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September 1, 2009

TO: PARTIES INTERESTED IN EVALUATION REPORTS ON BUILDING-INTEGRATED PHOTOVOLTAIC ROOF MODULES AND PANELS

SUBJECT: Proposed Revisions to the Acceptance Criteria for Building-integrated Photovoltaic (BIPV) Roof Modules and Panels, Subject AC365-1009-R1 (YM/CA)

Hearing Information:

Thursday, October 8, 2009
8:00 a.m.

Sheraton Gateway Hotel Los Angeles
6101 West Century Boulevard
Los Angeles, California 90045
(888) 627-7104

Dear Madam or Sir:

The enclosed proposed revisions to AC365, will be considered at the hearing noted above. The revisions are intended to expand the scope of the criteria to include the evaluation of BIPV plastic roof panels that are mechanically attached to a roof deck in conjunction with approved asphalt shingles, and BIPV roof modules that are adhered to a single-ply membrane roof covering and/or metal roof panel roof covering. The changes are based on submittals from report applicants, as well as other applicable provisions from the code or other acceptance criteria.

Staff is seeking input on the following:

1. For BIPV roof modules that are adhered to a new or existing roof covering: Section 1504.6 of the IBC (2009) requires that low-slope (roof slope < 2:12) roofs be evaluated for the effects of accelerated weathering on the physical integrity of the roof coverings. Section 3.2.4.3 of the enclosed criteria references UL 746C for evaluation of the physical integrity of the roof module after ultraviolet light exposure. The UL 746C method differs from the requirements found in Section 1504.6 of the IBC. For instance, the UL 746C method requires 1000 hours of ultraviolet light exposure, compared to the 2000 hours referenced in Section 1504.6 of the IBC. Additionally, the condition of acceptance in UL 746C allows for a 30 percent reduction in tensile strength for weathered specimens when compared to control specimens. Section 1504.6 of the IBC indicates that no significant loss in strength should take place. The differences in the test requirements and conditions of acceptance between UL 746C and IBC Section 1504.6 seem significant. However, staff believes that the proposed UL 746C method is acceptable, since the BIPV roof modules are to be adhered to an

approved roof covering that must comply with IBC Section 1504.6 when installed on low-slope roofs.

2. For BIPV roof modules that are adhered to a new or existing roof covering: Staff is seeking input on how the condition of an existing roof covering may affect the performance of the BIPV roof module and the existing roof covering. Currently, the requirements in AC365 are based on qualifying performance tests using new roof covering materials.
3. For BIPV roof modules that are adhered to a new or existing roof covering: Staff is seeking information on how roof covering materials from different manufacturers may affect the performance of the BIPV roof module, if in the qualifying tests the BIPV roof module is adhered to a specific roof covering manufacturer. For example can testing of a module adhered to a modified bitumen membrane made by one manufacturer be considered representative of the same module adhered to a modified bitumen membrane made by a different manufacturer.
4. For the BIPV plastic roof panel: An alternate method to test impact resistance has been proposed in Item c of Section 3.1.4.1.1 of enclosed draft criteria. The IEC 61646 method subjects the photovoltaic laminate to an impact of 8.2 ft-lb using 1.5-inch-diameter hailstones impacting the laminate at a velocity of 63 mph, while the UL 1703 method subjects the photovoltaic laminate to an impact of 5 ft-lb using a 2-inch-diameter steel sphere falling 51 inches. Staff believes that the IEC 61646 method can be used as an alternate to the UL 1703 method for impact resistance, since the IEC standard is more representative of the type of impact experienced by roof coverings. Furthermore, penetration testing is addressed in Section 3.1.5 and 4.2 of the criteria.
5. For the BIPV plastic roof panel: The requirements for referenced plastic roof tiles in Section 3.2 of the ICC-ES Acceptance Criteria for Special Roofing Systems (AC07), were selected for the evaluation of the BIPV plastic roof tile. The proponent proposes that the periodic testing requirements found in Section 3.2.9.2 of AC07 be excluded from this criteria, since the proponent's follow-up listing program already includes periodic testing to establish the maintenance of the fire test performance for the roof tile. Furthermore, BIPV roof panel must be manufactured under a follow-up inspection program, as indicated by Section 5.1 of the criteria.

You are cordially invited to submit written comments on agenda items, or to attend the Evaluation Committee hearing and present verbal comments. If you wish to contribute to the hearing, please note the following:

1. Written comments that are received by the Los Angeles business/regional office by **September 18, 2009**, will be forwarded to the committee prior to the hearing, and will be posted on the ICC-ES web site shortly after the comment deadline.
2. Written comments received up to ten days before the meeting, and staff memos responding to comments, will be posted to the web site on **September 29, 2009**.
3. ICC-ES is no longer providing printed copies at the meeting of proposed acceptance criteria, staff memos or public comments. These documents will be

available on a limited number of CDs at the meeting, for uploading to computers; and ICC-ES will make arrangements with the hotel business center to have hard copies available for photocopying.

4. Written comments that miss the deadline noted in item (1), above, will only be available at the meeting if you provide 35 copies, collated, stapled, and three-hole punched, either at the meeting itself or to the Los Angeles business/regional office by **September 29, 2009**.
5. If you plan to speak for more than 15 minutes, or offer a visual presentation lasting longer, you should notify ICC-ES staff as far as possible in advance. There will be a computer, projector, and screen available at the meeting for anyone wishing to make a visual presentation, and presentations in most cases will need to be in PowerPoint format. Also, ICC-ES will need to be provided with your presentation at least a half-hour before the start of the relevant meeting session (morning or afternoon) on either a CD or a flash card.
6. If you have any special needs related to a presentation, you should contact ICC-ES staff well in advance of the meeting.
7. Any visual aids for viewing at committee meetings (charts, overhead transparencies, slides, videos, electronic presentations, etc.) will be permitted only if a copy is provided to ICC-ES, before the presentation, in a medium that can be retained with other records of the meeting.
8. Any materials submitted for committee consideration are considered nonconfidential and available for public discussion, as noted in Section 2.7 of the ICC-ES Rules of Procedure for the Evaluation Committee.
9. Prior to the meeting, you should refrain from trying to communicate directly with committee members about agenda items, either verbally or in writing. Committee members reserve the right to refuse such communications.

Your cooperation with these guidelines is much appreciated, as is your interest in the deliberations of the Evaluation Committee. If you have any questions, please contact the undersigned at (800) 423-6587, extension 3260, or Chris Allen, P.E., senior staff engineer, at extension 3275. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Yamil Moya, P.E.
Staff Engineer

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Enclosures

cc: Evaluation Committee



ICC EVALUATION SERVICE, INC., RULES OF PROCEDURE FOR THE EVALUATION COMMITTEE

1.0 PURPOSE

The purpose of the Evaluation Committee is to monitor the work of ICC-ES, in issuing evaluation reports; to evaluate and approve acceptance criteria on which evaluation reports may be based; and to sponsor related changes in the applicable codes.

2.0 MEETINGS

2.1 The Evaluation Committee shall schedule meetings that are open to the public in discharging its duties under Section 1, subject to Section 3.

2.2 All scheduled meetings shall be publicly announced.

2.3 Two-thirds ($\frac{2}{3}$) of the voting Evaluation Committee members shall constitute a quorum. A majority vote of members present is required on any action.

2.4 In the absence of the nonvoting chairman-moderator, Evaluation Committee members present shall elect an alternate chairman from the committee for that meeting. The alternate chairman shall be counted as a voting committee member for purposes of maintaining a committee quorum and to cast a tie-breaking vote of the committee.

2.5 Minutes of the meetings shall be kept.

2.6 An electronic audio record of meetings shall be made by ICC-ES; no other audio, video, electronic or stenographic recordings of the meetings will be permitted. Visual aids (including, but not limited to, charts, overhead transparencies, slides, videos, or presentation software) viewed at meetings shall be permitted only if the presenter provides ICC-ES before presentation with a copy of the visual aid in a medium which can be retained by ICC-ES with its record of the meeting and which can also be provided to interested parties requesting a copy. A copy of the ICC-ES recording of the meeting and such visual aids, if any, will be available to interested parties upon written request made to ICC-ES together with a payment as required by ICC-ES to cover costs of preparation and duplication of the copy. These materials will be available beginning five days after the conclusion of the meeting but will no longer be available after one year from the conclusion of the meeting.

2.7 Parties interested in the deliberations of the committee should refrain from communicating, whether in writing or verbally, with committee members regarding agenda items. All written communications and submissions regarding agenda items should be delivered to ICC-ES. All such written communications and submissions shall be considered nonconfidential and available for discussion in open session of an Evaluation Committee meeting, and shall be delivered at least ten days before the scheduled Evaluation Committee meeting if they are to be forwarded to the committee. Materials delivered to ICC-ES at least ten

days before the scheduled meeting will be posted on the ICC-ES web site (www.icc-es.org) prior to the meeting. After this time, parties wishing to submit materials for consideration by the Evaluation Committee must deliver a sufficient number of copies as directed by ICC-ES. Consideration of materials not received by ICC-ES at least ten days before the meeting is at the discretion of the Evaluation Committee. Following the meeting, ICC-ES will make all materials considered by the Evaluation Committee available on the web site for a maximum period of one year following the meeting. The committee reserves the right to refuse recognition of communications which do not comply with the provisions of this section.

3.0 CLOSED SESSIONS

Evaluation Committee meetings shall be open except that the chairman may call for a closed session to seek advice of counsel.

4.0 ACCEPTANCE CRITERIA

4.1 Acceptance criteria are established by the committee to provide a basis for issuing ICC-ES evaluation reports on products and systems under codes referenced in Section 2.0 of the Rules of Procedure for Evaluation Reports. They also clarify conditions of acceptance for products and systems specifically regulated by the codes.

Acceptance criteria may involve a product, material, method of construction, or service. Consideration of any acceptance criteria must be in conjunction with a current and valid application for an ICC-ES evaluation report, an existing ICC-ES evaluation report, or as otherwise determined by the Evaluation Committee.

4.2 Procedure:

4.2.1 Proposed acceptance criteria shall be developed by the ICC-ES staff and discussed in open session with the Evaluation Committee during a scheduled meeting, except as permitted in Section 5.0 of these rules.

4.2.2 Proposed acceptance criteria shall be available to interested parties at least 30 days before discussion at the committee meeting.

4.2.3 The committee shall be informed of all pertinent written communications received by ICC-ES.

4.2.4 Attendees at Evaluation Committee meetings shall have the opportunity to speak on acceptance criteria listed on the meeting agenda, to provide information to committee members.

4.3 Approval of acceptance criteria shall be as specified in Section 2.3 of these rules.

4.4 Actions of the Evaluation Committee may be

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appealed in accordance with the ICC-ES Rules of Procedure for Appeal of Acceptance Criteria or the ICC-ES Rules of Procedure for Appeals of Evaluation Committee Technical Decisions.

5.0 COMMITTEE BALLOTING FOR ACCEPTANCE CRITERIA

5.1 Acceptance criteria may be issued without a public hearing following a 30-day public comment period and a majority vote for approval by the Evaluation Committee when, in the opinion of ICC-ES staff, one or more of the following conditions have been met:

1. The subject is nonstructural, does not involve life safety, and is addressed in nationally recognized standards or generally accepted industry standards.
2. The subject is a revision to an existing acceptance criteria that requires a formal action by the Evaluation Committee, and public comments raised were resolved by staff with commenters fully informed.
3. Other acceptance criteria and/or the code provide precedence for the revised criteria.

5.2 Negative votes must be based upon one or more of the following, for the ballots to be considered valid and require resolution:

- a. *Lack of clarity:* There is insufficient explanation of the scope of the acceptance criteria or insufficient description of the intended use of the product or system; or the acceptance criteria is so unclear as to be unacceptable. (The areas where greater clarity is required must be specifically identified.)
- b. *Insufficiency:* The criteria is insufficient for proper evaluation of the product or system. (The provisions of the criteria that are in question must be specifically identified.)
- c. *The subject of the acceptance criteria is not within the scope of the applicable codes:* A report issued by ICC-ES is intended to provide a basis for approval under the codes. If the subject of the acceptance criteria is not regulated by the codes, there is no basis for issuing a report, or a criteria. (Specifics must be provided concerning the inapplicability of the code.)

d. *The subject of the acceptance criteria needs to be discussed in a public hearings.* The committee member requests additional input from other committee members, staff or industry.

5.3 An Evaluation Committee member, in voting on an acceptance criteria, may only cast the following ballots:

- Approved
- Approved with Comments
- Negative: Do Not Proceed

6.0 COMMITTEE COMMUNICATION

Direct communication between committee members, and between committee members and an applicant or concerned party, with regard to the processing of a particular acceptance criteria or evaluation report shall take place only in a public hearing of the Evaluation Committee. Accordingly:

6.1 Committee members receiving an electronic ballot should respond only to the sender (staff). Committee members who wish to discuss a particular matter with other committee members, before reaching a decision, should ballot accordingly and bring the matter to the attention of ICC-ES staff, so the issue can be placed on the agenda of a future committee meeting.

6.2 Committee members who are contacted by an applicant or concerned party on a particular matter that will be brought to the committee will refrain from private communication and will encourage the applicant or concerned party to forward their concerns through the ICC-ES staff in writing, and/or make their concerns known by addressing the committee at a public hearing, so that their concerns can receive the attention of all committee members. ■

Effective March 18, 2008

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR BUILDING-INTEGRATED PHOTOVOLTAIC (BIPV) ROOF MODULES AND PANELS

AC365

Proposed October 2009

Previously approved October 2006

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (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.

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 proposed in this document, and otherwise meet the applicable performance requirements of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria proposed in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise meet the applicable performance requirements 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 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 for purposes of issuing ICC-ES evaluation reports.

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR BUILDING-INTEGRATED PHOTOVOLTAIC (BIPV) ROOF MODULES AND PANELS

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for recognition of building-integrated photovoltaic (BIPV) roof modules and panels in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the 2006~~9~~ *International Building Code*[®] (IBC), the 2006~~9~~ *International Residential Code*[®] (IRC), and the 1997 *Uniform Building Code*[™] (UBC). The bases of recognition are IBC Section 104.11, IRC Section R104.11, and UBC Section 104.2.8. The reason for the development of this criteria is to provide guidelines for the evaluation of BIPV roof modules and panels, which are not addressed in the codes.

1.2 Scope: This criteria is applicable to BIPV roof modules and panels used in roof covering systems. The BIPV roof panels are installed with an underlayment above a solid-sheathed wood roof deck with a slope greater than or equal to 2:12 (16.7 %~~percent~~) when used with asphalt shingles, or 2¹/₂:12 (20.8 %~~percent~~) when used with clay or concrete tiles. When installed as part of a roof covering system, the BIPV roof panels are installed with an underlayment and flashing, as determined by testing under this criteria and the installation instructions. Under this criteria, the BIPV roof panels are limited to use in conjunction with asphalt shingles and clay or concrete tiles. The BIPV roof modules are adhered to a new or existing single-ply membrane roof covering or metal roof panel roof covering. BIPV roof modules must be installed at a minimum roof slope of ¼:12 (2 percent), when installed over single-ply membrane roof covering, or the minimum roof slope indicated in Section 1507.4.2 of the IBC when installed over metal roof panels. The electrical safety requirements and solar energy performance of the BIPV roof modules and panels are outside the scope of this criteria.

1.3 Codes and Referenced Standards:

1.3.1 2006~~9~~ *International Building Code*[®] (IBC), International Code Council.

1.3.2 2006~~9~~ *International Residential Code*[®] (IRC), International Code Council.

1.3.3 1997 *Uniform Building Code*[™] (UBC).

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

1.3.5 ASTM D 638-01, Standard Test Method for Tensile Properties of Plastics, ASTM International.

1.3.6 ASTM D 903-98(2004), Test Method for Peel or Stripping Strength of Adhesive Bond, ASTM International.

1.3.7 ASTM G 152-~~04~~06, Practice for Operating Light-Exposure Apparatus (Carbon Arc-Type) with and without Water for Exposure of Nonmetallic Materials, ASTM International.

1.3.8 ASTM G 155-~~04~~05a, Practice for Operating Light Exposure Apparatus (Xenon Arc-Type) with and without Water for Exposure of Nonmetallic Materials, ASTM International.

1.3.9 UL 580-2006, Test Method for Uplift Resistance of

Roof Assemblies, Underwriters Laboratories Inc.

1.3.10 UL 746C-2004 (Sixth Edition), Polymeric Materials—Use in Electrical Equipment Evaluations—with Revisions Through February 20, 2006, Underwriters Laboratories Inc.

1.3.11 UL 790-~~98~~04, Standard Test Methods for Fire Resistance Tests of Roof Covering Materials, Underwriters Laboratories Inc.

1.3.12 UL 1703 Third Edition (2002), Flat Plate Photovoltaic Modules and Panels, Underwriters Laboratories Inc.

1.3.13 UL 1897-~~98~~04, Uplift Tests for Roof Covering Systems, Underwriters Laboratories Inc. with Revisions through November 2002.

1.3.14 ANSI Z97.1– 84(R1994), Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test (Reaffirmed 1994).

1.3.15 CPSC 16 CFR Part 1201 (1977), Safety Standard for Architectural Glazing Material.

1.3.16 SBCCI SSTD 11-97, Test Standard for Determining Wind Resistance of Concrete or Clay Roof Tiles.

1.3.17 TAS No. 100-95, Test Procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roofing Systems, 2001 Florida Building Code—Test Protocol HVHZ.

1.3.18 ICC-ES Acceptance Criteria for Special Roofing Systems (AC07), dated April 2007 (corrected February 2009).

1.3.19 IEC 61646 Edition 2.0, 2008-05, IEC International Standard, Thin-film Terrestrial Photovoltaic (PV) modules—Design qualification and type approval.

1.4 Definitions:

1.4.1 Rigid Photovoltaic Laminate: A rigid photovoltaic laminate consists of a transparent superstrate which forms the top (weather-exposed) surface of the BIPV roof panel; photovoltaic cells and electrical interconnects; a substrate which forms the back surface of the module; protective layers of encapsulant material as required between the superstrate cells; and other components.

1.4.2 Building-integrated Photovoltaic (BIPV) Roof Panel: An integrated, manufactured assembly consisting of the rigid photovoltaic laminate and other factory-assembled components, such as the support structure, with interlocking or overlapping edges. The BIPV roof panel is mechanically attached to the roof deck and is installed with other roof covering system components.

1.4.3 BIPV Roof Module: A flexible photovoltaic module consisting of a glass-free superstrate; photovoltaic cells and electrical interconnects; insulated and protective layers of encapsulant material as required between the superstrate cells; and other components. The BIPV roof module is adhered to a new or existing single-ply

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membrane roof covering or metal roof panel roof covering.

1.4.4 Roof Covering System Components:

Components installed in the field in conjunction with the BIPV modules and roof panels. For panels, these components include underlayment, flashing, and the roof covering (asphalt shingles, and concrete or clay tiles). For modules, these components include the single-ply membrane system or the metal roof panel system.

1.4.5 BIPV Roof Covering System: A complete roof system, consisting of BIPV roof modules and panels and the roof covering system components.

2.0 BASIC INFORMATION AND REPORT OF TESTS

The following basic information shall be submitted:

2.1 Product Description: Complete information, as applicable, concerning materials, dimensions, coatings, manufacturing process, and installation procedures for the BIPV roof module and panel.

2.2 Installation Instructions: Scale drawings; size and location of fasteners; and installation details, including flashing and roof slope limitations.

2.3 Packaging and Identification: The method of packaging and identifying the BIPV roof modules and panels shall be specified. Identification shall include the ICC-ES evaluation report number and notice of any product installation limitations.

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

2.5 Test Reports: Test reports shall comply with AC85.

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

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 BIPV Roof Panels (Mechanically Attached to Roof Deck):

3.1.1 Fire Classification Test: Fire-retardant roof tests conducted in accordance with ASTM E 108 or UL 790 (IBC, IRC) or UBC Standard 15-2 (UBC) are required. The minimum fire classification shall be Class C. The testing laboratory shall establish the most critical test assembly based on the roof covering assemblies for which recognition is desired. Roof underlayment and any other roof covering system component necessary for obtaining the classification in the tests shall be manufactured under the listing program of an inspection agency accredited by the International Accreditation Service or otherwise acceptable to ICC-ES.

3.1.2 Wind Resistance:

3.1.2.1 General: The BIPV roof panels shall be tested in accordance with UL 1897. As an alternative, tests may be conducted in accordance with Section 800 of SBCCI SSTDD 11-99, or an alternate static pressure or wind tunnel test procedure, provided the test procedures used are accepted by ICC-ES staff prior to testing. The panels shall be tested over solid sheathing, as applicable to the recognition sought. Connections to framing or to sheathing shall be based on minimum conditions. Connection density

shall be evaluated for both interior and perimeter corner zones. At least one roof deck shall be tested for each condition. The roof deck shall be representative of a roof deck used in the installation of the BIPV roof panels. Allowable loading will be based on a minimum safety factor of 2.0, applied to the ultimate load. Positive loads will be based on the adequacy of the structural framing and sheathing.

3.1.2.2 Allowable loads shall not exceed the established values for mechanical connectors, such as nails and screws. Fasteners used to attach BIPV roof panels to roof deck shall be corrosion-resistant and be made of similar materials to prevent a galvanic reaction.

3.1.3 Wind-driven Rain: Wind-driven rain tests shall be conducted in accordance with Florida Building Code TAS 100-95. All roof system variants intended for use with various roof types shall be tested. Roofing system components shall be installed as required by the BIPV manufacturer's instructions for the configuration under test. The BIPV roof system test assembly shall be installed in accordance with the manufacturer's published installation instructions on a 10-foot-by-10-foot (3.05 by 3.05 m) flat deck at the prescribed minimum slope. The test area is defined as an 8-foot-wide (2.44 m) section of this deck centered on the centerline of the wind generator nozzle. The BIPV roof system shall consist of at least four adjacent courses of BIPV panels, and roof system components as required by the installation instructions. One test shall be conducted for each approved roof covering type (asphalt shingles, and clay and concrete tiles) for which recognition is sought. The selected roof covering shall cover the remainder of the test deck. There must be at least one course of roofing material or 12 inches (305 mm), whichever is greater, below the BIPV roofing panels. One test must include vertical joints between the BIPV panels in the test area on at least three courses, and one test must include vertical joints between the BIPV roof panels and other roof covering in the test area of at least three courses. The same specimens may be used for both tests. Any openings on the perimeter of the test assembly may be sealed. Roof covering materials not immediately adjacent to the BIPV roof panels may be secured with additional fasteners or adhesives if required to prevent tear-off and impingement on the BIPV roofing system. If tear-off of nonadjacent roof covering results in a failure of the test, the test may be repeated.

3.1.4 Durability:

3.1.4.1 Rigid-Photovoltaic Laminate:

3.1.4.1.1 Superstrate: Reports of tests shall be submitted showing compliance with at least one of the following:

a. The requirements in the Performance Specifications and Methods of Test for Safety Glazing Material Used In Buildings, ANSI Z97.1-1984; or

b. The requirements in the Code of Federal Regulations, Title 16 CPSC Part 1201– Safety Standard for Architectural Glazing Materials; or

c. Reports of impact tests in accordance with Section 30 of UL 1703 or Section 10.17 of IEC 61646

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[using a 1.5-inch-diameter (35 mm) hailstone]. The condition of acceptance is that the superstrate of the rigid photovoltaic laminate shall not crack.

3.1.4.1.2 Temperature Cycling Test: Testing shall be conducted on the rigid photovoltaic laminate in accordance with UL 1703, Section 35.

Conditions of Acceptance: Testing of the rigid photovoltaic laminate shall not result in delamination, cracking or separation of materials.

3.1.4.1.3 Humidity Test: Testing shall be conducted on the rigid photovoltaic laminate in accordance with UL 1703, Section 36.

Conditions of Acceptance: Testing of the rigid photovoltaic laminate shall not result in delamination, cracking or separation of materials.

3.1.4.2 BIPV Roof Panel Materials: With the exception of the rigid photovoltaic laminate, the materials used to fabricate the BIPV roof panel shall comply with one of the following:

3.1.4.2.1 Exposed Metal Components: Reports of tests showing compliance with the material requirements of Tables 1507.4.3(1) and (2) of the IBC, Tables R905.10.3(1) and (2) of the IRC, or Section 1507.8 of the UBC, as applicable. For materials other than those listed in the above noted tables, the material shall be shown to be equivalent to those listed.

3.1.4.2.2 Polymeric or Elastomeric Materials of BIPV Roof Panel Tiles Used as Roof Covering: The following tests are required for all weather-exposed polymeric or elastomeric materials used in the BIPV roof panels:

1. Uplift bend tests in accordance with Section 3.2.3 of AC07 are required for recognition of roof slopes exceeding 60 degrees (173%) from the horizontal.
2. Data in accordance with Section 3.2.5.2 of AC07 shall be submitted.
3. Temperature-cycling test data in accordance with Section 3.2.6 of AC07 shall be submitted.
4. Weathering tests in accordance with Section 4.1 are required for all weather-exposed polymeric or elastomeric materials used in the BIPV roof panels. After the 2000-hour exposure, both exposed and-control specimens shall be tested in accordance with ASTM D 638. A minimum of five specimens shall be tested for both control and exposed condition.

Conditions of Acceptance: The average loss in tensile strength and elongation after the weatherometer test shall be evaluated on a case-by-case basis. Failure for exposed samples is also defined as surface changes, as viewed by minimum 5x magnification, such as cracking, checking, crazing, erosion, or chalking, that might affect performance.

3.1.4.3 Durability of Adhesive Components: When BIPV roof panels are adhered to each other or other approved roof covering, as demonstrated in the qualifying

tests described in Section 3.1.2 and 3.1.3 of this criteria, testing to determine the durability of the adhesive used shall be conducted in accordance with Section 3.2.6 of this criteria, except that the test samples shall be representative of the adhered substrate components (BIPV roof panel components and approved roof covering) for which recognition is sought.

3.1.5 Penetration Test: Penetration tests shall be conducted in accordance with Section 4.2.

Conditions of Acceptance: There shall be no shattering or cracking of the superstrate, causing exposure of the plastic or other compressible materials; or excessive permanent deformation under the applied load, resulting in unsatisfactory performance of the test panel.

3.2 BIPV Roof Module (Adhered to New or Existing Roof Coverings):

3.2.1 General: BIPV roof modules qualified under this criteria are intended for use with single-ply membrane systems or metal roof panel systems complying with the requirements of the code.

3.2.2 Fire Classification Test: Fire-retardant roof tests conducted in accordance with ASTM E 108 or UL 790 (IBC, IRC) or UBC Standard 15-2 (UBC) are required. The minimum fire classification shall be Class C. The testing laboratory shall establish the most critical test assembly based on the roof covering assemblies for which recognition is desired. Roof covering assemblies shall be manufactured under the listing program, as required by the code, of an inspection agency accredited by the International Accreditation Service or otherwise acceptable to ICC-ES.

3.2.3 Wind Uplift Resistance: Composite assemblies consisting of the BIPV roof modules adhered to the roof covering system shall be tested in accordance with UL 580. The composite assembly shall be tested for adhesion of the modules to the roof covering system and for ultimate uplift at load capacity of the composite assembly. The composite assembly tested, including the roof deck and one roof covering system, shall be representative of the composite assembly for which recognition is sought. Allowable loading will be based on a minimum safety factor of 2.0, applied to the ultimate uplift load of the assembly or the load where delamination of the module occurs, whichever is less.

3.2.4 Impact Resistance: BIPV roof modules installed as intended shall be tested for impact resistance in accordance with ASTM D 3746, ASTM D4272, CGSB 37-GP-52M or the "Resistance to Foot Traffic Test" in Section 5.5 of FM 4470, as applicable. The testing standard and the results of the testing shall be noted in the evaluation report.

3.2.5 Durability:

3.2.5.1 Temperature Cycling Test: Testing shall be conducted on the BIPV roof module in accordance with UL 1703, Section 35.

Conditions of Acceptance: Testing shall not result in specimen delamination, cracking or separation of

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materials.

3.2.5.2 Humidity Test: Testing shall be conducted on the BIPV roof module in accordance with Section 36 of UL 1703.

Conditions of Acceptance: Testing shall not result in specimen delamination, cracking or separation of materials.

3.2.5.3 Ultraviolet Light Exposure: Ultraviolet light exposure testing and conditions of acceptance for the BIPV roof module shall comply with the requirements found in Section 25 of UL 746C.

3.2.6 Retention of Adhesion after Temperature Cycling:

3.2.6.1 Sample: Samples shall be prepared in accordance with ASTM D 903, except as modified in this section (Section 3.2.6.1). Specimens shall be assembled individually, since cutting specimens to size after assembly may influence the test results.

3.2.6.1.1 Each sample shall consist of the following:

1. Five control specimens of the module adhered to each roof covering substrate for which recognition is sought. The specimens are to be conditioned at 75±2°F (23.9±1.1°C) and at a relative humidity of 50±2 percent, for not less than one hour prior to peel strength testing in accordance with Section 3.2.6.2 of this criteria. See Section 3.2.6.1.54 for length of conditioning materials before and after specimen assembly.

2. Five specimens consisting of the module adhered to each roof covering substrate for which recognition is sought. The specimens are to be subjected to temperature-cycling exposure in accordance with Section 3.2.6 of AC07. After the temperature-cycling exposure, the specimens are conditioned at 75±2°F (23.9±1.1°C) and at a relative humidity of 50±2 percent, for not less than one hour prior to peel strength testing in accordance with Section 3.2.6.2 of this criteria.

3.2.6.1.2 For module adhesion to substrate, the test specimen shall consist of one piece of BIPV roof module, 3 by 8 ±0.125 inches (76 by 203 ±2 mm), adhered to a 3-by-5-inch (76 by 127 mm) section of the roof covering substrate that measures 3 by 6 inches (76 by 152 mm). The roof covering substrate is to be securely bonded and/or nailed to a piece of minimum 1/4-inch-thick (6 mm), Exposure 1 plywood complying with Department of Commerce PS-1 or PS-2, and measuring 3 by 6 inches (76 by 152 mm).

3.2.6.1.3 The test specimen shall be rolled three times back and forth with a roller having a mass of 26 pounds (11.8 kg) ± 0.5 percent, a diameter of 5 inches (127 mm) ± 5 percent, and a width of 5 inches (127 mm) ± 5 percent, at an approximate rate of two to three seconds per rolling cycle.

3.2.6.1.4 Materials used to construct the control specimens and test specimens, and the roller described in Section 3.2.6.1.3, shall be conditioned for not less than 4 hours prior to the assembly.

3.2.6.2 Peel-strength Test Procedure: Samples shall be tested and results reported in accordance with ASTM D 903, except as modified in this section (Section 3.5.2.2).

3.2.6.2.1 A constant rate-of-jaw separation type tester shall be used. The rate of travel of the power-actuated grip shall be 2±1/16 inches per minute (51±1.6 mm/min) and shall be uniform throughout the test.

3.2.6.2.2 At least five specimens shall be tested for each test temperature. The test temperature is the condition temperature.

3.2.6.2.3 The free end of the adhered module material shall be separated from the substrate by hand for an approximate distance of 2 inches (51 mm), leaving a bonded area of approximately 3 by 3 inches (76 by 76 mm). The specimen shall be placed in the testing machine by clamping the free end of the substrate material in the lower grip, turning back the free end of the test module 180 degrees, and clamping it in the upper grip. The specimen shall be maintained in the approximate plane of the clamps during the test. Not less than three quarters of the bonded area shall be peeled to establish the peel curve.

3.2.6.2.4 The peel strength shall be determined by drawing on the autographic chart the average load line that will accommodate the recorded curve. The load shall be recorded, eliminating any peaks associated with module material tear. The result shall be converted to a lbf/ft width (kgf/30.5 cm width) value.

3.2.6.2.5 For each series of tests, the following shall be reported: the type of substrate (single-ply membrane or metal roof panel), the individual measurements, the average, and the standard deviation of all the test values in lb/ft (kg/mm) width.

3.2.6.3 Conditions of Acceptance: Specimens exposed to temperature-cycling shall display no loss in adhesion performance when compared to the control specimens.

4.0 TEST METHODS

4.1 Weatherometer Test:

4.1.1 Sample: Ten representative samples of the elastomeric or polymeric material shall be prepared in accordance with ASTM D 638, of which five shall be held as controls. The same sample preparation and method of loading shall be used for all specimens.

4.1.2 Apparatus: See ASTM G 152, Cycle 1 of Appendix Table X1, or ASTM G 155, Cycle 1 of Appendix X3.1.

4.1.3 Procedure: The test shall be conducted for a period of 2000 hours. Specimen condition, examined under 5x magnification, may be reported at the end of 500, 1000, and 1500 hours of exposure, and a report is required after 2000 hours.

4.2 Penetration Test:

4.2.1 Test Panel Assembly: A BIPV roof panel shall be installed in an assembly that will be the most critical to the BIPV roof panel and to other non-BIPV roof tiles or panels,

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as demonstrated in the BIPV manufacturer's installation instructions.

4.2.2 Apparatus: A 3-inch-diameter (76 mm) steel plate with rounded corners. A device capable of imposing a 200-pound (890 N) load.

4.2.3 Procedure: The test panel assembly shall be continuously supported by a rigid backing. A 200-pound (890 N) load, imposed on the steel plate, shall be applied at the most critical location of the test panel, as determined by the testing agency. The superimposed load shall be reduced to zero and there shall be reloading a minimum of four additional times. The test panel and other roof panels are to be inspected after the test and the condition at the steel plate interface noted.

5.0 QUALITY CONTROL

5.1 The BIPV roof modules and panels shall be manufactured under an approved quality control program with inspections by an inspection agency accredited by the International Accreditation Service (IAS) or otherwise acceptable to ICC-ES.

5.2 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted.

6.0 EVALUATION REPORT RECOGNITION

The evaluation report shall include the following statements:

1. Recognition of the BIPV roof module and panel is limited to use as part of a roof covering; the electrical safety requirements and solar energy performance of this product are outside the scope of this report.
2. BIPV roof ~~covering systems panels~~ shall be installed on roof decks with a slope equal to or greater than 2:12 (16.7 %) when used with asphalt shingles, or 2¹/₂:12 (20.8%) when used with clay or concrete tiles. BIPV roof modules shall be installed on roof covering with a minimum slope in accordance with the requirements for single-ply membrane and metal roof panel systems as indicated in Chapter 15 of the IBC.
3. The BIPV roof panels must be installed with an underlayment and flashing, ~~as required by the approved tests.~~
4. The BIPV roof panels shall be limited to use with asphalt shingles, and/or clay and concrete tiles.
5. The BIPV roof modules are limited to use over (single-ply membrane and/or metal roof panel) roof coverings. ■