Standard Specification for Poly(Vinyl Chloride) Sheet Roofing

This standard is issued under the fixed designation D4434/D4434M; 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 (e) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers flexible sheet made from poly(vinyl chloride) resin as the primary polymer intended for use in single-ply roofing membranes exposed to the weather. The sheet shall contain reinforcing fibers or reinforcing fabrics.

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, material compatibility, wind uplift resistance, in-situ shrinkage, among others, are factors that must 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 and health practices and determine the applicability of regulatory limitation prior to use.

2. Referred Documents

2.1 ASTM Standards:

D570 Test Method for Water Absorption of Plastics
D638 Test Method for Tensile Properties of Plastics
D751 Test Methods for Coated Fabrics
D1004 Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
D2136 Test Method for Coated Fabrics—Low-Temperature Bend Test
D3045 Practice for Heat Aging of Plastics Without Load
D5602 Test Method for Static Puncture Resistance of Roofing Membrane Specimens
D5635 Test Method for Dynamic Puncture Resistance of Roofing Membrane Specimens
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
G154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

3. Classification

3.1 Type II—Reinforced sheet in which fibers are incorporated into a production process, for example as a carrier, without appreciably affecting such physical property characteristics of the finished product as tensile strength or ultimate elongation, but may provide other desirable characteristics, such as dimensional stability.

3.2 Type III—Sheet that is internally reinforced with fabric and which may also have a fabric backing.

3.3 Type IV—Sheet that is internally reinforced with fabric and which may also have a fabric backing with minimum thickness of 0.91 mm [0.036 in.].

4. Materials and Manufacture

4.1 The sheet shall consist of poly(vinyl chloride) resin in amounts greater than 50% of the total polymer content suitably compounded with plasticizers, stabilizers, fillers, pigments, and other ingredients to satisfy the physical property requirements and accelerated durability tests.

4.2 To make seams and repairs, the sheet shall be capable of being bonded watertight to itself during the design service life of the sheets. The manufacturer shall recommend a suitable
5. Physical Requirements

5.1 The sheet shall conform to the physical requirements prescribed in Table 1.

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

5.3 The tolerance for temperature conditions (aging, weathering, and so forth) is ±2°C [±4°F] of the specified temperature, unless otherwise specified.

6. Dimensions

6.1 The width and length of the sheet shall be agreed upon between the purchaser and the supplier as part of the purchase contract. The width and length tolerance shall be ±3% ±0% after permitting the sheet to relax for 1 h at 1°C ±3°C [70°F ±5°F].

6.2 The thickness tolerance shall be ±10% of the thickness agreed upon by the purchaser and supplier, but in no case shall the thickness be less than the minimum in Table 1.

6.3 The sheet shall have a minimum coating or laminar thickness of 0.40 mm [0.016 in.] above the cross points of any fabric or fiber and the surface exposed to the weather.

7. Workmanship, Finish, and Appearance

7.1 The sheet and any factory seams shall be watertight. It shall be visually free of pinholes, particles of foreign matter, undispersed raw material, protruding fibers or reinforcement, or other manufacturing defects that might affect serviceability.

7.2 The sheet shall be visually free of nicks and cuts, voids, thin areas, delaminations, or other defects.

7.3 The sheet shall lay straight and flat to permit seaming without fishmouths.

8. Test Methods

8.1 Conditioning—Condition the test specimens in accordance with the individual test methods.

8.2 Overall Thickness—Test Method D638 for Type II and Test Method D751 for Type II, III, and Type IV.

8.3 Breaking Strength—Test Methods D751, Procedure B—1 in. strip for Type II and Procedure A for Type III and IV.

8.4 Elongation at Break—Test Method D751, Procedure B—1 in. strip for Type II and Procedure A for Type III and IV.

8.5 Seam Strength—Test Method D751, Procedure B—1 in. strip for Type II and Procedure A for Type III and IV. All testing shall be performed on seam specimens with the passing criteria specified as a percent of either unseamed sample tensile strength at break or unseamed sample breaking strength, dependent on type.

8.6 Heat Aging—Practice D3045 at 80 ± 1°C [176 ± 2°F] for 56 days ± 1 h.

8.7 Tear Resistance—Test Method D1004, for Type II.

8.8 Tearing Strength—Test Methods D751, B-Tongue Tear Method, for Type III and Type IV. Specimen size shall be 200 × 200 mm [8 × 8 in.].

8.9 Low Temperature Bend Test—Test Method D2136, at −40°C [−40°F].

8.10 Accelerated Weathering—Perform accelerated weathering for 5000 h using the exposure described either in 8.10.1 or 8.10.2. Choice of apparatus and exposure conditions selected shall be by mutual agreement among the interested parties. The two different types of exposures may produce

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**TABLE 1 Physical Requirements for Poly(Vinyl Chloride) Sheet**

<table>
<thead>
<tr>
<th>Property</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall thickness of PVC sheet, mm [in.]</td>
<td>1.14 [0.045]</td>
<td>1.14 [0.045]</td>
<td>0.91 [0.036]</td>
</tr>
<tr>
<td>Thickness over scrim, mm [in.]</td>
<td>0.40 [0.016]</td>
<td>0.40 [0.016]</td>
<td>0.40 [0.016]</td>
</tr>
<tr>
<td>Elongation at break, min, %:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine direction</td>
<td>250</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Cross-machine direction</td>
<td>220</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Seam strength, % of tensile or breaking strength</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Retention of properties after heat aging:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile strength, % of original</td>
<td>90</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Breaking strength, % of original</td>
<td>...</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Elongation, % of original</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Tear resistance, min, N [lbf]</td>
<td>45.0 [10.0]</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Tearing strength, min, N [lbf]</td>
<td>...</td>
<td>200 [45.0]</td>
<td>400 [90.0]</td>
</tr>
<tr>
<td>Low temperature bend</td>
<td>pass</td>
<td>pass</td>
<td>pass</td>
</tr>
<tr>
<td>Accelerated weathering test:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cracking (7x magnification)</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Crazing (7x magnification)</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Linear dimensional change, %</td>
<td>0.1</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Change in weight after immersion in water, %</td>
<td>≤3.0</td>
<td>≤3.0</td>
<td>≤3.0</td>
</tr>
<tr>
<td>Static Puncture Resistance</td>
<td>pass</td>
<td>pass</td>
<td>pass</td>
</tr>
<tr>
<td>Dynamic Puncture Resistance</td>
<td>pass</td>
<td>pass</td>
<td>pass</td>
</tr>
</tbody>
</table>

*A Above the cross points of any fabric or fiber and the surface exposed to the weather.
*B For reinforcing fabric only; elongation of PVC material shall be the same as Type II.
*C For Type II products, dynamic puncture shall be evaluated at an energy level of 10 J min. For Type III products, dynamic puncture shall be evaluated at an energy level of 20 J min.*
different test results. Therefore, they cannot be used interchangeably without supporting data that demonstrates equivalency of the procedures for the materials tested. Refer to Practice G151 for cautionary guidance regarding laboratory weathering.

8.10.1 Xenon Arc Light Exposure—Practice G155 apparatus shall be operated in accordance with the following conditions:

<table>
<thead>
<tr>
<th>Filter Type</th>
<th>Daylight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irradiance</td>
<td>0.35 W/(m²·nm) at 340 nm. The maximum allowable operational fluctuation of the irradiance setting is ±0.02 W/(m²·nm).</td>
</tr>
<tr>
<td>Set Point</td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>102 min light, 18 min light plus water spray on the front surface.</td>
</tr>
<tr>
<td>Black Panel Temperature, uninsulated</td>
<td>63°C [145°F] during the dry period. The maximum allowable operational fluctuation is ±2.5°C [±5°F].</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>30% ±5%</td>
</tr>
<tr>
<td>Chamber Air Temperature (where applicable)</td>
<td>44°C [111°F]. The maximum allowable operational fluctuation is ±2°C [±3.6°F].</td>
</tr>
<tr>
<td>Spray Water</td>
<td>Deionized. Refer to Practice G155, Section 6.6.1. Typical water temperature used for specimen spray is 21 ± 5°C [70 ± 9°F], if ambient temperature is low and holding tank is not used to store purified water, the water temperature can be below the typical range.</td>
</tr>
</tbody>
</table>

8.10.2 Fluorescent UV/Condensation Exposure—Practice G154 apparatus shall be operated in accordance with the following conditions: Using fluorescent UVA –340 lamps. Irradiance level shall be 0.68 W/(m²·nm) at 340 nm. The maximum allowable operational fluctuation of the irradiance setting is ±0.02 W/(m²·nm). Cycle 8 h light at 60°C [145°F], 4 h condensation at 50°C [122°F] uninsulated black panel temperature. The maximum allowable operational fluctuation is ±2.5°C [±5°F].

Note 1—If the operational fluctuations are greater than the maximum allowable after the equipment has stabilized, discontinue the test and correct the cause of the problem before continuing.

8.11 Linear Dimensional Change—Test Method D1204, 6 h at 80 ± 1°C [176 ± 2°F].

8.12 Change in Weight After Immersion in Water—Test Method D570, except for 168 ± 1 h at 70 ± 1°C [158 ± 2°F].

8.13 Static Puncture Resistance—Test Method D5602, at a load of 15 kg [33 lbf] min at 23 ± 1°C [73 ± 2°F].

8.14 Dynamic Puncture Resistance—Test Method D5635, at an energy of 10 J min at 23 ± 1°C [73 ± 2°F] for Type II and an energy of 20 J min for Type III and Type IV.

9. Inspection and Special Testing

9.1 The manufacturer shall inspect and test his production to ensure compliance of the product with this specification.

9.2 The purchaser may, in the contract, order special tests that the supplier shall be required to make beyond those described in Table 1.

9.3 If the results of any tests do not conform to the requirements of this specification, retesting to determine conformity shall be performed as agreed upon between the purchaser and the supplier.

10. Rejection and Resubmittal

10.1 Failure to conform to any one of the requirements prescribed in this specification shall constitute grounds for rejection. Rejection shall be reported to the supplier promptly and in writing. The seller shall have the right to reinspect the rejected shipment and resubmit the lot after removal of those packages not conforming to the specified requirements.

11. Product Marking

11.1 The sheet shall be identified on the side intended to be exposed to the weather with this ASTM designation, the name of the manufacturer or supplier, or PVC. The type of identification is at the manufacturer’s option. Such identification shall occur at intervals not to exceed 3 m [9.84 ft] in the long direction. The identification shall be applied in such a manner as to be legible five years from installation. Identification shall not be required when so specified by purchaser.

12. Packaging and Package Marking

12.1 The material shall be rolled on a substantial core and packaged in a standard commercial manner, unless otherwise specified, so as to be acceptable by commercial or other carriers for safe transportation to the point of delivery.

12.2 Shipping containers shall be marked with:

12.2.1 Name of the material,

12.2.2 Product code,

12.2.3 ASTM designation number, type and grade,

12.2.4 Size and quantity as defined by the contract order,

12.2.5 Name of the manufacturer or supplier, and

12.2.6 Number of the contract order.

13. Keywords

13.1 fillers; flexible sheet; physical properties; plasticizers; poly(vinyl chloride) resin; PVC; reinforcing fabrics; reinforcing fibers; seams; single-ply roofing membrane; stabilizers
ANNEX

(Mandatory Information)

A1. THICKNESS OF COATING OVER FABRIC REINFORCEMENT TEST METHOD D7635/D7635M

A1.1 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.

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