

WEATHERING EXPOSURE TESTS FOR INTERIOR TRIMS

GM9538P

1 SCOPE. This specification describes procedures for conducting natural weathering exposure tests to evaluate the exposure tolerance of interior automotive materials, components and assemblies. The tests are commonly conducted in climatic regions which offer extreme weathering environments, such as Arizona and Florida. Material and/or Performance Specifications will identify the region.

1.1 CLASSIFICATION. When using this specification, one or more of the following suffixes must be used after the specification number to identify the exposure fixture, i.e., GM9538P U/G-SSTL-XXX, where XXX is defined in 3.1.2.1.1.

Suffix	Description
U/G-SSTL-XXX	Under Glass - Static Sealed fixture Temperature Limited to a maximum of XXX degrees (3.1.2.1 through 3.1.2.1.3)
U/G-TSTL-XXX	Under Glass - Tracking Sealed fixture Temperature Limited to a maximum of XXX degrees (3.1.2.4)
U/G-SSTLW-XXX	Under Glass - Static Sealed fixture Temperature Limited with a Water tray for added humidity to a maximum of XXX degrees (3.1.2.3)
U/G-TSTLW-XXX	Under Glass - Tracking Sealed fixture Temperature Limited with a Water tray for added humidity to a maximum of XXX degrees (3.1.2.4)
Special	Special test which requires some nonstandard test condition(s) may be used as additional suffix to above test fixture designations (3.1.2.5)

1.2 APPLICABILITY. Any passenger car, truck, multipurpose vehicle or bus interior material, component or assembly that has the potential for deterioration in appearance or function when exposed to natural weathering.

1.3 DEFINITIONS.

1.3.1 Total solar radiation: Natural light less than 3000 nm in wavelength.

1.3.2 Ultraviolet (UV) radiation: Natural light less than 400 nm in wavelength.

1.3.3 Langley: A traditional unit of measure for natural light energy defined as 1 g-cal/cm². A Langley is equivalent to .04184 MJ/m².

NOTE: The Langley is restricted by definition to the expression of natural light energy. The MJ/m² is a more universally recognized unit of energy measurement. However, for the purposes of this specification, it is not appropriate to compare natural light exposure energies (measured over the total solar or the UV radiation wavelength ranges) and usually expressed

in MJ/m² with artificial light exposure energies (measured over a very narrow wavelength range) and usually expressed in kJ/m².

1.3.4 Seasonally Adjusted Solar Radiation (SASR): Total solar radiation measured under test fixture glazing and adjusted both to relate the various limit temperature fixtures to a common reference temperature and to account for the difference in time spent at the fixture limiting temperature during the various seasons. This allows testing throughout the entire year with comparable results.

1.3.5 L*a*b* Color System: A color measurement system using orthogonal coordinates to describe color. The L* axis is the white-black (light-dark) axis: Large L*=light, Small L*=dark. The a* axis is the red-green axis: +a*=red, -a*=green. The b* axis is the yellow-blue axis: +b*=yellow, -b*=blue.

1.3.6 Delta E (ΔE): A resultant color change calculated by the equation:

$$\Delta E = (\Delta L^*{}^2 + \Delta a^*{}^2 + \Delta b^*{}^2)^{1/2}$$

1.3.7 L*C*h* Color System: A color measurement system that converts the L*a*b* rectangular values to L*C*h* cylindrical polar coordinates. The L* is the same as in the L*a*b* system. The C* vector is the saturation value, distance from the L* (lightness) axis, in the a*b* plane: Large C*=pure color (vivid), Small C*=pastel (pale). C* is calculated by the equation:

$$C^* = (a^*{}^2 + b^*{}^2)^{1/2}$$

The h° value is the rotational distance in the a*b* plane and determines the hue. An h° of 0° = Red, 90° = Yellow, 180° = Green and 270° = Blue. The h° is calculated by the equation:

$$h^\circ = \arctan (b^*/a^*)$$

1.3.8 Delta H* (ΔH*): The computed hue difference between two points in the L*C*h* color space, calculated by the equation:

$$\Delta H^* = (\Delta E^*{}^2 - \Delta L^*{}^2 - \Delta C^*{}^2)^{1/2}$$

1.3.9 Specular Gloss: The ratio, expressed as a percent, of the quantity of light reflected from a surface to the quantity incident on the surface in the specular (mirror reflected) direction.

1.3.10 Degradation definitions and rating scale are shown in Appendix A.

2 REFERENCED STANDARDS.

ASTM D523

3 TEST EQUIPMENT AND MATERIALS.

3.1 TEST FACILITY AND EQUIPMENT.

3.1.1 Test Facility. GM Desert Proving Ground Solar Exposure Laboratory or equivalent. The approved laboratories

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to run this test are listed in the GM Approved Source file under this specification number.

3.1.2 Test Fixtures. Test fixtures should be mounted on racks which have adjustable supports such that exposures can be conducted at nonstandard angles (other than 45° or 51° from horizontal) if requested for development tests. The racks should be located and spaced such that no test fixture is significantly affected by shading or reflected radiation from another fixture or other object during daylight hours.

3.1.2.1 For U/G-SSTL-XXX, use sealed test fixtures glazed with 3 mm clear tempered glass or 5.8 mm clear laminated glass (as specified on the test request form [Data Sheet 2] and based on the intended usage location in the vehicle) for exposing automotive interior test samples. These fixtures should be inclined at 45° from horizontal; face the equator (south); and have sufficient interior volume to accommodate full assemblies such as instrument panels, consoles, door panels, and seat assemblies. This temperature limiting fixture, including black panel and water tray details are shown in Appendix G.

3.1.2.1.1 The fixtures should be equipped with a recirculating, thermostatically controlled blower to prevent the temperature from exceeding the specified maximum value (XXX). The available temperature limits should be 85, 93, 102, or 110°C. The limit temperature is measured on the back surface of a reference black panel. The black panel must be constructed of 0.61 mm thick (24 gage) sheet steel with dimensions of 100 x 125 mm, primed with Krylon #1357 and painted with Krylon #1614 black high heat spray paint. The panel must be mounted on 13 mm thick plywood, also painted black, whose dimensions are at least 110 x 135 mm with a machined recess to allow space for the temperature sensor and its lead wire on the back of the black panel. The black panel must be fastened to the plywood with small screws near the corners of the panel. A thermocouple must be fastened to the back of the black panel adjacent to the temperature sensor for monitoring purposes. The response of the temperature sensor must be such that its output does not lag the thermocouple by more than 2°C.

3.1.2.1.2 The air recirculation system must be designed so that a uniform flow of fixture interior air is directed across the black panel and the irradiated test sample surface from the rear toward the front of the fixture. The control system should turn the circulation on at the limit temperature and off at 3°C below the limit temperature. It is suggested that tangential inlet centrifugal fans arranged end-to-end be used to supply the recirculated air flow.

3.1.2.1.3 For 102 and 110°C temperature limit operation, all interior fixture surfaces below the fixture lid must be insulated with foil-faced insulating sheets with an R value of between 5 and 6. The fixture bottom and front insulation sheets must be removed for the 85 and 93°C temperature limit operation, leaving the back and end insulation sheets in place.

NOTE: The fixture described in 3.1.2.1 must be equipped with over temperature protection in case of control system, blower, or power failure. This protection must activate at less than 6°C above the limit temperature.

3.1.2.2 Use sealed fixtures described in 3.1.2.1 through 3.1.2.1.3 for U/G-TSTL-XXX, but inclined at 51° from horizontal and supported on solar azimuth tracking bases which cause the fixtures to face the sun during daylight hours.

3.1.2.3 Use sealed fixtures described in 3.1.2.1 through 3.1.2.1.3 for U/G-SSTLW-XXX, but also equipped with a water tray to increase humidity inside the fixture. The tray should provide a water surface area of $910 \text{ cm}^2 \pm 110 \text{ cm}^2$ and be located along the front edge of the fixture within 100 mm of the glass. This fixture will typically provide relative humidity between $35 \pm 5\%$ at the heat of the day and $85 \pm 5\%$ at the coolest part of the day.

3.1.2.4 Use sealed fixtures described in 3.1.2.2 for U/G-TSTLW-XXX, but also equipped with a water tray to increase humidity inside the fixture as described in 3.1.2.3.

3.1.2.5 Special test fixtures or test conditions such as elevation angles other than 45° or 51° to horizontal, nonstandard glazing, or samples not parallel to glass can also be conducted but differences should be accurately noted. These special tests could include static soak vehicles and bucks for real time exposure of the whole vehicle or components and assemblies that will not fit in a test fixture; a headliner, for example. Vehicles and bucks normally face south but may be faced in any direction to accommodate the test objectives.

NOTE: Vehicles and bucks must have design-representative insulation and body air leakage, along with a full complement of interior components if realistic vehicle interior temperatures are to be attained.

3.1.3 Record keeping system with the capability to accommodate necessary test sample records, signal events such as inspections, color measurements or sample removals, and assist in generating reports.

3.1.4 A camera and color film for recording different types of degradation.

3.1.5 Instrumentation.

3.1.5.1 Pyranometers mounted at test fixture angle under test fixture type glass capable of sensing incident solar radiation in 295 to 2800 nm wave length range, and recording and data reduction equipment capable of providing hourly radiations and integrating over time to provide accumulated solar energy.

3.1.5.2 Ultraviolet radiometers mounted at test fixture angle under test fixture type glass capable of sensing incident radiation in the 295 to 385 nm wavelength range, and recording and data reduction equipment capable of providing hourly radiations and integrating over time to provide accumulated solar energy. This instrumentation must be stationary or azimuth tracking to match the test condition.

3.1.5.3 Ambient air temperature measuring equipment capable of providing hourly temperatures.

3.1.5.4 Ambient humidity measuring equipment capable of providing hourly humidities.

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3.1.5.5 Colorimeter or sphere geometry spectrophotometer to measure reflected subject color in the CIELAB color space using illuminant D65, either 2° or 10° observer and including the specular reflectance component.

NOTE: The color measurement instrument must be capable of measuring the color on whole components.

3.1.5.6 Glossmeter capable of measuring the specular gloss on test sample surfaces in accordance with ASTM D523.

3.1.5.7 AATCC Gray Scale available from AATCC, P.O. Box 12215, Research Triangle Park, NC 27709.

3.1.5.8 Thermocouples and associated recording and data reduction equipment capable of providing temperature information on black panels and test samples on an hourly basis.

NOTE: All instrumentation is to be calibrated as required; record instrumentation details and date of calibration on Data Sheet 1 unless the information is otherwise preserved in the testing laboratory records.

3.2 TEST MATERIALS.

3.2.1 Test samples will be furnished by the exposure facility customer (test requester) and may be in the form of a basic material sample, component, assembly, buck or complete vehicle.

3.2.2 Test samples should be accompanied by other materials necessary to accomplish the test objectives. Examples include a small sample of the test material to be used as a color reference or a mounting frame that has correct attaching and support points for a component or assembly.

NOTE: Masking a portion of the test sample to produce an unexposed area is not recommended since the masked area would experience high temperatures. It is mandatory that textile test samples be accompanied by comparison samples if the Gray Scale evaluation is requested. Store comparison samples in a cool, dark environment when not in use.

3.2.3 The test request form, Data Sheet 2, for describing the test sample and stating the type of test, test duration, measurements, inspections and reporting requirements should be transmitted in time to arrive at the test facility at about the same time as the test sample.

4 TEST PROCEDURE.

4.1 TEST PREPARATION.

4.1.1 Inspect the test sample for shipping damage or other defects. Note any discrepancies in the Comments section of Data Sheet 2. Notify the test requester of any significant shipping damage or defects either by a telephone call or a written report or both.

4.1.2 Assemble any supplied mounting frame or hardware and attach the test sample to it. If mounting apparatus is not supplied, procure or fabricate any hardware necessary to properly orient and support the test sample in the test fixture.

4.1.2.1 Small material samples may be mounted on 13 mm (1/2") plywood. Cover the plywood with card stock to shield the test materials from plywood exudation. Suitable card stocks are Franklin, Grain long-felt side up, 110/500 white index Stock #06506 made by Union Company, or #9016 White Bristol Card Stock.

4.1.3 If sample temperature measurements are requested, install thermocouples on the test sample. Thermocouples on soft skin/filler laminates (such as vinyl/foam or cloth/foam) should be installed at the skin filler interface unless requested otherwise. Pierce the skin and insert the thermocouple at least 13 mm and parallel to the surface, making sure that the junction is embedded at the skin/filler interface.

4.1.3.1 All other thermocouples should be installed on the test sample surface with a small bead of gray opaque high temperature adhesive such as epoxy. Care must be exercised to assure that the thermocouple junction is in contact with the sample surface and covered by the adhesive. The adhesive bead should be the minimum size that will securely attach the thermocouple to the surface.

4.1.4 If color measurements are requested, mark color measurement locations on the test sample with a permanent marker. Make initial color measurements on the test sample and record the results on a color data sheet, Data Sheet 3. For similar samples, make color measurements in the same location on each sample.

4.1.5 If gloss measurements are requested, they should be made as close to the color measurement location as possible. Mark the 0° position and make four initial gloss measurements at 90° clockwise to each other on the test sample and record the results on gloss data sheet, Data Sheet 4.

NOTE: This is a departure from ASTM D523 to accommodate directional differences in gloss of textured surfaces typical of vehicle interior components.

4.2 TEST.

4.2.1 For all sealed fixture tests.

4.2.1.1 Install the correct glass on the test fixture.

4.2.1.2 Install a 19 mm exterior grade plywood sample shelf in the test fixture, if necessary, for proper elevation of the test sample.

4.2.1.3 Secure the test sample or its mounting frame to the sample shelf or the floor of the test fixture. Mount the test sample surface of major interest or that would be exposed to the most radiation in a vehicle parallel to the glass and 50 to 100 mm below the glass, unless the component performance specification dictates a different mounting position. Mount the test sample at least 150 mm from the east or west ends of the fixture and at least 100 mm from the north or south sides of the fixture.

NOTE: Small samples such as material plaques, door arm rests, mirrors, some garnish moldings, etc. should be tested in

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the upper 1/2 of the same area *or* be mounted on rotatable boards and placed in the upper 2/3 of the sample area. In the latter case, the boards should be rotated 180° in the sample plane at the midpoint of color measurement intervals or some other appropriate interval so that temperature stratification effects are minimized for each sample.

4.2.1.4 Position the air system outlet scroll the same distance below the glass as the test sample surface.

4.2.1.5 Position the black panel in the air stream in the same plane as the test sample surface and air system outlet scroll and to the rear of the test sample and toward the west end of the fixture (essentially in the northwest corner of the test sample area as defined in 4.2.1.3 when the fixture is facing south). Connect the temperature sensor lead wires to the temperature controller and set the controller to the specified limit temperature. Connect the black panel monitoring thermocouple to the recorder. Cycle the fixture over temperature protection curtain to assure proper function. Make sure the correct insulation as discussed in 3.1.2.1.3 is installed in the fixture for the specified limit temperature.

NOTE: The metal portion of the black panel must not be in contact with anything except its plywood backing; the black panel assembly must be fastened in place only by its plywood mounting. Make sure the sample shelf is sized and positioned to allow air flow across the test sample surface, down the front of the fixture, across the fixture floor and back to the fan inlet. This requires at least a 75 mm gap between the front edge of

the shelf and the front of the box. The black panel must not be shaded by the curtain cover at solar noon.

The black panel temperature must be recorded at least once per hour during fixture operation, and the record should be examined daily to detect any temperature limiting system abnormalities. This record should be preserved, and if requested supplied to the requester.

4.2.1.6 Record the installation time and date and fixture ID number in the appropriate spaces and note the thermocouple recorder channel numbers on the test request form, Data Sheet 2.

4.2.1.7 Enter the appropriate test sample information into the sample record keeping system.

NOTE: Fixture test durations will be measured in terms of SASR unless specified otherwise on Data Sheet 2.

SASR is calculated by multiplying the measured total solar radiation, in Langley's, by the adjustment factor, as listed below, for the fixture utilized (with temperature limit) and the month, i.e., for a U/G-TSTL-110 test in June the adjustment factor is 1.50. For testing in Arizona use the factors in Table 1 which are based on data measured at the GM Desert Proving Grounds in Mesa, AZ and account for seasonal climatic and atmospheric conditions.

The factors in Table 2 are based on measured data in Miami, FL and account for seasonal climatic and atmospheric conditions. They should be used when testing in Florida.

TABLE 1 - ARIZONA SASR FACTORS

Month	Static Fixture				Tracking Fixture			
	85°	93°	102°	110°	85°	93°	102°	110°
Jan	0.57	0.72	0.96	1.10	0.58	0.71	0.92	1.13
Feb	0.56	0.70	0.93	1.06	0.58	0.74	0.97	1.17
Mar	0.54	0.69	0.90	1.05	0.58	0.76	1.00	1.26
Apr	0.60	0.76	0.98	1.17	0.66	0.87	1.13	1.44
May	0.57	0.73	0.92	1.07	0.65	0.87	1.13	1.44
Jun	0.58	0.75	0.94	1.10	0.66	0.88	1.14	1.50
Jul	0.58	0.74	0.92	1.07	0.66	0.86	1.13	1.46
Aug	0.61	0.79	0.96	1.21	0.64	0.83	1.09	1.44
Sep	0.63	0.82	1.04	1.29	0.65	0.87	1.14	1.48
Oct	0.62	0.82	1.06	1.28	0.65	0.87	1.12	1.38
Nov	0.59	0.78	1.01	1.20	0.62	0.82	1.06	1.28
Dec	0.52	0.68	0.88	1.00	0.56	0.70	0.91	1.09

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TABLE 2 - FLORIDA SASR FACTORS

Month	Static Fixture			
	85°C	93°C	102°C	110°C
Jan	0.53	0.67	0.83	0.94
Feb	0.56	0.71	0.88	1.00
Mar	0.55	0.70	0.86	0.97
Apr	0.55	0.69	0.86	0.97
May	0.53	0.67	0.82	0.93
Jun	0.49	0.62	0.77	0.87
Jul	0.49	0.63	0.78	0.88
Aug	0.50	0.63	0.78	0.88
Sep	0.52	0.66	0.82	0.93
Oct	0.54	0.69	0.85	0.96
Nov	0.52	0.67	0.82	0.93
Dec	0.51	0.65	0.80	0.91

4.2.1.8 Notify the test requester, by either a telephone call or a written report or both, of the test start date along with a confirmation of test samples and test conditions.

4.2.2 Starting the vehicle or buck test.

4.2.2.1 Orient the vehicle or buck as directed by the test request. If a component test, install the component in the vehicle or buck using design intent mounting points and hardware.

4.2.2.2 Connect thermocouples, if any, to the recorder.

4.2.2.3 Make sure all windows are rolled up tight and close the doors.

4.2.2.4 Perform the appropriate tasks specified in the following: 4.2.1.6 through 4.2.1.8.

NOTE: Vehicle or buck test durations will be measured in terms of total solar radiation under clear tempered glass inclined at 45° to horizontal facing south unless specified otherwise on the test request.

4.2.3 Glass Cleaning.

4.2.3.1 The test fixture glass should be cleaned inside and outside once per month or as needed. Care must be exercised to avoid getting cleaning solution on the test samples.

4.2.3.2 The exteriors of static soak test vehicles should be cleaned monthly with a spray of clean water. Remove water droplets to prevent water spotting if not using deionized water. Windows should be cleaned inside and outside with GM Glass Cleaner (PN1050427), being careful not to get any cleaner on test sample surfaces.

4.2.4 Inspections and Reports.

4.2.4.1 Perform visual inspections of the test sample periodically as specified by the test requester. Issue reports at the specified reporting interval.

4.2.4.2 Perform visual inspections in natural light.

4.2.4.3 Using the Exposure Test Report form (Data Sheet 5) as a data recording form, visually inspect the test sample and record all applicable changes using the definitions contained in the Appendix. If necessary for clarity, add a verbal description of the changes in the Comments section at the bottom of Data Sheet 5. Include observations regarding the percent of surface area affected by the changes, if appropriate. Also include comments about changes that may not be covered by the definitions in the Appendix A.

NOTE: The ratings are with respect to the as-received condition, not with respect to the condition at the previous inspection. Rating example: A rating of DC-8 means the test sample exhibited trace discoloration.

4.2.4.4 Photograph or video tape significant test sample changes if needed for illustrative purposes.

4.2.4.5 Send the latest copy of Data Sheet 5 to the test requester at the specified report interval. Include any photographs or other documentation that would be helpful in interpreting the report.

NOTE: If significant changes have occurred to the test sample since the last report, and a periodically scheduled report is not due, promptly notify the test requester of the changes either by a telephone call or a written report or both. Label the written report as an Incident Report.

4.2.5 Color and Gloss Measurements.

4.2.5.1 Perform color and gloss measurements at the interval specified on Data Sheet 2.

4.2.5.2 The test sample surface must be clean before measuring color or gloss. If necessary, remove foreign material such as dust or lint from the test sample surface by brushing with a soft bristled brush or by wiping with a damp colorfast cloth, whichever is appropriate. The test sample surface must be thoroughly dry before measurements are made.

NOTE: Do not remove any effect of a degradation process - chalking, for example - during the cleaning process unless specified otherwise on Data Sheet 2.

4.2.5.3 If measurements are to be made outdoors with portable meters, allow the instruments to stabilize at the outdoor temperature before use.

4.2.5.4 Calibrate the color meter against its standard calibration panel. Measure the test sample color, calculate and record ΔL^* , Δa^* , Δb^* and ΔE on Data Sheet 3 (if color measurements in the $L^*C^*h^*$ color system are required, they can be calculated from the $L^*a^*b^*$ values using the formulae in 1.3.7 and 1.3.8). Record accumulated SASR, total and UV radiations in the spaces provided. Record the highest observed sample