



Sunroof Development and Validation Vehicle Test Procedure

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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. This procedure contains the instructions for testing the requirements of a manual or electric sunroof which defined in the SSTS/VTs on a vehicle level.

1.2 Applicability. This procedure applies to all passenger cars and light-duty trucks equipped with a manual or electric sunroof system. Not All procedure sections in this GMW are required for every program nor for every type of sunroof. Refer to the program specific SSTs to confirm which procedures are required for the specific program. All applicable test procedure sections shall be on the Analysis/Development/Validation Plan and Report (ADVP&R).

1.3 Remarks. This document is intended to test the entire sunroof performance requirements on vehicle level of a sunroof system. This test procedure contains a summary of different function tests for the sunroof at high temperature and under dust exposure. Depending upon the task, the details relevant for carrying out the tests under 3.2 shall be selected along with the test sheets of the denoted test procedure or general specification.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3067	GMW8518	GMW15085	GMW16591
GMW3600	GMW14264	GMW15819	
GMW8463	GMW14527	GMW16412	

2.3 Additional References.

- 5-Phase Document.
- Component Technical Specification (CTS).
- GM R&D Report AS-598, "Hearing Acuity Standard for Squeak and Rattle Evaluators."
- GM Security Guidelines. (<https://gmweb.gm.com/HR/Security/Pages/FutureGuide.aspx>).
- Milford Proving Ground Weather Report (<http://usmpgbd0413307.nam.corp.gm.com/eWeather/Stations/>)
- Subsystem Technical Specification (SSTs)
- Vehicle Technical Specifications (VTs)

3 Resources

3.1 Facilities. All the tests, which shall be performed on the stationary vehicle, can also be performed in a climate chamber. Specific test facility requirements are listed in each individual requirement and test procedure. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this specification shall be determined correctly with respect to its physical definition. The test facilities shall be accredited to ISO/IEC standards or by the International Laboratory Accreditation Cooperation.

A test track for dynamic road trials is required. Choose according to requirements.

Before starting the tests, the mechanics and all relevant interface components such as the glass panel, roof section, frames etc., shall meet the specified development state and release state.

The entire sunroof system and interface components shall be checked for fault-free assembly and possible damage. Deviations shall be brought into line with the specified release state. Changes shall be documented.

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

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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 All measuring equipment required for the test procedures and general specifications as described in 3.2.

3.2.2 Climate chamber for the range Tmin through Tmax. Select for entire vehicle.

- Recirculating air temperature cabinet.
- Test room, suitable for the execution of the test.
- Temperature range: (-40 through +90) °C.
- Permissible temperature accuracy: ± 3 °C.

3.2.3 Thermometer; hygrometer.

3.2.4 Voltmeter, stopwatch.

3.2.5 Measurement amplifier for stiffness check.

3.2.6 Push-pull gauge/pressure balance with measurement range up to 100 N maximum with hooks.

3.2.7 Digital camera or video recorder.

3.2.8 Handheld laser distance meter.

3.2.9 Measurement targets for distance meter.

3.2.10 Handheld scale or caliper.

3.2.11 Laser instrumentation.

3.2.12 Ammeter.

3.2.13 Personal Protection Equipment – Safety Glasses.

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 (homeline) 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.

3.3.1 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.

Calendar time: 98 d

Test time: See specific procedure in 4.3.

Coordination time: See specific procedure in 4.3.

3.5 Test Required Information. Requirements from the SSTS or respective specification or procedures are necessary in order to execute test methods in this document.

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

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

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

3.6 Personnel/Skills. The test facility shall have sufficient engineering resources and experience for performing the required tests.

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 R&D Report AS-598, "Hearing Acuity Standard for Squeak and Rattle Evaluators."

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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. This test procedure has been developed to reflect customer usage of markets which have more stable road systems and lesser amounts of unpaved and rough roads. Other regional or local requirements may necessitate additional test options. For further information, consult regional Engineering Center.

4.1.1 Test Samples. All test samples shall be design intent components that might affect performance behavior and meet all functional and dimensional requirements. These include the components such as glass panel, frame, electrical-drive, electronic components, wind deflector, sunshade, etc.

4.2 Conditions. 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 readjusted 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 the tests in the as-received condition without any special preconditioning.

4.2.1 Environmental Conditions. Symbol definitions required for test methods contained in this procedure are listed in Table 1. Actual requirement values for the symbols shall be obtained from the Subsystem Technical Specification (SSTS) or the respective specification and recorded on Data Sheet A1. If not otherwise specified, tests shall be performed at T_{room} . 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} , then at high temperature, and lastly at low temperature. If not specified, the test parameter for relative humidity shall be set at $50\% \pm 5\%$ and voltage set to U_{nom} .

The driving test can be performed in all types of weather. However, in situations where severe weather makes certain driving maneuvers unsafe, Test Procedure Subsections using those maneuvers shall be postponed until road conditions improve.

Table 1: Temperature and Voltage Definitions

Phrase	Symbol	Definition
Minimum Temperature	T_{min}	Minimum limit value of the ambient temperature at which the component is required to operate.
Maximum Temperature	T_{max}	Maximum limit value of the ambient temperature at which the component is required to operate.
Maximum Component Temperature	T_{HT}	High test temperature at which specific system components are expected to function.
Room Temperature	T_{room}	Ambient room temperature.
Minimum Voltage	U_{min}	Minimum limit value of the supply voltage at which the component is required to operate during the test.
Nominal Voltage	U_{nom}	Nominal supply voltage at which the component is operated during test.
Maximum Voltage	U_{max}	Maximum limit value of the supply voltage at which the component is required to operate during test.

4.2.1.1 System Performance Conditions. Symbol definitions required for test methods contained in this procedure are listed in Table 2. Actual requirement values for the symbols shall be obtained from the SSTS or the respective specification and recorded on Data Sheet A1.

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Table 2: System Performance and Test Definitions

Phrase	Symbol	Definition
Deflection Requirement for Stiffness Dynamic Test, Load 1	$d_{1stifffront}$	Deflection requirement for Stiffness Dynamic Test, load case 1 (glass panel middle front).
Deflection Requirement for Stiffness Dynamic Test, Load 2	$d_{2stiffrear}$	Deflection requirement for Stiffness Dynamic Test, load case 2 (glass panel middle rear).
Sunshade Sag Requirement, T_{room}	d_{1sag}	Sunshade sag, maximum displacement allowed for downward movement of material at T_{room} .
Sunshade Sag Requirement, T_{max}	d_{2sag}	Sunshade sag, maximum displacement allowed for downward movement of material at T_{max} .
Sunshade Sag Requirement, T_{min}	d_{3sag}	Sunshade sag, maximum displacement allowed for downward movement of material at T_{min} .
Sunshade Sag Requirement, $T_{HC}+V_{max}$	d_{4sag}	Sunshade sag, maximum displacement allowed for downward movement of material at T_{HC} and after performing V_{max} with open glass panel and closed Sunshade.
Sunshade Sag Requirement, $T_{HC}+V_{skibox}$	d_{5sag}	Sunshade sag, maximum displacement allowed for downward movement of material at T_{HC} and after performing with mounted Ski-box, open glass panel and closed Sunshade.
Sunshade Curl Requirement, T_{room}	d_{1curl}	Sunshade curl, maximum displacement allowed for downward movement of material at T_{room} .
Sunshade Curl Requirement, T_{max}	d_{2curl}	Sunshade curl, maximum displacement allowed for downward movement of material at T_{max} .
Sunshade Curl Requirement, T_{min}	d_{3curl}	Sunshade curl, maximum displacement allowed for downward movement of material at T_{min} .
Sunshade Curl Requirement, $T_{HC}+V_{max}$	d_{4curl}	Sunshade curl, maximum displacement allowed for downward movement of material at T_{HC} and after performing V_{max} with open glass panel and closed Sunshade.
Sunshade Curl Requirement, $T_{HC}+V_{skibox}$	d_{5curl}	Sunshade curl, maximum displacement allowed for downward movement of material at T_{HC} and after performing with mounted Ski-box, open glass panel and closed Sunshade.
Vehicle Speed	V_{max}	Maximum vehicle, at which the system is required to operate at U_{nom} .
Vehicle Speed, with ski-box on top	V_{skibox}	Maximum vehicle speed with ski-box on the roof top, at which the system is required to operate at U_{nom} .

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.

Such deviations shall be approved by the GM Validation Engineer and specified on the ADVP&R and test reports. Reference Table 3 and the applicable product specification documents for definitions of allowed tolerances.

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Table 3: Temperature and Voltage Tolerances

Parameter	Tolerance
T _{min}	Specification ± 3 °C
T _{max}	Specification ± 3 °C
T _{HT}	75 °C ± 3 °C
T _{CS}	Specification +3 °C
T _{room}	+23 °C ± 3 °C
Test Time	Specification ± 0.5%
Room Ambient Relative Humidity (RH)	30% through 70%
Chamber Humidity	Specification ± 5%
Pulse Width Modulation (PWM) Voltage	Specification +0.25 V
Voltage	Specification ± 0.25 V
Force (Loading)	Specification ± 5%
Distance (Excluding Dimensional Check)	Specification ± 5%

4.2.2.1 Unless otherwise specified, use a dynamic gun at 50 min⁻¹ (rpm) to dynamically torque the nut 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 °C for India
- T_{min} = -40 °C for Russia
- T_{min} = -15 °C for South America Only

4.3 Instructions. Vehicle Level Sunroof Tests Stiffness (Dynamic Requirements).

4.3.1 Dynamic Stiffness Sunshade.

4.3.1.1 Purpose. To ensure the sunshade meets the dynamic stiffness requirements of the program specific SSTs/CTS.

4.3.1.2 Sample Size. 3 Samples is preferred.

4.3.1.3 Test Time. 1 d.

4.3.1.4 Conditions. Take the measurement in vehicle at V_{max} or according to SSTs requirements. Put glass panel in ventilation position. Ensure that sunshade is closed.

4.3.1.5 Procedure. A feeler or steel dipstick is used for measuring the degree of bending. The measurement shall be performed in the middle of the sunshade at the leading and trailing edges respectively.

4.3.1.6 Requirements. The bending of the sunshade shall fulfill the requirements of the SSTs or the relevant specifications.

4.3.2 Dynamic Stiffness Glass Panel System.

4.3.2.1 Purpose. To ensure the Glass panel meets the dynamic stiffness requirements of the program specific SSTs/CTS.

4.3.2.2 Sample Size. 1 sample.

4.3.2.3 Test Time. 1 d.

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4.3.2.4 Conditions. Take the measurement in vehicle at $V_{\max}$ or according to SSTS requirements. Put glass panel in closed position. Ensure that sunshade is in open position. Record the measurement in the vehicle with and without skiing equipment box.

4.3.2.5 Procedure. A displacement transducer is used for measuring the degree of bending. The measurement shall be performed in the middle of the sunshade at the leading and trailing edges respectively. Record results on Data Sheet A5.

4.3.2.6 Requirements. The bending of the sunroof system shall fulfill the requirements of the SSTS or the relevant specifications.

4.3.3 Dynamic Vehicle Testing for Torque Operating Limits. See Figure 3 and example in Appendix C.

4.3.3.1 Purpose. To verify Sunroof system operation and torque when subject to vehicle speed, dust and temperature limits.

4.3.3.2 Sample Size. 1 sample.

4.3.3.3 Test Time. 1 d.

4.3.3.4 Conditions. Take the measurement in vehicle at $V_{\max}$, T_{HT} and V_{skibox} at T_{room} with skiing equipment box, supply U_{nom} to the test part. Ensure the sunshade is in the closed position. Sunroof movements according Table 4.

4.3.3.5 Procedure. Adapt sunroof drive motor with torque transducer gage or equivalent. Connect acquisition equipment. Create data plots of torque vs. angular rotation of the motor to achieve movement positions. Append data to the final report and complete Data Sheet A2.

Note: Measurement system settings shall be controlled with a resolution equal to 200 Hz minimum and without smoothing.

4.3.3.6 Requirements. The measured values must correspond to the requirements of the SSTS or the respective specification.

Table 4: Tilt and Slide Sunroof Movements for the Temperature and Torque Limits Test

Measurement Movement	Movement Description
1 st	Opening from zero position to tilt position (TP) - see Figure 2
2 nd	Closing from TP to zero
3 rd	Opening to comfort position
4 th	Opening to full slide position (SP) - see Figure 1
5 th	Closing from SP to zero position

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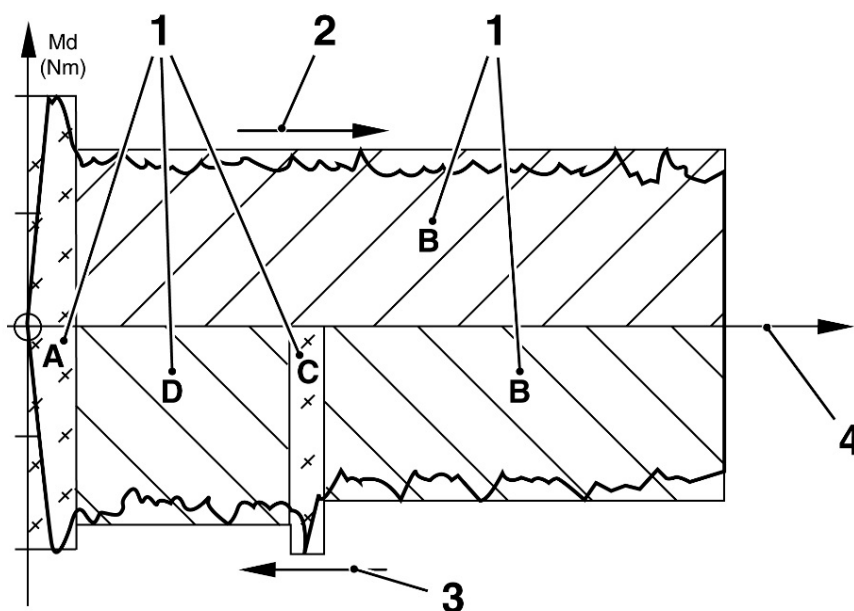
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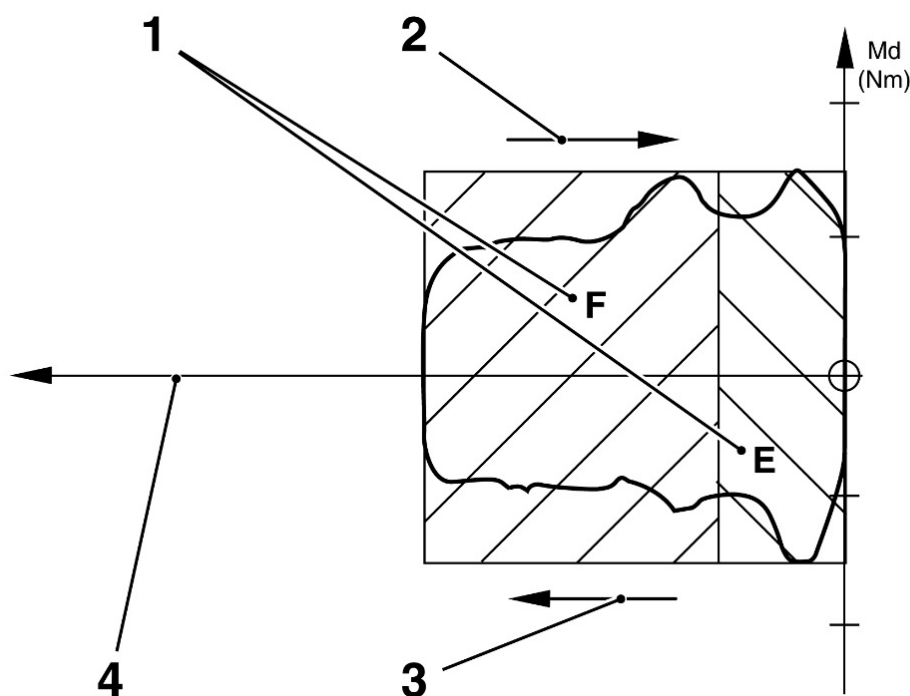
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- 1 Torque ranges
- 2 Sliding position open
- 3 Sliding position closed
- 4 Angle of rotation in [°]

Figure 1: Torque Diagram SP



- 1 Torque ranges
- 2 Close TP
- 3 Open TP
- 4 Angle of rotation in [°]

Figure 2: Torque Diagram TP

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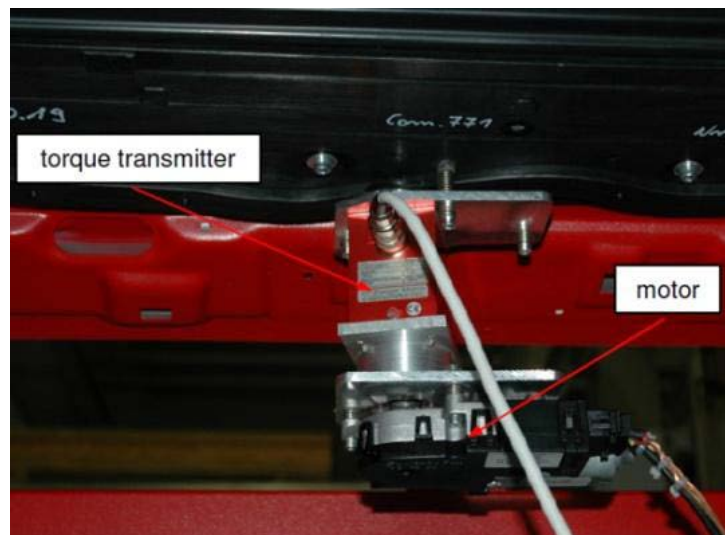


Figure 3: Torque Measurement System

4.3.4 Sunroof Freeze Performance Test.

4.3.4.1 Purpose. To verify Sunroof and sunshade systems when subjected to temperature limits. ($T_{min.}$) still meets SSTS requirements.

4.3.4.2 Sample Size. 1 sample.

4.3.4.3 Test Time. 1 d.

4.3.4.4 Conditions. According to Freeze Performance Test GMW15085. (Door slam test; 70 J.)

4.3.4.5 Procedure. According to Freeze Performance Test GMW15085.

4.3.4.6 Requirements. No crack of the glass panel. Sunroof and sunshade shall function properly after the test.

4.3.5 Jack Test.

4.3.5.1 Purpose. To verify sunroof and sunshade system function properly after the vehicle has been exposed to Jacking inputs.

4.3.5.2 Sample Size. 1 sample.

4.3.5.3 Test Time. 1 d.

4.3.5.4 Conditions. According to Jack Test GMW15819.

4.3.5.5 Procedure. According to Jack Test GMW15819.

4.3.5.6 Requirements. No crack of the glass panel. Sunroof and sunshade shall function properly after the test.

4.3.6 Water Drain Channel in Venting Position.

4.3.6.1 Purpose. To ensure that the sunroof drain channels have the proper water management system to meet program specific requirements.

4.3.6.2 Sample Size. Minimum of 3 samples.

4.3.6.3 Test Time. 1 d.

4.3.6.4 Conditions. Testing on the standing vehicle.

4.3.6.5 Procedure. Make a visual inspection that the water drain channel can accommodate water running off to the rear in every position of the panel in venting position. The location of the water drain channel with respect to the rear edge of the panel is rated. The vehicle roof shall have a painted and polished surface. The test shall not be conducted under rainy or windy conditions. The vehicle parking surface shall be level. The panel is sprayed with water until it is fully saturated (until the formation of water droplets is visible; Figure 4). This corresponds to a longer period when the vehicle is stationary in the rain. The panel is retracted into vent position.

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The vehicle is driven slowly forward, immediately brake down so that any water present on the roof quickly runs off toward the water drain channel of the sunroof. Record results on Data Sheet A4.



Figure 4: Water Drain Channel

4.3.6.6 Requirements. No water entry into the passenger compartment.

4.3.7 Roller Sunshade Sag.

4.3.7.1 Purpose. To verify sunroof sunshade system sag characteristics under vehicle driving conditions.

4.3.7.2 Equipment.

4.3.7.2.1 Handheld laser distance meter.

4.3.7.2.2 Measurement targets for distance meter.

4.3.7.2.3 Handheld scale or caliper.

4.3.7.3 Sample Size. 3 samples.

4.3.7.4 Test Time. 1 d.

4.3.7.5 Procedure.

4.3.7.5.1 Mount the sunroof module with sunshade to a production intent vehicle and use production fasteners or equivalent.

4.3.7.5.2 Move the roller sunshade to the full closed position. For guided systems, mark the absolute center of the fabric using a measurement target. For non-guided systems, mark the absolute center of the fabric and both center outboard edges as far outboard as practical using measurement targets as shown in Figure 5. If the sunshade is reinforced with multiple bows, place a center target and 2 outboard targets on every sunshade segment.

Note: If multiple bows, every segment has to be measured for sag.

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