ICC EVALUATION SERVICE

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To: ICC-ES Evaluation Committee

From: Elyse G. Levy, S.E., Senior Staff Engineer

Date: June 10, 2010

Subject: Proposed Revisions to the Acceptance Criteria for Tapping Screw Fasteners, Subject AC118-0610-R2 (EL/RK)

MEMO

Proposed revisions to the subject criteria were outlined in the staff letter dated May 13, 2010. The following responses have been received:

1. An e-mail from Eric C. Stovner, S.E., LEED AP, of Critical Structures, on behalf of Elco Fasteners; dated May 18, 2010.

2. A letter from Andrew T. Liechti, P.E., Technical Services Engineer; Hilti, Inc.; dated May 28, 2010.

Staff appreciates the comments we received regarding AC118. As noted in the staff letter dated May 13, 2010, there were several reasons that revisions to the criteria were proposed. The most urgent reason was 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. Mr. Stovner has proposed having AC118 address use of tapping screws for attaching wood to cold-formed steel and for attaching cold-formed steel to structural steel for non-diaphragm applications. Staff recommends addressing these proposals at a future date, for the following reasons:

   a. While the proposed criteria draft does not explicitly state that screws used to attach cold-formed steel to structural steel for non-diaphragm applications is within the scope of AC118, following receipt of an application for an evaluation report for recognition of this use for the fasteners, the ICC-ES staff will work with the applicant to ascertain whether the criteria has sufficient guidance for the evaluation. Revisions to the criteria may at that time be needed to explicitly address the qualification of screws used to attach cold-formed steel to structural steel for non-diaphragm applications.

   b. ICC-ES does not have any current applications for evaluation reports on screws used to attach wood to cold-formed steel, and therefore staff does not have a complete understanding of the intended use. For instance, it is not known if “wood” means wood structural panels, which are relatively thin, or if it means sawn lumber. Without a clear

understanding of the intended use of the screws, staff cannot fairly evaluate the proposal for testing requirements. When an application is received for screws used to attach wood to cold-formed steel, staff will consider the need for further revisions to the criteria and may propose additional revisions at a future date.

c. Addressing these uses is not required to update the criteria to the 2009 *International Building Code*® (IBC) and *International Residential Code*® (IRC).

2. The following comments address the comments in the letter from Mr. Liechti of Hilti, in the order Mr. Liechti's comments are presented in his letter:

   a. **Section 2.1.1.4:** Staff acknowledges that a manufacturer's specification for corrosion-resistant coatings may be either thickness-based or performance-based. To allow for both types of specifications, and to improve the general clarity of Section 2.1.1.4 of AC118, staff proposes that this section be revised as shown in the attached draft of the criteria.

   b. **Section 2.1.1.5:** Section 2.1 addresses items that need to be submitted as part of the evaluation, but does not require that each of these pieces of data be verified in a test report. As a result, no further revisions to this section of the criteria are proposed by the ICC-ES staff in response to the Hilti comment.

   c. **Section 3.1:** Staff does not support adding language from Section 6.2 of ASTM F 1941, regarding acceptance of corrosion seen at the edges of fasteners, as requested in the Hilti letter, for the following reasons:

      i. The term "edges" of the screws is not defined and is subject to interpretation. Rather than enhancing consistency between evaluation reports on screws, this proposed revision will make it more difficult for staff to maintain consistency in evaluation.

      ii. The corrosion resistance required by the criteria is already at the minimum level, with the requirement being that no red rust be apparent after 12 hours of testing. Staff believes that to comply with the code requirement (that the screws have a rust inhibitive coating), it is reasonable to expect that there will be no apparent rusting of the screw after the minimum test period, without exception.

      iii. Neither the code nor AC118 requires corrosion-resistant coatings for screws to comply with ASTM F 1941. Therefore, it is not necessary that AC118 include all of the language from Section 6.2 of ASTM F 1941.

   d. **Section 3.1:** Staff does not support Hilti's recommendation for removing the requirement that there be no evidence of white corrosion after three hours of salt spray testing. Many coatings may not show any signs of white corrosion, because of the materials used. For coatings that are prone to white corrosion, such as electrodeposited zinc, the lack of white corrosion gives evidence of the durability of the coating. Once again, it should be

noted that the requirement in AC118 is a minimal requirement. It is reasonable to expect compliance with this requirement.

e. **Section 3.1.8:** Staff respectfully disagrees with Hilti's position that screws intended for use in steel deck diaphrams should not be addressed in AC118. Historically, AC118 has been the criteria used by ICC-ES to evaluate tapping screws, while AC43 has been used as the basis for evaluating steel deck panels. In general, AC118 addresses tapping screws that are used to connect two pieces of steel together. Screws used for connecting steel deck panels at side seams and for attaching steel deck panels to supports fall within this scope. Staff acknowledges that the proposed sections of AC118 that are applicable to screws used in steel deck diaphrams can be improved, but is not aware of any technical reason why this should preclude having screws used in steel deck diaphragms addressed in AC118. It appears that Hilti is concerned with the information that will be published in an ICC-ES evaluation report on the screws, if diaphragm values are not reported. Staff views the evaluation report on the screws as a way for a screw manufacturer to prequalify the connection values for screws which are used in diaphragms. This is similar to issuance of an evaluation report to a foam plastic bead manufacturer to recognize prequalification of the beads, thereby saving the subsequent foam plastic insulation manufacturers significant time and money when they wish to obtain their own evaluation report. To improve the correlation of AC118 with the proposed revisions to AC43, and to describe the information to be reported in evaluation reports on tapping screws used to construct steel deck diaphragms, staff recommends revising Section 3.1.8 of the proposed criteria draft and adding a new Section 6.10, as shown in the attached criteria draft.

f. **Section 4.3.2:** Staff agrees with the comment from Hilti that the specified design base steel thickness should be the basis for reducing test values to account for test specimen thickness. Currently, AC118 allows the measured base steel thickness to be 5% greater than the specified design base steel thickness. Since the delivered thickness of cold-formed steel framing is allowed to be as little as 95% of the design thickness, this would allow the tested steel to be roughly 10% thicker than the delivered product. Staff finds that this is in conflict with the code. Section F1.1(c) of AISI S100 indicates that consideration should be given to the difference between the design thickness and the thickness of members used in testing. Therefore, staff proposes revising Section 4.3.2 of AC118 to read as shown in the attached criteria draft.

g. **Section 4.3.2:** Staff acknowledges that the relationship between tensile strength and connection strength may not be linear, as suggested by the equation in Section 4.3.2 of AC118. Staff also acknowledges that this issue is addressed by the ICC-ES Acceptance Criteria for Fasteners Power-driven in Concrete, Steel and Masonry Elements (AC70). However, staff has not had adequate time to study this issue as it applies to tapping screws evaluated under AC118, and is not prepared to propose related revisions to AC118 at this time. This issue should not hold up the update of AC118 to the 2009 IBC and IRC, and can be addressed at a future date.

h. **Section 5.4:** Evaluation reports on tapping screws for use in engineered connections recognize nominal fastener shear and tensile strengths, based on qualification testing. Therefore, the screw manufacturer's quality control system needs to ensure that these fastener strengths are maintained on an ongoing basis. In the past, applicants have indicated that there is a relationship between hardness and tensile strength. Staff has therefore accepted quality control systems that are based on verifying the case and core hardness of the screws. More recently, staff has been advised by members of the cold-formed steel industry that there is not a consistent relationship between hardness and tensile strength. This has led staff to propose the addition of Section 5.4 of AC118, to clarify that the manufacturer must be able to ensure the nominal fastener strengths recognized in the evaluation report, while allowing manufacturers flexibility in the methods for achieving this. As a result, the ICC-ES staff does not recommend further revisions to address this issue.

i. **Table 1:** Staff agrees with the comment from Hilti that testing for hydrogen embrittlement is not necessary for all tapping screws. The need for this should be based upon the requirements of the applicable national standards, including the coating standards. For example, Section 6.4.3 of ASTM F 1941 addresses this type of testing. Staff proposes adding a footnote to Table 1 as shown in the attached criteria draft.

j. **Table 1:** Hilti's intended revision to Table 1 regarding corrosion resistance is not clear. Staff finds that Table 1 already allows for corrosion resistance to be controlled by ongoing salt spray performance testing. As a result, the ICC-ES staff does not recommend any further revisions to address this issue.

Staff thanks the committee for consideration of these comments.

Enclosure

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PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR TAPPING SCREW FASTENERS

AC118

Proposed May 2010

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

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.

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR TAPPING SCREW FASTENERS

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)~~. This criteria is needed to clarify requirements in the code for tapping screws and to provide requirements for tapping screws which are alternates to the tapping screws prescribed in the code. This criteria is also needed to provide requirements for tapping screws which are intended for uses which are not addressed by the code.

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.

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 ~~NAS~~ S100 ~~or Section 2218 (item 3) of the UBC~~.

1.2.3 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~~.

1.2.4 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.

1.2.5 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~~,~~ and Section R702.3 of the IRC~~, and Sections 2502 and 2511 of the UBC~~.

1.2.6 Evaluating eye-lag tapping screws for use in connecting building elements suspended by wire to cold-formed steel framing.

1.2.7 Evaluating tapping screws for use as connectors in steel deck diaphragms evaluated in accordance with AC43.

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.~~

1.3.8 ASTM C 954-0~~0~~4, 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 1002-0~~1~~4, 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~~1~~4, 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, 2001~~ S100-07, North American Specification for Design of Cold-formed Steel Structural Members, ~~including 2004 Supplement~~, American Iron and Steel Institute.

1.3.13 AISI S200-07, North American Standard for Cold-formed Steel Framing—General Provisions, American Iron and Steel Institute.

1.3.14 AISI S213-07, North American Standard for Cold-formed Steel Framing—Lateral Design, American Iron and Steel Institute.

1.3.15 AISI ~~TS-4-02~~ S904-08, Standard Test Method for Determining the Tensile and Shear Strength of Screws, Part VI, AISI Manual, 200~~2~~8, Cold-Formed Steel Design, American Iron and Steel Institute.

1.3.16 AISI ~~TS-5-02~~ S905-08, Test Methods for Mechanically Fastened Cold-Formed Steel Connections, Part VI, AISI Manual, 200~~2~~8, Cold-Formed Steel Design, American Iron and Steel Institute.

1.3.17 ICC-ES Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43).

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 Base Steel Thickness: The base steel thickness is the thickness of the steel, exclusive of all coatings.

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

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

1.4.6 ~~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.~~ **Eye-Lag Tapping Screws:** Eye-lag tapping screws have a drilling point, a threaded shank and an elongated head with a

hole (eye). These screws are used to hang loads from the supporting cold-formed steel framing, through wire connected to the eye.

1.4.7 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.

1.4.8 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.)

1.4.9 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.)

1.4.10 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) thick, 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.)

1.4.11 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.)

1.4.12 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.)

1.4.13 Type: A family of screws with a consistent size (nominal diameter), 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, including brand name, model number, nominal screw size and point style.

2.1.1.3 Applicable s~~S~~crew fastener specification~~s~~ 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~~; raw material specifications; ~~and~~ final product specifications, including case and core hardness, ductility, and torsional strength; and ~~type and thickness of~~ specifications for protective coatings.

2.1.1.5 A comparison showing whether the dimensional, material and performance specifications comply with, or deviate from, the applicable standard.

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

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

2.1.1.8 Drilling capacity recommended by the manufacturer.

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 base steel 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 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: 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, ASTM C 1002~~,~~ or 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~~ standards or portions of a standard are ~~is~~ applicable for the end-use application described in the codes, and to clarify the mechanical, physical property and performance requirements for tapping screws that are either alternates to the screws prescribed in the codes or intended for end uses not addressed by the code.

Reports of testing shall be submitted to establish compliance with Sections 3.1.1 through 3.1.4~~7~~, as applicable. In addition, tapping screws shall have a corrosion-resistant coating 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.

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 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.

When the manufacturer's specifications deviate from an applicable standard, the manufacturer shall submit an analysis addressing how the deviations will affect structural performance. Test data supporting this analysis shall be submitted, when requested by ICC-ES.

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. Nominal screw size shall comply with the applicable code section. ~~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~~ S100 ~~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.~~ Available screw strength in tension and shear shall be determined in accordance with Section 3.2. Connection strength may be determined in accordance with Section 3.3.1.

3.1.3 Engineered Steel-to-steel Connections Based on Testing: When screw specifications deviate from the requirements of ASTM C 1513, available connection strength shall be determined in accordance with Section 3.3.2, unless the analysis submitted in accordance with Section 3.1 justifies the use of Section E4 of AISI S100. For screws which comply with ASTM C 1513, available connection strength may be determined in accordance Section 3.3.2.

3.1.4 Prescriptive Shear Walls in Accordance with the IBC ~~and UBC~~:

3.1.4.1 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 AISI S213 (referenced in Section 2210.5~~5~~6 of the IBC) ~~and Sections 2219 and 2220 of the UBC,~~ shall be either No. 8, ~~flat head~~ countersunk 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~~ countersunk 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.~~

3.1.4.2 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 AISI S213 (referenced in Section 2210.5~~5~~6 of the IBC), shall be minimum No. 8, 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.~~

3.1.4.3 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 AISI S213 (referenced in Section 2210.5~~5~~6 of the IBC) ~~and Sections 2219 and 2220 of the UBC~~, shall be minimum No. 6 self-drilling tapping screws complying with ASTM C 954~~, or self-piercing tapping screws complying with ASTM C 1002~~.

3.1.4.4 Fiberboard Panel Sheathing: Fasteners used to attach fiberboard to cold-formed steel wall framing members to provide resistance to lateral loads in the plane of the wall, as described in AISI S213 (referenced in Section 2210.6 of the IBC), shall be minimum No. 8, self-drilling or self-piercing tapping screws complying with ASTM C 1513, with minimum 0.43-inch-diameter (10.9 mm) heads, having a style which provides a flat bearing surface against the fiberboard.

3.1.5 Prescriptive 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 AISI S213 (referenced in Section 2210.~~5~~6 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~~ countersunk 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.~~

3.1.6 Prescriptive Connections of Sheathing Materials to Cold-Formed Steel Framing:

3.1.6.1 IBC: Screws used for fastening sheathing to cold-formed steel framing shall comply with ASTM C 1513 as required by Section D1.2 of AISI S200 (referenced in IBC Section 2210.1)

Screws used to attach gypsum board to cold-formed steel framing shall conform to ASTM C 954 or ASTM C 1002, as required by IBC Table 2506.2.

3.1.6.2 IRC: Screws used for fastening structural sheathing to cold-formed steel framing shall be minimum No. 8, countersunk head, self-drilling tapping screws, with a minimum head diameter of 0.292 inch (7.4 mm). complying with ASTM C 1513, as required by IRC Sections R505.2.4, R603.2 and R804.2.4.

Screws used to attach gypsum board to cold-formed steel framing shall be minimum No. 6 screws conforming to ASTM C 954 or minimum No. 6 bugle head screws complying with ASTM C 1513, as required by IRC Sections R505.2.4, R603.2.4, R702.3.6 and R804.2.4.

3.1.7 Engineered Connections Using Eye-Lag Screws: Eye-lag screws shall comply with the hardness, ductility and torsional strength requirements of ASTM C 1513. Connection strength shall be evaluated in accordance with Section 3.4.

3.1.8 Connections of Steel Deck Diaphragms: Connection strength and stiffness for screws used in steel deck diaphragms may be prequalified for use in obtaining ICC-ES evaluation reports on steel deck diaphragms in accordance with AC43. These connection values may be reported in an evaluation report on the screws, provided the Φ and Ω factors determined for the tested connections are no more severe than the values in Table D5 of AISI S100, (i.e. Φ≥0.65, Ω≤2.5).

Screws complying with ASTM C 1513 are considered to be generic screws for purposes of evaluating steel deck diaphragms in accordance with AC43. Screws which do not comply with ASTM C 1513 are considered proprietary fasteners and shall be evaluated in accordance with AC43. Connection strength and stiffness for generic and proprietary screws shall be determined in accordance with AC43.

3.2 ~~Tapping~~ Screw ~~Available~~ Strength:

~~3.2.1 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.~~

~~3.2.2 Shear and Tension Strength of Tapping Screws:~~ Each type ~~and size (diameter)~~ of tapping screw shall be tested in accordance with Sections 4.1 and 4.2 of this criteria. The available tensile and shear strengths ~~(IBC) and capacities (UBC)~~ of each screw type shall be determined in accordance with ~~the following:~~

~~3.2.2.1 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~~ S100. Screw type attributes that need to be considered include nominal size, threads per inch, material, and protective finish.

~~3.2.2.2 Analysis—UBC: The allowable shear capacity, Pas, and allowable tension capacity, Pat, 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.~~

3.3 ~~Available Strength Values of Tapping Screw Connections~~ Connection Strength for Engineered Steel Framing Connections: For screws intended for use in engineered connections of cold-formed steel framing, the available connection strength shall be determined in accordance with Section 3.3.1 or Section 3.3.2, as applicable.

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

~~3.3.1.1~~ ~~Available strength value of the tapping screw determined in accordance with Section 3.2.2.1 of this criteria.~~

~~3.3.1.2~~ Connection strength shall be determined by calculation ~~The calculated available strength value of a screw connection determined~~ in accordance with Sections E4.3, E4.4, and E4.5 of AISI~~-NAS~~ S100 using a safety factor , Ω, equal to 3.0, or a resistance factor, ~~φ~~Φ, equal to 0.50 as described in Section E4 of AISI~~-NAS~~ S100.

~~3.3.2 Connection Strength Analysis—UBC:~~ ~~Allowable strength of screw connections shall be the lesser of the following:~~

~~3.3.2.1~~ ~~Allowable capacity value of the tapping screw determined in accordance with Section 3.2.2.2 of this criteria.~~

~~3.3.2.1.1~~ ~~The shear capacity of the tapping screw shall be at least 125 percent of the nominal shear strength of the connection, P_{nas}, calculated in accordance with Section E6.3.1 (Connection Shear) as described in Amendment 3 in Section 2218 of the UBC.~~

~~3.3.2.1.2~~ ~~The tension capacity of the tapping screw shall be at least 125 percent of the nominal pull-out force, P_{not}, 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.~~

~~**3.3.2.2** 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.~~

~~3.4~~ 3.3.2 Empirically Derived Available Strength Values of Tapping Screw Connections ~~(Alternate to Section 3.3)~~:

~~**3.4.1 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.~~ Available connection strengths shall be determined on the basis of connection testing in accordance with Sections 4.1 and 4.3 of this criteria.

~~**3.4.2 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.~~

~~**3.4.3 Connection Strength Analysis—IBC:**~~ Available strength of a particular screw connection shall be the lesser of the following:

~~**3.4.3.1**~~ 1. Available screw strength ~~values of the tapping screw~~ determined in accordance with Section 3.2~~.2.1~~ of this criteria.

~~**3.4.3.2**~~ 2. The ~~allowable [design] strengths of the particular~~ available connection strength based on the tested values in conjunction with the safety factor, Ω, and resistance factor, ~~φ~~Φ, from Section F1 of AISI~~-NAS~~ S100.

~~**3.4.4 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:~~

~~**3.4.4.1** 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.~~

~~**3.4.4.2** 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.~~

3.4 Connection Strength of Eye-lag Tapping Screws: Eye-lag screws installed into 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 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 ~~10~~11 of ~~TS–5~~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 base steel thickness of the tested members is more than ~~5% greater than the minimum~~ specified design base steel thickness, the test results shall be calibrated to the specified minimum tensile strength and ~~minimum~~ specified design base steel thickness of the steel which the manufacturer intends to use, by applying the following adjustment factor, R_s:

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

where:

R_s = Adjustment factor.

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

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

$t_{(specified)}$ = Specified design base steel thickness, inch (mm).

$t_{(tested)}$ = Measured base 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 for the screws, 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 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. Sampling size for quality control tests shall be consistent with accepted procedures for quality control sampling.

5.4 For screws intended for use in engineered connections, the quality documentation shall address how the fastener strengths recognized in the evaluation report are verified on an ongoing basis.

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 screws evaluated under Section 3.1.2 t~~T~~he evaluation report shall note the ~~allowable [design]~~ available shear and tension strength values for tapping screws ~~used in cold-formed sheet steel-to-steel connections~~ determined in accordance with Section 3.2~~.2~~ of this criteria.

6.3 For screws evaluated under Section 3.1.2 or 3.1.3, t~~T~~he evaluation report shall note that the allowable load 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 evaluated under Section 3.1.2, ~~qualified in accordance with Section 3.3~~, the evaluation report shall include a statement that the available connection strength shall be determined in accordance with Section E4 of AISI ~~NAS~~ S100.

6.5 For connections qualified in accordance with Section ~~3.4~~3.1.3, the evaluation report shall include available tension and shear strength for the connection and the following:

6.5.1 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.

6.5.2 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.

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

6.6 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.

6.7 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.

6.8 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.

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

6.10 Evaluation reports on screws intended for use in steel deck diaphragms shall include a condition of use stating that diaphragms constructed using the screws must be recognized in a current ICC-ES evaluation report.■

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
Chemistry[2]	-	-
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[6]	-	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	-

[1]This 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.
[2]A certified copy of the material's chemical or product analysis, which is traceable to the lot of test specimens, shall be furnished.
[3]Hardness 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.
[4]If 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.
[5]The average of five measurements of same dimension should be evaluated for conformance with manufacturer's drawing dimensions and tolerances.
[6]Hydrogen embrittlement tests are required for cadmium or zinc electroplated (electrodeposited) screws, as required by the applicable national standard.