



Sunroof Drain Hose System Test Procedures

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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. Evaluation of the sunroof drain hose performance.

1.2 Applicability. This test procedure applies to all passenger vehicles with a sunroof module requiring drain hoses for water management. This applies to all sunroof systems as defined in the Vehicle Technical Specifications (VTS), Subsystem Technical Specification (SSTS), or Component Technical Specifications (CTS).

1.3 Remarks. This document is the GM Worldwide Sunroof Drain Hose Testing Standard. Its purpose is to establish a common test methodology for testing the Sunroof Module Drain Hoses 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 Sunroof Global Subsystem Leadership Team (GSSLT).

2 References

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

2.1 External Standards/Specifications.

ASTM D1044	ASTM D5374	ASTM D5423	ISO 12947
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2.2 GM Standards/Specifications.

GMW3059	GMW14125	GMW16443
GMW3600	GMW15760	GMW16740

2.3 Additional References.

- CG180 (ID) 5-Phase Document.
- GM Security Guidelines. <https://gmweb.gm.com/HR/Security/Pages/FutureGuide.aspx>.
- Program Specific Component Technical Specification (CTS).
- Subsystem Technical Specifications (SSTS).
- Vehicle Technical Specification (VTS).

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

3 Resources

3.1 Facilities. The test facilities shall be accredited to ISO/IEC standards or by the International Laboratory Accreditation Cooperation. However, all measuring variables as specified in this specification shall be determined correctly with respect to its physical definition.

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

3.1.1.1 All instrumentation is to be calibrated as required. Record instrumentation details and date of calibration on Appendix D, Data Sheet D1. If the information otherwise preserved in the testing laboratory records or corporate archives, then recording on Data Sheet D1 is not required.

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 Test fixture (representative of interfacing components/body) or vehicle body.

3.2.2 Hose routing in the body or fixture must be representative of the installed hose design position for the specific program.

3.2.3 Environmental/Thermal chamber with the following requirements:

- Temperature Range (-40 °C to +95 °C) and continuously adjustable.
- Controlled humidity.

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- Recirculating air temperature cabinet.
- Test room, suitable for the execution of the test.
- Permissible temperature accuracy: $\pm 3\text{ }^{\circ}\text{C}$.
- Explosion proof.

3.2.4 Vibration table.

3.2.5 Permanent marker.

3.2.6 Instron or similar tensile machine with the following:

- Load Capacity of 250 N.
- Speed Range of 50 mm/minute to 100 mm/minute.
- Test Area suitable for the required tests.

3.2.7 Force gauge.

3.2.8 Digital camera.

3.2.9 Scale or calipers.

3.2.10 Test samples.

3.2.11 Suitable saw or shears for preparation of test pieces.

3.2.12 Ovens. Unless otherwise specified, when an oven is required, it shall be a hot air oven. The oven type shall either be a forced air or mechanical convection. See Figure 1. The air shall enter the oven in such a way that it flows over the surface of the test pieces and exits near the top of the oven. The oven shall have not less than eight (8) and not more than 20 complete air changes per hour at the specified ageing temperature. See ASTM D5423 and ASTM D5374 for temperature uniformity and air exchange measurements.

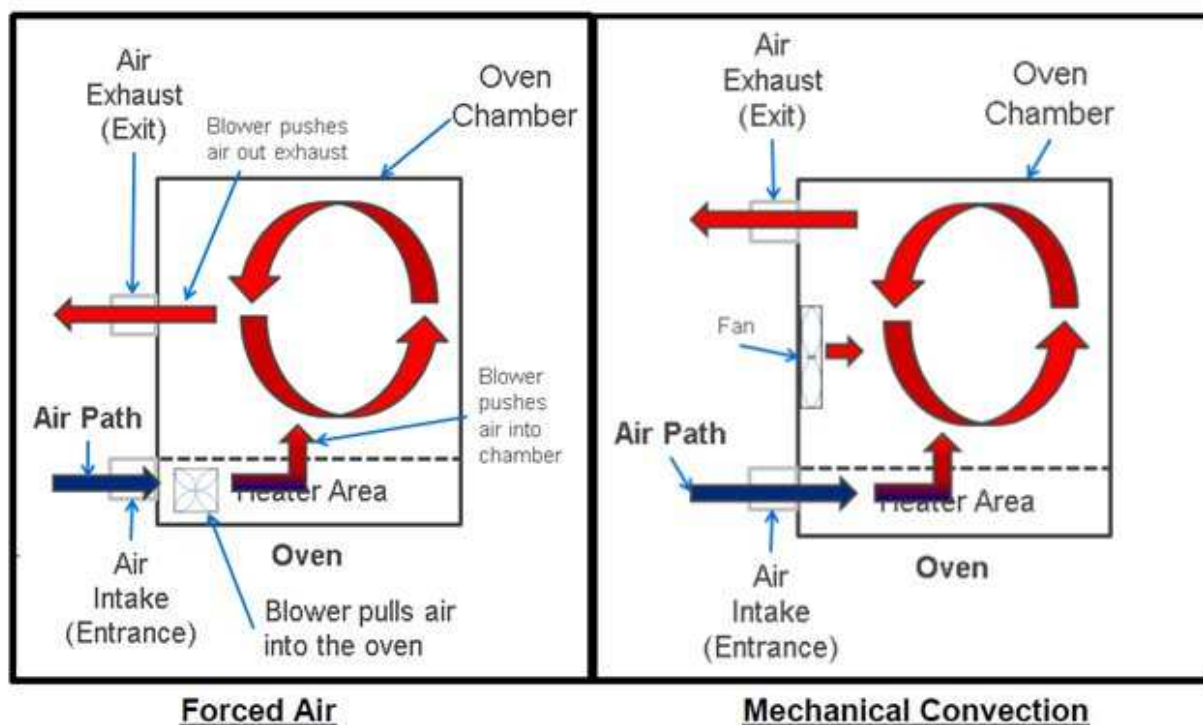


Figure 1: Ovens

3.3 Test Vehicle/Test Piece. 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

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validation methods for product/process changes before the supplier is committed to the change. Refer to GMW3600.

When more than one test is conducted on the same sample, the test sequence shall be clearly recorded in the test report or record of testing. It should be noted that if more than one test is conducted on the same sample, earlier tests can influence the results of subsequent tests. Also, if a sample fails when it has been subjected to more than one test, a direct comparison with single testing is not possible.

3.3.1 Material. The required material quality of the drain hoses is also designated by the relevant material specifications in the drawing.

3.3.2 Unless otherwise specified, three (3) 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.

3.3.4 All test samples are to be individually marked using a unique numbering system.

3.3.5 All test samples are to have a Bill of Materials (BOM). The BOM is to identify all release levels of the components in the test samples.

3.3.6 All test samples shall have dimensional data and all quality issues identified prior to conducting any testing or evaluation.

3.3.7 All test samples are to be selected using GMW15760 Multivariable Sample Selection.

3.4 Test Time.

Calendar time:	See specific tests in 4.3 for total individual test times.
Test time:	See specific tests in 4.3 for individual test times.
Coordination time:	See specific tests in 4.3 for individual test coordination times.

3.5 Test Required Information. Requirements from the SSTs or respective specifications are necessary in order to execute test methods in this document (see Appendix A, Table A1 and Table A2 for a list of variables required).

Note: Equipment and test sample detail is included in Section 4 of this document.

3.5.1 Notification. GM Validation is to be notified of test failures within a 24 h period of occurrence.

3.5.2 Five (5) Phase. Supplier to develop a 5-Phase Document (CG180) for all test failures. The Five Phase document shall be submitted within 48 h of test failure.

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

3.6 Personnel/Skills. The test facility shall have sufficient personnel having the necessary education, training, technical knowledge, and experience for performing the required tests.

3.6.1 Prior experience in setting up and running similar tests. Experience in the use of the referenced test equipment.

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/standards.

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.)

4.1.6 Ensure that ALL components are at the proper release level and signed off by the Design Engineer (DE) and Subsystem Validation Engineer (SVE) prior to testing.

4.1.7 Ensure that the fixture is in proper working order – proper representation of the body, no damage from previous test.

4.1.8 Ensure that all equipment is in proper working order, equipment is calibrated, counters are working properly.

4.1.9 Document environmental conditions (temperature, humidity, time and date), before start, during and end of test.

4.1.10 Fixtures. Unless otherwise specified, mount the test sample on a fixture of welded construction designed to place the test sample in its vehicle orientation. Mount with the production attachment strategy or, equivalent. Locating features and body metal interface must be represented in the fixture design. Position the fixture retention points to the test base such that the fixture can be removed without removing the sunroof. The GM Validation Engineer and GM Designing Engineer shall approve the design.

4.1.11 Test Samples. All test samples shall be design intent and meet all functional and dimensional requirements. Samples must have all design intent components that might affect performance. These include clips, grommets, connectors, hoses, sunroof spouts (or representation), etc. Preliminary tests may need to be made to evaluate whether a particular component may be worst case, e.g., connectors. The GM Validation Engineer and GM Designing Engineer shall approve any exceptions prior to the start of testing.

4.2 Conditions. Conditions are according to the relevant test procedure. All conditions specified shall be targeted toward the specified value with any given tolerance ($\pm$) used to compensate for variation. During testing, conditions specified shall not be adjusted within the tolerance unless it is to maintain the particular test condition within the specified tolerance. If such an adjustment is made, it shall be approved by the applicable GM engineer prior to the start of any testing. Unless otherwise specified, perform tests in the as received condition without special preconditioning. See Appendix A for condition definitions.

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). Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.1 Environmental Conditions.

4.2.1.1 Temperature and Voltage Definitions. Symbol definitions required for test methods contained in this procedure are listed in Appendix A, Table A1. Actual requirement values for the symbols shall be obtained from the Subsystem Technical Specification (SSTS) or the respective specification and recorded on Appendix A, Table A3. If not otherwise specified, tests shall be performed at $T_{room} = 23 \pm 3$ °C. If various temperature ranges for the tests are specified, the procedure shall be constructed, if not otherwise specified, in a way that all tests shall be performed first at $T_{room} = 23 \pm 3$ °C, then at high temperature and lastly at low temperature. If not specified, the test parameter for relative humidity (RH) shall be set at $50 \pm 5\%$ and voltage set to U_{nom} .

4.2.1.2 System Performance Conditions. Symbol definitions required for test methods contained in this procedure are listed in Appendix A, Table A2. Actual requirement values for the symbols shall be obtained from the SSTS or the respective specification and recorded on Appendix A, Table A3.

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 Drain Hose Environmental Test Procedure.

4.3.1.1 Purpose. To verify the drain hose performs under environmental conditions and there is no movement in the drain hose connections.

4.3.1.2 Equipment.

4.3.1.2.1 Environmental chamber.

4.3.1.2.2 Instron or force gauge.

4.3.1.2.3 Vibration table.

4.3.1.2.4 Holding fixture.

4.3.1.3 Samples. All tests require 6 samples unless otherwise specified in the program specific SSTS. GMW15760 is to be used to select test samples.

4.3.1.4 Test Time.

Calendar time:	8 d
Test time:	192 h

Coordination time:	4 h
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4.3.1.5 Test Preparation. See 4.1.

4.3.1.6 Test Conditions. See 4.2.

4.3.1.7 Procedure.

4.3.1.7.1 The drain hoses are to be installed in the fixture/body in the design position.

4.3.1.7.2 The insertion force should be recorded at this point. Also, three additional samples should be run to measure the retention force of the connector and meets program requirements.

4.3.1.7.3 Document the average, minimum, maximum and standard deviation of the insertion and extraction forces.

4.3.1.7.4 Once installed, the drain hoses are to be marked with a permanent marker. These marks are to be added to all points that are being inspected. Reference points should be established with GM Engineering before testing to identify growth or shrinkage of the hose under environmental conditions.

4.3.1.7.5 The test fixture/body shall be placed in the environmental chamber and cycled to the prescribed test procedure in Appendix B, Table B1. This test is to be run, with each design iteration, which represents a sample.

4.3.1.7.6 Document the test setup with either a photograph or video.

4.3.1.7.7 Document any changes at each step of Appendix B, Table B1.

4.3.1.7.8 After the test, run water through the drain hose system with the exit blocked. Look for water leaks.

4.3.1.7.9 Place the test setup on a vibration table.

4.3.1.7.10 Place the test setup in environmental chamber.

4.3.1.7.11 Set the thermal chamber to the temperature profile in Appendix B, Table B1.

4.3.1.7.12 Run the vibration profile based on vehicle specific loading conditions. Use Table 1 as the default if GM does not specify a program specific profile.

Table 1: Random Vibration Power Spectral Density (PSD)

	Car (1.12G)	Truck/SUV (1.66G)
Frequency	G ² /Hz	G ² /Hz
10	0.021084	0.046446
20	0.000680	0.001498
30	0.122422	0.269688
70	0.001506	0.003317
113	0.001266	0.002790
204	0.000001	0.000001

4.3.1.7.13 Document all observations in the test report.

4.3.1.7.14 After the test run water through the drain hose system with the exit blocked. Check for water leaks.

Note: This procedure is to be run statically **and** under road load inputs (provided by GM).

4.3.1.8 Test Requirements or Acceptance Criteria.

- The measured values must correspond to the requirements of the program specific SSTS or the respective specification.
- There shall be no water leaks after the test.
- No damage to the drain hoses.

4.3.2 Drain Hose Retention and Installation Tests.

4.3.2.1 Purpose. To verify the mechanical retention and removal force of drain hoses in the sunroof module system meets program specific requirements.

4.3.2.2 Equipment. Test setup capable of applying axial pull forces and push forces to the drain hoses; shall be used for measurement at T_{min} and T_{HT} . The test setup shall be approved by the GM Validation Engineer and specified on the test reports.

4.3.2.2.1 Tension/compression test bench with holding fixture. A portable test bench utilizing a handheld force gauge may be required to test to environmental extremes.

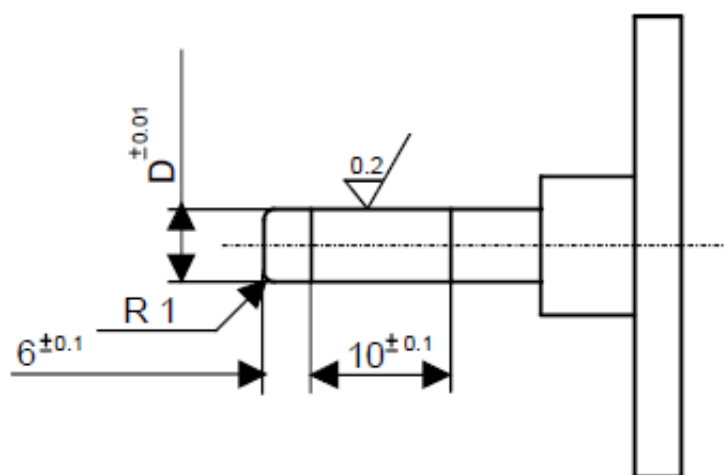
Note If a force gauge is used the sample size must be doubled.

4.3.2.2.2 Load adapter, 100 N.

4.3.2.2.3 Digital or video camera.

4.3.2.2.4 Load adapter to pull drain hose.

4.3.2.2.5 Steel mandrel of appropriate diameter for testing push-on force, as shown in Figure 2.



D = Inside hose diameter +1.0 mm.
Mean roughness value $R_a = 0.2 \mu\text{m}$.
Maximum roughness value $R_{max} = 1.0 \mu\text{m}$.

Figure 2: Mandrel for Push-on Force

4.3.2.3 Sample Size. Six (6) hose samples at each drain spout, at each temperature shall be tested. GMW15760 is to be used to select test samples.

4.3.2.4 Test Time.

Calendar time:	1 d
Test time:	6 h
Coordination time:	2 h

4.3.2.5 Test Preparation. See 4.1.

4.3.2.6 Test Conditions. See 4.2.

4.3.2.7 Procedure.

4.3.2.7.1 Cut the sunroof module frame into multiple sections, each to contain a water drain spout, to install in the test bench.

4.3.2.7.2 Cut drain hose test samples. The drain hose sections used to determine push-on force shall have a length of 60 mm, and those used to determine pull-off force shall have a length of 100 mm. Measure and record the drain hose diameters in the test report.

4.3.2.7.3 Mount a sunroof module frame section with drain spout in the test equipment examples in Figure 3 at T_{room} (ambient); with drain hoses not attached. Dwell for 60 minutes allowing frame section and drain hose samples to stabilize.

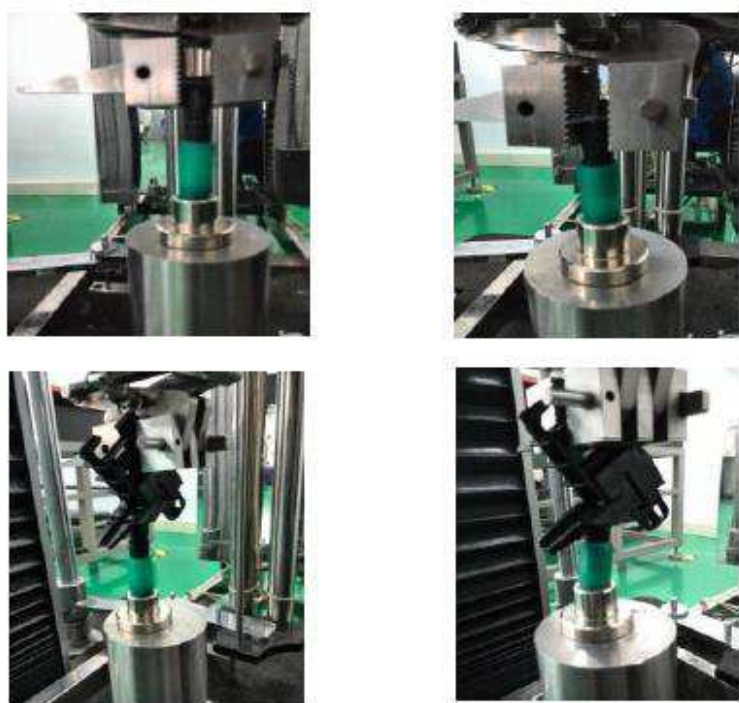


Figure 3: Example of Test Equipment

4.3.2.7.4 Mount one 60 mm section of hose, by hand, 5 mm onto the water spout of the sunroof module frame section. Ensure that the drain hose has been properly aligned.

4.3.2.7.5 Using the force gauge or other bench compression device with mandrel attached, push the hose section on to the spout an additional 10 mm at a speed of 25 mm/minute $\pm$ 5 mm/minute. Hose shall be pushed axially in line with the spout (see Figure 4). The maximum force shall be measured and recorded in the test report.

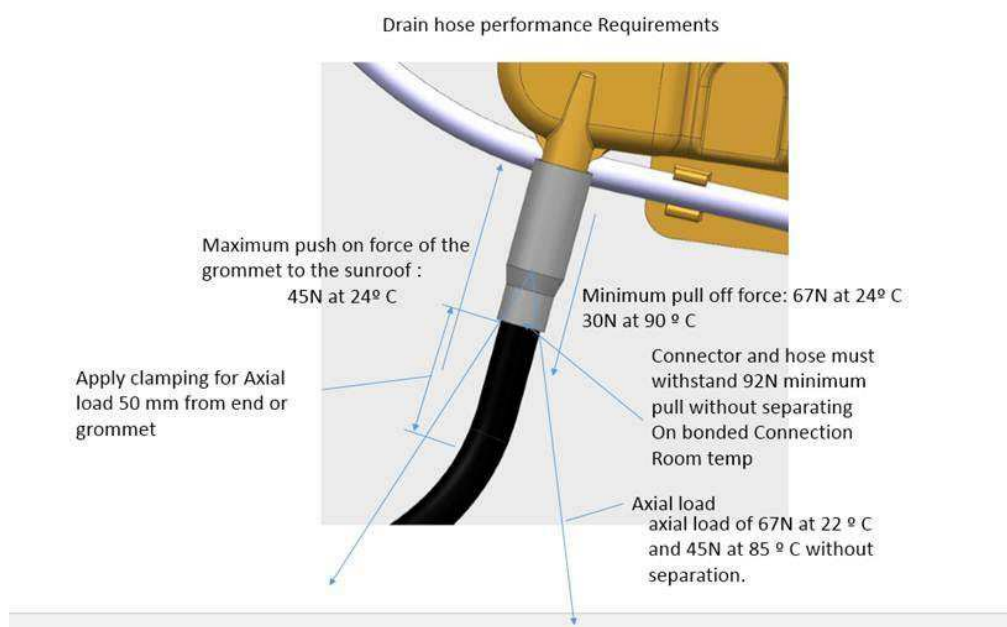


Figure 4: Drain Hose Test Loading Conditions

4.3.2.7.6 Repeat 4.3.2.7.3 thru 4.3.2.7.5 using 5 new drain hose samples.

4.3.2.7.7 At T_{room} , mount one 100 mm section of hose, by hand, 20 mm onto the water spout of the sunroof module frame section or to the fully installed design position if it is < 20 mm.

4.3.2.7.8 Using the force gauge or other bench tension device with force adapter attached, remove the hose section from the spout at a speed of 100 mm/minute $\pm$ 10 mm/minute. The direction of pull shall be kept axial to the drain spout throughout the range of travel. The maximum force shall be measured and recorded in the test report.

4.3.2.7.9 Repeat 4.3.2.7.7 thru 4.3.2.7.8 using 5 new hose samples.

4.3.2.7.10 Repeat 4.3.2.7.3 thru 4.3.2.7.9 as required for each of the remaining sunroof module frame sections, at T_{room} . Example: First test is with front right, then complete front left, rear left then rear right.

4.3.2.7.11 Mount a sunroof module frame section with drain spout in the test equipment at T_{HT} ; with drain hoses not attached. Dwell for 60 minutes allowing parts to stabilize.

4.3.2.7.12 Mount one 100 mm section of hose, by hand, 20 mm onto the water spout of the sunroof module frame section or to the fully installed design position if it is < 20 mm.

4.3.2.7.13 Using the force gauge or other bench compression device, remove the drain hose section from the spout at a speed of 100 mm/minute $\pm$ 10 mm/minute. The direction of pull shall be kept axial (refer to Figure 4) to the drain spout throughout the range of travel (refer to Figure 5). The maximum force shall be measured and recorded in the test report.

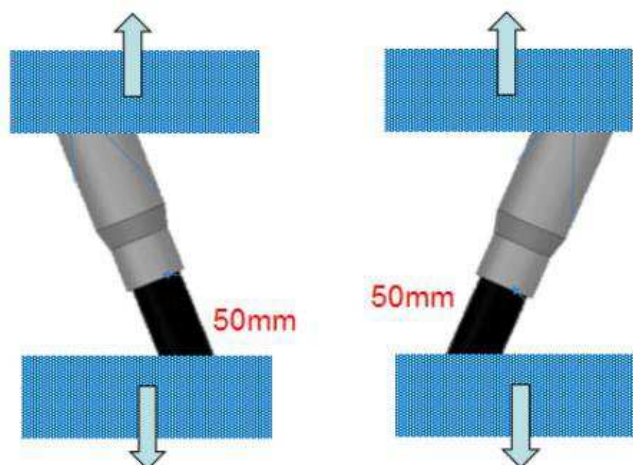


Figure 5: Axial loading of the Drain Hose

4.3.2.7.14 Repeat 4.3.2.7.12 thru 4.3.2.7.13 using 5 new hose samples.

4.3.2.7.15 Repeat 4.3.2.7.11 thru 4.3.2.7.13 as required for each of the remaining sunroof module frame sections, at T_{HT} . Example: First test is with front right, then complete front left, rear left then rear right.

4.3.2.8 Test Requirements or Acceptance Criteria.

- The measured values must correspond to the requirements of the SSTs or the respective specification.
- Photographs of test setup.
- Photographs of the test samples before and after testing.

4.3.3 Drain Hose to Body Attachments/Clips Retention and Installation Test.

4.3.3.1 Purpose. To verify the drain hose attachments or clips meet the retention requirements of the program specific SSTs.

4.3.3.2 Equipment.

4.3.3.2.1 Safety Equipment. Safety glasses.

4.3.3.2.2 Holding Fixture. Designed to adequately hold the test samples in the required configuration Figure 6.

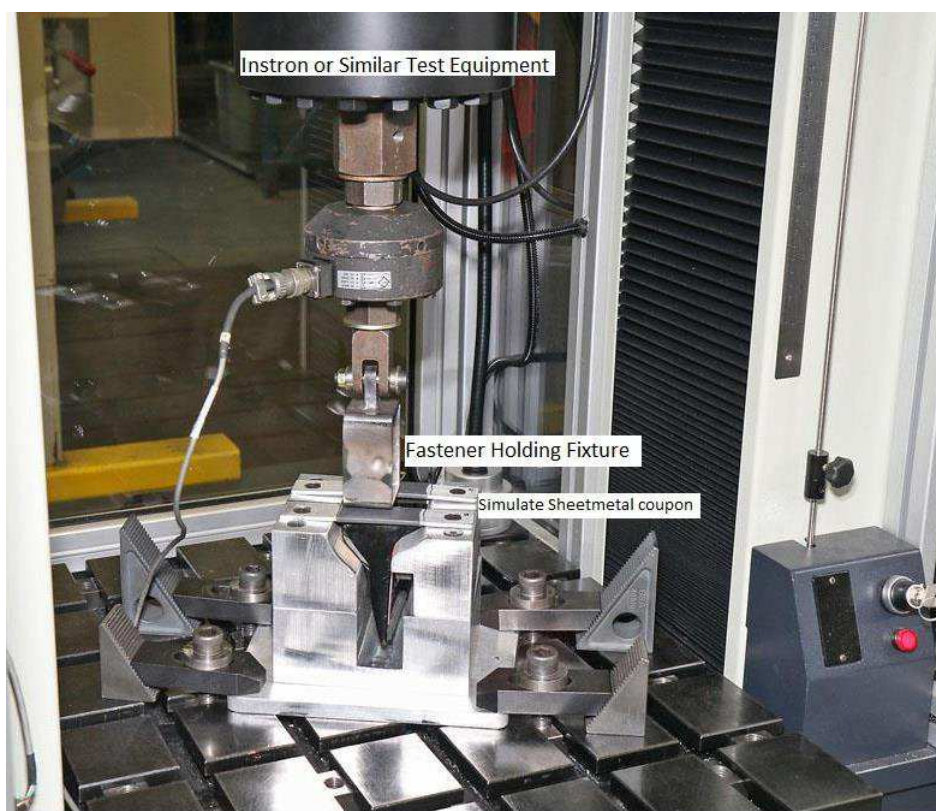


Figure 6: Example of Attachment/Clip Retention Test Fixture/Setup

4.3.3.2.3 Handheld scale or caliper.

4.3.3.2.4 Thermal chamber.

4.3.3.2.5 Digital or video camera.

4.3.3.2.6 Instron tensile test equipment or similar. Instron shall pull at 50 mm per minute.

4.3.3.2.7 Handheld Force Gauge. A handheld force gauge with > 250 N load capability may be used if approved by the design engineer (DE) and subsystem validation engineer (SVE). In cases where the handheld force gauge is used, pull as slowly and consistently as possible to minimize variation.

4.3.3.3 Sample Size. Three (3) samples for each environmental condition. GMW15760 is to be used to select test samples.

4.3.3.4 Test Time.

Calendar time:	1 d
Test time:	2 h
Coordination time:	8 h

4.3.3.5 Test Preparation. See 4.1.

4.3.3.6 Conditions.

4.3.3.6.1 Environmental Conditions. The minimum time period between vulcanization and testing of elastomers shall be 72 h. The test piece shall remain at a temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ for at least 8 h before testing and shall be free from strain during this period.

- $T_{\text{amb}} = 23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$
- $T_{\text{max}} = 90\text{ }^{\circ}\text{C}$ (if not specified in program specific SSTs/CTS)
- $T_{\text{min}} = -30\text{ }^{\circ}\text{C}$ (if not specified in program specific SSTs/CTS)