



**IAPMO UNIFORM EVALUATION**  
**SERVICES EVALUATION CRITERIA FOR**  
**JOIST HANGERS AND**  
**MISCELLANEOUS CONNECTORS**

**EC 002- 2017**  
**(Adopted June 2007, Revised August 2017)**

**1.0 INTRODUCTION**

**1.1 Purpose:** The purpose of this evaluation criteria is to establish requirements for evaluation of joist hangers and miscellaneous connectors under the 2015, 2012, 2009 and 2006 *International Building Code*<sup>®</sup> (IBC<sup>®</sup>), and the 2015, 2012, 2009 and 2006 *International Residential Code*<sup>®</sup> (IRC). This criteria provides guidelines for calculating and testing the performance of joist hangers and miscellaneous connectors, based on code provisions contained in 2006, 2009, and 2012 IBC Section 1711.1, and 2015 IBC Sections 2303.05 and 2304.10.3; and on the requirements in this evaluation criteria, for conditions where the codes do not address the necessary requirements. Bases of recognition are IBC Section 104.11 and IRC Section R104.11.

**1.2 Scope:** This evaluation criteria describes the testing requirements and procedures, the documentation required for review, and analysis methods used to determine allowable loads for joist hangers and miscellaneous connectors for recognition in an evaluation report issued by an approved certification body accredited in accordance with ISO/IEC 17065.

**1.2.1** This criteria for evaluation of hangers, connectors, and devices includes their recognition for use in wood-to-wood, wood-to-concrete or masonry, and wood-to-steel connections.

**1.2.2** This criteria may be modified as applicable for the analysis of connector devices such as hurricane ties, strap ties, column caps and bases, bent plates, truss connectors and roof mounted connectors (used with roof-mounted solar collectors) when such modifications are more appropriate for evaluating the end use of the connector.

Examples: Test configurations using a 1/8-inch (3.2 mm) gap may be applicable to joist hangers but may not be appropriate for all other connector types; and due to effects of eccentricities, results from testing a single connector may not be representative of field conditions where multiple connectors are used.

**2.0 REFERENCED STANDARDS**

**2.1** The following standards, referenced in this criteria, shall be applied consistently with the provisions of the applicable edition of the code(s) noted herein:

2006, 2009, 2012, 2015 IBC	International Building Code®
2006, 2009, 2012, 2015 IRC	International Residential Code®
2001, 2005, 2012, 2015 NDS	National Design Specification for Wood Construction (ANSI/AWC NDS)
ASTM D1761-88(2000) <sup>ε1</sup>	Test Methods for Mechanical Fasteners in Wood
ASTM D7147-11	Standard Specification for Testing and Establishing Allowable Loads of Joist Hangers
ASTM E575	Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies
ISO/IEC 17011-2004	Conformity assessment- General requirements for accreditation bodies accrediting conformity assessment bodies
ISO/IEC 17025-2005	General requirements for competence of testing and calibration laboratories
ISO/IEC 17065-2012	Conformity assessment -- Requirements for bodies certifying products, processes and services

### 3.0 BASIC INFORMATION

The following information shall be provided for review and evaluation:

- 3.1 Product Description:** Complete information pertaining to components, including dimensional drawings, material specifications, and the manufacturing processes. Materials shall comply with an appropriate recognized national standard(s).
- 3.2 Installation and Use Instructions:** Complete information pertaining to product installation and use. The installation instructions shall be the same as those published for use in the field for product installation, and in the laboratory for specimen preparation before testing.
- 3.3 Packaging and Identification:** Method(s) of packaging and product identification. Identification shall include, at minimum, the manufacturer's or report holder's name and address, product name and identification number, the certification body name or mark, and the evaluation report number.
- 3.4 Justifying Documentation:** Complete justification for the product's acceptability for the stated use in accordance with the applicable codes, standards, related criteria, including this criteria, and reports of testing and analysis prescribed therein and otherwise appropriate to justify recognition and approval.
- 3.4.1 Testing Laboratories:** Testing laboratories shall be accredited for the applicable testing procedures in accordance with ISO/IEC 17025 by a recognized accreditation body conforming to ISO/IEC 17011. Testing at a non-accredited laboratory shall be permitted, provided the testing is conducted under the supervision of an accredited laboratory, the testing complies with all of the requirements of the applicable standards, the product specimens comply with the minimum criteria for acceptance, and the supervising laboratory issues the test report.
- 3.4.2 Test Reports:** Test reports shall include all of the applicable information required by the applicable test standard and ASTM E575, as appropriate.
- 3.4.3 Product Sampling:** Sampling of the joist hangers or miscellaneous connectors for tests under this criteria shall be conducted at the manufacturing locations by an accredited testing laboratory or inspection agency. Alternatively, the specimens may be submitted to the laboratory by the manufacturer, provided the manufacturer attests that the submitted samples are representative of normal production and of the product

being evaluated. The accredited testing laboratory or accredited inspection agency shall compare the samples taken to the normal product specifications and shall conclude that the products comply.

#### **4.0 TEST AND PERFORMANCE REQUIREMENTS**

**4.1 Test Procedures:** The test procedures, equipment, and materials shall be in accordance with the building code, ASTM D7147 or ASTM D1761, as applicable, and the provisions of this document.

For recognition under the 2015 IBC and IRC, the testing of joist hangers shall be in accordance with IBC Sections 2303.5 and 2304.10.3, ASTM D7147, and the provisions of this document.

For recognition under the 2006, 2009, and 2012 IBC and IRC, the testing of joist hangers shall be in accordance with IBC Sections 1711.1 and 2304.9.3, ASTM D1761, and the provisions of this document.

Evaluation Reports based on testing in accordance with this section using ASTM D1761 are permitted to include recognition under the 2015 IBC and IRC, when allowable loads are determined in accordance with Section 5.1.2 of this criteria.

**4.1.1** For connections that rely in some part on wood bearing for resistance, such as joist hangers resisting gravity loads, a composite wood member, such as laminated veneer lumber (LVL), may be substituted for the solid sawn wood joist. For connections that rely solely on fasteners for resistance, such as joist hangers resisting uplift loads, solid sawn wood shall be used for the joist and the header in the test set-up.

**4.1.2** For recognition under the 2006, 2009, and 2012 IBC and IRC, based on testing in accordance with the provisions of ASTM D1761, joist and header lumber used in the test assemblies shall have specific gravity from 0.49 to 0.55. Alternatively, where actual specific gravity of the tested members falls outside this range, strength adjustments shall be made in accordance with ASTM D7147 Section 13.5 to account for the difference between published nominal values of specific gravity and the tested values for the lumber used in the test set-up.

For recognition based on testing in accordance with the provisions of ASTM D7147, strength adjustments shall be made in accordance with Section 5.1 of this criteria to account for the difference between published nominal values of specific gravity and the tested values for the lumber used in the test set-up.

**4.1.3** The moisture content of dimension lumber at the time of testing shall be not less than 11 percent for recognition based on testing in accordance with the provisions of ASTM D1761. Alternatively, where actual moisture content of the tested members falls below 11 percent, strength adjustments shall be made in accordance with ASTM D7147 Section 13.5.

For recognition based on testing in accordance with ASTM D7147, the moisture content of dimension lumber specimens used in testing may be less than 11 percent, provided the results are adjusted in accordance with Section 5.1 of this criteria. For structural composite lumber, structural glued laminated wood, and wood I-joists the moisture content shall be in accordance with Section 10.2 of ASTM D7147.

- 4.1.4** Test procedures for roof mounted connectors (for use with roof mounted solar collectors) shall be based on testing in accordance with ASTM D1761 (see Section 5.4) and shall include the roof covering intended for the recognized installation configuration. Vertical load tests shall be conducted with the roof mounted connector at the maximum and minimum roof slopes being evaluated. Roof mounted connectors shall be tested as a single unit. Deflection gages or other suitable devices shall be located within 1 inch (25.4 mm) of fastener locations.
- 4.1.5** For recognition based on testing in accordance with ASTM D1761, the number of samples tested shall be in accordance with IBC Section 1711.1.
- For recognition based on testing in accordance with ASTM D7147, the number of samples shall be in accordance with Section 8 of ASTM D7147.
- 4.1.6** Under the 2015 IBC and IRC, torsional moment capacity recognition, when requested, shall be based on testing in accordance with Appendix X of ASTM D7147. Alternatively, where joist hanger or connector capacity recognition is based on testing in accordance with ASTM D1761, torsional capacity determination when required based on the type of connector, or requested, shall be generally based on ASTM D1761 testing and capacity analysis shall be in accordance with 2012, 2009, or 2006 IBC Section 1711.1.
- 4.2** Test reports shall be in accordance with ASTM D7147 Section 12, or ASTM D1761 Section 29 and ASTM E575, as applicable.
- 5.0 DETERMINATION OF ALLOWABLE LOADS**
- 5.1 Recognition of joist hangers under the 2015 IBC and IRC:**
- 5.1.1** For recognition of joist hangers under the 2015 IBC and IRC, allowable loads for the connection devices shall be determined in accordance with ASTM D7147 Sections 13 through 15.
- 5.1.2** Alternatively, joist hangers are permitted recognition under the 2015 IBC and IRC using testing performed in accordance with ASTM D1761, provided allowable vertical loads are determined in accordance with ASTM D7147 Sections 13 through 15. Where material strengths, material properties, and dimensions of tested components are not shown in the test reports, values specified in accordance with Appendix A of this criteria shall be used to determine the adjustment factors specified in ASTM D7147.
- 5.2 Recognition under the 2006, 2009, and 2012 IBC and IRC:** For recognition under the 2006, 2009, and 2012 IBC and IRC, allowable loads and torsional capacities based on testing shall be in accordance with IBC Section 1711.1.
- 5.3** Duration factor adjustments may be taken in accordance with the NDS, unless the capacity limit is based on tested values.
- 5.4** For roof mounted connectors (used with solar collectors), the limit load shall be determined by testing in accordance with ASTM D1761. The allowable load reported shall be the lesser of the lowest ultimate load achieved by testing 3 samples, divided by a factor of safety of 3, the

load at maximum specified deflection, or the allowable design load based on calculations. The maximum specified deflection shall be 1/8-inch (3.2 mm). The vertical test deflection at each fastener shall be reported.

- 5.5** Joist hanger allowable design torsional capacity shall be determined in accordance with Section X1.3 in Appendix X of ASTM D7147.

## **6.0 QUALITY CONTROL**

- 6.1** Manufacturer's Quality Assurance System shall comply with the IAPMO UES Minimum Requirements for Listee's Quality Assurance System (IAPMO ES-010).
- 6.2** Inspections of manufacturing facilities by an approved and accredited certification or inspection agency are required for these products. The inspection agency shall be accredited in accordance with ISO/IEC 17020.

## **7.0 EVALUATION REPORT RECOGNITION**

- 7.1** Evaluation reports shall include the general information required in Section 3.0 of this criteria and allowable loads in accordance with Section 5.0 of this criteria.

- 7.2** The evaluation report shall include the following special inspection requirements:

**7.2.1.** Periodic special inspection shall be conducted when the product series includes components used within the main wind-force-resisting system of structures constructed in areas listed in the 2015 IBC Section 1705.11 or 2012 IBC Section 1705.10, 2009 IBC Section 1706.1, or 2006 IBC Section 1705.4. Special inspection requirements do not apply to structures, or portions thereof, that qualify for exception under the 2015 or 2012 IBC Sections 1704.2, 1705.3, 1705.10.1 or 1705.10.2; 2009 IBC Sections 1704.1, 1704.4, 1706.2 or 1706.3; or 2006 IBC Sections 1704.1 and 1704.4.

**7.2.2.** Periodic special inspection shall be conducted in accordance with the applicable portions of 2015 IBC Section 1705.12, 2012 IBC Section 1705.11, 2009 IBC Section 1704, or 2006 IBC Section 1707 when the product series are components within the seismic-force-resisting system of structures constructed in Seismic Design Category C, D, E or F. Special inspection requirements do not apply to structures, or portions thereof, that qualify for exception under 2015 and 2012 IBC Sections 1704.2, 1705.3, 1705.11 or 1705.12; or 2009 IBC Sections 1704.1, 1704.4, 1705.3, 1707.3, or 1707.4.

**7.2.3.** For installations under the IRC, special inspection is not normally required. However, for an engineered design where calculations are required to be signed by a registered design professional, periodic special inspection requirements and exemptions are as stated in Sections 7.2.1 and 7.2.2 of this criteria as applicable for installations under the IRC.

- 7.3** It shall be noted in the evaluation report that: "Fasteners used in contact with preservative-treated or fire-retardant-treated wood shall comply with 2015 IBC Section 2304.10.5 or 2015 IRC Section R317.3 (or 2012 IBC 2304.10.5, 2009 IBC Section 2304.9.5, 2012 IRC Section R317.3, 2019 IRC Section R317.3, or 2006 IRC Section R319.3, as applicable). The report holder or lumber treater shall be contacted for recommendations on minimum corrosion

resistance and connection capacities of fasteners used with the specific proprietary preservative-treated or fire-retardant-treated lumber”.

- 7.4 The hangers and connectors shall be of corrosion-resistant steel, or shall be coated for corrosion resistance.
- 7.5 The allowable vertical load capacity of roof-mounted connectors shall be reported at specified deflections in 1/8 inch (3.2 mm) increments.
- 7.6 Evaluation reports shall include a statement directing users to ANSI TPI 1 for design and installation guidance to avoid failures due to tension-perpendicular-to-grain loading.
- 7.7 The allowable design torsional capacities of the joist hangers as determined by testing or by calculation shall be reported. Where the torsional capacities are not known, the report shall state that the torsional capacities are not included in the report recognition.

## APPENDIX A

### USE OF ASTM D1761 DATA FOR DETERMINING ALLOWABLE LOADS AS AN ALTERNATIVE TO USING ASTM D7147

#### A1.0 OVERVIEW

Section 5.1.2 of this criteria allows evaluation reports recognizing compliance to the 2006, 2009, or 2012 IBC and IRC to be revised to recognize compliance to the 2015 IBC and IRC using testing performed under ASTM D1761, provided the allowable vertical loads are determined in accordance with ASTM D7147 Sections 13 through 15. This Appendix provides a procedure for calculating adjustment factors in accordance with the ASTM D7147 allowable load derivation procedure, when the tests were performed in accordance with ASTM D1761 when the information required by ASTM D7147 is not known. In such cases, this Appendix shall be used to calculate adjustments to tested capacity values in accordance with Section 13 of ASTM D7147. Capacities determined by tests under ASTM D1761 shall be adjusted by the procedures in this Appendix and used in the derivation of allowable loads in accordance with Section 15 of ASTM D7147. The overall adjustment factor to apply to the Test Strength Limit shall be determined as specified in Section A3.5 below, using the adjustment factors  $R_J$ ,  $R_{HF}$ ,  $R_{HT}$ ,  $R_S$ , and  $R_{MC}$  modified in accordance with the provisions of this appendix.

#### A2.0 APPLICABILITY

This procedure applies to test data determined from ASTM D1761 testing and reported on or before January 1, 2016, where the data is used to update an existing evaluation report to show recognition under the 2015 IBC and IRC. Data from ASTM D1761 testing reported at a date later than January 1, 2016, shall not be accepted as equivalent to that determined under ASTM D7147 testing.

#### A3.0 ADJUSTMENT FACTOR CALCULATION

**A3.1** Where joist hanger or connector steel strength or thickness, wood specific gravity, nail diameter, or nail bending yield strength are not reported in the ASTM D1761 testing results, these values shall be assumed as described in Section A3.2 for use in ASTM D7147 hanger or connector vertical load capacity determination.

**A3.2** Where values required to calculate the adjustment factors above are given in the test report, they shall be used. Where values required to calculate the adjustment factors are not in the test report, the following shall be assumed for the purposes of calculating the adjustment factors in this section:

**A3.2.1** Steel tensile strength:  $F_{u, \text{tested}} = F_{u, \text{spec}} \times 1.27$

**A3.2.2** Steel thickness (uncoated):  $t_{\text{tested}} = t_{\text{spec}}$

**A3.2.3** Wood specific gravity:  $G_{\text{tested}} = G_{\text{nominal}} \times 1.07$

**A3.2.4** Nail diameter:  $D_{\text{tested}} = D_{\text{nominal}} + 0.003$  inches

The diameter of the nail used in testing ( $D_{\text{tested}}$ ) is one variable analyzed to determine the reduction factors to apply to mitigate the effects of any possible over-strength where fasteners may have been larger than assumed.  $D_{\text{tested}}$  shall be conservatively assumed to have been 0.003 inches larger than the nominal diameter of the nail reported in the test documentation ( $D_{\text{nominal}}$ ).  $D_{\text{tested}}$  replaces “D” in the Yield Limit Equations of the NDS to determine the fastener lateral design value,  $Z_{\text{tested}}$ .

**A3.2.5** Nail bending yield strength:  $F_{y_b, \text{tested}} = F_{y_b, \text{nominal}} \times 1.1$  (where low- to medium-carbon steel nails were used in the test);  $F_{y_b, \text{tested}} = F_{y_b, \text{nominal}} \times 1.4$  (where hardened steel nails were used in the test)

**A3.3 Moisture Content:** Where the moisture content (MC) of the wood members in the ASTM D1761 test is greater than 11 percent, the values for  $F_{em\text{-tested}}$  and  $F_{c\perp\text{-tested}}$  shall be adjusted as follows:

**A3.3.1**  $F_{em, \text{tested}} = F_{em, \text{nominal}} \times R_{FEM}$

$R_{FEM}$  shall be calculated as follows:  $R_{FEM} = \frac{49.95 - (1.186 \times MC_{\text{test}})}{49.95 - (1.186 \times 11)}$  where  $MC_{\text{test}}$  is the moisture content reported in the ASTM D1761 test, and where  $F_{em, \text{nominal}}$  is the Main Member Dowel Bearing Strength used in the Yield Limit Equations to determine the fastener lateral design value,  $Z$ .

The main member dowel bearing strength shall be reduced appropriately where the moisture content in the ASTM D1761 testing was greater than 11 percent.  $F_{em, \text{tested}}$  is the new Main Member Dowel Bearing Strength, after the reduction for higher moisture content has been applied.

**A3.3.2**  $F_{c\perp, \text{tested}} = F_{c\perp, \text{nominal}} \times R_{FCP}$

$R_{FCP}$  shall be calculated as follows:  $R_{FCP} = \left(\frac{F_{12}}{F_g}\right) \left(\frac{11 - MC_{\text{test}}}{M_p - 12}\right)$  where  $MC_{\text{test}}$  is the moisture content reported in the ASTM D1761 test, and where  $F_{12}$ ,  $F_g$  and  $M_p$  are taken from the following table for the species of wood member:

Species or Species Combination	$F_{12}$ (psi)	$F_g$ (psi)	$M_p$ (psi)
Douglas Fir-Larch	770	375	24
Southern Pine	790	390	21
Spruce-Pine-Fir	620	300	27
Hem-Fir	550	280	28

**A3.4 Structural Composite Lumber (Joists):** Where structural composite lumber was used in the test for the joist,  $R_J$  is permitted to be taken as 1.00.

**A3.5 Adjustments to Test Strength Limit:** The Test Strength Limit values shall be multiplied by an adjustment factor equal to the lowest of  $R_J$ ,  $R_{HF}$ ,  $R_{HT}$ , and  $R_S$ , multiplied by  $R_{MC}$ , as determined using Sections 13.5.2, 13.5.3, 13.5.4, 13.5.7, and 13.5.8 of ASTM D7147 and using the adjusted values in accordance with this appendix, as applicable.

**A3.6 Allowable Joist Hanger Loads Limited by Calculations:** The allowable joist hanger load limited by calculations shall be the least of the values determined in 14.2 to 14.4 of ASTM D7147. The allowable load shall be calculated based on the minimum specified mechanical and physical properties of the materials. Steel thickness shall not include coating thickness.