to stabilize.

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