



Folding Top System Test Procedures

1 Introduction	4
1.1 Purpose.	4
1.2 Applicability.	4
1.3 Remarks.	4
2 References	4
2.1 External Standards/Specifications.	4
2.2 GM Standards/Specifications.	4
2.3 Additional References.	4
3 Resources	4
3.1 Facilities.	4
3.1.1 Calibration.	4
3.1.2 Alternatives.	4
3.2 Equipment.	4
3.3 Test Vehicle/Test Piece.	5
3.3.1 Test Material.	5
3.3.1.1 Test Procedure Definition.	5
3.3.2 Test Voltage.	5
3.4 Test Time.	5
3.5 Test Required Information.	5
3.5.1 Notification.	5
3.5.2 Five (5) Phase.	5
3.5.3 Product Security.	5
3.6 Personnel/Skills.	5
3.6.1 Sound Evaluators.	5
3.6.1.1 Hearing Requirements.	5
3.6.1.2 Auditor Skill Level.	6
4 Procedure	6
4.1 Preparation.	6
4.2 Conditions.	6
4.2.1 Environmental Conditions.	6
4.2.2 Test Conditions.	6
4.3 Instructions. Subsystem Testing.	7
4.3.1 Durability Test Procedure.	7
4.3.2 Obstruction Tests.	9
4.3.2.6 Individual Obstruction Test Procedures.	9
4.3.2.7 Final Bow Obstructions Test.	13

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August 2018

Page 1 of 49



Documents
Document Sharing Hub

4.3.3 Low and High Voltage Test.....	15
4.3.4 Resistance to Damage from Icing.....	15
4.3.5 Vehicle Attitude Operational Requirements.....	15
4.3.6 Convertible Top Operation after Prolonged Stowage Evaluation Procedure.	16
4.3.7 Parade Load.	16
4.3.8 Backlight Defogger.....	17
4.3.9 Snow Load.	18
4.3.10 Hot Storage Testing.	19
4.3.11 Cold Storage Testing.	19
4.3.12 Convertible Top Cycle Time and Quality of Motion.	20
4.3.13 Convertible Top Cycle Time and Quality of Motion.	21
4.3.14 Emergency Operation.	21
4.3.15 Convertible Top Kinematic Requirements.	22
4.3.16 Operational Requirements – Vehicle Attitude.....	22
4.3.17 Operating Effort Requirements.	23
4.3.18 Contact with Sun Visors.....	24
4.3.19 Top Cover to 1-bow Attachment.	24
4.3.20 Top Cover Premature Wear from Convertible Top Cycling.	26
4.3.21 Random Vibration.	26
4.4 Instructions. Vehicle Level Testing.	27
4.4.1 Pretest Requirements.	27
4.4.2 Ballooning of the Convertible Top.....	28
4.4.3 Durability.	28
4.4.4 Top Cover Premature Wear from Convertible Top Cycling.	29
4.4.5 Water Tests.....	29
4.4.6 Water Management –Tonneau Interface.....	30
4.4.7 Water Entry into Passenger Compartment over the Side of the Convertible Top.	30
4.4.8 Sound Evaluations.	31
4.4.8.1 Squeak and Rattle Evaluations.	31
4.4.8.2 Wind Noise Evaluations.	31
4.4.9 Environmental Testing.	31
4.4.9.1 Solar Exposure.....	31
4.4.9.2 Freeze Test.	32
4.4.9.3 Dust Intrusion Test.	32
4.4.9.4 Static Air Leak Testing.	32
4.4.10 Consistency of Tension-Bow Position.	33
4.4.11 Consistency of Stowed-Position of the Convertible Top.....	33
4.4.12 Consistency of 1-bow/Front Roof Panel Position from Power Actuation.....	34
4.4.13 Consistency of Rail-to-Rail or Panel-to-Panel Joint Position.....	35
4.4.14 Convertible Top after Prolonged Stowage.....	35
4.4.15 User-Subsystem Interface.	36
4.4.16 Vehicle Validation.	37
4.4.17 Subsystem Performance Requirements in Vehicle Crash.	37

GM Confidential

© Copyright 2018 General Motors Company All Rights Reserved

August 2018

Page 2 of 49

**Documents**

Document Sharing Hub

4.4.18 Functional Content – Convertible Top Power Actuation (Power Actuated Systems Only).	38
4.4.19 Header Latch/1-Bow Latch System Requirements.....	39
4.4.20 Direction from Latched Position Range.	40
4.4.21 No “Header-Slap/Header-Slam” During Power Actuation.	41
4.4.22 Tension Bow Locking System/Tension Bow Strength.	41
4.4.23 System Validation.	42
5 Data	43
5.1 Calculations.	43
5.1.1 Success Test.	43
5.1.2 Failure Test.	43
5.2 Interpretation of Results.	43
5.3 Test Documentation.	43
5.4 Samples/Components.	44
6 Safety	44
6.1 Safety Precautions.	45
7 Notes	45
7.1 Glossary.....	45
7.2 Acronyms, Abbreviations, and Symbols.	45
8 Coding System	46
9 Release and Revisions	47
Appendix A	48

GM Confidential

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August 2018

Page 3 of 49



Documents

Document Sharing Hub

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 test procedure is to ensure the Convertible Top System meets requirements set forth in the program specific SSTs.

1.2 Applicability. This procedure/ standard applies to all passenger vehicles, multipurpose passenger vehicles, trucks, and buses of 4536 kg gross vehicle mass (weight) rating or less with a folding convertible top.

1.3 Remarks. This document is the GM Worldwide Convertible Top System Testing Standard. Its purpose is to establish a common test methodology for Convertible Top System 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	GMW8463	GMW14528
GMW3067	GMW8518	GMW15085
GMW3600	GMW14527	GMW15308

2.3 Additional References.

- CG180 (ID) 5-Phase Document.
- CG1886 Convertible VCRI SOR Appendix G3 Template.
- Component EMC and ENVIRONMENTAL Test Database (CEMENT).
- Component Technical Specification (CTS).
- GM Exterior Materials Engineering Material Decision Trees for Noise Abatement Strategy
- GM Research and Development Report AS-598 Hearing Acuity Standard for Squeak and Rattle Evaluators
- GM Security Guidelines. (<https://gmweb.gm.com/HR/Security/Pages/FutureGuide.aspx>).
- Subsystem Technical Specifications (SSTs).
- Vehicle Technical Specifications (VTS).

(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.

Note: Folding top system refers to both fabric top and retractable hard top (RHT) roof systems.

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 Personal Protection Equipment (PPE).

3.2.2 Power Supply capable of producing the minimum and maximum voltage and current required in the program specific SSTs/CTS.

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

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August 2018

Page 4 of 49



Documents

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3.2.3 Thermal chamber large enough to minimally contain one (1) test buck and capable of -40 °C to 105 °C with controlled humidity. The chamber shall 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.

3.2.4 Force gage with a minimum range of 0 N to 250 N.

3.2.5 Load cell with minimum 1500 N capacities.

3.2.6 Stop watch.

3.2.7 Digital camera and or Video camera.

3.2.8 Temperature measuring equipment.

3.2.9 Body buck – to include the following:

- All interfacing sheet metal must be in production intent and quality.
- On a body truck for ease in moving within the test facility.

3.2.10 Trimmed body buck – to include:

- All interfacing sheet metal must be in production intent and quality.
- Interfacing components – interior, electrical and exterior.
- On a body truck for ease in moving within the test facility.

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 validation methods for product/process changes before the supplier is committed to the change. Refer to GMW3600. Sample size is identified on the program specific CG1886 Convertible VCRI SOR Appendix G3 Template.

3.3.1 Test Material.

3.3.1.1 Test Procedure Definition.

3.3.1.1.1 Cycle Definition. One (1) convertible top cycle starts in the fully closed and latched condition, (top up condition). The convertible top cycles to the fully open or stowed and latched condition. The convertible top then cycles back to the fully closed and latched condition.

3.3.2 Test Voltage. Unless otherwise specified, the voltage measured at the motor wiring harness terminals is to be 13.5 V $\pm$ 0.2 V.

3.4 Test Time. Time is dependent on test being performed.

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 five phase document (CG180) 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.

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 is a reference: GM Research and Development Report AS-598, "Hearing Acuity Standard for Squeak and Rattle Evaluators."

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Page 5 of 49

Documents
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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 being 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 torques have been confirmed before test.

4.1.7 Ensure that all critical Bolts have been marked before test.

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

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

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

4.2.1 Environmental Conditions. The following conditions apply to all tests unless otherwise specified in the program specific SSTS/CTS:

- Ambient temperature: $+23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.
- Voltage: $V_{\text{nom}} \pm 0.3\text{ V}$ at motor terminals.
- Humidity shall be 50% to 75% for all tests unless otherwise specified.
- 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.

4.2.2.1 Any of the following conditions constitute a failure during laboratory convertible top cycle testing.

- a. Any disabled convertible top functions.
- b. Any broken or detached parts.
- c. Any visibly detectable cracks to welds or components.
- d. Any operating efforts or latching characteristics that are outside of the specified limits.
- e. Any customer-objectionable noises, squeaks or rattles.
- f. Any tears or customer-objectionable wear-marks in the convertible top cover or headliner.
- g. Any scratches or abrasions to appearance surface of roof panels or headliner of a retractable hardtop system.
- h. Any distortion or abrasion of weather seals.
- i. Movement in convertible top structural threaded fasteners. (Fastener position shall be marked after the fastener is installed and fully torqued before the start of test. Fastener position shall be monitored every 1500 cycles.)
- j. Any loss of alignment, or loss of adjustment, that requires readjustment to restore normal function of the convertible top system.

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Page 6 of 49



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- k. Any failure or loss of function of systems that are outside of the convertible top system shall be reported as incidents to the responsible engineers, the components replaced and the test of the convertible top system resumed.
- l. Any loss of signal from a convertible top system sensors (micro-switches, limit-switch, proximity sensor, potentiometers, etc.)
- m. Any damage to the tonneau panel or body.

4.3 Instructions. Subsystem Testing.

4.3.1 Durability Test Procedure.

4.3.1.1 Purpose. To ensure that the folding top will meet the reliability and durability requirements for the program.

4.3.1.2 Test Equipment. See 3.2.

4.3.1.3 Test Samples. Unless otherwise specified or agreed to by GM Validation, 6 samples are to be used.

4.3.1.4 Test Time. Dependent on the number of properties used to meet the reliability requirements for the program.

4.3.1.5 Test Preparation. See 4.1.

4.3.1.5.1 Install the complete folding top system in a test buck or vehicle including all interfacing components.

4.3.1.5.2 Measure and record release handle, tonneau panel, and lift efforts to stow and close manual top system on Data Sheet A1.

4.3.1.5.3 Mark fastener rotational position after the fastener is tightened to specification. Monitor fastener position every 1500 cycles.

4.3.1.5.4 Verify function of the rear window/backlight defogger if applicable.

4.3.1.6 Test Procedure.

4.3.1.6.1 Run the durability cycle (see Figure 1) as follows if there is no program specific requirement. Changes to the default schedule shall be approved by GM Validation.

- Complete 3500 cycles at $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ with 30% to 50% Relative Humidity (RH).
- Complete 2500 cycles at $80\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ with 15% to 30% RH.
- Complete 1500 cycles at $40\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ with 90% RH minimum.
- Complete 20 cycles at $-5\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.

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Page 7 of 49



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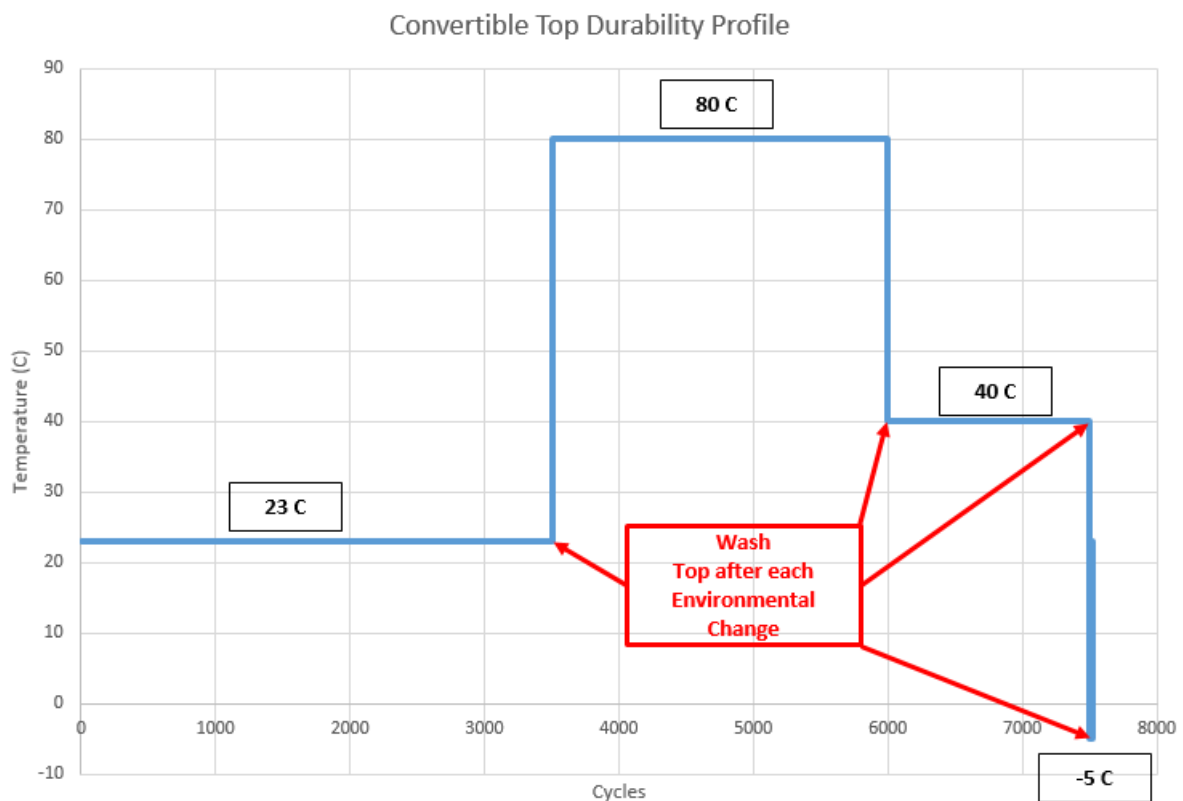


Figure 1: Convertible Top Generic Durability Schedule

Note: Four (4) h soak time required at each temperature prior to cycling.

Note: Segments may be run in any order. Unless otherwise specified in the program specific SSTs, cycle the top system for 7520 cycles under the preceding conditions.

Note: At the completion of each temperature cycle, allow folding top system to reach ambient temperature of $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$. Measure and record release handle efforts and cycle times on Data Sheet A1.

4.3.1.7 Durability Test Requirements and Documentation Criteria. During and post-test, note any of the following conditions.

- Measure and record the cycle time for powered top systems on Data Sheet A1.
- Spray each dynamic joint and hydraulics at the end of each 500 cycle interval with solution. The solution shall be applied so as to completely cover the test surfaces with a 0.1 mm coating. This solution represents exposure to the mechanisms over time. Solution formula (by mass) is:
 - a. 5% Degreasing Solvent.
 - b. 13% Salt.
 - c. 7% Dust/GM Air Cleaner.
 - d. 75% Water.
- Premature wear marks, wrinkles, other witness marks, or color change during initial convertible top operation of 100 cycles.
- Loss of convertible top functions, or loss of smooth operation.
- Broken or detached parts.
- Visibly detectable cracks to welds or components.
- Operating efforts or latching characteristics outside of the specified limits.

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Page 8 of 49



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- Customer-objectionable noises, squeaks or rattles.
- Wear-through condition causing an opening to the passenger compartment or a hole in the headliner.
- Tears or customer-objectionable wear-marks in the convertible top cover or headliner.
- Distortion or abrasion of weather seals.
- Scratches or abrasions to appearance surface of roof panels or headliner of a Retractable Hardtop System.
- Movement of structural threaded fasteners.
- Temporary, or permanent, loss of signal from any sensor, potentiometer, micro-switch or limit switch during cycle test or road durability test.
- Loss of alignment or adjustment that requires action to restore normal function.
- Loss of function of other systems outside of the folding top system.
- Observed Degradation. Degradation of the folding top system inherently involves subjective judgments. Document the onset of top cover wrinkles, wear marks on the top cover or headliner, or witness marks on the convertible top parts. Photograph these conditions as they progress, and review with the design-responsible engineer and validation engineer. Specific degradation conditions to be noted including, but are not limited to the following:
 - Change in any of the following dimensions beyond the specified limits during the cycle testing of the Folding Top Subsystem.
 - Change in position of 1-bow or front roof panel ready to latch position or latch entry into latch receivers.
 - Change of 1-bow or front of front roof panel height in the top-down (stowed) position.
 - Development of header-slap/header-slam over the service life of the folding top system.
 - Change in any rail-to-rail or panel-to-panel dimensional relationship in the top-up position.
 - Change in the tension-bow position.
 - Change of front rail/center rail joint or rear of front roof panel in the top-down (stowed) position.
 - Conditions observed in convertible top after prolonged stowage.

4.3.2 Obstruction Tests.

4.3.2.1 Purpose. To ensure that when the folding top is obstructed, the system will function properly after the obstruction is removed and there will be no permanent damage to the system.

4.3.2.2 Test Equipment. Obstruction holding fixture adjustable to the various obstruction locations

4.3.2.3 Test Samples. 3 samples.

4.3.2.4 Test Preparation. See 4.1.

4.3.2.5 Test Conditions. See 4.2.2.

4.3.2.6 Individual Obstruction Test Procedures.

4.3.2.6.1 Windshield Header Obstruction. Place a 100 mm diameter × 100 mm long rigid tube or 100 mm × 100 mm × 10 mm block on the windshield header approximately 100 mm inboard from either outboard edge with the 100 mm dimension in the vertical axis. See Figure 2. Cycle the top mechanism to the closed position until stall occurs. Stall motor for a minimum of 10 s. Document any breakage or loss of function to the Folding Top or Folding Top Weather Seal System.

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Page 9 of 49

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Figure 2: Example of Obstruction at 3 Header Locations

4.3.2.6.2 Maximum Height Obstruction. Determine the maximum travel height of the top mechanism. Place an obstruction approximately 100 mm below the maximum travel height at the vehicle centerline. See Figure 3. Cycle the top from closed to open and open to closed position. Stall the motor for a minimum of 10 s. Document any breakage or loss of function to the Folding Top or Folding Top Weather Seal System.

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Page 10 of 49



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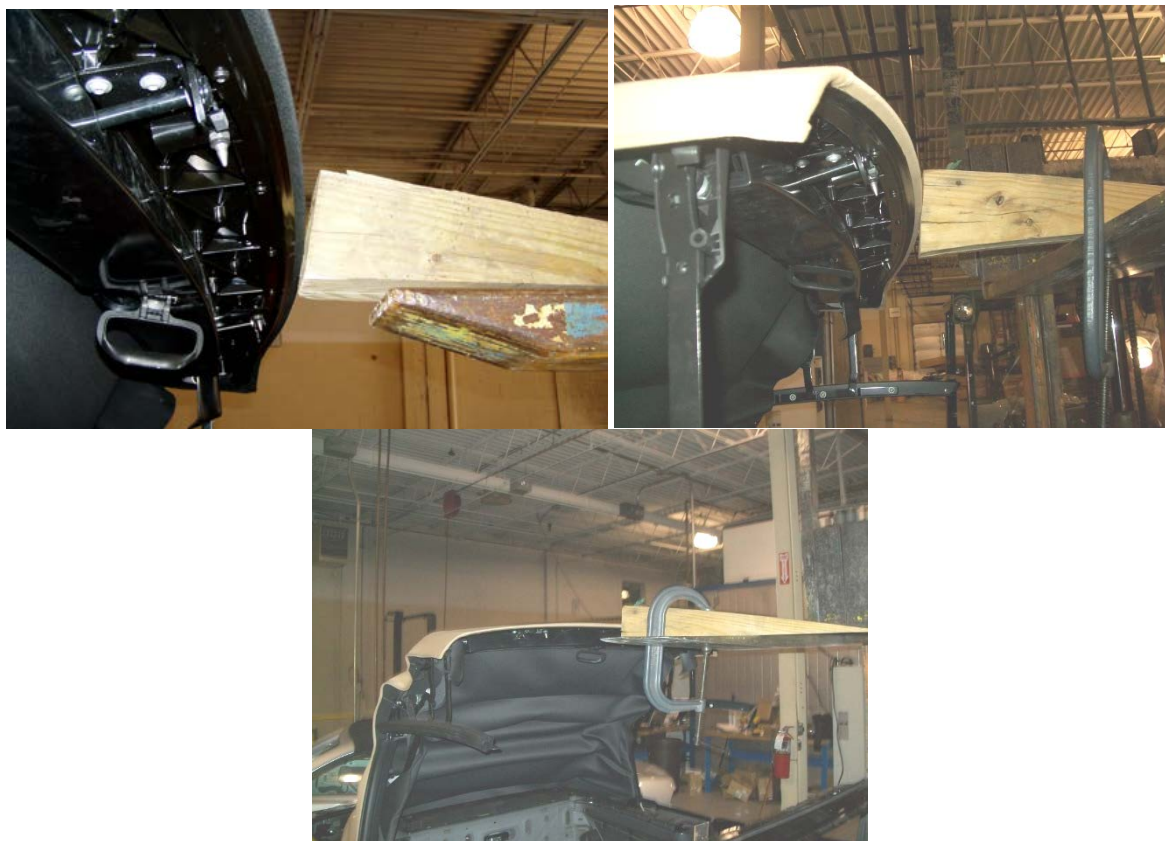


Figure 3: Example of Maximum Height Obstruction

4.3.2.6.3 Luggage Obstruction. Disable the luggage shade sensor prior to the test. Place a 100 mm × 300 mm × 400 mm block (to simulate a briefcase or computer bag) in the top stowage area that prevents the top mechanism from reaching the fully stowed and latched position. Cycle the top from the closed position to the stowed position. See Figure 4. Document any breakage or loss of function to the folding top system. Verify backlight defogger functions after obstruction is removed. Disregard any abrasion damage to the Soft convertible top or Retractable Hard Top (RHT) or minor dents (RHT only) to the exterior surface of the folding top system at the point of contact with the obstruction. This test is only applicable for vehicles which the top stows in the luggage compartment. Luggage can be placed in the tonneau area. The test should be conducted for all folding tops.

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Page 11 of 49



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Figure 4: Examples of Luggage Obstruction

4.3.2.6.4 Stowed Condition Obstructions. Place the top in the stowed position. Position a 100 mm diameter $\times$ 100 mm long rigid tube or 100 mm $\times$ 100 mm $\times$ 10 mm block along the Center line. Ensure that it is properly constrained so as not to move when the top is actuated. See Figure 5, Figure 6 and Figure 7. Cycle the top from closed to open position. Run until the system stalls for a minimum of 10 s. Repeat using two blocks at 45 degree angles along the rear outboard edges. Repeat for blocks positioned along the leading edge of the downstack, Document any breakage or loss of function to the Folding Top or Folding Top Weather Seal System.



Figure 5: Obstruction from the Stowed Position at CL

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Page 12 of 49



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Figure 6: Obstruction from the Stowed Position at 45 Degrees across the Downstack



Figure 7: Obstruction across the Leading Edge of the Downstack

4.3.2.7 Final Bow Obstructions Test.

4.3.2.7.1 Purpose. To take into account any body structure influences that would not be comprehended by the stated fixed dimensions of the block already.

4.3.2.7.2 Procedure.

4.3.2.7.2.1 With the Top in the Nominal Full Down position, add incremental blocks of 1.5" (2x4 Block) and cycle the top. Increments should span from fully stowed position, to Nominal Latched Position. (See Figure 8.)

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Page 13 of 49



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Final Bow Obstruction Test Procedure Tension Bow System

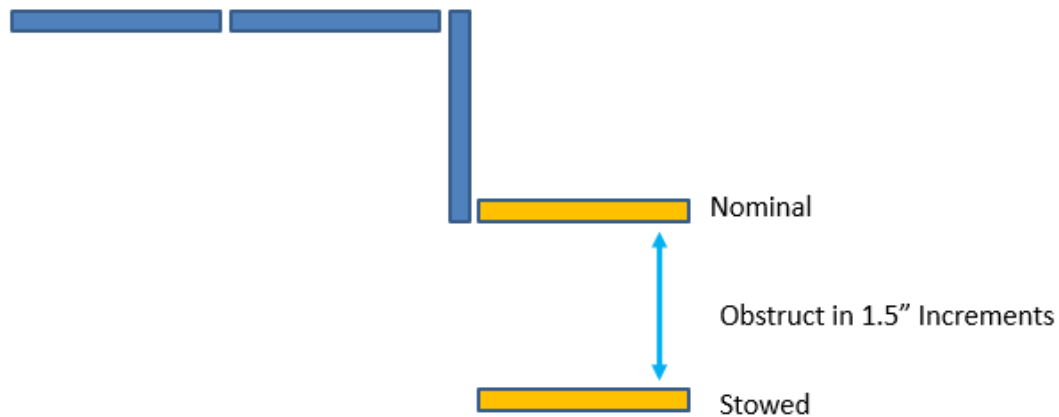


Figure 8: Tension Bow System

4.3.2.7.2.2 For Compression Bow Systems, the mid-position of the final bow, and the full up position of the final bow should also be obstructed. (See Figure 9.)

Final Bow Obstruction Test Procedure Compression Bow System

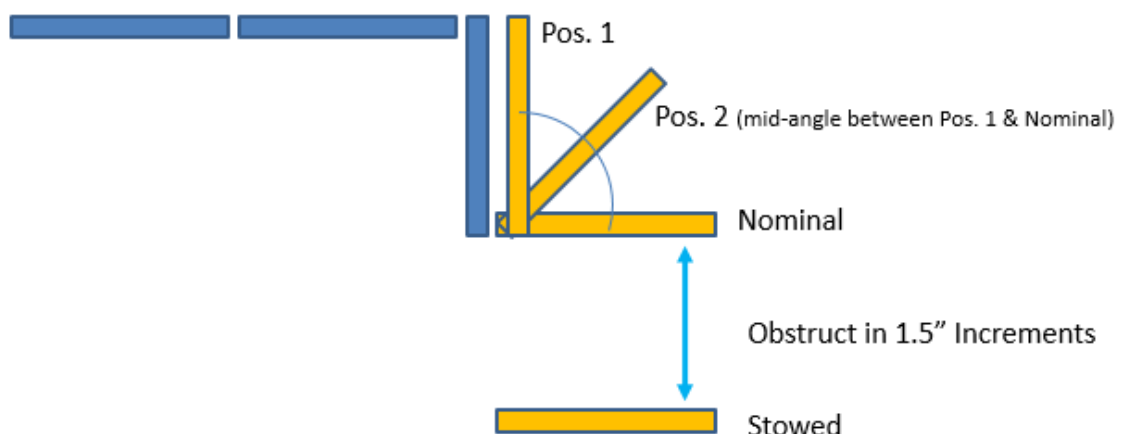


Figure 9: Compression Bow System

Note: All blockades should be positioned Normal to the direction of Travel.

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Page 14 of 49



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4.3.2.7.3 Acceptance Criteria.

- The system shall function after the obstruction has been removed.
- There shall be no degradation in system performance after the obstruction has been removed.

4.3.3 Low and High Voltage Test.

4.3.3.1 Purpose. To ensure, under different voltage outputs from the vehicle, the folding top will cycle to meet program requirements.

4.3.3.2 Test Equipment.

4.3.3.2.1 Power supply.

4.3.3.2.2 Volt/amp meter.

4.3.3.3 Test Samples. 3 samples.

4.3.3.4 Test Preparation. See 4.1.

4.3.3.5 Test Conditions. See 4.2.2.

4.3.3.6 Procedure. Cycle the folding top system at 10.0 V and 16.0 V at ambient temperature. Record the cycle time on Data Sheet A1.

4.3.3.6.1 Set voltage to 10 V and document the environmental conditions.

4.3.3.6.2 Cycle the folding top system.

4.3.3.6.3 Record the cycle time on Data Sheet A1.

4.3.3.6.4 Repeat 4.3.3.6.1 through 4.3.3.6.3. at 13.5 V and then repeat at 16.0 V.

4.3.3.7 Documentation Criteria. Note any damage or improper function after cycling at these voltages. Document the cycle time, environmental conditions and the voltage.

4.3.4 Resistance to Damage from Icing.

4.3.4.1 Purpose. To ensure that the folding top does not sustain damage when exposed to icing conditions and the customer tries to actuate the top.

4.3.4.2 Test Equipment.

4.3.4.2.1 Thermal chamber.

4.3.4.2.2 Snow/Ice making apparatus.

4.3.4.3 Test Samples. 1 sample.

4.3.4.4 Test Preparation. See 4.1.

4.3.4.4.1 Soak convertible roof system with the convertible top, doors and windows closed at -30 °C for 4 h.

4.3.4.4.2 Mist the vehicle with water until ice builds up to a thickness of 3.0 mm over the convertible top and windows. Not unless specified in GMW15085.

4.3.4.5 Test Conditions. See 4.2.2.

4.3.4.6 Procedure.

4.3.4.6.1 While in the chamber, open the doors and windows, with a 3.0 mm ice build-up.

4.3.4.6.2 Close the doors and window.

4.3.4.6.3 Document any damage or loss of attachment of any convertible top component or weather seal.

4.3.4.7 Test Requirements. Per SSTs; "The convertible vehicle shall not be damaged when subjected to the Door System Freeze Performance Test". (GMW15085).

Note: This evaluation may be combined with door system test per GMW15085.

4.3.5 Vehicle Attitude Operational Requirements.

4.3.5.1 Purpose. To ensure the convertible top will function when the vehicle is at various attitudes.

4.3.5.2 Test Equipment.

4.3.5.2.1 Tilt table.

4.3.5.2.2 Power supply as necessary.

4.3.5.3 Test Samples. 1 sample.

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Page 15 of 49



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