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## Standard Specification for Thermoplastic Polyolefin-Based Polyolefin-Based Sheet Roofing<sup>1</sup>

This standard is issued under the fixed designation D6878/D6878M; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope

1.1 This specification covers flexible sheet made from thermoplastic polyolefin (TPO) as the principal polymer, intended for use in single-ply roofing membranes exposed to the weather. The sheet shall contain reinforcing fabrics or scrim.

1.2 The tests and property limits used to characterize the sheet are values intended to ensure minimum quality for the intended purpose. In-place roof system design criteria, such as fire resistance, field seaming strength, material compatibility, and uplift resistance, among others, are factors which should be considered but are beyond the scope of this specification.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *This standard may involve hazardous materials, operations, and equipment. 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.*

1.5 *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:<sup>2</sup>

[D471 Test Method for Rubber Property—Effect of Liquids](#)

[D573 Test Method for Rubber—Deterioration in an Air Oven](#)

[D751 Test Methods for Coated Fabrics](#)

[D1149 Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment](#)

[D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheet or Film at Elevated Temperature](#)

[D2137 Test Methods for Rubber Property—Brittleness Point of Flexible Polymers and Coated Fabrics](#)

[D5538 Practice for Thermoplastic Elastomers—Terminology and Abbreviations](#)

[D7635/D7635M Test Method for Measurement of Thickness of Coatings Over Fabric Reinforcement](#)

[G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources](#)

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.18 on Nonbituminous Organic Roof Coverings.

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

**G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials**

**3. Materials and Manufacture**

3.1 The sheet shall be formulated from ethylene and higher alpha-olefin polymers, copolymers, and mixtures thereof, in amounts greater than ~~50%~~50 % by weight of the total polymer content, suitably compounded to satisfy the physical requirements in the specification (see Practice **D5538**).

3.2 The sheet shall be capable of being heat welded, fused, or adhesively bonded to itself for making watertight field splices and repairs, and the supplier or fabricator shall recommend suitable methods and materials.

3.3 Sheet shall be reinforced with fabric or scrim.

**4. Physical Properties and Tolerances**

4.1 Each sheet specimen shall meet or exceed the physical requirements prescribed in **Table 1**.

4.2 The tolerance for time conditions (aging, weathering, and so forth) is  $\pm 15$  min or  $\pm 1$  % of the period, whichever is greater, unless otherwise specified.

4.3 The tolerance for temperature conditions (aging, weathering, and so forth) is  $\pm 2^\circ\text{C}$  [ $\pm 4^\circ\text{F}$ ] $\pm 2^\circ\text{C}$  [ $\pm 4^\circ\text{F}$ ] of the specified temperature, unless otherwise specified.

**5. Dimensions and Permissible Variations**

5.1 The width and length of the sheet shall be agreed upon between the purchaser and the supplier.

5.1.1 The width and length tolerance shall be  $+3$  %,  $-0$  %.

5.1.2 The thickness tolerance shall be  $+15$  %,  $-10$  % of thickness agreed upon by the purchaser and supplier, but in no case shall it be less than the minimum in **Table 1**.

5.1.3 The thickness of coating over scrim (reinforcing fabric) of the weathering side shall be at least 30 % of the overall thickness as agreed upon by the purchaser and supplier, but in no case shall it be less than the minimum in **Table 1**. The table below can be used as a reference for commonly used thicknesses.

**TABLE 1 Physical Requirements for TPO Sheet**

Thickness, min, mm [in.]	
Sheet-overall	1.0 [0.039]
Coating over fabric or scrim, weathering side only	0.38 [0.015]
Breaking strength, min, N [lbf]	976 [220]
Elongation at reinforcement break, min, %	15
Tearing strength, min, N [lbf]	245 [55]
Brittleness point, max, $^\circ\text{C}$ [ $^\circ\text{F}$ ]	-40 [-40]
Brittleness point, max, $^\circ\text{C}$ [ $^\circ\text{F}$ ]	-40 [-40]
Ozone resistance, no cracks	Pass
Properties after heat aging:	
Weight change (mass), max %	$\pm 1.5$
Inspect at 7 $\times$ magnification for cracks when bent over a 3 in. diameter mandrel	Pass
Linear dimensional change, max, %	$\pm 1$
Water absorption, max, mass %	$\pm 3.0^A$
Factory seam strength, min, N [lbf]	290 [66]
Weather resistance:	
Visual inspection	Pass

<sup>A</sup> Test performed on top coating material only. (Use Test Method **D471**, Procedure for Change in Mass.)



Overall Thickness, mm [in.]	Thickness of Coating Over Scrim, min, mm [in.]
1.1 [0.045]	0.38 [0.015]
1.5 [0.060]	0.48 [0.018]
2.0 [0.080]	0.60 [0.024]

## 6. Workmanship, Finish, and Appearance

6.1 The sheet, including factory seams, if present, shall be watertight and free of pinholes, particles of foreign matter, protruding fibers or reinforcement, undispersed raw material, nicks and cuts, voids, thin areas, delaminations, or other manufacturing defects that might adversely affect serviceability.

6.2 Edges of the sheets shall be capable of being seamed to one another without fishmouthing.

## 7. Test Methods

7.1 *Dimensions*—Test Methods **D751**, after permitting the sheet to relax at  $23^{\circ}\text{C}$  [ $73^{\circ}\text{F}$ ]/ $23^{\circ}\text{C}$  [ $73^{\circ}\text{F}$ ] for 1 h.

7.2 *Thickness, Sheet Overall*—Refer to Test Methods **D751**.

7.3 *Thickness of Coating Over Scrim (Reinforcing Fabric)*—Test Method **D7635/D7635M**. Follow preparation procedures as specified in Test Method **D7635/D7635M**. The thickness measurements shall be conducted as described in the test method on the coating on the side intended to be exposed to the weather.

7.4 *Breaking Strength*—Test Methods **D751**, Grab Method.

7.5 *Elongation at Break*—Test Methods **D751**, Grab Method.

7.6 *Tearing Strength*—Test Methods **D751**, 2 in./min jaw speed [8 by 8 in. sample size].

7.7 *Brittleness Point*—Test Methods **D2137**, Method B.

7.8 *Ozone Resistance*—Test Method **D1149**. Inspect at 7× magnification on specimens exposed to 100 mPa [ $1 \times 10^{-5}$  psi] ozone in air at  $40^{\circ}\text{C}$  [ $104^{\circ}\text{F}$ ]/ $40^{\circ}\text{C}$  [ $104^{\circ}\text{F}$ ]. Specimens shall be wrapped around a 75-mm [3-in.] diameter mandrel for 166 h exposure. Specimen shall be wrapped around the same size mandrel for inspection. The required specimen width is 25 mm [1.0 in.].

7.9 *Heat Aging*—Test Method **D573**. Sheet specimens are to be cut to a size of 50 × by 150 mm [2 by 6 in.]. Three specimens from across the sheet in a row are required, one from the center and one 200 mm [8 in.] away from each sheet edge. Specimens shall be preconditioned at standard laboratory conditions (**Note 1**) and then weighed immediately prior to heat aging using an analytical balance. Age sheet specimens for either (1)  $5376 \pm 6$  h (224 days or 32 weeks) at  $116^{\circ}\text{C}$  [ $240^{\circ}\text{F}$ ]/ $116^{\circ}\text{C}$  [ $240^{\circ}\text{F}$ ]; or (2)  $1344 \pm 6$  h (56 days or 8 weeks) at  $135^{\circ}\text{C}$  [ $275^{\circ}\text{F}$ ]/ $135^{\circ}\text{C}$  [ $275^{\circ}\text{F}$ ]. Provision shall be made for suspending specimens vertically without touching each other or the sides of the aging chamber. Aged specimens are then allowed to cool to room temperature, re-weighed, and inspected at 7× magnification when bent over a 3-in.-3-in. mandrel for surface cracking. The same specimen is used for both weighing and surface inspection and shall be evaluated within 4 h of removal from heat aging. Weight loss shall be expressed as the difference between the original weight and the aged weight, expressed as a percentage of the original weight to a precision of  $\pm 0.1$  %. If any cracking or weight change above the maximum allowed change is observed in any specimen, then the entire set of specimens will have failed the heat aging test.

NOTE 1—Specimens can be preconditioned at standard laboratory conditions ( $23^{\circ}\text{C}$  [ $23^{\circ}\text{C}$   $\pm$   $2^{\circ}\text{C}$   $2^{\circ}\text{C}$ ] and 50 %  $\pm$  5 % relative humidity) for 24 h.

7.10 *Linear Dimensional Change*—Test Method **D1204**. Age specimen for 6 h at  $70^{\circ}\text{C}$  [ $158^{\circ}\text{F}$ ]/ $70^{\circ}\text{C}$  [ $158^{\circ}\text{F}$ ] or 1 h at  $100^{\circ}\text{C}$  [ $212^{\circ}\text{F}$ ]/ $100^{\circ}\text{C}$  [ $212^{\circ}\text{F}$ ].

7.11 *Water Absorption*—Test Method **D471** for 166 h at  $70^{\circ}\text{C}$  [ $158^{\circ}\text{F}$ ]/ $70^{\circ}\text{C}$  [ $158^{\circ}\text{F}$ ]. Test performed on top coating material only. (Use Test Method **D471**, Procedure for Change in Mass.)

7.12 *Factory Seam Strength*—Test Methods **D751**, Grab Method. Modify procedure by cutting a 25 mm [1.0 in.] wide by 300 mm [12 in.] long sample across the lap seam. Place in jaws approximately 50 mm [2.0 in.] from edges of the overlap area and test at a jaw separation rate of 50 mm/min [2 in./min].

7.13 *Weather Resistance*—Accelerated weathering tests shall be performed using Practice **G155**.

7.13.1 *Practice Practices G151 and G155*—Xenon-arc apparatus shall be operated in accordance with the following conditions:

Filter Type	Daylight
<del>Irradiance</del>	<del>0.35 to 0.70 W/(m<sup>2</sup>·nm) at 340 nm. The maximum allowable operational fluctuation of the irradiance setting is ±0.02 W/(m<sup>2</sup>·nm).</del>
<u>Irradiance</u>	<u>0.35 to 0.70 W/(m<sup>2</sup>·nm) at 340 nm. The maximum allowable operational fluctuation of the irradiance setting is ±0.02 W/(m<sup>2</sup>·nm).</u>
Cycle	690 min light, 30 min light plus water spray on the front surface
<del>Uninsulated Black Panel Temperature</del>	<del>80°C. The maximum allowable operational fluctuation is ±2.5°C.</del>
<u>Uninsulated Black Panel Temperature</u>	<u>80 °C. The maximum allowable operational fluctuation is ±2.5 °C.</u>
Relative Humidity	50 %. The maximum allowable operational fluctuation is ±5 %.
<del>Spray Water</del>	<del>Refer to Practice <b>G155</b>, section 6.6.1. Typical water temperature used for specimen spray is 21 ± 5°C, but if ambient temperature is low and a holding tank is not used to store purified water, the water temperature can be below the typical range.</del>
<u>Spray Water</u>	<u>Refer to Practice <b>G155</b>, section 6.6.1. Typical water temperature used for specimen spray is 21 ± 5 °C, but if ambient temperature is low and a holding tank is not used to store purified water, the water temperature can be below the typical range.</u>
Specimen Repositioning	Refer to Practice <b>G155</b> , section 9.5
<del>Radiant Exposure</del>	<del>10 080 kJ/(m<sup>2</sup>·nm) at 340 nm (1209.6 MJ/m<sup>2</sup> at 300 to 400 nm)</del>
<u>Radiant Exposure</u>	<u>10 080 kJ/(m<sup>2</sup>·nm) at 340 nm (1209.6 MJ/m<sup>2</sup> at 300 to 400 nm) Inspect at 7× magnification for aging.</u>