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Standard Specification for Metal Black Panel and White Panel Temperature Devices for Natural Weathering Tests[1]

This standard is issued under the fixed designation G179; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification provides specific information for the manufacturing and use of metal black and white panel temperature devices to measure temperatures that estimate highest maximum (black) and lowest maximum (white) temperatures of coated metal specimens during natural weathering tests.

1.1.1 The construction of a black or white panel has a significant effect on the indicated temperature. This standard describes a robust construction from the panels investigated, which has been shown to provide the highest, most consistent temperatures when compared side-by-side with other black panel constructions.

1.2 This specification includes details on design requirements and quantitative measurement techniques, which will lead to the proper selection of materials and use for black and white panel temperature sensors.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory requirements prior to use.*

NOTE 1—There is no equivalent ISO standard describing the selection and use of black panel sensors for natural weathering tests.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D523 Test Method for Specular Gloss

E220 Test Method for Calibration of Thermocouples By Comparison Techniques

E430 Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry

E772 Terminology of Solar Energy Conversion

E881 Practice for Exposure of Solar Collector Cover Materials to Natural Weathering Under Conditions Simulating Stagnation Mode

E903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres

G7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials

G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

2.2 *ISO Standard:*[3]

ISO 4892-1 Plastics: Exposure to Laboratory Light Sources—General Guidance

3. Terminology

3.1 The definitions given in Terminologies G113 and E772 are applicable to this practice.

4. Significance and Use

4.1 The measurement of the primary elements of weather; solar radiation, temperature, and moisture is necessary to quantify the weather conditions during exposure in natural weathering (outdoor) tests. This practice is applicable to weathering tests described in Practices G7, G24, or D4141 (Method A) and other standards in which these standards are referenced.

4.2 The surface temperature of exposed materials depends primarily on the amount of radiation absorbed, the emissivity of the specimen, the thermal conduction within the specimen, and the heat transfer between the specimen and the air in contact with the specimen surface and specimen holder. Since

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

it is often not practical to measure the surface temperature of individual test specimens, a specified black or white panel temperature sensor is used to measure a reference temperature. This reference temperature provides an indication of the temperature of a black or white specimen of similar construction to the panel sensor. It is important to locate the black or white panel sensor in proximity to the specimens, using the same support, so that it receives the same radiation and cooling conditions as the test specimen. For sites where multiple exposure racks are used, a single black or white panel temperature measurement made at the site and at the same exposure orientation as the exposure racks is acceptable.

4.3 Black panels are used in weathering applications since they are an indicator of the maximum specimen temperature achieved during exposure due to the high solar absorptance of the black coating. White panels are used as an indicator of the lowest maximum specimen temperature.

4.4 Consideration must be given to the panel construction (for example, type of metal, type of sensor, sensor mounting, type of backing, coating system), as different configurations may give different results.

NOTE 2—At low irradiance, the temperature difference between backed and unbacked panels will be small compared to higher levels of irradiance. Backed panels also have a slower response time due to the insulating effects of the wood.

NOTE 3—In an effort to provide temperature comparisons between laboratory and natural weathering, some users have used the black panels described in Practice G151 or ISO 4892-1 in natural weathering tests. Direct comparisons between black panel temperatures in laboratory and natural weathering should not be made unless correlation has been established. For instance, the temperature of specimens in a laboratory chamber with a black panel temperature of 60 °C may be very different from the temperature of outdoor specimens when the outdoor black panel reads 60 °C.

5. Reference Panel Types

5.1 Two types of reference panel sensors are commonly used in natural weathering tests: *(a)* Unbacked metal panels, or *(b)* Backed metal panels.

5.1.1 *Unbacked Panels*—These panels are mounted directly to the fixture by securing the top and bottom edges of the panel to the fixture. Ambient air can circulate on the front and back side of the panel to provide maximum cooling conditions for the panel.

5.1.2 *Backed Panels*—These panels are mounted onto a plywood substrate, which insulates the back of the panel. The panel and backing are then mounted on the exposure frame. Ambient air is only cooling the front side of the panel since the back side is insulated, resulting in higher surface temperatures.

NOTE 4—The selection of the proper type of panel backing is very important since the measured temperatures will be different. Typically, backed black panels are 5 to 10 °C higher than unbacked black panels depending on the level of irradiance, wind speed, and other factors. If a more realistic exposure of the panel simulating test panel conditions is desired, the panel shall be mounted in the same manner (backed or unbacked) as the test panels.

6. Reference Panel Requirements

6.1 *Substrate*—Unless otherwise specified, the substrate shall be a flat cold rolled steel panel with nominal dimensions of 300 mm long, 100 mm wide, and 1.0 mm thickness.

NOTE 5—Less corrosive materials may need to be used if the black or white panel is used in a corrosive environment. If a corrosion resistant material is used as a substrate, an alternate construction method may be required. Alternate constructions may not compare to panel constructions described in this specification.

6.2 *Primer*—The panel shall be treated with an automotive technology zinc phosphate and coated with an automotive after-market grade two-component epoxy primer to ensure adequate corrosion resistance. Apply the two-component epoxy primer, according to the manufacturer's recommendations. Allow to air-dry for 24 h or baked at 30 min at 60 °C (140 °F). Sand primer with 320-400 grit sandpaper. Remove sanding residue with a final wash solvent and a clean cloth.

6.3 *Sensor*—The sensor shall consist of a Type T thermocouple (copper/constantan) meeting accuracy requirements of better than or equal to ±1.0 °C throughout the measuring range. The sensor shall be small enough to attach to the panel and have a known response throughout the expected temperature range. The thermocouple shall be attached to the panel by spot-welding it to the middle of the back side. The thermocouple junction must be in contact with the bare metal panel. Care shall be taken to provide support to the spot weld joint to avoid loosening of the connection. This can be achieved by adding a mounting point on the thermocouple lead, which can act as a stress relief for the junction.

6.4 Two coating colors are commonly used on temperature reference panels in natural weathering tests: *(a)* Black coating, or *(b)* White coating.

6.4.1 *Black Coating*—The top (exposed) surface of the panel shall be coated with a automotive technology high gloss black basecoat clearcoat system after the thermocouple sensor has been spot-welded to the panel. The coated panel shall absorb 90 % or greater at all wavelengths from 300 to 2500 nm per Test Method E903.

6.4.2 *White Coating*—The top (exposed) surface of the panel shall be coated with a automotive technology high gloss white basecoat clearcoat system after the thermocouple sensor has been spot-welded to the panel. The reflectance of the white panel at all wavelengths between 300 nm and 1000 nm shall be 90 % or greater and 60 % or greater between 1000 nm and 2500 nm per Test Method E903.

6.4.3 *Basecoat*—Wipe the prepared primer surface with a tack rag to remove dust and lint. Apply two to three coats of either an acrylic or a polyester basecoat, according to the manufactures recommendations. Allow 5 to 10 min flash off between coats and allow to dry for 30 min before applying clearcoat.

6.4.4 *Clearcoat*—Wipe prepared basecoat surface with a tack rag to remove dust and lint. Apply two coats of an automotive after-market two-component urethane clearcoat, according to the manufacturers recommendations. Allow 5 to 10 min flash off between coats. Allow to air-dry for 24 h or baked at 30 min at 60 °C (140 °F).

NOTE 6—ASTM subcommittee G03.02 has conducted natural weathering exposures on commercially available black coatings for a period of 6 years. For more information about this study and the coatings used see Appendix X1.