ICC EVALUATION SERVICE

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ACCEPTANCE CRITERIA FOR SPECIAL ROOFING SYSTEMS

AC07

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PREFACE

Evaluation reports issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

> The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (|) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (→) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports.

ACCEPTANCE CRITERIA FOR SPECIAL ROOFING SYSTEMS (AC07)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this criteria is to provide a procedure for recognition of roofing systems in ICC Evaluation Service, LLC, evaluation reports under the 2009 and 2006 *International Building Code*® (IBC), the 2009 and 2006 *International Residential Code*® (IRC) and the 1997 *Uniform Building Code*™ (UBC). This criteria references code sections of each of the various codes. For each evaluation, the applicable section is the section of the code under which the system is being evaluated, unless noted otherwise.

The reason for the development of this criteria is to provide guidelines for the evaluation of special roofing systems, since the code does not provide test methods and performance requirements for such systems.

1.2 Scope: This criteria covers Wood Roof Covering Systems in Section 3.1, Plastic Tiles and Panels in Section 3.2, Cement-based Panels in Section 3.3, and Noninterlocking Composite Tiles, Consisting of an Expanded Polystyrene Backing and a Cementitious Facing, in Section 3.4. The specific requirements for each of the product types are covered in the noted sections.

1.3 Codes and Reference Standards: Where standards are referenced in this criteria, the standards shall be applied consistent with the requirements of the applicable code. Editions of the standards applicable to each code are summarized in Table 1.

1.4 Referenced Documents:

1.4.1 2009 *International Building Code*® (2009 IBC), International Code Council.

1.4.2 2009 *International Residential Code*® (2009 IRC), International Code Council.

1.4.3 2006 *International Building Code*® (2006 IBC), International Code Council.

1.4.4 2006 *International Residential Code*® (2006 IRC), International Code Council.

1.4.5 1997 *Uniform Building Code*™ (UBC).

1.4.6 ICC-ES Acceptance Criteria for Adhesive Attachment of Clay and Concrete Roof Tiles (AC152).

1.4.7 ASTM B 117-03, Practice for Operating Salt-spray (Fog) Apparatus, ASTM International.

1.4.8 ASTM C 67-03ae01 or -07, Sampling and Testing Brick and Structural Clay Tile, ASTM International.

1.4.9 ASTM C 140-07, Standard Test Method for Sampling and Testing Concrete Masonry Units and Related Units, ASTM International.

1.4.10 ASTM C 297/297M-04, Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions, ASTM International.

1.4.11 ASTM C 578-04 or -07, Specification for Rigid, Cellular Polystyrene Thermal Insulation, ASTM International.

1.4.12 ASTM C 1167--03, Standard Specification for Clay Roof Tiles, ASTM International.

1.4.13 ASTM C 1492-03, Standard Specification for Concrete Roof Tile, ASTM International.

1.4.14 ASTM D 226-97a or -06, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing, ASTM International.

1.4.15 ASTM D 635-03 or -06, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position, ASTM International.

1.4.16 ASTM D 638-03, Standard Test Method for Tensile Properties of Plastics, ASTM International.

1.4.17 ASTM D 790-03, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials, ASTM International.

1.4.18 ASTM D 1929-96(2001)e01, Standard Test Method for Determining Ignition Temperature of Plastics, ASTM International.

1.4.19 ASTM D 2017-05, Standard Test Method for Accelerated Laboratory Test of Natural Decay Resistance of Woods, ASTM International.

1.4.20 ASTM E 108-04 or -07a, Test Methods for Fire Tests of Roof Coverings, ASTM International.

1.4.21 ASTM G 152-04 or -06, Practice for Operating Light-Exposure Apparatus (Carbon Arc-Type) With and Without Water for Exposure of Nonmetallic Materials, ASTM International.

1.4.22 ASTM G 155-04 or -05a, Practice for Operating Light-Exposure Apparatus (Xenon Arc-Type) With and Without Water for Exposure of Nonmetallic Materials, ASTM International.

1.4.23 Florida Building Code Test Protocol HVHZ, Testing Application Standard (TAS) No. 100-95, Test Procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roof Systems.

1.4.24 Florida Building Code Test Protocol HVHZ, Testing Application Standard (TAS) No. 114-95, Test Procedures for Roof System Assemblies in the High Velocity Hurricane Zone Jurisdiction.

1.4.25 UL 790-98 or -04, Test Methods for Fire Tests of Roof Coverings, Underwriters Laboratories, Inc.

1.4.26 U.S. DOC PS-1-95 or -07, Construction and Industrial Plywood, United States Department of Commerce.

1.4.27 U.S. DOC PS-2-92 or -04, Performance Standard for Wood-based Structural-use Panels, United States Department of Commerce.

2.0 BASIC INFORMATION AND REPORT OF TEST

The following basic information shall be submitted:

2.1 Product Description: Complete information, as applicable, concerning formulation, density, protective coatings, manufacturing process, installation procedures, dimensioned scale drawings and details noting all thicknesses, and size and location of fasteners.

2.2 Installation Description: Installation instructions with typical installation details, including flashing and roof slope limitations.

2.3 Packaging and Identification: Method of packaging and identifying components shall be specified.

Identification shall include the ICC-ES evaluation report number and notice of any product installation limitations.

2.4 Field Preparation: Method of field cutting, trimming or forming, and treatment of cut edges.

2.5 Testing Laboratories, Reports of Tests and Product Sampling:

2.5.1 Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the Rules of Procedure for Evaluation Reports.

2.5.2 Product Sampling: Sampling of products shall be in accordance with Section 3.1 of AC85.

2.5.3 Test reports shall comply with AC85.

2.6 Foam Plastic: Information indicating compliance with UBC Section 2602, IBC Section 2603 and IRC Section R314, and the ICC-ES Acceptance Criteria for Foam Plastic Insulation (AC12), shall be submitted for systems incorporating foam plastics.

3.0 REQUIRED DATA

3.1 Wood Roof Covering Systems: These requirements apply to classified or non-classified wood roof covering systems that may or may not be fire-retardant treated. This section excludes products complying with the UBC, IBC and IRC.

3.1.1 Weatherometer Test: Weatherometer tests on panels or other systems coated with a plastic, bituminous, acrylic, vinyl or similar product on exposed surfaces or when preservative-treated in any manner shall be submitted demonstrating compliance with Section 4.1.

3.1.2 Wind Resistance: Installation shall be justified as having equivalent wind resistance to installation of similar products in IBC Chapter 15 or IRC Chapter 9, or UBC Chapter 15, as applicable.

3.1.3 Uplift-bend Test: For roof slopes exceeding 60 degrees (173%) from the horizontal uplift-bend tests shall be submitted demonstrating compliance with Section 4.4.

3.1.4 Fire Classification Test: Fire-retardant roof tests conducted in accordance with ASTM E 108 or UL 790, using the rain test outlined in ASTM D 2898 Method A (IBC, IRC) or UBC Standard 15-2 (UBC) and this criteria are necessary for recognition in new construction and for recognition of all reroofing over existing roof covering materials. See Section 4.6.1. Roof underlayments necessary for obtaining the classification in the tests shall be manufactured under a listing program of an inspection agency accredited by the International Accreditation Service, or otherwise acceptable to ICC-ES.

EXCEPTION: Roof construction recognized as nonrated (UBC) or nonclassified (IBC or IRC).

3.1.5 Temperature-cycling Test: See Section 4.9.

EXCEPTION: Western red cedar or redwood wood shakes and shingles installed in accordance with the applicable code for wood shakes and shingles.

3.1.6 Decay-resistance Test: See ASTM Test Method D 2017. Additional data on durability may be required on nondurable wood species.

EXCEPTION: Wood products determined to be inherently decay-resistant.

3.1.7 Quality Control:

3.1.7.1 General: Wood shakes and shingles shall be manufactured under an approved quality control program with quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) and the ICC-ES Acceptance Criteria for Quality Control of Wood Shakes and Shingles (AC09). Quality control inspections shall be conducted by an inspection agency accredited by the International Accreditation Service, Inc. (IAS) or otherwise acceptable to ICC-ES.

3.1.7.2 Fire-retardant-treated shakes and shingles: In addition to the requirements in Section 3.1.7.1, Fire-retardant-treated shakes and shingles shall comply with the applicable requirements outlined in the ICC-ES Acceptance Criteria for Classified Wood Roof Systems (AC107).

3.1.7.3 Quality control provisions for fire-retardant-treated panelized or remanufactured roof systems will be determined on a case-by-case basis.

3.1.8 Detailed Installation Instructions: The instructions shall specify minimum roof slope, sheathing type, underlayment, flashing and attachment details.

3.1.9 Special Installation Requirements:

3.1.9.1 IBC, IRC: For areas where the average daily temperature in January is 25°F (-4°C) or less or where there is a possibility of ice forming along the eaves and causing a backup of water, or in other areas as designated by the proponent or building official, installation instructions shall specify solid sheathing, and two layers of underlayment, complying with ASTM D 226, Type I, cemented together, extending from the eave's edge to a point at least 24 inches (610 mm) inside the exterior wall line of the building.

3.1.9.2 UBC: For uses in areas subject to wind-driven snow, ice buildup, wind-driven dust or sand, or in other areas as designated by the proponent or building official, installation instructions shall specify solid sheathing, with two layers of Type 15 felt applied shingle-fashion, solid-cemented together with approved cementing material between the plies, extending from the eave up the roof to a point 36 inches (914 mm) inside the exterior wall line of the building.

3.2 Plastic Tiles and Panels: These requirements apply to curved or flat tiles manufactured from durable plastic materials. Additional substantiating data may be necessary to justify recognition of plastic roof panels as defined in IBC Section 2609 or UBC Section 2603.6.

3.2.1 Weatherometer Test: See Section 4.1 for test procedure.

Five specimens shall be exposed. After the 2000-hour exposure, both the exposed and five control specimens shall be tested in accordance with ASTM D 638. Loss in tensile strength and elongation after the weatherometer test will be evaluated on a case-by-case basis.

For systems to be installed over spaced sheathing as described in Section 3.2.8, three additional specimens shall be exposed in the weatherometer. Exposed and control specimens shall be 1 inch (25.4 mm) wide, 6 inches (152 mm) long and the same thickness as the exposed tile or panel portion. After the 2,000-hour exposure, both the exposed and the control specimens

shall be tested at a 4-inch (102 mm) span in flexure in accordance with Procedure A, Test Method I, of ASTM D 790. The test results from the control and exposed specimens shall demonstrate, at 95 percent confidence level, that the mean flexural strength of the exposed specimens is not less than 90 percent of the mean flexural strength of the control specimens.

3.2.2 Wind Resistance: See Section 4.2.

3.2.3 Uplift-bend Test: For roof slopes exceeding 60 degrees (173%) from the horizontal, see Section 4.4.

3.2.4 Penetration Test: See Section 4.5.

3.2.5 Fire Classification Test:

3.2.5.1 Fire-retardant roof tests conducted in accordance with ASTM E 108 or UL 790 (IBC, IRC) or UBC Standard 15-2 (UBC), and these criteria are necessary for new construction and for recognition of reroofing over existing roof-covering materials. See Section 4.6. A minimum Class C classification is required. Roof underlayments necessary for obtaining the classification in the tests shall be manufactured under a listing program of an inspection agency accredited by International Accreditation Service (IAS).

3.2.5.2 Data shall be submitted on retention of fire-retardant qualities of the roof covering over its expected life. Specimens shall be subjected to the weatherometer test described in Section 3.2.1. The number of specimens shall be sufficient to conduct the ignition properties and burning rate tests. The exposed specimens and control specimens shall be tested in accordance with ASTM D1929 and ASTM D 635 for compliance under the IBC or IRC and UBC Standards 26-6 and 26-7 for compliance under the UBC. The test results from the control and exposed specimens shall demonstrate, at 95 percent confidence level, that the mean of the exposed specimens shall not vary by more than 10 percent of the mean of the control specimens for each test method.

3.2.6 Temperature-cycling Test: See Section 4.9.

3.2.7 Wind-driven Rain Test: See Section 4.10.

EXCEPTIONS:

1. Not required for compliance under the IBC or IRC when solid sheathing and either one layer of ASTM D 226, Type II, or two layers of ASTM D 226, Type I, asphalt-saturated felt underlayment, are used, and for compliance under the UBC when solid sheathing and a layer of Type 30 or two layers of Type 15 asphalt-saturated felt underlayment are used.

2. Not required when system installation complies with Section 3.2.8.

3.2.8 Installation over Spaced Sheathing: For installation over spaced sheathing, the following additional data is required:

1. Results of flexural strength tests described in Section 3.3.10. Results shall comply with Table 1 for the flat shingle or shake style type.

2. Installation instructions complying with Section 3.2.10.2.

3.2.9 Quality Control:

3.2.9.1 General: Plastic tiles and panels shall be manufactured under a quality control program with quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10). Quality control inspections shall be conducted by an inspection agency accredited by IAS, or otherwise acceptable to ICC-ES.

3.2.9.2 Periodic Testing: As a minimum, provisions for the following periodic tests shall be included in the approved quality control manual. All sampling and testing shall be supervised by the accredited inspection agency. Test results shall confirm equivalency to the original qualifying test data. If not, immediate follow-up reinspection, sampling of materials and retesting of the test(s) resulting in nonconformance of the product shall be conducted. Any failure of the retested samples shall be cause for immediate suspension of labels until a thorough investigation to determine the cause(s) has been completed. The inspection agency must notify ICC-ES, in writing, within ten days when label service is suspended. Tests noted in Sections 3.2.9.2.1, 3.2.9.2.2 and 3.2.9.2.3 shall be conducted with the product sampling and test frequency as noted.

EXCEPTION: When the recycled raw materials used are sourced 100 percent from post-industrial waste streams, the product sampling and test frequency noted in Sections 3.2.9.2.1, 3.2.9.2.2 and 3.2.9.2.3 shall be yearly.

3.2.9.2.1 Infrared Analysis (IR) Test: Tests shall be conducted on product samples obtained during each quarterly inspection.

3.2.9.2.2 Penetration Tests: Tests shall be conducted in accordance with Section 4.5. on product specimens obtained during each quarterly inspection.

3.2.9.2.3 Fire Tests: Tests shall be conducted in accordance with ASTM E 108 or UL 790 (IBC, IRC) or UBC Standard 15-2 (UBC) on a minimum of one spread-of-flame test deck and one burning-brand test deck. Tests are to be conducted at six-month intervals. The spread-of-flame test deck shall consist of equal amounts of material sampled during two consecutive quarterly quality control inspections. Materials sampled from the two remaining quarterly inspections shall be used in the burning-brand test deck. These periodic fire tests are minimum requirements to establish adequacy of the quality control program. Testing frequency may be reduced after the first year upon confirmation by ICC-ES that test results show equivalency to the original qualifying test data.

3.2.10 Detailed Installation Instructions:

3.2.10.1 Solid Sheathing: The instructions shall specify a 3:12 (25%) minimum roof slope, solid sheathing with two layers of ASTM D 226, Type I underlayment or one layer of ASTM D 226, Type II underlayment for compliance under the IBC or IRC or two layers of Type 15 felt or one layer of Type 30 felt for compliance under the UBC, and the requirements specified in Section 3.1.9 of this criteria. For deletion of felt underlayment, see Wind-driven Rain Test under Section 3.2.7.

3.2.10.2 Spaced Sheathing: For systems qualified under Section 3.2.8 with spaced sheathing, the following details shall be included in the installation instructions:

1. 3:12 (25%) minimum roof slope.

2. Minimum Type II asphalt-saturated organic felt interlayment and/or underlayment shall be installed over the sheathing.

3. Minimum nominal 1-by-4 or 1-by-6 spaced sheathing or solid sheathing. Spaced sheathing shall be installed with a clear spacing not exceeding the nominal width of the sheathing.

4. Maximum 50 percent panel exposure to weather when installed in shingle or shake fashion.

5. A minimum of two fasteners per panel.

6. Procedure for replacing damaged or defective panels.

3.3 Cement-based Panels, Tiles, Shingles or Shakes with Organic or Inorganic Fibers: These requirements apply to cement-based products not complying with the ICC-ES Acceptance Criteria for Clay and Concrete Tile (AC180).

3.3.1 Dimensions and Weight: Prior to commencement of tests, specimens shall be checked for shape, squareness of lugs (if any), and dimensional discrepancies. They shall also be checked for consistency in weight. Noninterlocking panels and tiles are permitted a $^1/_2$-inch (12.7 mm) width and length tolerance before being considered off-size. A minimum of ten specimens shall be individually weighed to the nearest 0.01 pound (0.004 kg). The individual panel weights shall be within ± 5 percent of the average of all ten specimens.

Installed weight shall be determined in accordance with Section 4.11.

3.3.2 Weatherometer Test: See Section 4.1.

3.3.3 Wind Resistance: See Section 4.2.

3.3.4 Uplift-bend Test: For roof slopes exceeding 60 degrees (173%) from the horizontal, see Section 4.4.

3.3.5 Penetration Tests: See Section 4.5.

3.3.6 Fire Classification Test: Fire tests conducted in accordance with ASTM E 108 or UL 790 (IBC, IRC) or UBC Standard 15-2 (UBC) and this criteria are necessary for new construction and for recognition of reroofing over existing roof-covering materials. See Section 4.6. A minimum Class C classification is required. Roof underlayment necessary for obtaining the classification in the tests will be identified in detail in the evaluation report and shall bear identification showing compliance with a nationally recognized standard.

3.3.7 Permeability Tests: See Section 4.7.

3.3.8 Freeze-thaw Test: See Section 4.8.

Conditions of Acceptance (IBC, IRC): There shall be no breakage and no greater than 1 percent loss in dry weight of any individual tile or panel section after the 50 cycles of exposure.

Conditions of Acceptance (UBC): There shall be no breakage and no greater than $1^1/_2$ percent loss in dry weight of any individual tile or panel section after the 100 cycles of exposure.

EXCEPTION: Not required if the fiber-cement-based tiles are restricted to areas where the mean annual rainfall does not exceed 20 inches (508 mm) and the average of the daily lows for every month is at least 30°F (–1.1°C). The fiber-cement-based tiles under consideration shall not have water absorption exceeding 30 percent by weight, when tested in accordance with Section 3.3.9.

3.3.9 Water-absorption Test: Testing shall be performed in accordance with Section 8 of ASTM C 140 or UBC Standard 15-5. Dry and saturated weights shall be reported for individual specimens.

3.3.10 Flexural-strength Test: Flexural-strength tests shall be conducted on conditioned specimens maintained for 72 hours at an ambient temperature of 72 ± 5°F (22.2 ± 2.8°C) and a 50 ± 5 percent relative humidity. In addition, wet-flexural-strength tests shall be conducted on roof coverings that exceed a 15 percent water-absorption limitation when tested in accordance with Section 3.3.9. The wet-flexural strength specimens shall be immersed for 24 hours in water as required for the water absorption test in Section 8 of ASTM C 140 or for 48 hours as required in UBC Standard 15-5. Flexural strength tests shall be conducted on water-saturated specimens within 30 minutes of removal from water tanks. The test deck shall consist of nominal 2-by-4 runners, spaced 16 inches (406 mm) on center with nominal 1-by-6 sheathing boards installed across the runners with a $5^1/_2$-inch (140 mm) clearance between the sheathing boards. For systems limited to solid sheathing, the test deck may consist of solid sheathing in lieu of spaced sheathing. Specimens shall be installed on the sheathing in a manner identical to field practices with maximum weather exposure and side spacing (keyway). The tested assembly can include underlayment or interlayment, fasteners and starter course or cant strip. The width of the test specimen assembly is not limited. Test specimens are loaded at midspan of the roof covering units between the spaced sheathing by a nominal 2-by-4 by 12-inch-long (305 mm) wood loading beam placed with the $3^1/_2$-inch (89 mm) width in contact with the specimen surface. Laterally, the loading beam shall be centered on the roof covering unit width, or centered over the keyway between specimen units, whichever yields lower values. The tested locations shall be reported. See Figure 1. An optional dampening pad may be placed between the loading beam and the test specimen. The dampening pad shall be maximum $^1/_2$-inch-thick (12.7 mm) felt, foam rubber, flexible urethane foam or other suitable material. The load shall be applied with a self-aligning fixture at a uniform rate between 200 and 500 pounds (890 and 2220 N) per minute. Initial fracture and ultimate loads shall be recorded to the nearest 5 pounds (22 N). Continuous chart recording of the test is to be included in the test report. A strip chart recorder, an X-Y plotter, or other suitable continuous recording device is to be used to provide a graph distinguishing between initial and final breaking loads. A chart speed of 5 inches (127 mm) per minute should be used. Failure modes must be described. Specimen age (in days) at time of flexural strength tests must be reported. Barrel-shape specimens shall be tested for flexural strength in accordance with Section 7.4 of ASTM C 1492 or UBC Standard 15-5, as applicable.

Conditions of Acceptance: The failure loads for the conditioned and saturated specimens shall be as required in Table 1.

3.3.11 Wet/Dry Cycling Test with Fasteners on a Restricted Frame: The test specimens are conditioned at 68°F ± 4°F (20°C ± 2.2°C) and 50 ± 5 percent relative humidity for 28 days, and installed on a rigid frame simulating the manufacturer's installation practices.

3.3.11.1 Aging Procedure: Three samples are subjected to 50 cycles of immersion for 24 hours in water at 68°F ± 4°F (20°C ± 2.2°C), followed by 24 hours in a forced-air oven at 158°F ± 5°F (70°C ± 2.8°C). Each cycle comprises 24 hours in the water followed by 24 hours in the oven.

Condition of Acceptance: After the cycling, the specimens shall be examined under 5× magnification to determine cracking or damage. There shall be no signs of distress at or adjacent to the fastener locations.

3.3.11.2 Bending-strength Test: After visual examination, as noted above, the samples are removed from the test frame and soaked in water at 68°F ± 4°F (20°C ± 2.2°C) for 24 hours prior to the bending strength test. Three conditioned (unaged) samples are also soaked in water at 68°F ± 4°F (20°C ± 2.2°C) for 24 hours prior to the bending strength test. This test is carried out on a set of three control (unexposed) samples and three samples cut from aged specimens. If the product has directional properties, additional specimens will be needed to evaluate bending strength in both machine and cross directions. Care must be exercised in preparation of the specimens, to avoid damage prior to the bending-strength test. The width of each test specimen shall be 4 inches (102 mm) and the length shall be 16*t* ± 1 inch, where *t* is the nominal thickness of the panel in inches. (For **SI:** 1 inch = 25.4 mm.)

Procedure: Each test specimen shall be simply supported on parallel metal rollers having a radius of $^1/_2$ inch (12.7 mm). The rollers must be free to rotate, which may necessitate use of ball or roller bearings; the center-to-center distance between the rollers shall be 16*t* measured to the nearest $^1/_{32}$ inch (0.8 mm). A load perpendicular to the face of the test piece shall then be applied at the center of the span with a metal bar of $^1/_2$-inch (12.7 mm) radius, parallel to the supporting rollers and in contact with the test specimen over its whole width. The load shall be applied at a uniform rate, or at a rate producing uniform increase in strain. The rate of application shall be so adjusted that the time from the initial load application to failure of the test specimen is not less than 30 seconds and not more than 120 seconds. The failing load for each test specimen shall be recorded to the nearest pound or 0.5 percent of the load.

Condition of Acceptance: When cement-based panels are tested in accordance with this test method after the aging procedure, the average flexural strength shall be at least 90 percent of the average flexural strength obtained on the control samples.

3.3.12 Hot-water Test: Samples shall be divided into two sets of five each. If the product has directional properties, additional samples may be needed to evaluate bending strength in both machine and cross directions. The control set is wrapped in plastic sheeting and stored at ambient temperatures for 58 days, then unwrapped and immersed in water at ambient temperatures for 48 hours. The second set of five samples shall be immersed in water at 140°F ± 5°F (60°C ± 2.8°C) for 60 days. Both sets shall be removed simultaneously from the water and allowed to drain. The hot-water immersion set shall be then be examined for cracks, structural alterations and delaminations, and findings are recorded. A specimen shall be placed on the supports of a simple-beam, center-point loading, flexural test fixture, which will accommodate the section size being tested. In no case shall the test specimen be less than 6 inches (152 mm) in width nor have a free span less than 12 inches (305 mm) in length. Care must be exercised in preparation of the test specimens, to prevent damage prior to the load test. Through the loading beam, a load is applied at a uniform rate and the load at failure is recorded.

Conditions of Acceptance: When cement-based panels are tested in accordance with this test method, the specimens after immersion in hot water shall comply with the following:

1. No visible cracks, structural alteration or delamination shall be apparent.

2. The mean-bending strength per unit width shall be at least 80 percent of the mean-bending strength per unit width of the control specimens.

3.3.13 Quality Control: Cement-based panels, tiles, shingles or shakes with organic or inorganic fibers require a quality control program with quality system documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10). Quality control inspections shall be conducted by an inspection agency accredited by IAS, or otherwise acceptable to ICC-ES. As a minimum, the quality control manual shall include dimensions, weight, flexural-strength and water-absorption tests for samples drawn from each production shift. The flexural-strength tests shall be conducted on either conditioned or immersed specimens. The minimum age specified in the manual at time of shipment must correlate to the minimum corresponding conditioned or immersed flexural strength values in Section 3.3.10 of this criteria.

3.3.14 Detailed Installation Instructions: The instructions must include the following:

1. 3:12 (25%) minimum roof slope.

2. Minimum Type II (IBC or IRC) or Type 30 (UBC) asphalt-saturated organic felt interlayment and/or underlayment shall be installed over sheathing.

3. Minimum nominal 1-by-4 or 1-by-6 spaced sheathing or solid sheathing. Spaced sheathing shall be installed with a clear spacing not exceeding the nominal width of the sheathing.

4. Limitations of maximum panel exposure to weather of 50 percent when installed in shingle or shake fashion.

5. Minimum two fasteners per panel.

6. Procedure for replacing damaged or defective panels.

3.4 Noninterlocking Composite Tiles Consisting of an Expanded Polystyrene Backing and a Cementitious Facing: These requirements apply to roof covering systems that consist of the subject tiles adhered, with adhesive complying with Section 3.4.3 of this criteria, to self-adhering underlayment complying with Section 3.4.4 of this criteria, which is, in turn, adhered to the wood structural panel sheathing roof deck. The minimum roof slope of the installed system shall be 3:12.

3.4.1 Foam Plastic: The nominal density of the expanded polystyrene (EPS) foam plastic shall be a minimum of 1.0 pcf (16.02 kg/m^3).

3.4.2 Dimensions and Weight: Prior to commencement of tests, the test laboratory shall check the tiles for shape, squareness of lugs (if any), dimensional discrepancies, and consistency in weight. Tiles are permitted a $^1/_2$-inch (12.7 mm) width and length tolerance before being considered off-size. A minimum of ten tiles shall be individually weighed to the nearest 0.01 pound (0.004 kg). The individual tile weights shall be within ± 5 percent of the average of all ten tiles.

Installed weight shall be determined in accordance with Section 4.11.

3.4.3 Roof Tile Adhesive: The roof tile adhesive, as it is to be used in the roof covering system, shall comply with the ICC-ES Acceptance Criteria for Adhesive Attachment of Concrete or Clay Roofing Tiles (AC152).

3.4.4 Self-adhering Underlayment: The self-adhering underlayment used in the roof covering system shall comply with Section 3.4 of AC152 and be qualified for use with the roof tile adhesive qualified under Section 3.4.3 of this criteria.

3.4.5 Weatherometer Test: See Section 4.1.

3.4.6 Tensile Bond: Tensile bond testing of the EPS-cementitious facing interface shall be performed on full-size tiles in accordance with ASTM C 297. Testing shall be performed on five control tiles, on five accelerated aged tiles (see Section 3.4.7), and on five freeze-thaw tiles (see Section 3.4.14). The test report shall include the details described in Section 14 of ASTM C 297.

Conditions of Acceptance: EPS foam shall fail cohesively in all tiles. Also, see Sections 3.4.7.2 and 3.4.14.

EXCEPTIONS:

1. Maximum 25 percent adhesion failure is acceptable.

2. Where tensile bond strength values are 6 psi (105 kPa) or greater, adhesion failure up to 100 percent is acceptable.

3.4.7 Accelerated Aging Test:

3.4.7.1 Five, full-size tile specimens shall be subjected to 10 test cycles, with each cycle consisting of air drying at 120°F (49°C) for a minimum of eight hours, total immersion in water at 70°F to 80°F (21.1°C to 26.7°C) for eight hours and then exposure at -20°F (-28.9°C) for 16 hours. The five exposed specimens are then subjected to the tensile bond strength test, as described in Section 3.4.6.

3.4.7.2 Conditions of Acceptance:

3.4.7.2.1 As viewed by minimum 5× magnification, there shall be no surface changes such as cracking, checking, crazing, erosion or other characteristics that may affect performance.

3.4.7.2.2 There shall be no delamination or indication of same between components.

3.4.7.2.3 The loss in tensile bond strength, when compared to the control specimens, shall not exceed 20 percent.

3.4.8 Salt Spray Resistance Test:

3.4.8.1 Testing shall comply with ASTM B 117. Three tiles shall be tested for 500 hours.

3.4.8.2 Conditions of Acceptance: There shall not be any deleterious effects from salt spray after 500-hour exposure.

3.4.9 Wind Resistance: See Section 4.3.

3.4.10 Uplift-bend Test: For roof slopes exceeding 60 degrees (173%) from the horizontal, see Section 4.4. Testing shall be performed over solid sheathing.

3.4.11 Penetration Test: See Section 4.5.

3.4.12 Roof Classification Test: Fire-retardant roof tests conducted in accordance with ASTM E 108 or UL 790 (IBC, IRC) or UBC Standard 15-2 (UBC) and this criteria are necessary for the installation configuration for which recognition is sought. A minimum Class C classification is required. See Section 4.6. Self-adhering roof underlayment necessary for obtaining the classification in the tests will be identified in detail in the evaluation report and must bear identification showing recognition in a current ICC-ES evaluation report.

3.4.13 Permeability Test: See Section 4.7.

3.4.14 Freeze-thaw Test: Testing shall be performed in accordance with Section 7.3 of ASTM C 1492. After the freeze-thaw exposure, the five exposed, full-size specimens are then subjected to the tensile bond strength test, as described in Section 3.4.6.

Conditions of Acceptance: There shall be no breakage or delamination and no greater than 1 percent loss in original dry weight of any individual tile after the 50 cycles of exposure. The loss in tensile bond strength, when compared to the control tiles, shall not exceed 20 percent.

EXCEPTION: Not required if the tiles are restricted to areas where the mean annual rainfall does not exceed 20 inches (508 mm) and the average of the daily lows for every month is at least 30°F (–1.1°C). The tiles under consideration shall not have water absorption exceeding 30 percent by weight, when tested in accordance with Section 3.4.15.

3.4.15 Water-absorption Test: Testing shall be performed in accordance with Section 8 of ASTM C 140 or UBC Standard 15-5 (UBC), as applicable. Dry and saturated weights shall be reported for individual specimens.

3.4.16 Wet/Dry Cycling Test with Fasteners on a Restricted Frame: See Section 3.3.11. Aging exposure testing shall be performed, as described in Section 3.3.11.1, on full-size tile specimens, with foam backing attached. The foam backing shall then be removed, and bending strength test specimens shall be prepared and tested, as described in Section 3.3.11.2.

Conditions of Acceptance: The mean bending strength of the aged specimens shall be at least 90 percent of the mean bending strength of the control specimens.

Hot-water Test: Tile samples, with foam backing, shall be divided into two sets of five each. If the product has directional properties, additional samples may be needed to evaluate bending strength in both machine and cross directions. The control set is wrapped in plastic sheeting

and stored at ambient temperatures for 58 days, then unwrapped and immersed in water at ambient temperatures for 48 hours. The second set of five samples shall be immersed in water at 140°F ± 5°F (60°C ± 2.8°C) for 60 days. Both sets shall be removed simultaneously from the water and allowed to drain. The hot-water immersion samples shall then be examined for cracks, structural alterations and delaminations, and findings recorded. The foam backing shall be removed from tiles prior to performing the flexural test. A specimen shall be placed on the supports of a simple-beam, center-point loading, flexural test fixture, which will accommodate the section size being tested. In no case shall the test specimen be less than 6 inches (152 mm) in width nor have a free span less than 12 inches (305 mm) in length. Care must be exercised in preparation of the test specimens, to prevent damage prior to the load test. Through the loading beam, a load is applied at a uniform rate and the load at failure is recorded.

Conditions of Acceptance: The specimens, after immersion in hot water, shall comply with the following:

1. No cracks, structural alteration or delamination shall be apparent.

2. The mean flexural strength per unit width of the specimens immersed in hot water shall be at least 80 percent of the mean flexural strength per unit width of the control specimens.

3.4.17 Quality Control: The products require a quality control program with quality system documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10). Quality control inspections shall be conducted by an inspection agency accredited by the International Accreditation Service, or otherwise acceptable to ICC-ES.

3.4.18 Detailed Installation Instructions: The instructions shall describe a roof covering system that is consistent with the components and system configuration that was subjected to qualification testing. The special installation requirements in Section 3.1.9 of this criteria shall also be specified.

4.0 TEST PROCEDURES

4.1 Weatherometer Tests:

4.1.1 Sample: A minimum of five representative product specimens shall be tested.

4.1.2 Apparatus: See ASTM G 152, Cycle 1 of Appendix Table X1.1.

4.1.3 Alternate Apparatus: See ASTM G 155, Cycle 1 of Appendix X3.1.

4.1.4 Procedure: The test shall be run for a period of 2,000 hours. Specimen condition, examined under 5× magnification, may be reported at the end of 500, 1,000, and 1,500 hours of exposure, and is required after 2,000 hours.

4.1.5 Conditions of Acceptance: Failure is defined as surface changes, as viewed by minimum 5× magnification, such as delamination, cracking, checking, crazing, erosion, or chalking that might affect performance.

4.2 Wind Resistance: This section applies to plastic tiles and panels, under Section 3.2, and to cement-based panels, tiles, shingles or shakes with organic or inorganic fibers, under Section 3.3.

4.2.1 Recognition under the UBC: Recognition may be granted for use in areas subject to a maximum basic wind speed (fastest mile) of 80 mph (129 km/h) on structures having a mean roof height of 40 feet (12.2 m) in Exposure B areas, provided the manufacturer can verify, in writing, that he has investigated and determined that the product will perform satisfactorily when installed under these conditions. Recognition beyond these limits will require full-scale dynamic wind uplift tests, static uplift tests, structural calculations, or a combination thereof, as an acceptable alternate. Test procedures used shall be accepted by ICC-ES staff prior to testing.

4.2.2 Recognition under the IBC, IRC: Recognition may be granted for use in areas subject to a maximum basic wind speed (3-second gust) of 100 mph (161 km/h) on structures having a mean roof height of 40 feet (12.2 m) in Exposure B areas, provided the proponent can verify, in writing, that he has determined that his product will perform satisfactorily when installed under these conditions. Recognition beyond these limits will require full-scale dynamic wind uplift tests, static uplift tests, structural calculations, or a combination thereof, as an acceptable alternate. Test procedures used shall be accepted by ICC-ES staff prior to testing.

4.3 Wind Uplift Test: This section applies to noninterlocking composite tiles consisting of an expanded polystyrene backing and a cementitious facing, described in Section 3.4. Testing shall be conducted in accordance with Sections 4.3.1 and 4.3.2.

4.3.1 Testing shall be performed in accordance with the delamination test described in Section 2 of Appendix H of the Florida Building Code TAS 114, “Test Procedures for Small Scale QC and Physical Properties of Approved Roof System Assemblies,” with the following revisions:

- Five assemblies shall be tested.
- The surface area of each assembly shall be the size of one full-size tile.
- Each assembly shall consist of the full thickness (from the sheathing to the tile) of the roof covering assembly for which recognition is sought.
- Testing shall be performed using steel plates that match the size of the assembly.
- Construction details, including dimensions, specific components and conditioning details of the assembly, shall be reported.
- Individual and average failure loads shall be reported in pounds (N) and pounds per square foot (Pa).
- Mode(s) of failure shall be reported.

Conditions of Acceptance: The minimum average failure load [psf (Pa)] shall be 112 psf (5363 Pa).

4.3.2 Testing shall be conducted in accordance with, and shall meet the conditions of acceptance of, Florida Building Code TAS 100. The tested assembly and components shall be representative of those for which recognition are sought.

Conditions of Acceptance: There shall be no leakage observed on the bottom of the test deck, and no tiles shall blow off.

4.3.3 Recognition under the IBC, IRC: Systems complying with Sections 4.3.1 and 4.3.2 qualify for use in areas subject to a maximum basic wind speed (3-second gust) of 100 mph (161 km/h) on structures having a mean roof height of 40 feet (12.2 m) in Exposure C areas.

4.3.4 Recognition under the UBC: Systems complying with Sections 4.3.1 and 4.3.2 qualify for use in areas subject to a maximum basic wind speed (fastest mile) of 80 mph (129 km/h) on structures having a mean roof height of 40 feet (12.2 m) in Exposure C areas.

4.4 Uplift-bend Test:

4.4.1 General: The test specimen is a roof, four courses high and four tiles (minimum) or panels wide. Spaced or solid sheathing over typical roof framing, using minimum-size components, must be used to typify field conditions. Fastener loads cannot exceed approved allowable values. Where allowable values are not available, load shall be based on a minimum factor of safety of 4, unless allowed otherwise. The test roof shall be erected and secured in a vertical position for testing, with the required loads applied horizontally. The horizontal load is applied at the center of the butt edge of an inner tile or panel in the second course from the bottom of the test specimen. The loads required to lift the tile butt a distance of $^1/_8$ inch (3.2 mm) and 2 inches (51 mm) are to be recorded. The latter is considered to be ultimate load. If failure occurs before the 2-inch (51 mm) movement, the method of failure shall be recorded. The same procedure is repeated for the butt edge of an inner tile or panel in the top course of the test structure, recording the same loads. The test is continued with a load equal to three times the tile weight applied horizontally outward and vertically downward at the center of the butt edge of an inner tile in the second course from the bottom of the test deck.

4.4.2 Condition of Acceptance: The load required to lift the tile butt $^1/_8$ inch (3.2 mm) shall be a minimum of twice the weight. When subjected to a load equivalent to three times the tile weight, the tile shall not crack, break or fall off the specimen deck.

4.5 Penetration Test:

4.5.1 Sample: Five representative specimens shall be tested.

4.5.2 Apparatus: A 3-inch-diameter (76 mm) steel plate with rounded corners. A device capable of imposing a 200-pound (890 N) load, and a measuring device capable of determining surface penetration to the nearest hundredth of an inch (0.025 mm).

4.5.3 Conditions of Acceptance: There shall be no tearing or cracking of the protective coating, causing exposure of the plastic, glass fibers, foam or other compressible materials; or excessive permanent deformation under the applied load, resulting in unsatisfactory performance of the roof covering.

4.5.4 Procedure: The test specimens shall consist of the roof covering and representative compressible insulation if used in the roof covering assemblies to be recognized. Specimens shall be continuously supported by a rigid backing such as concrete. The 200-pound (890 N) load is imposed on the plate which is centered on the specimen. The surface penetration is determined to the nearest hundredth of an inch (0.025 mm). The superimposed load is reduced to zero and reloaded a minimum of four additional times, with penetration and residual readings taken each time without removing the plate. The specimen is to be inspected after the test and the condition at the steel plate interface noted.

4.6 Roof Classification Test: Roof classification tests are to be conducted in accordance with ASTM E 108 or UL 790 (IBC, IRC) or UBC Standard 15-2 (UBC), as applicable.

4.6.1 Roof Classification for Wood Roof Covering: Wood roof covering shall comply with the ICC-ES Acceptance Criteria for Classified Wood Roof Systems (AC107).

4.7 Permeability Test:

4.7.1 General: Three tiles shall be tested for permeability. Each specimen is sealed along edges with suitable metal frame and putty, mastic or other compound to provide a watertight seal. The frame extends from below the underside of the specimen to not less than 2 inches (51 mm) above top surface of the specimen, or invert of the main water course, as applicable. Inverts of the side water channels, where present, shall not be covered by the sealant. Nail holes are sealed. The specimen shall be supported in a horizontal position by the metal frame alone. A 2-inch (51 mm) head of water measured from the top surface of the specimen, or invert of the main water course, as applicable, shall be maintained on the specimen for a period of 24 hours. If necessary, water shall be added during the test to maintain this level. The specimen condition shall be reported at least once each hour for the first eight hours and at the termination of the 24-hour test period.

4.7.2 Condition of Acceptance: At the end of 24 hours, there shall be no indication that water has dripped from the underside of the specimens.

4.8 Freeze-thaw Test: See test procedure outlined in ASTM C 67 (IBC, IRC) or ASTM C 67-93a (UBC) or as specified for clay tile, for test details. The test shall be conducted on five specimens. Each specimen shall include one sawn edge. For recognition under the UBC, the specimens are subjected to 100 cycles of freezing and thawing. For recognition under the IBC or IRC, the specimens are subjected to 50 cycles of freezing and thawing. The number of cycles are performed unless the test specimens break or appear to have lost more than 3 percent of their original weight as judged by visual inspection. The weight loss as a percentage of original weight of the dried specimen and the number of cycles causing breakage or withdrawal of the specimen must be reported. The manner of breakage or disintegration must be reported in detail.

4.9 Temperature-cycling Test:

4.9.1 General: A minimum of five samples shall be subjected to 25 consecutive cycles of this test, each cycle consisting of one hour of water exposure at room temperature prior to six hours at minus 40°F (–40°C), 2 hours at 70°F (21.1°C), 14 hours at 180°F (82°C), and 1 hour at 70°F (21.1°C). Between cycles, such as on weekends and holidays, the samples may be maintained

at 70°F (21.1°C). A plus 5°F (2.8°C) tolerance is allowed on the above temperatures. The roofing material shall be applied to a rigid wood frame simulating the field installation procedure recommended by the manufacturer. Horizontal and vertical joints shall be included in the specimens. Spray nozzles for the water exposure must be located approximately 7 feet (2134 mm) above the test decks and must deliver 6 inches (152 mm) of water per hour at a temperature of 40°F to 60°F (4.4°C to 15.6°C). The test decks must be installed at the lowest slope recommended for field installation. At the conclusion of the 25 cycles, the specimens shall be examined under 5× magnification.

4.9.2 Condition of Acceptance: The product is considered to have passed this test if no crazing, cracking or other deleterious surface or joint changes are noted at the end of the test. Additionally, there shall be no sign of failure or distress at fastener locations and at the panel joints. Wood roofing shall be evaluated to determine that performance is equivalent to or better than that of western red cedar of equivalent type and grade.

4.10 Wind-driven Rain Test:

4.10.1 General: The test frame shall be approximately 10 feet by 10 feet (3048 mm by 3048 mm) and hinged at the lower end to permit roof pitch variations. It shall be rigidly supported during the test. The test specimen shall be sized to fill the area within the test frame as completely as possible. Components shall be conditioned to have an initial moisture content representative of field conditions. Components shall be trimmed as necessary to fit within the test frame and to provide pitched, vertical and horizontal joints, if this is the practice. Components shall be laid in accordance with installation instructions that must be a part of the laboratory report. Batten lifts removed while cutting peripheral tile must be simulated with suitable packing. Gaps along the frame and unused nail holes must be sealed with a suitable compound. The frame shall not be erected against the side of a higher building or other solid surface where normal airflow over the specimen can be affected. The airflow over the test frame shall be directed and smoothed by suitably shaped baffles. The airstream velocity measured on a vertical plane midway between the upper and lower edge of the test specimen on a 24-inch (610 mm) grid shall be within the required axial velocity. The test report shall include the wind velocity profile developed on the 24-inch (610 mm) grid basis. The axial velocity over the test section shall be monitored with a calibrated vane-type velocimeter mounted approximately 6 feet (1829 mm) downstream of the wind source at the midheight of the panel. The velocimeter readings shall be taken with a stopwatch using a minimum 1-minute duration. The wind velocity is maintained between 35 and 40 miles per hour (56 and 64 km/h), and water is introduced into the wind stream.

4.10.2 Apparatus:

4.10.2.1 Wind Source: Airflow over the test rig shall be calibrated as previously indicated.

4.10.2.2 Water Supply: A sprinkle-pipe system, mounted on a movable frame capable of simulating a uniform 6-inch-per-hour (152 mm/hr) rainfall as monitored with flow gages calibrated in cubic feet per second, is an example of an acceptable system.

Uniform distribution of simulated rainfall requires calibration of water flow gages, monitoring the water supply to ensure sufficient distribution over the test specimen surface at each specified pitch, proper orientation and airspeed. The simulated rain striking the test specimen shall be uniformly distributed within a 20 percent variation over the test deck.

Distribution and calibration of water flow may also be determined by the following method: A shallow tray is attached to the test rig in place of the test specimen. The tray bottom is covered with a layer of thick absorbent paper (high-wet-strength, extra-thick, white filter paper) that has been weighed and lined to form 12-inch (305 mm) squares. At the required wind velocity, water is fed into the airstream at a suitable rate, indicated by the flow-rate meters, for a time sufficient to wet but not saturate the paper. The air and water flows are then stopped, and the paper is removed and cut into squares. Each square is weighed. Using the initial average dry weight and sample weight after exposure, the amount of water striking the test area, and the distribution, can be determined. The test is repeated with different flow meter settings at the same air velocity, to determine if distribution is affected by water flow. A chart shall then be prepared, for review and future reference that describes the simulated-rain distribution for each flow meter setting, pitch and orientation. When the simulated-rain distribution is determined, calibration may be made by collecting water falling into a sealed box gasketed and clamped to the underside of the test rig when the test specimen frame is left open. The volume of water collected in the box over a suitable time interval serves as a check for the required flow. This method allows water to be collected over a longer period or allows water to be measured continuously as it is drained from the test rig box.

4.10.3 Procedure: The underside of the test specimen shall be photographed immediately prior to starting tests. The airflow shall be between 35 and 40 miles per hour (56 and 64 km/h), with velocity and pressure differentials across the test surface measured and recorded. The pressure distribution across the surface shall be measured at not less than 10 points. The water supply rate shall be adjusted for a simulated rainfall of 6 inches (152 mm) per hour. The roof slope should be the flattest proposed for installation. For tile and panel roofing materials, a slope of 3:12 (25%) is used. The test must commence at the specified airspeed with three cycles of simulated rainfall of 15 minutes each, with the wind generator stopped for 5 minutes after each cycle to allow observation and recording of the specimen condition. The condition of joints (as viewed from the underside) must be reported after each rainfall insofar as water infiltration is concerned. Damage, if any, to specimens and fasteners shall also be reported. Upon completion of the test, components shall be dismantled and condition of lapped areas and under surfaces noted and photographed.

4.10.4 Conditions of Acceptance: There shall be no leaks. The test report shall indicate the extent of tile or panel fluttering during the test periods and whether it was due to oversized nail holes or loosening fasteners.

4.11 Installed Weight Test: This test method applies to cement-based panels, tiles, shingles or shakes with organic or inorganic fibers (Section 3.3), and to

noninterlocking composite tiles, consisting of an expanded polystyrene backing and a cementitious facing (Section 3.4).

4.11.1 Test Method:

1. Provide a suitable frame which can be adjusted from a 2:12 to a 5:12 (16.67% to 41.67%) slope. The standard setting shall be a 2:12 (16.67%) slope, unless a greater slope is requested by the manufacturer. Construct a test frame with metal C studs or equivalent so that the open spaced sheathing is installed at a maximum clear span recommended by the product manufacturer. The test frame shall be a minimum of 40 inches (1016 mm) wide and 50 inches (1270 mm) long. Record the weight of the test frame, to the nearest one-quarter pound, and designate it (W_{fi}).

2. Before any testing is started, it shall be confirmed by appropriate methods of analysis that there are no surface sealer treatments of any type present on the specimens to be evaluated.

3. Prior to installation of the product on the test deck, condition test specimens within limits of 75°F ± 5°F (23.9°C ± 2.8°C) and a relative humidity of 40 to 50 percent for 28 days. The test specimens used to construct the test deck shall be separated from each other during conditioning, to allow free air circulation around all surfaces.

4. Install the conditioned product on the test frame, with minimum recommended head and side laps. The outside cut edges at the top end of the test deck are to be sealed with appropriate waterproofing material. All other cut edges are to be left as installed. Record the weight of the test frame and test product roof covering after completion of the installation, to the nearest one-quarter pound, and designate the weight as (W_{fs}).

5. Prior to positioning the test deck for testing, place a calibration deck or other suitable panel in the test chamber for calibrating the water intensity. The entire surface of the test deck is to be wetted with sufficient overlap coverage so that all areas of the deck are exposed to a rainfall intensity of 6 inches (152 mm) per hour. Use rain gauges and flow meters to calibrate the system. Furthermore, the test deck shall be divided into a 10-inch-by-10-inch (254 mm by 254 mm) grid system, with the rain pattern being measured in each sector so as to ensure a uniform water distribution over the entire surface of the test deck. Maintain the temperature of the water in the line to the spray nozzle at 70°F ± 10°F (21.1°C ± 5.5°C). After calibrating the rain-fall intensity, remove the calibration panel and install the test deck.

6. Wet the test deck continuously for 6 hours, following with a 12-hour "rest" period within the rain chamber. No air movement over the deck by fans or blowers or by any other means is permitted. Follow the first complete cycle, with a second 6-hour wetting cycle, but do not continue with the "rest" procedure. Determine and record the weight of the test deck after 10 minutes, to the nearest $^1/_4$ pound (0.11 kg), and designate the weight as W_{10}.

7. **Drying Cycle:** After determining the wet weight, the complete test deck assembly shall be placed in a circulating-air drying oven at 150°F ± 10°F (65.5°C ± 5.5°C), and dried until constant weight is obtained. Constant weight is determined when two consecutive weighs change by not more than 0.10 pound (0.045 kg). Dry weight is designated as (W_{fd}) and shall be recorded to the nearest $^1/_4$ pound (0.11 kg).

8. **Reporting of Data:**

   a. Initial weight of the test frame = (W_{fi}) pounds (kg).

   b. Weight of test frame plus roofing product, installed = (W_{fs}) pounds (kg).

   c. Weight of test frame plus roofing product, 10 minutes after completion of the second rain cycle = (W_{10}) pounds (kg).

   d. Weight of test frame plus roofing product, after drying to constant weight = (W_{fd}).

Calculated installed weight:

A_{sf} = test deck area in square feet (m^2).

Wet installed weight in psf (kg/m^2), (10 min. after 2nd rain cycle) =

$$\frac{W_{10} - W_{fi}}{A_{sf}}$$

Dry installed weight in psf (kg/m^2), (dry weight) =

$$\frac{W_{fd} - W_{fi}}{A_{sf}}$$

TABLE 1—FLEXURAL LOAD REQUIREMENTS

PRODUCT TYPE	MINIMUM LOAD IN POUNDS							
	Conditioned				Immersed			
	Average[1]		Individual[2]		Average[1]		Individual[2]	
	Initial[3]	Ultimate	Initial[3]	Ultimate	Initial[3]	Ultimate	Initial[3]	Ultimate
Flat shingle or shake style	225	300	200	250	215	250	200	225
Barrel	N/A	400	N/A[4]	350	N/A[4]	325	N/A[4]	275

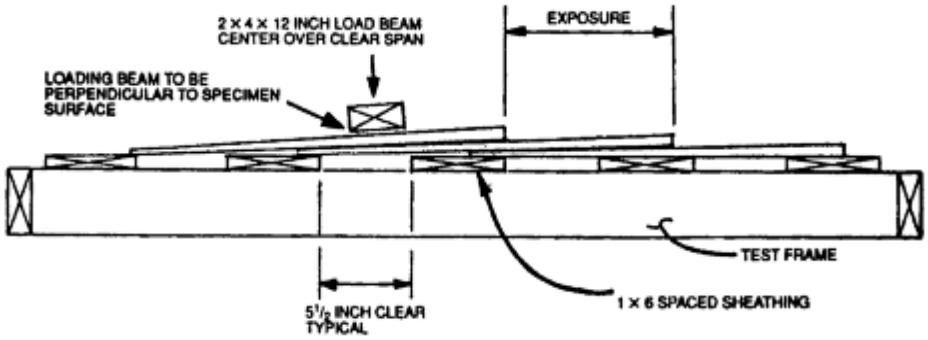
For **SI:** 1 inch = 25.4 mm, 1 pound = 4.45 N.

[1]Average value of five consecutive tests
[2]Minimum individual test value
[3]Acceptance of initial fracture loads will be considered only when the method of field installation precludes any shingle, shake or tile from becoming dislodged from its originally installed position.
[4]N/A = Not applicable.

TABLE 2 – CROSS REFERENCE OF EDITIONS OF STANDARDS

STANDARD	-2009 IBC/IRC	-2006 IBC/IRC	-1997 UBC
ASTM B 117	-03	-03	-94
ASTM C 67	-07	-03ae01	-93a
ASTM C 140	-07	-03	-90
ASTM C 297/297M	-04	-04	-94
ASTM C 578	-07	-04	-92
ASTM C 1167	-03	-03	UBC Standard 15-5
ASTM C 1492	-03	-03	UBC Standard 15-5
ASTM D 226	-06	-97a	-89
ASTM D 635	-06	-03	UBC Standard 26-7
ASTM D 638	-03	-03	-84
ASTM D 790	-03	-03	-92
ASTM D 1929	-96(2001)e01	-96(2001)e01	UBC Standard 26-6
ASTM D 2017	-05	-05	-81(1994)e01
ASTM E 108	-07a	-04	UBC Standard 15-2
ASTM G 152	-06	-04	--
ASTM G 155	-05a	-04	--
TAS No. 100	-95	-95	-95
TAS No. 114	-95	-95	-95
UL 790	-04	-98 (IBC[1]), -04 (IRC)	UBC Standard 15-2
U.S. DOC PS-1	-07	-95	UBC Standard 23-2
U.S. DOC PS-2	-04	-92	-92

[1] 2006 IBC – UL 790-98 with revisions through July 1998.



For **SI:** 1 inch = 25.4 mm.

FIGURE 1