

ACCEPTANCE CRITERIA FOR STAPLES

AC201

Approved July 2005

Effective August 1, 2005

(Editorially revised April 2011)

Previously approved July 2002

PREFACE

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

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

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

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

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

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

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1.0 INTRODUCTION

1.1 Purpose: This criteria establishes minimum requirements for recognition of staples in ICC Evaluation Service, LLC (ICC-ES), evaluation reports under the 2009 *International Building Code*® (2009 IBC), 2009 *International Residential Code*® (2009 IRC), 2006 *International Building Code*® (2006 IBC), the 2006 *International Residential Code*® (2006 IRC), and the 1997 *Uniform Building Code*™ (UBC).

1.2 Scope: This acceptance criteria applies to steel wire staples used to connect wood or metal elements into wood and wood-based materials.

1.3 Codes and Referenced Standards:

1.3.1 2009 *International Building Code*® (2009 IBC), International Code Council.

1.3.2 2009 *International Residential Code*® (2009 IRC), International Code Council.

1.3.3 2006 *International Building Code*® (2006 IBC), International Code Council.

1.3.4 2006 *International Residential Code*® (2006 IRC), International Code Council.

1.3.5 1997 *Uniform Building Code*™ (UBC).

1.3.6 ASTM A 641/A 641 M-03, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire, American Society for Testing and Materials.

1.3.7 ASTM F 1575-03, Standard Test Method for Determining Bending Yield Moment of Nails, American Society for Testing and Materials.

1.3.8 ASTM F 1667-05 for 2009 IBC, IRC -03 for 2009 IBC, IRC, Standard Specification for Driven Fasteners: Nails, Spikes and Staples, American Society for Testing and Materials.

2.0 BASIC INFORMATION

2.1 General:

2.1.1 Description: Staple description shall be reported, including wire diameter and gage, crown width and leg length.

2.1.2 Staple Dimensions and Tolerances: Dimensions and tolerances for Nos. 14, 15 and 16 gage staples shall comply with Sections 8.3 and 8.4 of ASTM F 1667.

2.2 Packaging and Identification: The method of packaging and identifying the staples shall be reported and shall comply with Section 12 of ASTM F 1667. The evaluation report number shall appear on the packaging.

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

2.4 Test Reports: Reports shall comply with AC85. These reports shall include sample selection procedure, test specimen preparation, test procedures, and results of all tests. Where indicated, photographs shall be included in the reports.

2.5 Product Sampling: Sampling of the staples for tests under this criteria shall comply with Section 3.2 of AC85.

3.0 REQUIRED DATA

3.1 Scope: All staples shall be evaluated in accordance with Sections 3.2 through 3.5 of this criteria, as applicable.

3.2 Zinc-coated Steel Wire: For staples recognized as complying with ASTM A 641, Class 1, coating weight, zinc-coated carbon-steel wire shall be tested and found to comply with ASTM A 641, Class 1, coating weight in accordance with Table S1.1. A test sample shall consist of a minimum of seven specimens, unless otherwise specified in the standard.

3.3 Stainless Steel Wire and Staples: Stainless steel wire or staples shall comply with Section 6.2 of ASTM F 1667.

3.4 Coatings: Coatings other than zinc shall be described.

3.5 Bending Yield Moment: Bending moment of staples shall be evaluated in accordance with ASTM F 1575 as modified below on at least 15 specimens per wire diameter. Results shall be recorded as moments and all values shall comply with Table 1 of this criteria. The following changes shall be made to the procedures of ASTM F 1575:

3.5.1 The distance between staple supports shall be 1 inch (25.4 mm). (Modification of ASTM F 1575, Section 9.1.1.1.)

3.5.2 The staple leg shall be placed on supports such that it is resting on the "width" of the staple leg, the leg cross-section dimension perpendicular to the length of the staple crown. (Modification of ASTM F 1575, Section 9.1.1.1.)

3.5.3 The diameter of the staple leg measured and used in calculations shall be the "width" of the staple leg. (Modification of ASTM F 1575, Section 8.2.)

3.5.4 Measure and record staple bending moment [lbs.-in. (N-m)], rather than computing a fastener bending yield strength. (Modification of ASTM A 1575, Section 8.5.)

4.0 ANALYSIS

4.1 Design Values: Staples, complying with ASTM F 1667, used in wood-to-wood or wood-to-metal connections, and meeting the staple specifications noted in ASTM F 1667, may reference the design values as follows:

4.1.1 ASD Lateral Design Values: ASD lateral design values (Z) of stapled connections for two-member joints may be calculated from the following formulas:

Failure Mode I:

$$Z = F_{es}t_s d / K_D$$

Failure Mode II:

$$Z = \frac{dF_{em}}{K_D} \frac{t_m}{1 + \frac{F_{es}}{F_{em}}} \left[\sqrt{\frac{F_{es}}{F_{em}} + 2 \left(\frac{F_{es}}{F_{em}} \right)^2 \left[1 + \frac{t_s}{t_m} + \left(\frac{t_s}{t_m} \right)^2 \right]} + \left(\frac{F_{es}}{F_{em}} \right)^3 \left(\frac{t_s}{t_m} \right)^2 - \frac{F_{es}}{F_{em}} \left(1 + \frac{t_s}{t_m} \right)} \right]$$

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Failure Mode III:

$$Z = \frac{1}{K_D} \left[\frac{-t_s F_{es} d + F_{es} d}{2 \frac{F_{es}}{F_{em}} + 1} + \sqrt{\frac{t_s^2}{\left(2 \frac{F_{es}}{F_{em}} + 1\right)^2} + \frac{t_m^2}{2 \frac{F_{es}}{F_{em}} + 1} + \frac{4M}{F_{es} d \left(2 \frac{F_{es}}{F_{em}} + 1\right)}} \right]$$

Failure Mode IV:

$$Z = \frac{2F_{em} d}{K_D} \sqrt{\frac{M}{F_{em} d \left(1 + \frac{F_{em}}{F_{es}}\right)}}$$

where:

Z = Nominal lateral design value, lbf (N).

F_{em} = Embedment strength of main member, psi (Pa). (For 14, 15 and 16 gage staples, values are 900 psi plus the value recognized for nailed connections in the applicable code.)

F_{es} = Embedment strength of side member, psi (Pa). For metal, F_{es} is the specified tensile strength, (F_u). (For 14, 15 and 16 gage staples, values are 900 psi plus the value recognized for nailed connections in the applicable code.)

d = Staple leg diameter, inch (mm).

M = Staple bending moment, in-lbs (N-m).

t_s = Thickness of side member, inches (mm).

t_m = Thickness of main member, inches (mm).

K_D = Diameter coefficient for staple connections = 2.2

4.1.2 LRFD Lateral Design Values: LRFD lateral design values are determined by multiplying values established in Section 4.1.1 by 3.3.

4.1.3 ASD Withdrawal Design Values: ASD withdrawal design values (W) installed in side grain of wood may be calculated using the following equation:

$$W = 1380 G^{5/2} D$$

For **SI:** $W = 243.4 G^{5/2} D$

where:

W = Staple withdrawal design value, in pounds per inch (N/mm) of penetration in the member holding point.

G = Specific gravity of the wood based on oven dry weight and volume.

D = Leg diameter of the staple, in inches (mm).

4.1.4 LRFD Withdrawal Design Values: LRFD withdrawal design values (Z_w) installed in side grain of wood may be calculated using the following equation:

$$Z_w = 4.59 G^{5/2} D p$$

For **SI:** $Z_w = 31.6 G^{5/2} D p$

where:

Z_w = Staple withdrawal design value, in pounds (N) of penetration in the member holding point.

G = Specific gravity of the wood based on oven dry weight and volume.

D = Leg diameter of the staple, in inches (mm).

p = Length of leg in the member holding the point, inches (mm).

4.1.5 Calculations presented in Sections 4.1.1 through 4.1.4 are for one staple leg and shall be doubled for design values because both staple legs are active in connection response.

4.2 Alternatives to Code-prescribed Nails: Staples may substitute for code-prescribed, non-design nails where no structural values are assigned, under the following conditions:

- Lateral and withdrawal design values equal or exceed values described in the applicable code for the corresponding nail.

- Staple crown area $[W(C-2T)]$ equals or exceeds net head area $[\pi (H^2 - D^2)/4]$ of corresponding nail.

5.0 QUALITY CONTROL

5.1 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted. The quality control program shall verify continued fastener compliance with fastener specifications in Section 2.1.

5.2 Third-party follow-up inspections are not required under this acceptance criteria.

5.3 See Annex A for alternate procedures for qualification and quality control of staples that are produced by manufacturers other than the report holder or a listee on the evaluation report.

6.0 EVALUATION REPORT RECOGNITION

The evaluation report shall include the following:

1. Basic information required by Section 2.1 and 2.2, including product description, packaging and identification.

2. Design values based on Section 4.1 of this criteria.

3. Placement methods, based on code requirements.

4. (Optional) A statement regarding substitution for code-prescribed nails, based on Section 4.2 of this criteria. ■

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TABLE 1

STAPLE GAGE	NOMINAL DIAMETER (inch)	MINIMUM BENDING MOMENT (lbs.-in.)
14	0.080	4.3
15	0.0720	4.0
16	0.0625	3.6

For SI: 1 inch = 25.4 mm; 1 lbf-in = 0.1129848 N-m.

ANNEX A

Qualification and Quality Control Procedures for Purchased Fasteners

A1.0 General:

A1.1 Purpose: The purpose of this annex is to set forth alternate procedures for qualification of staples as complying with the provisions of AC201, and establishment of quality control for such staples, for staples that are produced by manufacturers other than the report holder.

A1.2 Scope: This annex applies to report holders who purchase staples from sources who have not submitted a quality control manual to ICC-ES, and whose manufacturing facilities have not been audited by ICC-ES.

A1.3 Referenced Standards:

A1.3.1 ASTM F 1470-02, Standard Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection, ASTM International.

A1.3.2 MIL-STD-1916, April 1, 1996, DOD Preferred Methods for Acceptance of Product, Department of Defense.

A1.4 Definitions:

A1.4.1 Report Holder: For the purposes of this annex, the term "report holder" shall refer to evaluation report holders or listees on evaluation reports who are recognized in the evaluation report to purchase fasteners.

A2.0 Qualification Process:

A2.1 General: The qualification process consists of four stages. At each stage, the quantity of fasteners ordered increases, until consistent conformance to the requirements of ASTM F1667, and comparable engineering drawings issued by the report holder, is assured. Characteristics subject to inspection and testing include staple bending moment, ductility for stainless steel staples, hardness and ductility for hardened staples, galvanized coating weight (where applicable), and physical dimensions for all fasteners as required by AC201. Sampling and evaluation shall be consistent with Table III, "Variables sampling plans," verification level V of MIL-STD-1916. In this case, the sample size is 64 pieces.

At every step of the qualification process, or at any point in the auditing process, any product that is found to be nonconforming shall be scrapped, returned, or otherwise controlled so that it is not identified as covered by the evaluation report.

A2.2 Stage 1: The first step of the process is to obtain carton size quantities of each staple diameter, material type and configuration (smooth, ring, screw, hardened, stainless, etc.), to be qualified. Sixty-four fasteners shall be selected from the carton and all test samples are to come from this selection. Testing shall be conducted in accordance with the requirements of AC201. Tests may be performed by the report holder and do not have to be performed by an accredited laboratory. Depending on the number of tests to be performed (stiffness, ductility, etc.) and the number of fasteners to be tested in each test (sample size of 7, 15, etc.) not all 64 fasteners may be used in a test. Each individual sample is to be tested as outlined in Section A2.1 for characteristics subject to inspection and testing. If compliance to all aspects is achieved, proceed to Section A2.3. If any nonconformances are found, the supplier shall be notified, and the process restarted, with new products submitted for testing. Upon the conclusion of testing, the fasteners in the sample shall be scrapped.

A2.3 Stage 2: The second stage of the process is to apply the quantity of fasteners to skid quantities of each type to be qualified. Testing shall be performed by an accredited laboratory. If fasteners pass all tests, the report holder shall provide a copy of the test report(s) to ICC-ES. The new samples shall be manufactured from a different heat of rod than was used in the sample under Stage 1. The samples shall be tested as described in Stage 1, with the exception that the 64 fasteners will be sampled from a number of cartons as specified by ASTM F 1470. The number of cartons from which the 64 fasteners are selected for each fastener type is the "sample size" indicated in ASTM F 1470, Table 3, for Sample Level A, for a "lot size" equal to the number of cartons in the skid that contain the type of fastener being tested. Even though ASTM F 1470 specifies Sampling Level B or C for some fastener characteristics in its Table 1, all fastener tests are performed on fasteners from the group of 64 selected from the number of boxes specified in ASTM F 1470, Table 3, for Sample Level A. If the samples all exhibit conformance to the requirements of ASTM F 1667 and AC201, proceed to Section A2.4. If nonconformances related to ICC-ES requirements such as staple bending moment, hardness, ductility, etc., are found, the process must restart at Section A2.2, or be abandoned. Upon the conclusion of testing, the fasteners in the sample shall be scrapped.

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A2.4 Stage 3: The third stage of the process is to move to container quantities. At the container level, the fasteners will generally be mixed by type within the container. The number of cartons from which the 64 fasteners are selected for each fastener type is the "sample size" indicated in ASTM F 1470, Table 3, for Sample Level A, for a "lot size" equal to the number of cartons in the skid that contain the type of fastener being tested. Tests may be performed by the report holder and do not have to be performed by an accredited laboratory. Inspection and testing shall be as outlined in Section A2.2, above. If the fasteners demonstrate conformance, move to normal purchase practice, Section A2.5. In the case of major nonconformances related to ICC-ES requirements such as staple bending moment, hardness, ductility, etc., the process shall restart at Section A2.2, or be abandoned.

A2.5 Stage 4: The next six shipments of fasteners require testing, but at a reduced level. A "shipment" consists of product received from one order. For sampling purposes, each intermodal container or truckload is considered a separate shipment. If a shipment contains different fastener types, each fastener type shall be tested. For staple bending moment testing, a "type" consists of one diameter regardless of length. Test and inspect as described in Section A2.2, above, determining the number of cartons from which the 64 fasteners are to be selected using ASTM F1470 as described in Section A2.3, above. If nonconformances related to ICC-ES requirements such as staple bending moment, hardness, ductility, etc., are found, the process shall restart at Section A2.2, or be abandoned. If the fasteners are conforming, the supplier shall be considered to be qualified.

Supplier qualification shall continue with testing of each fastener type in each future shipment. However, after ten consecutive shipments have been tested with all fasteners conforming to all requirements, the Sample Level used in application of ASTM F1470 will change from Sample Level A to Sample Level B. This will always result in the 64 fasteners being selected from a smaller number of fastener cartons.

After five additional consecutive shipments have been tested with all fasteners conforming to all requirements, the Sample Level used in application of ASTM F1470 will change from Sample Level B to Sample Level C. This will usually result in the 64 fasteners being selected from a smaller number of fastener cartons.

After Sample Level has been switched from A to B or C, if any tested fastener types fail any test, the Sample Level will revert to A as at the beginning of Section A2.4.

A3.0 Quality System:

The report holder shall provide a quality control manual complying with the ICC-ES Acceptance Criteria for Quality Documentation. The manual shall document procedures complying with this annex. The report holder's testing facility shall demonstrate that equipment, procedures and personnel are adequate to conduct the necessary testing.