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To: ICC-ES Evaluation Committee
From: Elyse G. Levy, S.E., Senior Staff Engineer
Date: January 28, 2010
Subject: Proposed Revisions to the Acceptance Criteria for Tapping Screw Fasteners, Subject AC118-0210-R1 (EL/RK)

MEMO

Proposed revisions to the subject criteria were outlined in the staff letter dated December 29, 2009. The following responses have been received:

1. A letter from Andrew T. Liechti, P.E., Technical Services Engineer; Hilti, Inc.; dated January 18, 2010.
2. A letter from Robert J. Leichti, Compliance Manager, Fasteners, Stanley Fastening Systems; dated January 18, 2010.
3. A letter from Jeff Ellis, P.E., S.E., Code Report & Branch Engineering Manager, Simpson Strong-Tie Co., Inc.; dated January 19, 2010.

Staff appreciates the thoughtful and constructive comments we received regarding AC118. As noted in the staff letter dated December 29, 2009, there were several reasons that revisions to the criteria were proposed. The most urgent reason is to update the criteria to the 2009 *International Building Code*® (IBC) to allow applicants to obtain evaluation reports addressing the 2009 IBC. With this in mind, the following comments are offered in response to the correspondence that has been received:

1. The following comments address the comments in the letter from Mr. Liechti of Hilti, in the order they are presented in his letter:
 - a. This comment is editorial and will be addressed during final editing of the revisions to the criteria, if and when they are approved.
 - b. To further clarify that the testing and reporting requirements for manufacturers are not the same as for third-party testing laboratories, staff proposes subdividing Section 2.4 of the criteria as shown in the attached draft of the criteria.
 - c. Staff proposes to remove the last sentence of Section 3.1 of the proposed criteria, as requested. This proposed revision was not prompted by a change in the code, and is therefore not necessary to update the criteria to the 2009 IBC.

- d. Staff proposes to add the words, “as applicable” to the end of Section 3.3.4 of the proposed criteria.
- e. The insertion of the phi symbol is a typographical error. This will be addressed during final editing of the revisions to the criteria, if and when they are approved.
- f. The intent of the last sentence of Section 3.9.1 of the proposed criteria is to ensure that for connection capacities determined through testing, the failure mode is not due to the failure of the screws themselves. This is consistent with Section 1.6 of AISI S905-08, which is the applicable test method.
- g. Staff is willing to consider other test methods for determining the pullover capacity of proprietary screws used to attach sheathing materials. However, no alternative test method has been proposed at this time. Staff will study this issue further and will assist applicants in proposing additional revisions to Section 3.9.3 of the criteria as the need arises. In the meantime, staff continues to propose revising the criteria as described in our staff letter dated December 29, 2009. Doing so will alert report applicants to the need to justify pullover capacity when screws are intended for use in engineered design of sheathing connections, and will avoid delaying the approval of an updated criteria, which is the primary goal.
- h. Staff disagrees with Hilti’s position that screw fasteners intended for use in steel deck panel side seam connections and to attach steel deck panels to supports should not be addressed in AC118. AC118 addresses tapping screw fasteners, and it is the staff opinion that this criteria should address all requirements for tapping screw fasteners (including steel deck panel screws) that staff and applicants seeking evaluation reports on tapping screws need to be aware of.

In regard to whether addressing screws used as deck fasteners in AC118 causes a safety concern due to the screws not being tested and/or evaluated in accordance with the Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43), it should be noted that at this time, significant revisions to AC43 are being considered by the Evaluation Committee and it remains to be seen if any additional testing will be required for deck panel screws. Also, both Sections 3.9.4 and 3.9.5 of the proposed criteria provide clear reference to AC43 for design of diaphragms. Evaluation reports on deck panel screws evaluated under the proposed revisions to AC118 would either include diaphragm values determined in accordance with AC43, or would stipulate that diaphragm values based on the screw connection values must be recognized in an ICC-ES evaluation report issued to the steel deck panel manufacturer.

When revisions to AC43 are approved, AC118 can be further revised as needed to maintain consistency with AC43. In the meantime, the proposed revisions to AC118 regarding screws used as deck fasteners constitute a

significant improvement over the current edition of AC118, which does not specifically address screws intended for this type of use.

Therefore, at this time, staff is not proposing further revisions to AC118 regarding screws used as deck fasteners, beyond those proposed in our staff letter dated December 29, 2009.

2. The following comments address the comments in the letter from Mr. Leichti of Stanley, in the order they are presented in his letter:
 - a. Mr. Leichti has commented on the assignment of responsibilities to the testing laboratories, regarding confirmation of compliance with the screw manufacturers' specifications. In staff's experience, submitted test reports on screws commonly provide measured dimensions and material properties of tested screws and compare them to the manufacturers' specifications. The proposed revisions to the criteria are intended to reflect what is already typically done, to ensure consistency amongst applicants. The comparisons that are required should be simple numeric comparisons, and should be within the capabilities of any accredited testing laboratory. No further revisions are proposed to address this comment.
 - b. Staff recognizes that the performance testing required by ASTM C 954 relates to installation performance and not to structural performance of the completed assembly. However, if a manufacturer wishes to have the evaluation report state that the subject screws comply with ASTM C 954, compliance with all of the requirements of ASTM C 954 must be demonstrated.
 - c. Regarding the connection testing for proprietary screws used in engineered steel-to-steel framing connections, Mr. Leichti has correctly understood the notation in the table. Pull-out testing is required, because the equations in the 2007 Edition of the AISI North American Specification for the Design of Cold-Formed Steel Structural Members (AISI S100) for pull-out do not address the effects of proprietary thread designs. The proposed revisions to AC118 do not require testing for either pull-over capacity or shear connection capacity, because staff considers the equations in AISI S100 for these limit states to be applicable to proprietary screws.
 - d. Sections E4.2 and E4.3.2 of AISI S100 address edge and end distance requirements for screws. The factors in Equation E4.3.2-1 in Appendix A of AISI S100 are all related to the connected steel. Neither the geometry or the material properties of the screws affect the determination of shear strength based on edge distance. Therefore, there is no data required for proprietary screws to establish minimum end and edge distances for screws used in steel to steel connections.
3. The following comments address the comments in the letter from Mr. Ellis of Simpson Strong-Tie, in the order they are presented in his letter:

- a. Staff apologizes for overlooking the application mentioned by Mr. Ellis. It is noted that Mr. Ellis does not indicate that the proposed criteria needs to be revised to address the Simpson Strong-Tie product. After a cursory review of this application, staff finds that the proposed criteria combined with code provisions provide sufficient guidance for evaluating the subject products. Staff will continue to work with the applicant, and will propose further modifications to AC118 in the future, if such modifications are needed to facilitate the evaluation of the Simpson Strong-Tie product.
- b. Please also refer to comment 1. f., above. Mr. Ellis is correct to state that AISI S100 does not require the screw capacity to be greater than the capacity of the connected parts when calculating the strength of a connection. However, when connection capacities are established through testing, AC118 currently references AISI-5-02. Section 1.5 of this test method indicates that the test method is applicable to connections in which the fasteners do not fail. This requirement has been retained in AISI S905-08, which is the updated Test Method for Mechanically Fastened Cold-Formed Steel Connections. The last sentence of Section 3.9.1 of the proposed criteria is meant to address this requirement in Section 1.6 of AISI S905-08, and is consistent with the currently approved criteria.
- c. Without more detailed information on how the proprietary screws differ from those that comply with ASTM C 1513, it is not possible to assess whether deviation from the standard can be considered. To try to capture all possible deviations in Table 2 of the proposed criteria is not feasible. An attempt to modify Table 2 at this time could substantially delay approval of an updated criteria. Staff will study this issue further with Mr. Ellis, and if need be, will propose additional changes to AC118 in the future.

Staff thanks the committee for consideration of these comments.

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR TAPPING SCREW FASTENERS

AC118

Proposed January 2010

Previously approved November 2009, May 2008, February 2008, October
2007, December 2006, June 2005, July 1996, June 2004

PREFACE

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

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

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

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

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

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1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for tapping screw fasteners to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the ~~2006~~ 2009 *International Building Code*[®] (IBC), and the 2006 2009 *International Residential Code*[®] (IRC), ~~and the 1997~~ *Uniform Building Code*[™] (UBC).

1.2 Scope: This criteria provides a basis for:

1.2.1 Evaluating the material, dimensional, and performance properties of self-drilling, self-piercing, thread-cutting, and thread-forming tapping screws, for the end uses shown in Table 2.

1.2.2 Determining the ~~allowable [design]~~ available shear and tension strength values for tapping screws used in cold-formed sheet steel-to-steel connections as described in Section E4 of AISI-NASS100 ~~or Section 2218 (item 3) of the UBC.~~

1.2.3 Determining available bearing (shear), pullout and pullover strengths of screw connections in accordance with Section E4 of AISI-S100.

~~**1.2.4** Recognizing tapping screws for use in cold formed steel framed lateral force resisting assemblies described in Section 2210.5 of the IBC and Chapter 22, Division VIII, of the UBC.~~

~~**1.2.5** Recognizing tapping screws for use in prescriptive cold formed steel connections as described in Section 2210 of the IBC and Sections R505, R603, and R804 of the IRC.~~

~~**1.2.6** Recognizing tapping screws for attaching gypsum panel products to cold formed steel framing members as described in Sections 2210.4 and 2508 of the IBC, Section R702.3 of the IRC, and Sections 2502 and 2511 of the UBC.~~

1.3 Codes and Reference Standards:

1.3.1 ~~2006~~ 2009 *International Building Code*[®] (IBC), International Code Council.

1.3.2 ~~2006~~ 2009 *International Residential Code*[®] (IRC), International Code Council.

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

~~**1.3.4** ANSI/ASME B18.6.4,1998, Standard Specification for Thread Forming and Thread Cutting Screws, ASME International.~~

~~**1.3.5** SAE J78 (1998), Steel Self-drilling Tapping Screws, Society of Automotive Engineers.~~

1.3.6 ASTM B 117-07, Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM International.

~~**1.3.7** ASTM B 633-07, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel, ASTM International.~~

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1.3.8 ASTM C 954-0-~~04~~, Standard ~~Standard~~ Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness, ASTM International.

~~1.3.9~~ ASTM C 1002-01, ~~Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs~~, ASTM International.

1.3.10 ASTM C 1513-0-~~14~~, Standard Specifications for Tapping Screws for Cold-formed Steel Framing Connections, ASTM International.

~~1.3.11~~ AISI Specification for Design of Cold-formed Steel Structural Members, 1996 edition, American Iron and Steel Institute.

1.3.12 AISI-~~NAS~~, 2004 S100-2007 North American Specification for Design of Cold-formed Steel Structural Members, 2007 edition including 2004 Supplement, American Iron and Steel Institute.

1.3.13 AISI ~~TS 4-02~~ S904-08, Standard Test Method for Determining the Tensile and Shear Strength of Screws, Part VI, AISI Manual, 200-~~28~~, Cold-Formed Steel Design, American Iron and Steel Institute.

1.3.14 AISI ~~TS 5-02~~ S905-08, Test Methods for Mechanically Fastened Cold-Formed Steel Connections, Part VI, AISI Manual, 200~~28~~, Cold-Formed Steel Design, American Iron and Steel Institute.

1.4 Definitions:

1.4.1 Allowable Strength: Allowable strength is the nominal strength divided by the safety factor.

1.4.2 Available Strength: Available strength is the design strength or allowable strength, as appropriate.

1.4.3 Connection: A connection is a combination of structural elements and joints used to transmit forces between two or more members.

1.4.4 Design Strength: Design strength is the nominal strength ~~resistance factor~~ multiplied by the ~~nominal strength~~ resistance factor.

~~1.4.5~~ **Joint:** A joint is an area where two or more ends, surfaces, or edges are attached, and is categorized by type of fastener and method of force transfer.

1.4.6 Nominal Strength: Nominal strength is the strength of the screw or connection, without the resistance factor or safety factor applied, to resist the load effects determined in accordance with the code.

1.4.7 Tapping Screws: Tapping screws are externally threaded fasteners with the ability to “tap” their own internal mating threads when installed through steel material. Tapping screws are high-strength, one-piece, one-side-installation fasteners. (Reference Section 3.2.12 of ASTM C 1513.)

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1.4.8 Self-drilling Tapping Screws: Self-drilling tapping screws are externally threaded fasteners with the ability to drill their own hole and form or cut their own internal mating threads, into which they are driven without breaking during assembly. (Reference Section 3.2.9 of ASTM C 1513.)

1.4.9 Self-piercing Tapping Screws: Self-piercing tapping screws are externally threaded fasteners with the ability to self-pierce metallic material 33 mils (0.84 mm), or less, form a sleeve by extruding metallic material and “tap” their own mating threads when driven. Self-piercing screws have a sharp-point with a point angle not more than 30 degrees. (Reference Section 3.2.10 of ASTM C 1513.)

1.4.10 Thread-cutting Tapping Screws: Thread-cutting tapping screws are for application in materials where disruptive internal stresses are undesirable or where excessive driving torques are encountered with thread-forming screws. (Reference Section 1.3.2 of ASME B18.6.4.)

1.4.11 Thread-forming Tapping Screws: Thread-forming tapping screws are for application in materials where large internal stresses are permissible, or desirable, to increase resistance to loosening. (Reference Section 1.3.1 of ASME B18.6.4.)

1.4.12 Type: A family of screws with a consistent size, thread design, head style, point style, raw material and mechanical property specifications. Screws within the family may vary in length and coating specification.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted ~~and shall be included in the submitted test reports:~~

2.1.1 Screws:

2.1.1.1 A description of the intended end use of the screws and the scope of recognition sought.

2.1.1.2 ~~Type and d~~ Description of screw fasteners.

2.1.1.3 Screw fastener specifications standard, such as ASTM C 954, ~~ASTM C 1002, or~~ ASTM C 1513, ~~or SAE J78,~~ as applicable. Any deviations from the applicable specification ~~or~~ standard shall be noted, along with the intended end use of the fastener.

2.1.1.4 Drawings and details noting dimensions, including tolerances for each screw size, configuration, and head and point type, and noting material specifications including raw material, case and core hardness, and type and thickness of protective coatings.

2.1.1.5 Head markings used on each screw fastener, when practical.

2.1.1.6 Installation instructions, including description of the recommended tool, and of the recommended tool operation, such as speed and torque, during installation.

2.1.1.7 Drilling capacity recommended by the manufacturer.

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2.1.2 Cold-formed Steel: ~~Steel description, including material specification, and measured yield strength, tensile strength and minimum uncoated steel thickness for the tested cold-formed steel connections. Limits on steel connected by the screw, including minimum and maximum thickness and mechanical properties.~~

2.2 Packaging and Identification: The method of packaging and identifying the screw fasteners shall be reported. The identifying information on each box or package of fasteners shall include the screw brand name and model number, nominal screw size (number, fraction or decimal equivalent), nominal screw length (fraction or decimal equivalent), point type, the evaluation report holder's name, the ASTM designation (when applicable), and the ICC-ES evaluation report number. Each screw fastener head marking or manufacturer's logo shall be reported.

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:

2.4.1 From third-party testing laboratories: Test reports ~~prepared by third party testing laboratories~~ shall comply with AC85 and the report requirements in the applicable test standard. Test reports shall include a description of the cold-formed steel used in tested connections, including material specification, measured yield strength, measured tensile strength and uncoated steel thickness.

2.4.2 From Manufacturers Location Qualification Tests: The qualification tests performed at the manufacturing location shall be representative of the manufacturer's ongoing quality control procedures and shall be documented in accordance with the manufacturer's quality documentation. Third-party witnessing is not required.

2.5 Product Sampling:

2.5.1 Sampling of the screw fasteners for tests under this criteria shall comply with Section 3.2 of AC85.

2.5.2 Where the tested fasteners are prototypes, the fasteners shall be representative of later production, and shall be proven to be identical, within specified tolerance limits, to production fasteners by confirming dimensions, material, and performance requirements set forth in the applicable specification or standard.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 Mechanical Performance and Physical Property Requirements for Tapping Screws Based on End-use Applications: Different sections of the code require tapping screws to comply with different standards, such as ASTM C 954, ~~or ASTM C 1002, ASTM C 1513, or SAE J78,~~ depending upon the end use of the screws. ~~The purpose of this section (Section 3.1) is to clarify which test standard is applicable for the end use application described in the codes. See Table 2 for test and performance requirements based on the intended end use of the screws. Reports of third-party testing and documentation of manufacturer testing shall be submitted to establish compliance with Table 2 Sections 3.1.1 through 3.1.4, as applicable. Sample size for testing in accordance with the applicable tapping screw standard shall comply with Table 1. Sample size for tests conducted by the manufacturer is established under the manufacturer's quality program. Screw type attributes that need~~

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to be considered include nominal size (number, fraction or decimal equivalent), threads per inch, nominal length (fraction or decimal equivalent), point type, material, and protective finish. Screws shall have sufficient length to penetrate through the supporting steel a minimum of three threads, or as recommended by the manufacturer. The manufacturer shall submit a matrix of applicable support steel thickness combined with applicable connected material thicknesses for each length of screw. The matrix shall also address the applicable material strengths for the connected materials and the supporting steel.

3.1.1 — Prescriptive Steel-to-steel Connections in Accordance with the IRC and IBC:

3.1.1.1 — IRC: Fasteners shall be self-drilling tapping screws conforming to SAE J 78 and shall have a Type II coating in accordance with ASTM B 633 or a coating shown to have equivalent or better corrosion resistance when tested in accordance with Section 10.3 of ASTM B 633.

3.1.1.2 — IBC: Fasteners shall be self-drilling or self-piercing tapping screws complying with ASTM C 1513. Tapping screws shall comply with SAE J78 or ANSI/ASME B18.6.4, whichever is more restrictive, when the screw size is not covered under ASTM C 1513. Tapping screws shall have a corrosion-resistant treatment and shall be tested in accordance with ASTM B 117 for a minimum 12-hour test period. Screws shall not show products of corrosion from the coating (white corrosion) after three hours, and shall not show corrosion from the base metal (red rust) at the end of the test period.

3.1.2 — Engineered Steel-to-steel Connections in Accordance with Section E4 of AISI-NAS or Section 2218 of the UBC: Fasteners shall be thread-forming or thread-cutting tapping screws, with or without a self-drilling point, and shall comply with both ASTM C 1513 and ASME B18.6.4. The screws shall have a corrosion-resistant treatment and shall be tested in accordance with ASTM B 117 for a minimum 12-hour test period. Screws shall not show products of corrosion from the coating (white corrosion) after three hours, and shall not show corrosion from the base metal (red rust) at the end of the test period.

3.1.3 — Shear Walls in Accordance with the IBC and UBC:

3.1.3.1 — Wood Structural Panel Sheathing: Fasteners used to attach wood-based structural-use panels to cold-formed steel wall framing members and to provide resistance to lateral loads in the plane of the wall, as described in Section 2210.5 of the IBC and Sections 2219 and 2220 of the UBC, shall be either No. 8, flat head, self-drilling or self-piercing tapping screws with a minimum head diameter of 0.285 inch (7.24 mm) or No. 10, flat head, self-drilling or self-piercing tapping screws with a minimum head diameter of 0.333 inch (8.46 mm) complying with ASTM C 1513. The flat head, self-drilling tapping screws shall have a corrosion-resistant treatment and shall be tested in accordance with ASTM B 117 for a minimum 12-hour test period. Screws shall not show products of corrosion from the coating (white corrosion) after three hours, and shall not show corrosion from the base metal (red rust) at the end of the test period.

3.1.3.2 — Sheet Steel Sheathing: Fasteners used to attach sheet steel to cold-formed steel wall framing members and to provide resistance to lateral loads in the plane of the wall, as described in Section 2210.5 of the IBC, shall be self-drilling or self-piercing tapping screws complying with ASTM C 1513. Tapping screws shall comply with SAE J78 or ANSI/ASME B18.6.4, whichever is more restrictive, when the screw size is not covered under ASTM C 1513. Tapping screws shall have a

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corrosion resistant treatment and shall be tested in accordance with ASTM B 117 for a minimum 12 hour test period. Screws shall not show products of corrosion from the coating (white corrosion) after three hours, and shall not show corrosion from the base metal (red rust) at the end of the test period.

~~**3.1.3.3 Gypsum Board Panel Sheathing:** Fasteners used to attach gypsum board to cold formed steel wall framing members and to provide resistance to lateral loads in the plane of the wall, as described in 2210.5 of the IBC and Sections 2219 and 2220 of the UBC, shall be self-drilling tapping screws complying with ASTM C 954, or self-piercing tapping screws complying with ASTM C 1002.~~

~~**3.1.4 Wood Structural Panel Diaphragms in Accordance with the IBC:** Fasteners used to attach wood based structural use panels to roof or floor cold formed steel framing members as described in Section 2210.5 of the IBC for structural diaphragms, shall be minimum No. 8 (when framing members have a designation thickness of 54 mils or less) or No. 10 (when framing members have a designation thickness greater than 54 mils) flat head, self-drilling or self-piercing tapping screws complying with ASTM C 1513. The flat head self-drilling tapping screws shall have a corrosion resistant treatment and shall be tested in accordance with ASTM B 117 for a minimum 12 hour test period. Screws shall not show products of corrosion from the coating (white corrosion) after three hours, and shall not show corrosion from the base metal (red rust) at the end of the test period.~~

3.2 ASTM C 1513 Generic Screws:

3.2.1 Dimensions and Case Depth: The screw manufacturer's specifications for dimensions and case depth shall comply with Section 6 of ASTM C 1513, except drill point design may deviate from the standard. For each screw type, the testing laboratory shall compare the dimensional measurements of the screws and the case depth to the manufacturer's specifications.

3.2.2 Raw Material: The screw manufacturer's raw material specification shall comply with Section 5 of ASTM C 1513. For each type of screw, the testing laboratory shall confirm that the screws submitted for testing have been produced from material that complies with the manufacturer's specifications. This verification may be based on mill certificates provided by the manufacturer.

3.2.3 Mechanical Properties: For each type of screw, data shall be submitted verifying that the hardness, ductility and torsional strength of the finished screws comply with Section 8 of ASTM C 1513.

3.2.4 Performance Requirements: Data shall be submitted verifying compliance with the drill drive requirements of Section 8 of ASTM C 1513. See Section 3.5 for drill capacity requirements.

3.2.5 Finish: See Section 3.6 for corrosion protection requirements.

3.3 ASTM C 954 Generic Screws:

3.3.1 Dimensions and Case Depth: The dimensions in the screw manufacturer's specifications shall comply with Section 5.2 of ASTM C 954, and the specified case depth shall comply with Section 5.1.1 of ASTM C 954. The testing

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laboratory shall compare the dimensional measurements and the case depth of the screws to the manufacturer's specifications.

3.3.2 Raw Material: The screw manufacturer's raw material specifications shall comply with Section 4 of ASTM C 954. The testing laboratory shall confirm that the screws submitted for testing have been produced from material that complies with the manufacturer's specifications. This verification may be based on mill certificates provided by the manufacturer.

3.3.3 Mechanical Properties: For each type of screw, data shall be submitted verifying that the ductility of the finished screws complies with Section 5 of ASTM C 954.

3.3.4 Performance Requirements: For each type of screw, data shall be submitted verifying compliance with the performance requirements of Section 6 of ASTM C 954, as applicable.

3.3.5 Finish: See Section 3.6 for corrosion protection requirements.

3.4 Screws with Proprietary Specifications:

3.4.1 Dimensions and Case Depth: The testing laboratory shall compare the dimensional measurements and the case depth of the screws to the manufacturer's specifications.

3.4.2 Raw Material: The testing laboratory shall confirm that the screws submitted for testing have been produced from raw material that complies with the screw manufacturer's specifications. This verification may be based on mill certificates provided by the manufacturer.

3.4.3 Mechanical Properties: The testing laboratory shall verify that the screws comply with the screw manufacturer's specifications for mechanical properties.

3.5 Drilling Capacity: For each type of screw, data shall be submitted verifying that the screws are capable of drilling through the applicable materials in the maximum thickness recommended by the screw manufacturer.

3.6 Corrosion Protection: The screws shall have a corrosion-resistance treatment. The minimum and maximum screw size of each type shall be tested with each type of corrosion-resistance treatment. Testing shall be in accordance with ASTM B 117 for a minimum 12-hour test period. Screws shall not show products of corrosion from the coating (white corrosion) after three hours, and shall not show corrosion from the base metal (red rust) at the end of the test period.

When the evaluation report describes the coating type and thickness as complying with a national standard, data shall be submitted verifying that the applicable properties, such as coating thickness, hydrogen embrittlement and corrosion resistance, comply with the requirements of the coating standard when tested in accordance with the coating standard.

3.7 Tapping Screw Available Strength:

~~**3.7.1 General:** Tapping screws designed to transmit design forces acting on steel to steel connections described in Section 1.2.2 of this criteria shall comply with this section.~~

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~~3.7.2 — Shear and Tension Strength of Tapping Screws:~~ The nominal shear and tension strengths of eEach type and size (diameter) of tapping screw shall be tested ~~determined by testing~~ in accordance with Sections 4.1 and 4.2 of this criteria. The available shear and tension strengths of the screw shall be determined in accordance with Sections E4.3.3 and E4.4.3, respectively, of AISI S100. The available tensile and shear strengths (IBC) and capacities (UBC) of each screw type shall be determined in accordance with the following:

~~3.7.2.1 — Analysis—IBC:~~ The available shear and tension strength of the screw shall be in accordance with Section E4.3.3 (Shear in Screws) and E4.4.3 (Tension in Screws), respectively, of AISI NAS.

~~3.7.2.2 — Analysis—UBC: The allowable shear capacity, P_{as} , and allowable tension capacity, P_{at} , of the screw shall be determined in~~ accordance with Sections E6.3.2 (Shear in Screws) and E6.4.3 (Tension in Screws), respectively, as described in Amendment 3 in Section 2218 of the UBC, using a safety factor of 3.0.

3.8 Calculated Available Strength Values of Tapping Screw Connections: Calculated connection strengths may be reported based on the following:

3.8.1 Shear: Available shear strength of the connection shall be the least of the following:

1. Shear limited by tilting and bearing of the screw, in accordance with Section E4.3.1 of AISI S100.
2. Shear limited by end distance, in accordance with Section E4.3.2 of Appendix A of AISI S100.
3. Shear strength of the screw, determined in accordance with Section 3.7 of this criteria.

3.8.2 Tension: Available tension strength of the connection shall be the least of the following:

1. Pull-out capacity, in accordance with Section E4.4.1 of AISI S100.
2. Pull-over capacity, in accordance with Section E4.4.2 of AISI S100.
3. Tension strength of the screw, determined in accordance with Section 3.7 of this criteria.

~~3.8.1 — Connection Strength Analysis—IBC:~~ Available strength of screw connections shall be the lesser of the following:

~~3.8.1.1 — Available strength value of the tapping screw determined in accordance with Section 3.2.2.1 of this criteria.~~

~~3.8.1.2 — The calculated available strength value of a screw connection determined in accordance with Sections E4.3, E4.4, and E4.5 of AISI NAS using a safety factor, Ω , equal to 3.0, or a resistance factor, ϕ , equal to 0.50 as described in Section E4 of AISI NAS. ϕ~~

~~3.8.2 — Connection Strength Analysis—UBC:~~ Allowable strength of screw connections shall be the lesser of the following:

~~3.8.2.1 — Allowable capacity value of the tapping screw determined in accordance with Section 3.2.2.2 of this criteria.~~

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR TAPPING SCREW FASTENERS

~~3.8.2.1.1~~ — The shear capacity of the tapping screw shall be at least 125 percent of the nominal shear strength of the connection, P_{ns} , calculated in accordance with Section E6.3.1 (Connection Shear) as described in Amendment 3 in Section 2218 of the UBC.

~~3.8.2.1.2~~ — The tension capacity of the tapping screw shall be at least 125 percent of the nominal pull-out force, P_{no} , and of the nominal pull-over force, P_{noV} , of the connection calculated in accordance with Section E6.4.1 (Pull-out) and Section E6.4.2 (Pull-over) of the connection as described in Amendment 3 in Section 2218 of the UBC.

~~3.8.2.2~~ — The calculated allowable shear and tension force values of a screw connection determined in accordance with Sections E6.3 (Shear) and E6.4 (Tension), respectively, as described in Amendment 3 in Section 2218 of the UBC, using a safety factor, Ω , equal to 3.0.

3.9 Empirically Derived Tested Available Strength Values of Tapping Screw Connections (~~Alternate to Section 3.3~~):

~~3.9.1 General:~~ The available strength values of particular screw connections empirically derived in accordance with this section (Section 3.4) are not required to be compared to the available strength connection values calculated in accordance with Sections 3.3.1 (IBC) or 3.3.2 (UBC) of this criteria.

~~3.9.2 Connection Testing:~~ Reports of connection testing in accordance with Sections 4.1 and 4.3 of this criteria shall be submitted when empirically derived available strength values for particular connection applications are sought for recognition in an evaluation report.

~~3.9.3 Connection Strength Analysis—IBC:~~ Available strength of a particular tested screw connection shall be the lesser of the following:

~~3.9.3.1~~ 1. Available strength values of the tapping screw determined in accordance with Section ~~3.2.2.4~~ 3.7 of this criteria.

~~3.9.3.2~~ 2. The allowable ~~[design]~~ available strengths of the particular connection based on the tested values in conjunction with the safety factor, Ω , and resistance factor, ϕ Φ , from Section F1 of AISI-NASS100.

As a condition of acceptance, the failure of the connection shall not be due to the failure of the screws.

~~3.9.4 Connection Strength Analysis—UBC:~~ Allowable strength values of the tapping screw shall be determined in accordance with Section 3.2.2.2 of this criteria, and the following:

~~3.9.4.1~~ — The shear capacity of the screw, determined per Section 3.2.2.2 of this criteria, shall be at least 125 percent of the shear test results from connection testing conducted per Section 3.4.2 of this criteria.

~~3.9.4.2~~ — The tension capacity of the tapping screw shall be at least 125 percent of the pull out and pull over force test results from the connection testing conducted per Section 3.4.2 of this criteria.

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3.9.2 Screws Used in Steel-to-steel Framing Connections: Framing connections shall be tested in shear and tension in accordance with Sections 4.1 and 4.3.

3.9.3 Screws Used to Attach Sheathing Materials to Cold-formed steel framing: Screwed connections of sheathing materials to cold-formed steel shall be tested for shear capacity, pull-out capacity and for pull-over capacity in accordance with Sections 4.1 and 4.3.

3.9.4 Screws Used to Connect Steel Deck Panels to Steel Supports: The nominal shear strength, Q_r , and flexibility, S_r , of the connection shall be determined through testing in accordance with Section 4.1 and 4.3. Multiple test series are required to address the range of applicable conditions shown in the matrix required in accordance with Section 3.1. In lieu of testing every applicable connection, a test plan describing the connections that will be tested may be submitted to ICC-ES for review and approval, prior to testing.

Available diaphragm strengths and diaphragm flexibilities must be determined in accordance with the ICC-ES Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43).

3.9.5 Screws Used as Stitch Connectors of Steel Panels of Steel Deck Diaphragms: The nominal shear strength, Q_s and the flexibility, S_s , shall be determined through testing in accordance with Section 4.1 and 4.3. Multiple test series are required to address the range of applicable conditions shown in the matrix required in accordance with Section 3.1. In lieu of testing every applicable connection, a test plan describing the connections that will be tested may be submitted to ICC-ES for review and approval, prior to testing.

Available diaphragm strengths and diaphragm flexibilities must be determined in accordance with the ICC-ES Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43).

3.9.6 Eye Lag Screws Used to Attach Suspended Ceiling Support Wire to Cold-formed Steel Joists: Eye lag screws installed in cold-formed steel framing shall be tested for pullout capacity in accordance with Sections 4.1 and 4.3. Multiple test series are required to address the applicable installation orientations (e.g., perpendicular to the joist flange; at 45 degrees to the joist flange, with the load applied parallel to the member; at 45 degrees to the joist flange, with the load applied towards the joist web; at 45 degrees to the joist flange, with the load applied away from the joist web).

4.0 TEST METHODS

4.1 General: As a minimum, a series of three identical tests shall be performed for each combination of variables that affect the performance of the ~~connector~~ screw or connection, as applicable, provided deviation of any individual test result from the average value does not exceed ± 15 percent. If such a deviation from the average value exceeds ± 15 percent, more tests of the same kind shall be conducted until the deviation of any individual test result from the average value obtained from all the tests does not exceed ± 15 percent, or until at least three additional tests have been conducted. No test result shall be eliminated unless a rationale for its exclusion can be given. The average value of all tests ~~made~~ shall be regarded as the

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nominal strength, R_n , for the series of the tests. The nominal strength, R_n , and the coefficient of variation, V_P , of the test results shall be determined by statistical analysis.

4.2 Fastener Testing: Tension and shear testing of screws shall comply with ~~TS-4~~AISI S904. Steel plates or shapes used in the tests shall comply with ~~TS-4~~AISI S904. Reporting shall comply with Section ~~45~~ of ~~TS-4~~AISI S904.

4.3 Connection Testing:

4.3.1 ~~Tension (pull-over and pull-out) and shear~~ Test specimen setup and dimensions and load application shall comply with ~~TS-5~~AISI S905. Steel plates or shapes used in the tests shall comply with ~~TS-5~~AISI S905, and be representative of connected steel material that is to be recognized in the evaluation report. Reporting shall comply with Section ~~40~~11 of ~~TS-5~~AISI S905.

4.3.1.1 Shear (Bearing) Tests: Selection of shear test setup shall be based on intended end use. For framing connections, the standard specimen described in Section 8.2.2. of AISI S905 shall be used. For connections of sheathing to steel, the standard test setup shall be modified to accommodate the sheathing material thickness. For connections of steel deck panels to supporting steel, the standard setup may be used, in accordance with Section 8.2.2.3 of AISI S905. For connections of steel deck panel side seams, an applicable alternative setup shall be used, in accordance with Sections 8.2.3 and 8.2.4 of AISI S905. When applicable, connection flexibility shall be determined in accordance with Section 8.2.5 of AISI S905.

4.3.1.2 Tension Tests (Pull-over and Pull-out): Tension test setup shall be in accordance with Section 8.3.1 of AISI S905. For pull out testing of eye lag screws, the test setup shall comply with Section 8.3.2.3 of AISI S905.

4.3.2 If the tensile strength of the ~~steel from which the tested steel structural~~ members forming the tested connection are ~~formed~~ is greater than the specified minimum value, and/or the steel thickness of the tested members is more than 5% greater than the minimum specified thickness, the test results shall be calibrated to the specified minimum tensile strength and minimum specified thickness of the steel which the manufacturer intends to use, by the following adjustment factor, R_s :

$$R_s = \left(\frac{F_{u(\text{specified})}}{F_{u(\text{tested})}} \right) \times \left(\frac{t_{(\text{specified})}}{t_{(\text{tested})}} \right) \leq 1.0$$

where:

R_s = Adjustment factor.

$F_{u(\text{specified})}$ = Specified tensile strength of the steel, psi (Pa).

$F_{u(\text{tested})}$ = Measured tensile strength of the steel, psi (Pa).

$t_{(\text{specified})}$ = Specified steel thickness, inch (mm).

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$t_{(tested)}$ = Measured steel thickness, inch (mm).

~~If the thickness of the steel, from which the critical cold formed elements of tested connectors are made, is greater than the specified (design) thickness by more than 5 percent, the test results shall be reduced by the ratio of the specified (design) thickness of the connector to the measured thickness, as shown in the formula above.~~

5.0 QUALITY CONTROL

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

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

5.3 For generic screws, ongoing quality control tests shall be conducted in accordance with the standards upon which the screws have been qualified and shall meet the conditions of acceptance noted in the appropriate section of the standard as it relates to the type of fastener. For screws with proprietary mechanical property and/or performance specifications, ongoing quality control tests shall verify that the screws comply with each of the manufacturer's specifications. Sampling size for quality control tests shall be consistent with accepted procedures for quality control sampling.

6.0 EVALUATION REPORT RECOGNITION

6.1 The following statement shall appear in the Conditions of Use section in the product evaluation report "Fasteners ~~are~~ must be installed in accordance with the manufacturer's published installation instructions and this report. In the event of a conflict between this report and the manufacturer's published installation instructions, this report governs."

6.2 For generic screws intended for use in engineered connections, ~~t~~The evaluation report shall note the ~~allowable~~ available shear and tension strength values for the tapping screws ~~used in cold formed sheet steel to steel connections determined in accordance with Section 3.2.2 of this criteria~~ for use in designing the connections in accordance with AISI S100. The evaluation report shall include a statement that the available connection strength shall be in accordance with Section E4 of AISI S100.

6.3 The evaluation report shall note that the allowable ~~load~~ strength values (ASD) for screws or for screw connections are not permitted to be increased for short-duration loads, such as wind or earthquake loads.

~~6.4 For screws qualified in accordance with Section 3.3, the evaluation report shall include a statement that the available connection strength shall be in accordance with Section E4 of AISI NAS.~~

6.4 For connections qualified in accordance with Section 3.49, the evaluation report shall include the nominal or available tension strength, shear strength and shear stiffness of the connections, as applicable, following:

~~6.4.1 A statement indicating that the most restrictive of fastener tensile strength, pull out from the supporting material or pull over of the supported material governs.~~

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR TAPPING SCREW FASTENERS

6.4.2 ~~A statement indicating that the more restrictive of fastener shear strength and bearing and tilting capacity of the connected steel, including minimum end and edge distances, governs.~~

6.4.3 ~~Description of the specific tested connections, including physical and dimensional properties and material specifications.~~

6.5 The evaluation report shall include a description of the screw fasteners, including the screw series, model, size, threads per inch (tpi), point number or type, head type, head diameter, minor and major shank diameter, overall length, thread length, and drill point length.

6.6 The evaluation report shall note that screw fasteners are limited to dry, interior applications unless coatings or other corrosion-resistant materials are used to provide specific higher levels of corrosion resistance. The coating, material or required corrosion resistance shall be noted on the construction documents.

6.7 The evaluation report shall include a condition of use stating that the rust-inhibitive (corrosion-resistant) coating shall be suitable for the intended use, as determined by the registered design professional.

6.8 For each screw, the evaluation report shall describe the applicable thicknesses, materials and material strengths of the connected elements. ■

TABLE 1—SAMPLE SIZE FOR THIRD-PARTY AND MANUFACTURING LOCATION QUALIFICATION TESTS SPECIFIED IN SCREW STANDARDS REFERENCED IN SECTION 3.1 OF THIS CRITERIA

CHARACTERISTIC	THIRD- PARTY QUALIFICATION TEST SAMPLE SIZE	MANUFACTURING LOCATION QUALIFICATION TEST SAMPLE SIZE
Proper Seating Test, Section 6.2.1.1 of ASTM C 954; Section 12.6.3 of ASTM C 1002	-	Per ASTM C 954 Section 9
Assembly Tension, Section 6.2.1.2 of ASTM C954	5	Per ASTM C 954 Section 9
Case Depth	5	Per ASTM C 1513 Section 10
Raw Material Chemistry²	-	-
Corrosion Resistance (salt-spray testing)	5	Per ASTM C 1513 Section 10
Drill Capacity	-	Per ASTM C 1513 Section 10
Drill Drive	-	Per ASTM C 1513 Section 10
Drill Hole Size, Section 5.4 of SAE J78	-	Per ASTM C 1513 Section 10
Ductility	5	Per ASTM C 1513 Section 10
Hardness	5 ³	Per ASTM C 1513 Section 10
Hydrogen Embrittlement	-	Per ASTM C 1513 Section 10
Plating/Coating Thickness ⁴	-	Per ASTM C 1513 Section 10
Spin out (Section 6.1 of ASTM C 954)	-	Per ASTM C 954 Section 9
Torsional Strength	5	Per ASTM C 1513 Section 10
Dimensional Checks ⁵	5	-
<u>Fastener Strength</u>	<u>See Section 4.1</u>	-
<u>Connections</u>	<u>See Section 4.1</u>	-

¹This table relates to the sample sizes for tests required to verify compliance with the applicable sections of ASTM C 954, ~~C 1002~~ and C 1513. Requirements for the purpose of quality control are in Section 5.3.

²A certified copy of the raw material's chemical or product analysis, which is traceable to the lot of test specimens, shall be furnished.

³Hardness ranges listed in Section 5.1.2 of ASTM C 954 are not for the final product. This test is not required for screws to be recognized for ASTM C 954 applications.

⁴If the plating/coating thickness test is performed as a qualification test in addition to the salt-spray test, the manufacturing location test that is used may be either the salt-spray test or the plating/coating thickness test.

⁵The average of five measurements of same dimension should be evaluated for conformance with manufacturer's drawing dimensions and tolerances.

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TABLE 2—TESTING AND PERFORMANCE REQUIREMENTS BASED ON INTENDED END USE OF TAPPING SCREWS

End Use	ASTM C 1513							ASTM C 954					PROPRIETARY SPECIFICATIONS			DRILLING CAPACITY – SEE SECTION 3.5		CORROSION RESISTANCE – SEE SECTION 3.6		SCREW STRENGTH – SEE SECTION 3.7		CONNECTION STRENGTH CALCULATED – SEE SECTION 3.8		CONNECTION STRENGTH TESTED – SEE SECTION 3.9		CONNECTION STIFFNESS – SEE SECTION 3.9		
	Dimensions – See Section 3.2.1	Case depth – See Section 3.2.1	Raw material – See Section 3.2.2	Hardness – See Section 3.2.3	Ductility – See Section 3.2.3	Torsion – See Section 3.2.3	Drill Drive – See Section 3.2.4	Dimensions – See Section 3.3.1	Case depth – See Section 3.3.1	Raw material – See Section 3.3.2	Ductility – See Section 3.3.3	Performance – See Section 3.3.4	Dimensions – See Section 3.4.1	Raw materials – See Section 3.4.2	Mechanical properties – See Section 3.4.3													
Prescriptive Use Under the 2009 IBC ¹ :																												
Prescriptive framing connections in AISI S230 referenced in IBC Section 2210.7																												
Prescriptive shear wall assemblies and diaphragms described in AISI S213, referenced in IBC Section 2210.6:																												
Shear walls with sheet steel sheathing																												
Shear walls with wood structural panel sheathing																												
Shear walls with gypsum board panel sheathing																												
Shear walls with fiberboard panel sheathing																												
Diaphragms with wood structural panel sheathing																												
Prescriptive Use Under the 2009 IRC ¹ :																												
Steel-to-steel Framing Connections																												
Structural sheathing to framing																												
Gypsum board to framing																												
Steel-to-steel framing connections, engineered in accordance with AISI S100																												
Generic Screws																												
Proprietary Screws																												
Engineered connections of wood structural panels to steel framing																												
Engineered connections of gypsum board to steel framing																												
Connections of Steel Deck panels to steel supports																												
Generic Screws																												
Proprietary Screws																												
Connections of steel deck panel side seams																												
Generic Screws																												
Proprietary Screws																												
Specialty screws for attaching building materials to steel:																												
Eye lag screws used to connect ceiling wire to cold-formed steel framing																												

¹Refer to applicable code for prescribed screw sizes, head styles and head dimensions.
X = Required O = Optional