



TP-0000701

# Lightfastness of Materials to Artificial Weathering

TEST PROCEDURE | VERSION 02

## 0 Overview & Guidance

This standard outlines approved methodology for the study of the lightfastness characteristics of automotive materials in laboratory conditions, pursuant to the following terms and conditions.

0.1 **Laws.** This standard shall never supersede applicable laws and regulations.

0.2 **Language.** Only the English language version of this text shall be binding.

0.3 **Process Accreditation.** All materials testing must be conducted by a laboratory accredited to ISO/IEC 17025 or registered to ISO/TS 16949 by an established third-party auditor.

0.4 **Standard Obsolescence.** It is the responsibility of the supplier to ensure that the most current versions of all cited standards are employed.

## 1 Principle & Scope

High-energy UV radiation, in concert with other environmental stressors, is a key contributor to the visual and functional degradation of materials in vehicle service, both inside and outside the cabin. This document defines methods through which such degradation may be artificially accelerated by simulating the degradatory photochemical pathways encountered in natural weathering. Assessments of appearance and/or functional integrity may then be made in the laboratory.

In this method, simulated sunload is imparted by the radiant exposure and spectral power distribution produced by controlled-irradiance xenon arc lamps. The terms of exposure (including irradiance, temperature and humidity) are largely derived from standards J2412 (for interior applications) and J2527 (for exterior applications) published by the Society of Automotive Engineers (SAE). This procedure is complementary to the SAE documents and, unless explicitly stated otherwise, does not supersede the requirements or recommendations made therein.

In Appendices A and B, recommended levels of exposure are prescribed per vehicle zone for both interior and exterior applications.

## 2 References

ASTM E1164

ISO 105-A02, 2813, 3167-A

SAE J2412, J2527

## 3 Materials & Equipment

Controlled-irradiance xenon-arc test chamber per SAE J2412/J2527

**Spectrophotometer** per ASTM E1164

**Glossmeter** per ISO 2813

**Gray scale** per ISO 105-A02

**CIE Standard Illuminant D65**

**Specimens** of appropriate dimension

## 4 Method

**4.1 Sampling.** For initial approval of natural or generic-color plastic resins, molded test plaques shall be smooth (ungrained) and of sufficient size to be safely secured in the specimen holder and facilitate post-test evaluation. For initial approval or new color qualification of color-matched resins, molded test plaques shall be in appearance-approved color, grain and gloss. For the evaluation of all other materials and for testing of production parts, preference shall be given to test specimens cut from production-tooled components finished per the production process; upon agreement, purpose-made coupons in representative color, grain, gloss and finish may be substituted.

For the verification of mechanical properties after weathering, specimens of proper dimensions shall be produced as prescribed in the respective test specification. Test samples shall not be extracted from larger specimens post-test without prior approval.

Specimen surfaces must be protected from contamination prior to commencement of testing. A minimum of 3 specimens (from 3 separate parts, when applicable) shall be tested per requirement, with at least 5 measurements taken per specimen. Provision shall be made for control specimens when measuring changes in properties.

**4.2 Conditioning.** Specimens (or parts from which specimens are derived) shall be fabricated no sooner than 7 days prior to commencement of testing. Specimens must be conditioned for at least 48 hours at  $+23\pm 2^{\circ}\text{C}$  and  $50\pm 5\%$  RH prior to testing.

**4.3 Procedure.** For interior applications, refer to SAE J2412. For exterior applications, refer to SAE J2527. An extended-UV filter shall be used in all cases. The following configuration requirements are provided for reference:

Lamp	Xenon-arc
Inner Lamp Filter	Quartz
Outer Lamp Filter	Borosilicate
Irradiation Level	0.55 W/m <sup>2</sup> at 340 nm

Depending on placement in the cabin, interior materials may be tested to one of four exposure levels (see Appendix A). A material requiring a certain radiation dose at end of test shall also be evaluated colorimetrically at all intervening exposure levels; for instance, a material requiring a total dose of 902.4 kJ/m<sup>2</sup> shall also be evaluated at 225.6 and 601.6.

Likewise, exterior materials may be tested to one of two exposure levels (see Appendix B). Assessment

of color and gloss shall be made at intervals of 500 kJ/m<sup>2</sup>.

Clean specimen surfaces with a damp cloth prior to each evaluation.

4.4 **Evaluation.** Reported values for  $\Delta L^*$ ,  $\Delta a^*$ ,  $\Delta b^*$ ,  $\Delta H^*$ ,  $\Delta C^*$  and  $\Delta E^*$  (CIE 2000) for a given weathered specimen shall be the difference of the averages of at least 5 measurements taken on the weathered specimen and the reference control. The average over 3 specimens shall constitute the final value. Measurements shall be taken per ASTM E1164, using CIE Standard Illuminant D65, 10° observer, 0°/45° (or 45°/0°) measuring geometry and a field diameter of no less than 7 mm.

Gloss measurements shall be made according to ISO 2813. Gloss shall be measured at 60 degrees unless otherwise noted. Change in gloss against a control shall be determined as described for changes in color.

Visual evaluation shall be conducted according to the gray scale per ISO 105-A02. Any objectionable visual defect not captured by color or gloss readings shall be noted in the test report.

Post-test property evaluation shall be conducted as prescribed in the appropriate test procedure.

## 5 Document History

VERSION	ISSUER	DATE	DESCRIPTION OF CHANGE
01	A. Pezeshkian	2014-02	Initial Release
02	A. Pezeshkian	2019-03	Revision of sampling, evaluation methodology Replacement of ISO 7724 with ASTM E1164

## Appendix A: Interior Exposure Zones

The degree of sunload borne by any interior component is a function of a collection of factors, some of which are invariable (e.g., proximity to glazings) and others that are inherently variable (e.g., service environment).

The guidelines below delineate interior zones with corresponding minimum exposure requirements to facilitate the materials approval process. Zone criteria are presented for guidance only and are not intended to be comprehensive; this information should be used in consultation with Tesla Materials Engineering unless explicit written direction is provided in a related standard.

TABLE 2

ZONE 1 1240.8 kJ/m <sup>2</sup>	Largely horizontal surfaces at or above the beltline (excluding overhead trim), OR
	Surfaces under direct sunload during most daylight hours
ZONE 2 902.4 kJ/m <sup>2</sup>	Largely vertical surfaces at or above the beltline, OR
	Surfaces under oblique sunload during most daylight hours with some direct sunlight
ZONE 3 601.6 kJ/m <sup>2</sup>	Surfaces between beltline and floor under oblique sunload during most daylight hours
ZONE 4 225.6 kJ/m <sup>2</sup>	Surfaces under minimal sunload during most daylight hours

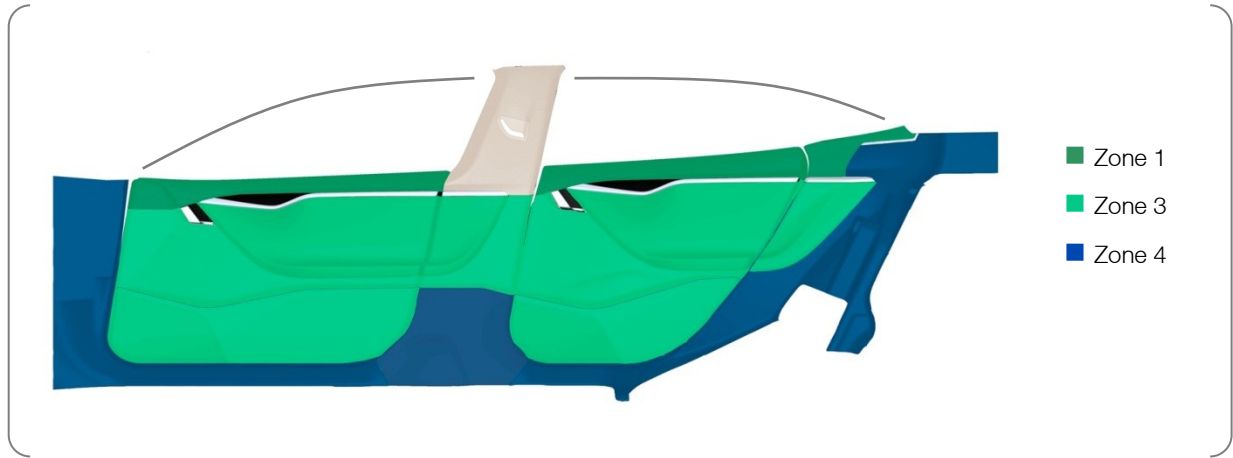
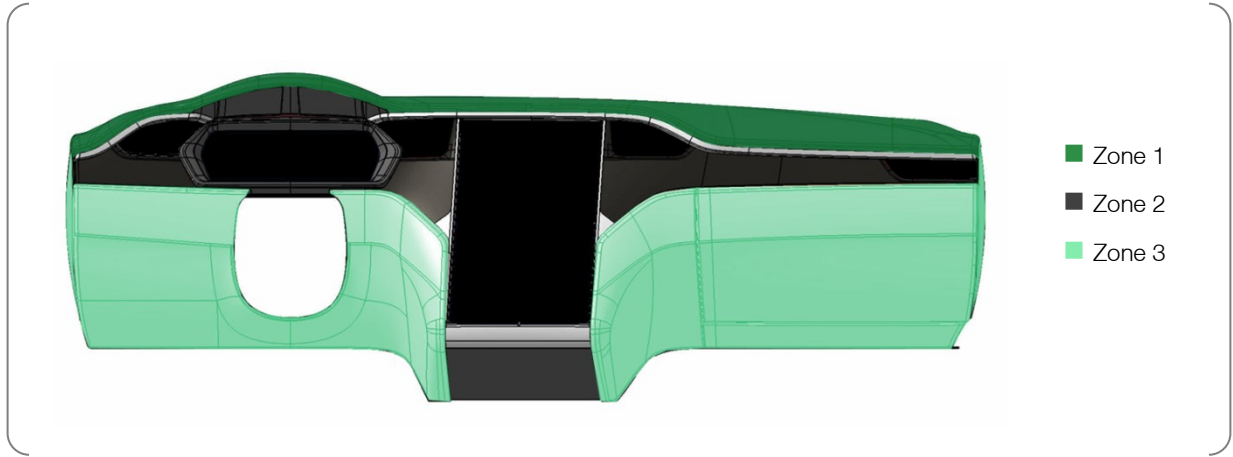
Interior components that commonly meet the described zone criteria are listed below. This list is neither comprehensive nor universal and should be used with caution. Illustrations are provided for additional clarity and may not apply to all programs as presented. Components marked by an asterisk are especially likely to vary by body style or equipment level. Consult Tesla Materials Engineering for further guidance.

**Zone 1:** Upper instrument panel, defroster grille, mirror housing, upper door trim, upper pillar trim\*, liftgate trim\*, parcel shelf

**Zone 2:** Middle instrument panel, steering wheel and column, sun visors, upper pillar trim\*, upper center console\*, front seating surfaces and head restraints, liftgate trim\*

**Zone 3:** Lower instrument panel, lower door trim, lower center console, seats\* (second and third row), seatbacks (front row), seat belts

**Zone 4:** Overhead console, lower seat trim, lower pillar trim, floor-level components, most overhead trim\*



## ⊕ Appendix B: Exterior Exposure Zones

The guidelines below delineate exterior zones with corresponding minimum exposure requirements to facilitate the materials approval process. Zone criteria are presented for guidance only and are not intended to be comprehensive; this information should be used in consultation with Tesla Materials Engineering unless explicit written direction is provided in a related standard.

TABLE 3

ZONE A 4500 kJ/m <sup>2</sup>	Largely horizontal surfaces along the hood, roof and liftgate
	Examples: Roof appliques, decklid spoiler
ZONE B 2500 kJ/m <sup>2</sup>	Largely vertical surfaces along vehicle front, sides and rear
	Examples: Fascia trim, body-side moldings, wheel trim