



Designation: D3161/D3161M – 20

# Standard Test Method for Wind Resistance of Steep Slope Roofing Products (Fan-Induced Method)<sup>1</sup>

This standard is issued under the fixed designation D3161/D3161M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

## 1. Scope

1.1 This test method covers the procedure for evaluating the wind resistance of many discontinuous, air permeable, steep slope roofing products that results from the product's rigidity, with or without contribution from sealant to help hold down the leading edge of the tabs, or mechanical interlocking, with or without contribution from sealant to help hold down the leading edge of the tabs, or any combination thereof. The products are applied to a test panel in accordance with the manufacturer's instructions and tested at a 2:12 (17 %) slope, or at the lowest slope permitted by those instructions.

1.2 This method evaluates wind resistance using a fan-induced procedure, delivering a stream of air across the exposed surface of the test specimens. This method does not measure structural performance, and does not provide a measure of uplift resistance. Consequently, this method is not applicable to continuous, non-permeable roof systems or coverings (such as membranes or mechanically seamed metal roof panels).

1.3 This test method was formerly titled "Wind Resistance of Asphalt Shingles (Fan-Induced Method)" but was revised to acknowledge that the method is applicable to many other steep slope roofing products and has been used to evaluate the wind resistance of those products for many years by several testing and certification laboratories. Steep slope roofing products that fall under the scope of this test method, in addition to asphalt shingles, are polymer-based shingles, fiber-cement shingles, concrete tiles, clay tiles, metal shingles, and photovoltaic shingles.

1.4 This test method is limited to steep slope roofing product applied with a maximum exposure of 410 mm [16 in.].

1.5 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 nonconformance with the standard.

1.6 *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 limitations prior to use.*

1.7 *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>

[D1079 Terminology Relating to Roofing and Waterproofing](#)  
[E230/E230M Specification for Temperature-Electromotive Force \(emf\) Tables for Standardized Thermocouples](#)

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology [D1079](#).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *seal*—as it relates to steep slope roofing products, is the bonding that results from the use of sealant.

3.2.2 *sealant*—as it relates to steep slope roofing products, is defined as factory-applied or field-applied material designed to help hold down the leading edge of the tabs.

3.2.3 *sealed*—the condition of the products after they are subjected to the conditioning procedure described in [8.2](#).

3.2.4 *steep slope roofing product, n*—a unit having a maximum width of 1321 mm [52 in.] and a maximum exposure of

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee [D08](#) on Roofing and Waterproofing and is the direct responsibility of Subcommittee [D08.02](#) on Steep Roofing Products and Assemblies.

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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.

410 mm [16 in.] designed for use as a roof covering in an air permeable system on a steep slope roof.

3.2.5 *steep slope, adj*—in wind-resistance testing of steep roofing products, having a slope equal to, or greater than 2:12 (17 %).

3.2.6 *tab, n*—a discrete section of the exposed portion of a steep slope roofing product.

3.2.6.1 *Discussion*—Typically, the exposed portion of an asphalt shingle consists of one or more tabs. Many other steep slope roofing products consist of a single tab per unit.

## 4. Classes of Steep Slope Roofing Products

4.1 Products are of three classes:

4.1.1 *Class A*—Pass at a test velocity of 97 km/h [60 mph].

4.1.2 *Class D*—Pass at a test velocity of 145 km/h [90 mph].

4.1.3 *Class F*—Pass at a test velocity of 177 km/h [110 mph].

## 5. Significance and Use

5.1 Most steep slope roofing products that have demonstrated wind resistance by this test have also performed well in use. Natural wind conditions differ with respect to intensity, duration, and turbulence; these conditions are beyond the means of this test to simulate. The results of this test do not directly correlate to wind speeds experienced in service, and no accommodation is made in this test method for building height, building exposure category, or building importance factor.

5.2 Many factors influence the wind resistance of a steep slope roofing product in the field; for example, temperature, time, roof slope, contamination by dirt and debris, and fasteners, both appropriate and inappropriate, that are misaligned or misplaced, or over- or under-driven, and sealant adhesion, if used and functioning. It is beyond the scope of this test method to address all of these influences. This test method is designed to evaluate the wind resistance of products as described in the scope when representative samples are applied to test panels in accordance with the manufacturer's instructions and conditioned as specified before testing.

## 6. Apparatus

6.1 *Test Machine*, capable of delivering a horizontal stream of air through a rectangular opening 914 mm [36 in.] wide and 305 mm [12 in.] high at a velocity not less than 97 km/h [60 mph]. At a velocity of not less than 177 km/h [110 mph], it is permissible to add a duct section to the equipment to lower the height of the rectangular opening to 152 mm [6 in.]. The machine shall be equipped with an adjustable stand to receive a test panel and be adapted to setting the test panel at any desired slope, at any horizontal distance from the lower edge of the duct opening, and at various angles incident to the wind direction.

6.1.1 *Calibration*—As a minimum, at the start of each test day, and at the start of each new desired test velocity, the air velocity shall be calibrated. Obtain calibration measurements using a bare panel as described in 7.1, or the test panel with the candidate product to be tested. With the panel positioned as described in 9.1, the velocity shall be measured using cali-

brated airflow measuring devices, such as pitot tubes or airflow anemometers. Velocity measurements shall be taken at a minimum of three evenly spaced locations across the duct orifice. The average measured velocity shall not vary more than  $\pm 5$  mph from the target test velocity selected to achieve the desired class of product.

6.2 *Timer*, capable of reading to the nearest minute.

6.3 *Mechanical Circulation Conditioning Cell or Room*, having forced circulation of air capable of receiving a 1.27-m [50-in.] wide by 1.68-m [66-in.] long, or larger test panel on a slope of 2:12 (17 %), or the lowest slope recommended in the product manufacturer's installation instructions, and of maintaining a uniform temperature of 57 to 60 °C [135 to 140 °F].

## 7. Test Samples

7.1 The test panels shall be of plywood, tightly matched sheathing boards, or other suitable decking material and not less than 1.27 by 1.68 m [50 by 66 in.] in size. They are to be of such rigidity that they will not twist or distort with normal handling, or vibrate from the wind velocity during the test.

7.2 Apply products with multiple tabs to duplicate panels, parallel to the short dimension of the panel, in the normal manner recommended by the manufacturer. Use roofing nails or other fasteners as specified by the manufacturer, positioned in accordance with the manufacturer's instructions, to fasten the product to the test panel. Apply products with single tabs to duplicate panels, parallel to the short dimension of the panel, in such a manner that there is at least one full shingle in each course. Use roofing nails or other fasteners as specified by the manufacturer, positioned in accordance with the manufacturer's instructions, to fasten the product to the test panel. Do not apply sealant to fasten down tabs unless required by the manufacturer's installation instructions. Do not apply pressure to the product either during or after application unless required by the manufacturer's instructions.

7.3 Apply interlocking-type product to an additional two panels, parallel to the short dimension of the panel, in accordance with the manufacturer's instructions.

7.4 Secure the exposed portion of any partial product tab with face nailing or stapling such that the partial product tabs will remain in place for entire duration of the test.

7.5 Control the temperature at  $27 \pm 8$  °C [ $80 \pm 15$  °F] and maintain the slope of the panel at 2:12 (17 %), or the lowest slope recommended in the product manufacturer's installation instructions, during application of the product.

## 8. Conditioning of Product Test Panels

8.1 Maintain the test panels at a slope of 2:12 (17 %), or the lowest slope recommended in the product manufacturer's installation instructions, and at a temperature of  $27 \pm 8$  °C [ $80 \pm 15$  °F] until beginning heat conditioning.

8.2 For a product with sealant to help hold down the leading edge of the tabs, place the test panels in the conditioning cell or room on a slope of 2:12 (17 %), or the lowest slope recommended in the product manufacturer's installation instructions, and maintain the temperature with air circulation

such that the temperature of the product specimen in the target area of the test airflow achieves the specified temperature of 57 to 60 °C [135 to 140 °F] for a continuous period of  $16 \pm 0.5$  h. The product specimen shall attain the specified temperature within  $2 \pm 0.5$  h.

8.2.1 *Temperature Measurement*—During preparation of the panel, and before conditioning, install at least one thermocouple placed under a tab of the product specimen within the target area of the test airflow on each panel. Position the thermocouple(s) junction bead(s) under the exposed tab in the area up-slope of, and a minimum of 25 mm [1 in.] from, any sealant. Take care that the thermocouple(s) lead wires do not contact, nor interfere with the sealant. Type T and Type K fine wire (0.3 mm [0.01 in.]) thermocouples have been found satisfactory for this purpose (see Specification E230/E230M). Connect the thermocouple(s) to a suitable data logging device to measure the temperature at least every 15 min during the conditioning period.

8.2.2 It is permitted to conduct the test with the thermocouple(s) remaining in position to avoid risk of disturbing the seal.

8.3 For a product that does not use sealants, place the test panels in a conditioning cell or a room on a slope of 2:12 (17 %), or the lowest slope recommended in the product manufacturer's installation instructions, and maintain at room temperature  $27 \pm 8$  °C [ $80 \pm 15$  °F] for a continuous period of at least 16 h.

8.4 After completion of the conditioning period, allow the test panels to come to room temperature  $27 \pm 8$  °C [ $80 \pm 15$  °F] while being maintained at a slope of 2:12 (17 %), or the lowest slope recommended in the product manufacturer's installation instructions. Remove the thermocouple(s) from the panel without damaging the shingles or disrupting the sealant bond.

8.5 Exercise care to avoid pressure on, or damage to, the product by any twisting or distortion of the test panels in handling.

## 9. Test Procedure

9.1 *Location of the Test Panel*—Install the panel on the test carriage and accurately adjust it in relation to the duct so that the exposed edge of the target course will be on the same level as the lower edge of the duct orifice at a horizontal distance of  $178 \pm 1$  mm [ $7 \pm \frac{1}{16}$  in.]. The target course shall be the third course up from the bottom of the panel for products applied with exposure less than 230 mm [9 in.], and shall be the second course up from the bottom of the panel for product applied with exposure of 230 mm [9 in.] and greater up to the maximum of 410 mm [16 in.]. The test slope shall be 2:12 (17 %) or the lowest slope recommended by the manufacturer for the product being tested. The test panel and carriage on which the test panel is supported shall be braced or otherwise prevented from movement during the test.

9.1.1 Test a minimum of two panels for each product being tested.

9.1.2 Since the design of interlocking-type product makes it difficult to determine the most critical angle of wind direction,

conduct the test at a minimum of three different angles using a separate panel for each test (head-on, with the bottom of the target course parallel to and 178 mm [7 in.] away from the machine orifice; and with the panel rotated 30 and 60° from the head-on position, with the bottom corner of the target-course tab nearest the duct being 178 mm [7 in.] away from and in the same horizontal plane as the bottom of the machine orifice). Test another panel at the position judged to be most critical on the basis of the first three tests.

9.2 *Performing the Test*—Maintain the ambient temperature at  $24 \pm 3$  °C [ $75 \pm 5$  °F] during the tests.

9.2.1 When the test panel is set in position, start the fan to produce the target test velocity, as established during calibration. The fan shall be operated continuously without adjustment for 2 h, or until such lesser time as a failure occurs.

9.2.2 During the test, observations are to be made by an observer or by video, or both, and recorded when any lifting of product tabs can be seen or noted. Any observable damage to the product or the disengaging of any interlocking feature, or a product tab, or the detachment of any part of the product from the deck, including any failure of sealant, with its time of occurrence shall be recorded. The full assessment of damage, as required by 10.3, is possible only after the cessation of the test.

9.2.3 In the event that observable failure occurs during the test, stop the air flow and record the elapsed time. The observable end point for failure shall be taken at the time of the observed failure or upon review of the video at the conclusion of the test in which any one or more full product tabs lift beyond perpendicular to the deck, or any interlocking feature tears loose or disengages from its interlocked position.

NOTE 1—It is not prohibited to use this test method with different test velocities and different time intervals of stop-and-go frequencies to do research on the performance of a steep slope roofing product in an unsealed condition. If this is done, the product does not have to be conditioned as specified in 8.2 before testing, and it is not prohibited to use different criteria for failure than those presented in 9.2.3. It is also not prohibited to interpret the results obtained in research testing of a product that does not use sealant to help hold down the leading edge of the tabs differently than as described in 10.3.

## 10. Interpretation of Results

10.1 Any steep slope roofing product assembly that uses sealant to help hold down the leading edge of the tabs and that restrains full product tabs from lifting (as defined in 9.2.3) shall be considered as having passed this test.

10.2 Any interlocked steep slope roofing product assembly that restrains full product tabs from tearing loose, or disengaging from their interlocked position, shall be considered as having passed this test.

10.3 Any steep slope roofing product assembly that does not use sealant to help hold down the leading edge of the tabs, nor any mechanical interlocking, shall be considered as having passed this test when the product (1) restrains full tabs from lifting beyond perpendicular to the deck during the test, (2) shows no permanent damage as a result of the test (such as by creasing, tearing, cracking, splitting, or breaking), and (3) has its leading edge return to within 13 mm [ $\frac{1}{2}$  in.] of its pre-test location within 1 h of cessation of the test.