**IAPMO UNIFORM EVALUATION SERVICES EVALUATION CRITERIA FOR**

**JOIST HANGERS AND MISCELLANEOUS CONNECTORS**

**EC 002- 2024**

**(Adopted June 2007; Revised 2011, December 2014, August 2017, August 2018; editorially revised January 2021, Proposed Revision October 2024)**

**1.0 INTRODUCTION**

**1.1 Purpose:** The purpose of this evaluation criteria is to establish requirements for the evaluation of joist hangers and miscellaneous connectors under the 2024, 2021, and 2018 *International Building Code*® (IBC®), and the 2024, 2021, and 2018 *International Residential Code*® (IRC). This criteria provides guidelines for calculating and testing the performance of joist hangers and miscellaneous connectors, based on code provisions contained in 2018 IBC Sections 2303.5 and 2304.10.3; and 2024 and 2021 IBC Sections 2303.5, 2304.1, and 2304.10.4; and on the requirements in this evaluation criteria, for conditions where the codes do not address the necessary requirements. The bases of recognition are 2024 IBC Section 104.2.3 (2021 and 2018 IBC Section 104.11) and 2024 IRC Section R104.2.2 (2021 and 2018 IRC Section R104.11).

**1.2 Scope: 1.2.1 Structural Connections:** 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 by a recognized accreditation body conforming to ISO/IEC 17011.

**1.2.1.1** 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.

**1.2.1.2** 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.

**1.2.2 Fire Protection of Connections:** Where joist hangers and miscellaneous connectors are intended to be components of fire-resistance-rated assemblies in IBC Type IV-A, IV-B, or IV-C constructions, compliance with 2024 or 2021 Section 2304.10.1 is required. The methodology for establishing compliance shall be reviewed and accepted by the certification body before submittal. References for the analysis option include ANSI/AWC NDS Chapter 16, AWC FDS, and AWC TR10.

**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:

|  |  |
| --- | --- |
| 2018, 2021, and 2024 IBC | International Building Code® |
| 2018, 2021, and 2024 IRC | International Residential Code® |
| ANSI/AWC NDS  | National Design Specification for Wood Construction  |
| ANSI/TPI 1 | National Design Standard for Metal Plate Connected Wood Truss Construction |
| ASTM D1761 | Test Methods for Mechanical Fasteners in Wood |
| ASTM D7147 | 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 |
| AWC TR10 | Technical Report 10: Calculating the Fire Resistance of Wood Members and Assemblies |
| AWC FDS-2021 | AWC Fire Design Specification |
| ISO/IEC 17011-2017 | Conformity assessment — Requirements for accreditation bodies accrediting conformity assessment bodies |
| ISO/IEC 17020-2012 | Conformity assessment — Requirements for the operation of various types of bodies performing inspection |
| ISO/IEC 17025-2017 | 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 the 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 the 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 evaluation report number, and optionally, the certification body name or mark.

**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 IBC or IRC, ASTM D7147, and the provisions of this document.

 For recognition under the IBC and IRC, the testing of joist hangers shall be in accordance with 2024 and 2021 IBC Sections 2303.5 and 2304.10.4 (2018 IBC Sections 2303.5 and 2304.10.3), ASTM D7147, and the provisions of this document.

 As an alternative, evaluation reports based on earlier testing in accordance with ASTM D1761 are permitted under the 2024, 2021, and 2018 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** 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.

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.

**4.1.3** Test procedures for roof-mounted connectors (for use with roof-mounted solar collectors) shall comply with Section 5.3 of this criteria based on testing in accordance with ASTM D1761 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. The moisture content of dimension lumber at the time of testing shall be not less than 11 percent. Alternatively, where the actual moisture content of the tested members falls below 11 percent, strength adjustments shall be made in accordance with ASTM D7147 Section 13.5. 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.

**4.1.4**  For recognition based on testing in accordance with either ASTM D1761 (roof-mounted connectors only) or ASTM D7147, the number of samples shall be in accordance with Section 8 of ASTM D7147.

**4.1.5** Torsional moment capacity recognition, when requested, shall be based on testing in accordance with Appendix X of ASTM D7147.

**4.2** Test reports shall be in accordance with ASTM D7147 Section 12, or ASTM D1761 Section 29 (roof-mounted connectors only), and ASTM E575.

**5.0 DETERMINATION OF ALLOWABLE LOADS**

**5.1 Recognition of joist hangers under the IBC and IRC:**

**5.1.1** For recognition of joist hangers under the 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 2024, 2021, and 2018 IBC and IRC using earlier 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** Duration factor adjustments may be taken in accordance with the ANSI/AWC NDS, unless the capacity limit is based on tested values.

**5.3** 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 three samples, divided by a factor of safety of three, 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.

**5.4** 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 Evaluation Standard for Quality Documentation (IAPMO UES ES-010).

**6.2** Inspections of manufacturing facilities by an approved and accredited certification body or inspection agency are required for these products. The inspection agency shall be accredited in accordance with ISO/IEC 17020 by a recognized accreditation body conforming to ISO/IEC 17011.

**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 2024 or 2021 IBC Section 1705.12, or 2018 IBC Section 1705.11. Special inspection requirements do not apply to structures, or portions thereof, that qualify for exceptions under the 2024 and 2021 Sections 1704.2, 1705.3, and 1705.12.1; or 2018 IBC Sections 1704.2, 1705.3, and 1705.11.1.

**7.2.2.** Periodic special inspection shall be conducted in accordance with the applicable portions of 2024 or 2021 IBC Section 1705.13, or 2018 IBC Section 1705.12, 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 exceptions under 2024 and 2021 IBC Sections 1704.2, 1705.3, 1705.13 or 1705.13.2; or 2018 IBC Sections 1704.2, 1705.3, 1705.12 or 1705.12.2.

**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** Fasteners used in contact with preservative-treated or fire-retardant-treated wood shall comply with 2024 and 2021 IBC Section 2304.10.6, 2018 IBC Section 2304.10.5; 2024 IRC R304.3, or 2021 and 2018 IRC Section R317.3, as applicable. Statements to this effect, as applicable, shall be included in the evaluation report. The following statement shall also be included in the evaluation report: “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’s recognition.

**7.8** When conformance to Section 1.2.2 of this criteria is justified, evaluation reports shall include fire-resistance ratings for connections incorporating joist hangers. Inspections in accordance with 2024 or 2021 IBC Section 110.3.5 shall be referenced in the evaluation report where applicable.

**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 2012 and earlier IBC and IRC to be revised to recognize compliance to the 2024, 2021, or 2018 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, and 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 2024, 2021, or 2018 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: Fu, tested = Fu, spec x 1.27

**A3.2.2** Steel thickness (uncoated):ttested = tspec

**A3.2.3** Wood specific gravity:Gtested = Gnominal x 1.07

**A3.2.4** Nail diameter:Dtested = Dnominal + 0.003 inches

The diameter of the nail used in testing (Dtested) 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. Dtested shall be conservatively assumed to have been 0.003 inches larger than the nominal diameter of the nail reported in the test documentation (Dnominal). Dtested replaces “D” in the Yield Limit Equations of the ANSI/AWC NDS to determine the fastener lateral design value, Ztested.

**A3.2.5** Nail bending yield strength:Fyb, tested = Fyb, nominal x 1.1 (where low- to medium-carbon steel nails were used in the test); Fyb, tested = Fyb, nominal x 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-tested* and 𝐹𝑐⊥−𝑡𝑒𝑠𝑡𝑒𝑑 shall be adjusted as follows:

**A3.3.1** Fem, tested = Fem, nominal × RFEM

R*FEM* shall be calculated as follows: RFEM= $\frac{49.95-\left(1.186 × MC\_{test}\right)}{49.95-(1.186 ×11) }$ where MCtest is the moisture content reported in the ASTM D1761 test, and where Fem, 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. Fem, tested is the new Main Member Dowel Bearing Strength, after the reduction for higher moisture content has been applied.

**A3.3.2** Fc⊥, tested = Fc⊥, nominal × RFCP

RFCPshall be calculated as follows: RFCP = $\left(\frac{F\_{12}}{F\_{g}}\right)^{\left(\frac{11-MC\_{test}}{M\_{p}-12}\right)} $ where MCtest is the moisture content reported in the ASTM D1761 test, and where F12, Fg, and Mp are taken from the following table for the species of wood member:

|  |  |  |  |
| --- | --- | --- | --- |
| **Species or Species Combination** | **F12 (psi)** | **Fg (psi)** | **Mp (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, RJ 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 from Sections 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.