



ACCEPTANCE CRITERIA FOR SANDWICH PANEL ADHESIVES

AC05

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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.

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.

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ACCEPTANCE CRITERIA FOR SANDWICH PANEL ADHESIVES

1.0 INTRODUCTION

The purpose of this acceptance criteria is to establish minimum requirements for ICC Evaluation Service, Inc. (ICC-ES), recognition of self-adhered foamed-in-place core materials of nonpermeable faced panels and adhesives under the 2003 *International Building Code*® (IBC), the 2003 *International Residential Code*® (IRC), the 1999 *Standard Building Code*® (SBC), the BOCA® *National Building Code/1999* (BNBC) and the 1997 *Uniform Building Code*™ (UBC), for use in sandwich panels complying with the ICC-ES Interim Criteria for Sandwich Panels (AC04).

1.1 The criteria establishes minimum performance levels pertaining to moisture, temperature, accelerated aging, creep, oxidation or ozone (whichever is selected), mold, chemical reagents and compatibility.

1.2 The criteria provides the adhesive manufacturer with a means of recognition for his product as set forth in Section 2. Recognition of an adhesive in an evaluation report, unrelated to any panel system, will provide basic information on the adhesive under conditions set forth in Section 1.1, and additionally, as an option, shear and bond strengths with panel-facing materials of the adhesive manufacturer's choice. In both instances, basic adhesive information shall be determined by tests (Sections 8.3 through 8.8) conducted with stable materials set forth in Sections 5.1.1 through 5.1.4. The specific stable material or materials used shall be representative of intended use; basic tests on Douglas fir-larch, as one example, would not be sufficient for a metal facing panel application. In all instances, creep tests may be waived for a Type I adhesive. See Table 1 for qualifying tests for adhesives and see Table 2 for qualifying tests for self-adhered foamed-in-place core materials of non-permeable faced panels.

1.3 Recognition of specific panel facings with an adhesive or self-adhered foamed-in-place core material of nonpermeable faced panels requires that shear and bond strengths of the panel facing be determined, and adhesive or adhesion compatibility with the facings be established. Adhesive and adhesion compatibility also need to be established if the facings are treated with fire retardants or preservatives. Panel facing tests are conducted on specimens that are cured and conditioned in accordance with the panel manufacturer's recommendations. These must be compatible with those recommended by the product manufacturer. Testing shall be as noted in Section 8.1.1. In conjunction with sandwich panel applications, the adhesive and self-adhered foamed-in-place core material of non-permeable faced panels shall be justified in accordance with Sections 8.1.1 and 8.1.2, and 8.9 through 8.12.

1.4 This criteria does not attempt to establish allowable values for sandwich panels. These values are regulated by the ICC-ES Acceptance Criteria for Sandwich Panels (AC04).

1.5 Reference Documents:

1.5.1 2003 *International Building Code*® (IBC), International Code Council.

1.5.2 2003 *International Residential Code*® (IRC), International Code Council.

1.5.3 BOCA® *National Building Code/1999* (BNBC).

1.5.4 1999 *Standard Building Code*® (SBC).

1.5.5 1997 *Uniform Building Code*™ (UBC).

1.5.6 ICC-ES Acceptance Criteria for Sandwich Panels (AC04).

1.5.7 ASTM D 905-49 (1989), Test Methods for Strength Properties of Adhesive Bonds in Shear by Compression Loading, ASTM International.

1.5.8 ASTM C 273-94, Test Method for Shear Properties of Sandwich Core Materials, ASTM International.

1.5.9 ASTM C 297-61 (1988), Test Method for Tensile Strength of Flat Sandwich Constructions in Flatwise Plane, ASTM International.

1.5.10 ASTM D 1623-78 (1995), Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics, ASTM International.

1.5.11 ASTM D 2559-92, Specification for Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions, ASTM International.

1.5.12 ASTM D 1002-72 (1983), Test Method for Strength Properties of Adhesives in Shear Tension Loading (Metal-to-Metal), ASTM International.

1.5.13 ASTM D 2294-69 (1980), Test Method for Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal), ASTM International.

1.5.14 ASTM D 1212-91, Test Methods for Measurement of Wet Film Thickness of Organic Coatings, ASTM International.

1.5.15 ASTM D 1183-70 (1987), Test Methods for Resistance of Adhesive to Cyclic Laboratory Aging Conditions, ASTM International.

1.5.16 ASTM D 572-88, Test Method for Rubber Deterioration by Heat and Oxygen, ASTM International.

1.5.17 ASTM D 1149-91, Test Method for Rubber Deterioration Surface Ozone Cracking in a Chamber, ASTM International.

1.5.18 ASTM D 896-90, Test Method for Resistance of Adhesive Bonds to Chemical Reagents, ASTM International.

1.5.19 ASTM D 1622-93, Test Method for Apparent Density of Rigid Cellular Plastics, ASTM International.

1.5.20 ASTM C 393-62 (1988), Method for Flexure Test of Flat Sandwich Constructions, ASTM International.

2.0 ADHESIVE CLASSIFICATION

The adhesives shall be classified in accordance with their use and characteristics as follows:

2.1 Type I: An adhesive for use in wall panels subject only to short-term transverse or racking shear loads resulting from wind or seismic forces.

2.1.1 Class 1: An adhesive with low resistance to moisture and creep, acceptable for interior nonbearing partitions.

2.1.2 Class 2: An adhesive with high moisture resistance and low creep resistance, acceptable for exterior nonbearing walls and other locations where high moisture resistance is necessary.

2.2 Type II: An adhesive for use in panels supporting loads other than the panel weight.

2.2.1 Class 1: An adhesive with low moisture resistance and high creep resistance, acceptable for interior bearing walls, exclusive of those exposed to heavy moisture conditions.

2.2.2 Class 2: An adhesive with high moisture and high creep resistance.

3.0 BASIC INFORMATION

The following basic information shall be submitted:

3.1 Recommended moisture content of material, where applicable, at the time of gluing.

3.2 Complete mixing instructions for the adhesive or self-adhered foamed-in-place core material of non-permeable faced panels.

3.3 Application instructions, including the rate of spread, the thickness of wet and dry film, the number of coats, whether the adhesive is to be applied to one or both contact surfaces, the conditions for drying where more than one coat is required, and the weight per square foot in spray applications.

3.4 Assembly conditions, including room temperature, humidity and time limitations.

3.5 Curing conditions, including pressure, time under pressure, and temperature of the assembly under pressure. Limiting temperature should be clarified as that of the glue line or air.

3.6 Pot life; storage temperature; maximum storage life; and permitted fillers, if any, and their maximum quantities.

3.7 Method of packaging and identifying components. Identification shall include the ICC-ES evaluation report number.

4.0 TESTING LABORATORIES, TEST REPORTS, AND PRODUCT SAMPLING

4.1 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.

4.2 Test Reports and Product Sampling: Test reports and product sampling shall comply with the ICC-ES Acceptance Criteria for Test Reports (AC85). All reports of tests must be prepared by the testing laboratory. The test report must be of sufficient detail to identify all aspects of the test program, including the data required in Section 3.

5.0 TEST SPECIMENS

5.1 The basic tests for an adhesive or self-adhered foamed-in-place core material of non-permeable faced panels require curing, conditioning and accelerated aging of specimens prior to testing. Stable materials specified in Sections 5.1.1 through 5.1.4 shall be used.

5.1.1 Hard maple blocks having a minimum specific gravity of 0.65 based on oven-dry weight and volume (see the Appendix of ASTM D 905 for specific gravity measurement)—straight-grained and free of defects such as knots, bird's-eyes, short grain and decay—are to be used for adhesives bonding assemblies by valence forces (chemical bond).

5.1.2 Clear straight-grained Douglas fir-larch wood having a specific gravity range between 0.45 and 0.55, based on oven-dry weight and volume, is to be used for adhesives bonding assemblies by mechanical adhesion (interlocking action).

5.1.3 Metals may be used. The specification and the aluminum heat treatment number are to be reported, together with the required condition of the faying surface and any special treatment necessary before bonding.

5.1.4 Other materials require prior approval before tests are conducted.

5.2 The faying surfaces of the test specimens shall be protected from contamination prior to the gluing or pouring operations. Wood specimens are to be surfaced within 24 hours prior to gluing or pouring, and are to be at the equilibrium moisture content recommended by the adhesive manufacturer. In the absence of such a recommendation, the moisture content shall be from 10 to 12 percent, based on oven-dry weight. When the recommended spread of the moisture content between the two specimens being bonded is 6 percent or more, samples at the upper and lower limits are to be tested to determine variations in strength.

5.3 The grain of the wood specimens shall be parallel and perpendicular to the direction of the applied load in the shear and bond tests, respectively.

5.4 Test specimens for shear, bond and creep properties of adhesives or of self-adhered foamed-in-place core material of non-permeable faced panels shall be as follows:

5.4.1 Block shear test specimens for adhesives are assembled in accordance with Sections 6,7, and 8, and Figures 2 and 3, of ASTM D 905. The test specimens shall be hard maple or Douglas fir-larch complying with Sections 5.1.1 or 5.1.2. See Section 5.5 for other facing materials. Wood blocks shall have the same specific gravity (0.04 maximum variation), and their bonded contact area shall be determined by dimensions to the nearest 0.01 inch (0.254 mm). See Section 5.7 for block shear test specimen preparation for adhesives for metal-to-metal or metal-to-wood test specimens.

5.4.2 Block shear test specimens for foamed-in-place core material of non-permeable faced panels shall be assembled in accordance with Section 5 of ASTM C 273. The test specimens shall be non-permeable faced panel (metal) complying with Section 5.1.3.

5.4.3 Bond strength test specimens for adhesives shall be hard maple or Douglas fir-larch as described in Section 5.1.1 or 5.1.2. Preparation shall conform to ASTM C 297. The two elements of each specimen shall be 2 inches square (190 mm²) and ³/₄ inch (19.1 mm) thick. The contact areas shall be based on dimensions to the nearest 0.01 inch (0.254 mm). See Section 5.7 for bond-test specimen preparation for metal-to-metal and metal-to-wood evaluation tests. See Section 5.5 for other facing materials to be tested.

5.4.4 Bond strength test specimens for self-adhered foamed-in-place core material of non-permeable faced panels shall be metals as described in Section 5.1.3. Preparation shall conform to the Type A, B or C requirements of ASTM D 1623.

5.5 Panel facing materials such as plywood, particleboard, hardboard, special wood panel products, gypsum wallboard, fiberboard, and fiberglass are not considered stable enough to be subjected to the accelerated aging under Section 7.

5.5.1 Test specimens are to be prepared for each of the facing materials for which the manufacturer seeks recognition. The two halves of each test specimen may be bonded to a backing material of hard maple or Douglas fir-larch with an adhesive complying with ASTM D 2559, to provide a net half-specimen thickness of ³/₄ inch (19.1 mm). The grain of the facing material, when evident, is to be oriented parallel to the direction of load application for the block shear tests and normal to the applied force for bond tests.

5.5.2 The two halves of each specimen are bonded so the faying surface is bonded at the facing material under

consideration. At the proponent's option, only one of the faying surfaces need be the laminating material under consideration. Precautions are necessary in selecting the test specimen thicknesses, to avoid affecting the block shear test results of the standard test equipment.

5.5.3 The test specimens are bonded in accordance with the conditions in Section 5.2 and then cut to the dimensions noted in ASTM D 905 for block shear tests, and in ASTM C 297, using 2-inch square (1290 mm²) specimens, for bond tests. Contact area dimensions are determined to the nearest 0.01 inch (0.254 mm).

5.6 Test specimens to evaluate creep characteristics of adhesives are assembled in accordance with ASTM D 1002. Test specimens for self-adhered foamed-in-place core material of non-permeable faced panels are assembled in accordance with ASTM C 273. The test specimens are provided with the required holes set forth in ASTM D 2294. See Figure 1 of this criteria.

5.6.1 As an alternative, when the adhesive is designed for bonding wood to wood, specimens may be a pair of 1-inch-wide-by-1-inch-long-by- $\frac{1}{8}$ -inch-thick (25.4 mm by 25.4 mm by 3.2 mm) pieces of hard maple or Douglas fir-larch, each bonded to a No. 16 gage metal strip. Wood shall comply with Section 5.1.1 or 5.1.2. The adhesive bonding the wood to metal shall be one that is unaffected by the test conditions and not subject to creep; adhesives complying with ASTM D 2559 are considered acceptable. See Figure 1 for construction of the test specimens.

5.6.1.1 The face of the each wood piece shall be surfaced, unsanded, free of dust, straight-grained, and free from defects including knots, bird's-eyes (for hard maple), short grain, decay and any unusual discoloration within the shearing area. The grain direction is to be parallel to the direction of pull. Moisture content shall comply with Section 5.2.

5.6.1.2 The wood-to-wood test specimens shall have the same wood specific gravity (maximum 0.04 variation). The wood portion of each subassembly is coated with the adhesive in accordance with the manufacturer's instructions and brought into full contact. Pressure and heat, when specified, shall be applied for the required time period. Excess adhesive is removed from all edges prior to adhesive setting.

5.6.2 Where metal-to-wood shear specimens are tested, specimens shall be constructed as set forth in Figure 1.

5.7 Metal-to-metal shear test specimens are assembled as set forth in ASTM D 1002, with excess adhesive removed to ensure a definite, uniform area of glue line. Metal-to-metal bond test shall be conducted on 2-inch square (1290 mm²) specimens with sufficient metal plate thickness to accommodate the testing apparatus of ASTM C 297, or the specimens shall be bonded to filler blocks of the required thickness to fit the apparatus. Metal-to-wood bond test specimens are prepared in the same manner as for wood-to-wood specimens discussed in Section 5.4.3, except only one layer of wood is required between the two metal test blocks, and the same test adhesive is used on both faces of the wood.

5.8 The dry-film thickness and weight per square foot of each adhesive application must comply within 10 percent of manufacturer's recommendations. Compliance may be determined by placing a preweighed sheet of aluminum foil of a known area in a position where it will be coated at the same time as the test specimens (preweigh and calculated the dry adhesive deposited per unit area). From the known

adhesive density, the dry-film thickness can be computed. The wet-film thickness may be determined by means of ASTM D 1212, Method A or B.

5.9 In order to evaluate the effect of variations in the glue-line thickness, six sets of five specimens each are to be assembled in accordance with Section 5.6, 5.6.1.2 or 5.6.2. The six sets are to be divided into two groups of three sets each. The first group is to be prepared using one half of the recommended glue-line thickness, and the second group is to be prepared using one-and-one-half times the recommended glue-line thickness. Two sets of specimens are to be conditioned in accordance with Section 6.0 prior to testing as conditioned-only (control) specimens, and the other four sets are to be subjected to accelerated aging in accordance with Section 7. The total number of sets may be reduced to four when Class 1 adhesives are involved, since testing under Section 7.2 is not required. The conditioned (control) specimen sets are to consist of one set from each group, and the specimen sets subjected to accelerated aging are to be made up of the remaining sets from each group. Refer to Section 8.6.6 for test procedures.

6.0 SPECIMEN CONDITIONING

The test specimens are to be conditioned after curing in accordance with the adhesive manufacturer's recommendations or, for self-adhered foamed-in-place core material of non-permeable faced panels, Section 6 of ASTM D 1623, prior to any testing or accelerated aging. If no specific conditioning procedure is recommended, the test specimens are to be subjected to an atmosphere having a relative humidity of 50 ± 2 percent and a temperature of $73^\circ\text{F} \pm 2^\circ\text{F}$ ($23.7^\circ\text{C} \pm 1.1^\circ\text{C}$), for a period of seven days, or until specimens reach equilibrium as indicated by an absence of progressive change in weight. Specimens conditioned in accordance with this section but not accelerated-aged in accordance with Section 7, are designated as conditioned-only (control) specimens. The tabulation of the specimen weight and dimensional changes may be omitted.

7.0 ACCELERATED AGING

7.1 Accelerated aging of "stable" specimens under cyclic laboratory aging conditions are to be conducted in accordance with ASTM D 1183. Class 1 adhesives may be aged in accordance with Procedure "A" for three cycles. Class 2 adhesives are aged in accordance with Procedure "C" for three cycles, except that the -70°F (-56.7°C) temperature may be raised to -40°F (-40°C) and corresponding relative humidity at -40°F reduced from 100 percent to less than 10 percent. After completion of accelerated aging procedures, the specimens are conditioned again in accordance with Section 6 and then tested. The tabulation of the specimen weight and dimensional changes may be omitted for both procedures.

7.2 For Class 2 adhesives, five additional specimens are to be submerged in water at room temperature for 48 hours, and then dried for eight hours at a temperature of $145^\circ\text{F} \pm 5^\circ\text{F}$ ($63^\circ\text{C} \pm 2.8^\circ\text{C}$). This is followed by three cycles of soaking for 16 hours and then drying for eight hours under the same conditions and temperatures. After exposure, the specimens are to be conditioned again in accordance with the Section 6.0, prior to testing.

7.3 Accelerated aging of self-adhered foamed-in-place core material of non-permeable faced panel specimens under cyclic laboratory aging conditions are to be tested in accordance with Procedure C of ASTM D 1183 for three cycles.

8.0 SPECIMEN TESTING

8.1 The tests described in Sections 8.3 through 8.12 are required to substantiate each adhesive or self-adhered foamed-in-place core material of non-permeable faced panels in accordance with its type and class or end use. Alternate tests or procedures require written approval prior to testing. The alternate methods shall be substantiated, including reasons for not complying with this criteria, and justification of the equivalence of the alternate to the test method of the criteria.

8.1.1 The adhesives or self-adhered foamed-in-place core materials of non-permeable faced panels are to be tested with each panel facing material for which recognition is sought. A sufficient number of test specimens is to be prepared and conditioned so that each panel facing material may be subjected to both the block shear test (Section 8.3) and the bond test (Section 8.5) in a conditioned-only (control) state, to determine the adhesives' ultimate strength values or the adhesion strength of the self-adhered foamed-in-place core material of non-permeable faced panels. These values are for comparison with the test results derived from the hard maple, Douglas fir-larch or metal-to-metal test specimens, which are to be tested both in a conditioned-only state and an accelerated-aged state.

8.1.2 When the coefficients of expansion for core and facing materials vary excessively, appropriate tests shall be conducted to justify that differential movement of the elements will not be detrimental to the panel integrity. This testing is optional under this criteria, but mandatory under the ICC-ES Acceptance Criteria for Sandwich Panels (AC04).

8.2 The test report shall indicate the manner of failure for each specimen. This includes whether the adhesive, self-adhered foamed-in-place core material of non-permeable faced panels, or the laminating or facing material failed and the percentage failure of each.

8.2.1 Each test finding shall be based on the average of at least five tests. Should there be obvious inconsistencies, at the option of ICC-ES, additional tests shall be performed.

8.2.2 The test specimens of "stable" materials under Section 5.1 are subjected to tests set forth in Sections 8.3 through 8.9. A sufficient number of test specimens is to be prepared to permit a minimum of five tests in both a conditioned-only (control) state and an accelerated-aged state, or as directed for each test.

8.3 Block Shear: Testing for adhesives shall be performed in accordance with ASTM D 905, except that a load application rate of 0.015 inch (0.381 mm) per minute is used and the testing machine shall have a safe working capacity greater than the maximum applied load. This test is required for all panel facings for which recognition is sought. Curing and conditioning in accordance with Section 6 are necessary. Test specimens are to comply with Section 5.4.1 or 5.5. Only hard maple or Douglas fir-larch test specimens shall be tested as conditioned in accordance with Section 6 and tested after accelerated aging in accordance with Section 7.1. When a Class 2 adhesive is involved, a third set of specimens must be tested after soaking in accordance with Section 7.2.

8.4 Shear Metal-to-metal or Metal-to-wood Specimens:

8.4.1 Specimens for adhesives designed to bond metal to metal, or metal to wood (a metal to hard maple or Douglas fir-larch), shall be fabricated in accordance with Section 5.6 or 5.7, and tested in accordance with ASTM D

1002, in both a conditioned-only (control) state and an accelerated-aged state. An additional five specimens are to be tested in a conditioned-only state at a glue-line test temperature of $182^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($83^{\circ}\text{C} \pm 1.1^{\circ}\text{C}$), under an uncontrolled humidity condition.

8.4.2 Specimens for self-adhered foamed-in-place core material of non-permeable faced panels shall be fabricated in accordance with Section 5.4.2 and tested in accordance with ASTM C 273, in a conditioned-only (control) and an accelerated-aged state. An additional five specimens are to be tested at a temperature of $182^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($83^{\circ}\text{C} \pm 1.1^{\circ}\text{C}$) under an uncontrolled humidity condition.

8.5 Bond:

8.5.1 Testing for adhesives shall be in accordance with ASTM C 297. This test is required for all facing materials for which recognition is sought, and requires conditioning in accordance with Section 6.0. Test specimens shall be prepared in accordance with Section 5.4.3 or 5.5. Hard maple, Douglas fir-larch or metal-to-metal test specimens are to have a minimum of five conditioned-only (control) specimens tested, and one set of tests are to be conducted on five additional specimens that have been accelerated-aged in accordance with Section 7.1. One additional set of specimens is required for tests under Section 7.2 where Class 2 adhesives are called for. The test report is to indicate whether the adhesive or the laminating material failed, and the percentage failure of each, and is also to provide the information required by ASTM C 297.

8.5.2 Testing for self-adhered foamed-in-place core material of non-permeable faced panels shall be in accordance with ASTM D 1623. This test is required for all facing materials for which recognition is sought, and requires conditioning in accordance with Section 6. Test specimens shall be prepared in accordance with Section 5.4.4. Metal-to-metal testing specimens are to have a minimum of five conditioned-only (control) specimens tested, and one set of tests are to be conducted on five additional specimens that have been accelerated-aged in accordance with Section 7.3. The test report shall indicate the failure mode, the percentage failure of each specimen, and information required by ASTM D 1623.

8.5.3 Specimens for adhesives designed to bond metal to wood (metal to a hard maple or Douglas fir-larch) or metal to metal shall comply with Section 5.7.

8.5.4 Bond tests with stable materials discussed in Section 5.1, or with weather-resistive materials, shall be conducted on both conditioned-only (control) specimens and on accelerated-aged specimens in accordance with Section 7.

8.6 Creep: The creep test is to be performed on all Type II adhesives and self-adhered foamed-in-place core material of non-permeable faced panels in compliance with ASTM D 2294. The desired shear stress shall be predetermined so test specimens can be loaded to that stress plus 25 percent.

8.6.1 The test specimens are prepared in accordance with Section 5.6. Tests are conducted to determine the allowable shear strength for Class 2 adhesives. For each test, allowable creep is limited to an average of 0.002 inch per inch (0.0508 mm/mm) in the first hour, with an average of 0.005 inch per inch (0.127 mm/mm) for the entire duration of each test. The testing laboratory is to describe the test markings on each specimen prior to applying the test load, with a reading taken immediately after loading and then at the intervals prescribed in this criteria.

8.6.2 The specimens are conditioned in accordance with Section 6.0 prior to loading and testing. One set of five specimens is tested as conditioned-only (control) specimens for a period of 30 days in an uncontrolled temperature and humidity condition, with creep readings taken every hour for the first eight hours, daily for the next seven days, and then weekly for the remainder of the 30 days.

8.6.3 A second set of five specimens shall be tested as conditioned-only (control) specimens in an uncontrolled humidity and temperature at an elevated temperature of $158^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($70^{\circ}\text{C} \pm 2.8^{\circ}\text{C}$) for one week; the temperature shall be $182^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($83^{\circ}\text{C} \pm 1.1^{\circ}\text{C}$) where bonded metal surfaces are involved. Creep readings are taken every hour for the first eight hours, and then twice daily for the remainder of the test. The two test series may be conducted simultaneously.

8.6.4 Specimens for adhesives designed to bond metal to wood or metal to metal are prepared in accordance with Section 5.6.2 or 5.7. The specimens are then tested in accordance with Section 8.6.2 or 8.6.3. Results are to be controlled by the same limitations set forth in Section 8.6.1.

8.6.5 Specimens for self-adhered foamed-in-place core material of nonpermeable faced panels designed to bond metal to metal are prepared in accordance with Section 5.6 or 5.7. The specimens are then tested in accordance with Section 8.6.2 or 8.6.3 with the same limitations set forth in Section 8.6.1.

8.6.6 Specimens for adhesives under Section 5.9 shall be tested in an uncontrolled temperature and humidity condition in accordance with Section 8.6 for seven days, with readings taken at intervals specified in Section 8.6.3. All creep measurements shall be recorded for comparison with the related tests.

8.7 Oxidation: Adhesives such as elastomers, synthetic elastomers, rubber cement, or others suspected of being affected by long-term aging, shall be evaluated in accordance with ASTM D 572. The adhesives shall first be evaluated for possible ingredients known to react violently with oxygen at the test pressures or temperatures. If such an ingredient exists, the alternate ozone test described in Section 8.7.2 shall be conducted.

8.7.1 Five block shear test specimens prepared in accordance with Section 5.4.1 are conditioned in accordance with Section 6.0 and then subjected to suspension in an oxygen atmosphere at $158^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($70^{\circ}\text{C} \pm 2.8^{\circ}\text{C}$) and 300 ± 15 pounds per square inch (2068.4 ± 103.4 kPa) pressure for a period of 500 hours; the temperature shall be $182^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($82^{\circ}\text{C} \pm 1.1^{\circ}\text{C}$) where bonded metal surfaces are involved. After exposure, the specimens are again conditioned and then tested immediately in accordance with ASTM D 905, except that a load application rate of 0.015 inch (0.381 mm) per minute is used.

Specimens utilizing adhesives designed to bond metal to metal or metal to wood are to be prepared in accordance with Section 5.6.2 or 5.7. The specimens are then subjected to the oxidation test in Section 8.7, conditioned as indicated therein, and tested in accordance with ASTM D 1002 for shear.

8.7.2 As an alternate to the oxidation test, the test procedure under ASTM D 1149, (flat specimen), may be used. The ozone concentration shall be 50 parts per

100,000,000 by volume, measured before and adjusted after the introduction of the test specimens into the chamber, then twice daily once the proper concentration has been reached. The standard chamber temperature is to be $122^{\circ}\text{F} \pm 2^{\circ}\text{F}$ ($50^{\circ}\text{C} \pm 1.1^{\circ}\text{C}$) for the duration of each test.

8.7.2.1 Five block shear test specimens, prepared and conditioned in accordance with Section 5.4.1 and 6.0, are subjected to suspension in the ozone test chamber for a period of 72 hours. After exposure, the specimens are again conditioned and are tested immediately in accordance with ASTM D 905, except that a load application rate of 0.015 inch (0.381 mm) per minute is used.

8.7.2.2 Adhesives designed to bond metal to metal or metal to wood are prepared and tested as for specimens of the oxidation test, except that the ozone test in Section 8.7.2 is used in place of the oxidation test.

8.8 Mold: The test procedure for mold shall be in accordance with Sections 8.8.1 through 8.8.4.

EXCEPTION: Mold testing according to Section 8.8 is not required when the manufacturer attests that neither amylaceous nor protein fillers and extenders are used.

8.8.1 Ten specimens of hard maple or Douglas fir-larch material are prepared in accordance with Sections 5.4.1 and 5.4.3, conditioned in accordance with Section 6.0 and then inoculated and exposed as noted in Section 8.8.2.

8.8.2 A thin mixture of water and food-grade, acid-precipitated, 80 to 90 mesh casein, with a minimum protein content of 82 percent¹, is prepared. It is mixed at a casein-to-water ratio of 1:5 by weight. Allow to stand one hour at 72°F to 80°F (22.2°C to 26.7°C). Prepare a mold inoculum by soaking three sheets or more of sapwood veneers, approximately 1 square foot ($92\ 903$ mm²) each, for one hour in the casein suspension. Before removing the veneers, stir the casein suspension to ensure trapping a thin layer of the casein on the surface of the veneers as they are removed. Store the wet sheets, properly spaced for free circulation of air, in loosely covered chamber for seven days or until their surfaces are covered with a thick growth of mold, whichever is the shorter period. The chamber shall be a suitable size glass, metal or fiber drum with a polyethylene liner, equipped with a loosely fitting cover; or a metal chamber with a suitable door. The chamber shall be capable of maintaining an inside temperature of 72°F to 80°F (22.2°C to 26.7°C) and of providing essentially a saturated vapor conditions at these temperatures. The chamber shall be equipped with racks or wire trays to support the specimens and to allow good air circulation over the specimens.

Scrape the mold spores from the three sheets of veneer into 1,500 ml of tap water at 72°F to 80°F (22.2°C to 26.7°C), and stir to ensure that uniform distribution in the water. Immerse the test specimens in this suspension of mold spores for 30 to 60 seconds. Remove and space loosely on racks or wire trays, and place the racks or trays in the chamber with the cover or door closed.

Maintain the chamber at 72°F to 80°F (22.2°C to 26.7°C) for eight weeks. Check the specimens at intervals during exposure to be certain that they are always covered with an active mold growth.

After mold exposure, the specimens are tested in accordance with ASTM D 905 and ASTM C 297.

¹One source for casein complying with these specifications is the American Casein Company, 109 Elbow Lane, Burlington, New Jersey 08016-4123. Other sources can be used, provided the casein complies with the above specifications.

8.8.3 Mold testing is required for self-adhered foamed-in-place core material of nonpermeable faced panels. Following mold exposure as described in Section 8.8.1 and 8.8.2, the specimens are tested in accordance with ASTM D 1623.

8.8.4 The percentage of efficiency of the inoculated specimens, as compared to the conditioned-only (control), must exceed 90 percent, unless the adhesive is classified as Type I, Class 1.

8.9 Chemical Reagents:

8.9.1 Adhesive: Five adhesive specimens are each prepared in accordance with Sections 5.4.1 and 5.4.3. All samples are then conditioned in accordance with 6.0 and exposed to the chemical reagents for which recognition of resistance is sought. The tests are conducted in accordance with ASTM D 896. The adhesive shall demonstrate no loss of strength when specimens are tested in accordance with ASTM D 905 and ASTM C 297. A load application rate of 0.015 inch (0.381 mm) per minute shall be used in the block shear test. The test may be waived when the adhesive is limited to use in Group H and Group I Occupancies, except where fire retardant or preservative treatment is involved.

8.9.2 Foamed-in-place Material: Panels consisting of frothed, injected or poured-in-place self-adhering foam shall be prepared in accordance with Sections 5.4.2 and 5.4.4. All specimens are conditioned as described in Section 6.0 and exposed to the chemical reagents for which recognition of resistance is sought. The tests are conducted in accordance with ASTM D 896. The self-adhered foamed-in-place core material of nonpermeable faced panels shall demonstrate no loss of strength when specimens are tested in accordance with ASTM C 273 and ASTM D 1623. A load application rate of 0.015 inch (0.381 mm) per minute shall be used in the block shear test. The test may be waived when the adhesive is limited to use in Group H and Group I Occupancies, except where fire-retardant or preservative treatment is involved.

8.10 Density: The density test is to be performed on all self-adhered foamed-in-place core material of non-permeable faced panels in accordance with ASTM D 1622.

8.11 Compatibility: The adhesive or sandwich panel proponent shall indicate that the core material for which recognition is sought is compatible with the adhesive. For spray applications, three representative samples of each core material shall have the following adhesive coatings applied to a smooth even surface: In three consecutive spray applications, each at a rate to provide one-half the final recommended thickness, one coat shall be applied to three specimens, a second coat to two specimens, and a third coat to one specimen.

When a spray application is not recommended, the three samples shall have one-half, full and one-and-one-half the recommended thickness of adhesive, applied in accordance with the adhesive manufacturer's standard instructions except with respect to thickness.

Additionally, ten 2-inch-square (1290 mm²) specimens of each core material shall be coated and bonded in pairs at the recommended adhesive thickness, to form a specimen for testing in accordance with ASTM C 297. Bond strength in accordance with ASTM C 297 is then determined after the three-week period noted in Section 8.11.2.

8.11.1 All samples shall be maintained at the recommended temperature and humidity during panel fabrication, and observations shall be made concerning the surfaces and edges during the drying or curing period.

8.11.2 All samples shall be retained in areas of uncontrolled moisture and temperature after drying, and observations shall be made at the end of the first, second, and third weeks. Any evidence of deterioration, softening, hardening or cracking of the samples, noted during the application, curing and observation periods, shall be reported. The core material shall be of different densities when polyurethane or polystyrene foams or similar materials are used, to ensure compatibility over a range of core applications.

8.12 Core-facing Bond: Testing specified in ASTM C 393, shall be conducted when there is insufficient evidence that core shear failure will consistently occur before failure at the bond line between the core and facing.

9.0 CONCLUSIONS

9.1 Adhesives:

9.1.1 General: For adhesives intended for use in sandwich panels evaluated in accordance with Section 4 of the ICC-ES Acceptance Criteria for Sandwich Panels (AC04), the evaluation report on the adhesive must include the adhesive classification and allowable shear stress of Type II adhesives based on creep tests, if applicable.

For adhesives intended for use in sandwich panels evaluated in accordance with Section 5 of AC04, the allowable bond stress, shear stress and maximum percent loss in strength shall be determined and reported with the adhesive classification in the evaluation report.

9.1.2 Classification: One of the classifications described in Section 2 of this criteria shall be assigned, provided all tests pertinent to the classification are conducted and the adhesive does not exhibit a loss in strength of more than 20 percent from control due to aging or temperature test exposures.

EXCEPTIONS:

1. Adhesives used in sandwich panels evaluated in accordance with Section 5 of AC04 are permitted to have a strength loss of more than 20 percent, provided additional data is submitted to demonstrate that the adhesive does not lose additional strength beyond that shown in testing over the expected life of the sandwich panels.

2. Adhesives used in sandwich panels evaluated in accordance with Section 4 of AC04 are permitted to have strength loss of more than 20 percent, provided all of the following conditions are met:

- The sandwich panels utilize foam plastic cores having a density not exceeding 3.0 pcf (48.1 kg/m³).
- The strengths are at least 300 psi (2068.4 kPa).
- Additional cyclic aging tests beyond those specified in this criteria demonstrate that the adhesive has a strength of at least 60 psi (413.7 kPa) at the point where the strength loss per cycle approaches zero percent.

3. Adhesives used in sandwich panel systems evaluated in accordance with Section 4 of AC04 are permitted to have strength loss of more than 20 percent when subjected to accelerated aging defined under Section 7.1 or 7.2, provided all of the following conditions are met:

- The strengths of all specimens conditioned in accordance with Section 6.0 and exposed to accelerated aging defined within Sections 7.1 or 7.2 shall be at least 300 psi (2068.4 kPa).
- Specimens are exposed to additional cycles of accelerated aging. Additional accelerated aging cycles shall

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be similar to the accelerated aging that resulted in a strength loss greater than 20 percent.

- Tests of specimens exposed to additional accelerated aging cycles beyond those specified in this criteria demonstrate that the adhesive has an average strength of at least 60 psi (413.7 kPa), but not less than 20 percent of the control specimens, at the point where the average strength loss per cycle approaches zero percent. For the purpose of this exception, the strength of the test specimens when the average strength loss per cycle approaches zero percent shall be considered the “exposed” strength.

- The allowable loads based on sandwich panel strength, as determined through testing, shall be multiplied by the ratio of the average “exposed” strength of the specimens to the average strength of the control specimens.

4. Adhesives used in sandwich panel systems evaluated in accordance with Section 4 of AC04 are permitted to have strength loss of more than 20 percent when subjected to elevated temperature, provided all of the following conditions are met:

- The strengths of all specimens conditioned in accordance with Section 6.0 and tested at the elevated temperature defined within Section 8.4 shall be at least 300 psi (2068.4 kPa).

- Tests are conducted on specimens that are exposed to multiple cycles of elevated temperature (see note below).

Note: One cycle of temperature exposure is defined as follows:

a. Start with specimens that have a glue-line temperature meeting the appropriate Section of AC05.

b. Maintain the required glue-line temperature for a period of at least 10 minutes.

c. Lower the glue-line temperature to $73^{\circ}\text{F} \pm 2^{\circ}\text{F}$ by removing the specimens from the oven and placing them in a “room temperature” atmosphere.

d. Maintain the glue-line temperature for a minimum of 10 minutes.

e. Raise the glue-line temperature to the required elevated temperature by removing the specimens from the “room temperature” atmosphere and placing them into an oven that has been pre-heated to the required elevated temperature.

f. Maintain the specimens at a glue-line temperature for a minimum of 10 minutes.

- Tests of specimens exposed to multiple cycles of elevated temperature and then tested at the required elevated temperature, demonstrate that the adhesive has an average strength of at least 60 psi (413.7 kPa), but not less than 20 percent of the control specimens, at the point where the average strength loss per cycle approaches zero percent. For the purpose of this exception, the strength of the test specimens when the average strength loss per cycle approaches zero percent shall be considered the “exposed” strength.

- The allowable loads based on sandwich panel strength, as determined through testing, shall be multiplied by the ratio of the average “exposed” strength of the specimens to the average strength of the control specimens.

5. Adhesives used in sandwich panel systems evaluated in accordance with Section 4 or 5 of AC04 are permitted to have strength loss of more than 20 percent when subjected

to elevated temperatures provided all of the following conditions are met:

- The strengths of all specimens conditioned in accordance with Section 6.0 and tested at the elevated temperature defined within Section 8.4 shall be at least 300 psi (2068.4 kPa).

- Tests are conducted on specimens that are exposed to multiple cycles of elevated temperature. (See Exception 4 for definition of one cycle of temperature exposure.)

- Tests of specimens exposed to multiple cycles of elevated temperature and then tested at the required elevated temperature, demonstrate that the adhesive has an average strength of at least 60 psi (413.7 kPa), but not less than 20 percent of the strength of the control specimens, at the point where the average strength loss per cycle approaches zero percent. For the purpose of this exception, the strength of the test specimens when the average strength loss per cycle approaches zero percent shall be considered the “exposed” strength.

- The average strength of specimens exposed to an equal number of temperature cycles as the specimens used to define the “exposed” strength and then tested at a temperature of $73^{\circ}\text{F} \pm 2^{\circ}\text{F}$ is within 20 percent of the average strength of the control specimens.

- For the design of sandwich panels in accordance with Section 4 of AC04, allowable loads to be used during design, for all load combinations except those that include snow loads, shall be determined by multiplying the allowable load based on AC04 test results by the ratio of the average “exposed” strength to the average strength of the control specimens. For load combinations that include snow loads, the allowable loads to be used during design shall be based on AC04 test results for the panel, without reduction for loss of strength caused by exposure to elevated temperatures.

- For the design of sandwich panels in accordance with Section 5 of AC04, allowable loads to be used during design for all load combinations, except those that include snow loads, shall be calculated using the average “exposed” strength of the adhesive divided by the factor of safety presented within Section 9.3. For load combinations that include snow loads, the allowable loads to be used during design shall be calculated using the average strength of the control specimens divided by the factor of safety presented within Section 9.3.

9.2 Self-adhered Foamed-in-place Core Material: For self-adhering foamed-in-place core material of non-permeable faced panels intended for use in sandwich panels evaluated in accordance with Section 4 of the ICC-ES Acceptance Criteria for Sandwich Panels (AC04), the evaluation report on the foamed-in-place core material can recognize the foam core material for use in exterior bearing and nonbearing walls and other locations where high moisture and high creep resistance are necessary. The allowable bond and shear maximum percentage loss in strength shall be determined and reported.

For self-adhered foamed-in-place core material of non-permeable faced panels intended for use in sandwich panels evaluated in Section 5 of the ICC-ES Acceptance Criteria for Sandwich Panels (AC04), the allowable bond and shear maximum percentage loss in strength shall be determined and reported.

The self-adhered foamed-in-place core material of non-permeable faced panels is permitted for use in sandwich panels, provided tests demonstrate that the core material

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does not exhibit a strength loss of more than 20 percent from control due to aging or temperature-test exposure.

EXCEPTION: Foam core material used in sandwich panels evaluated in accordance with AC04 is permitted to have a strength loss of more than 20 percent, provided additional data is submitted to demonstrate that the foam core material does not lose additional strength beyond that shown in testing over the expected life of the sandwich panels.

9.3 Factor of Safety: Allowable bond and shear stress, when reported, shall be based on a factor of safety of 5.0, applied to ultimate test loads. The lowest ultimate load values for each test shall be used, based on conditioned-only (control), accelerated-aged or elevated-temperature test specimens.

9.4 Shear Stress of Type II Adhesives: The allowable shear stress of Type II adhesives shall not exceed 80 percent of the creep test stress.

10.0 QUALITY CONTROL

Adhesives and components of self-adhering foamed-in-place core material are required to be manufactured under a quality control program documented in a manual complying with the ICC-ES Acceptance Criteria for Quality Control Manuals (AC10). Follow-up inspections by an inspection agency are not required under this criteria. ■

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TABLE 1—TEST TABULATION

CATEGORY	EVALUATION REPORT ¹		SPECIMEN ^{2,3}	CONDITIONING ^{2,4}	AGING ²	TEST PROCEDURE
	Adhesive	Panel				
Shear	X	—	5.4.1 maple or Douglas fir–larch	6	7	8.3
	X	—	5.1.3 and 5.7 metal or fiberglass	6	7	8.4
	—	X	5.5 other facing materials	6	None	8.3
Bond	X	—	5.4.3 maple or Douglas fir–larch	6	7	—
	X ⁵	—	5.1.3 and 5.7 metal	6	7	8.5
	—	X	5.5 other facing materials	6	None	—
Creep (not required for Type I adhesives)	X	—	5.6.1 and 5.9 maple or Douglas fir–larch	6	None	8.6
	X ⁵	—	5.1.3, 5.7 and 5.9 metal	6	None	8.6
Oxidation ⁶	X	—	5.4.1 maple or Douglas fir–larch	6	8.7	8.7.1 or 8.7.2.1
	X	—	5.1.3, 5.6.2 and 5.7 metal	6	8.7	8.7.1 or 8.7.2.2
Mold	X	—	5.4.1 and 5.4.3 maple, Douglas fir–larch or metal	6	None	8.8
Chemical reagents ⁷	—	X	5.4.1 and 5.4.3 maple or Douglas fir–larch	6	None	8.9
Core compatibility	—	X	Core	8.11.1 and 8.11.2	None	8.11
Core-facing bond	—	X	Core-facing	6	None	8.12

¹Tests for panel reports assume that an already approved adhesive will be used. Optionally, the adhesive manufacturer may also include panel materials in the report. See Section 1.2.

²Reference number(s) refers to section(s) of this acceptance criteria.

³Section 5.2 is applicable in all cases, and Section 5.3 is applicable to shear and bond tests.

⁴See test procedures for variations.

⁵Shear, bond and creep tests on steel and fiberglass samples are optional in an adhesive report if the manufacturer is not seeking recognition for these materials.

⁶Qualifying tests with wood or steel samples are acceptable for all core and facing materials.

⁷Includes fire-retardant and preservative treatments.

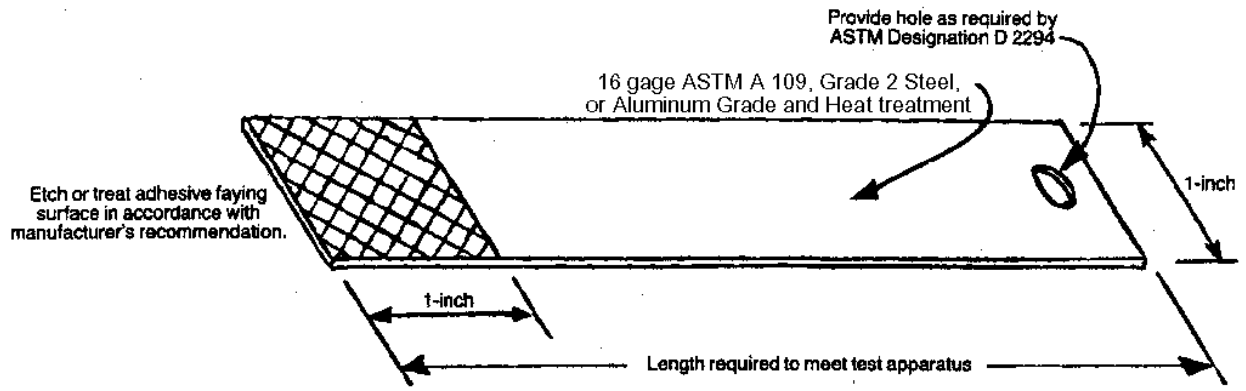
TABLE 2—QUALIFYING TEST FOR SELF-ADHERED FOAMED-IN-PLACE CORE MATERIALS OF NON-PERMEABLE FACED PANELS

CATEGORY	SPECIMEN ¹	CONDITIONING ^{1,2}	AGING ¹	TEST PROCEDURES ¹
Shear	5.4.2 nonpermeable face (metal)	6	7.3	8.4
Bond	5.4.4 metal	6	7.3	8.5
Creep	5.6 nonpermeable face (metal)	6	None	8.6
	5.1.3 and 5.7.1 metal	6	None	8.6
Mold	5.4.2 and 5.4.4 metal	6	None	8.8.3
Chemical reagents	5.4.2 and 5.4.4 nonpermeable face (metal)	6	None	8.9
Density	Core	6	None	8.10

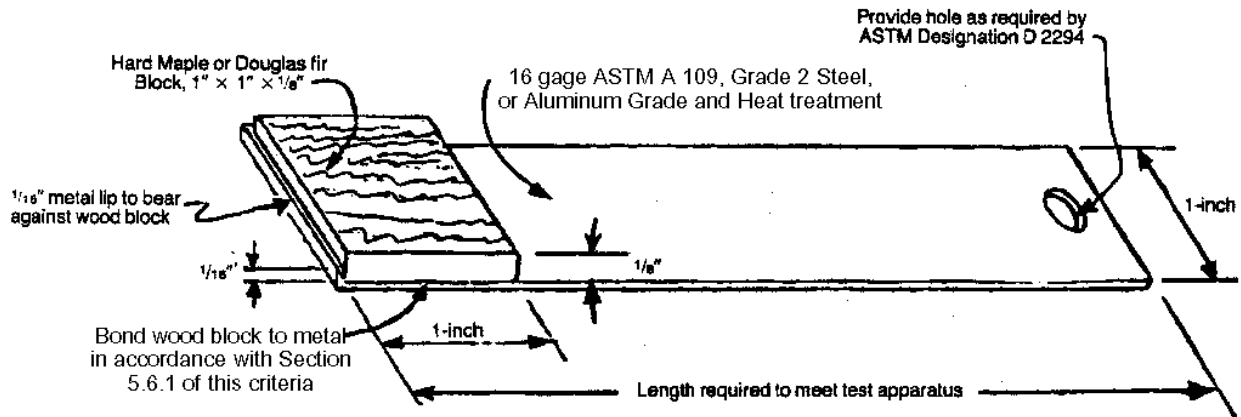
¹Reference number(s) refers to section(s) of this acceptance criteria.

²See test procedures for variations.

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One required for each specimen in Paragraph 5.6.2



Two required for each specimen in Section 5.6.1 of this criteria
 One required for each specimen in Section 5.6.2 of this criteria

FIGURE 1