Technical Evaluation Report
TER 1703-01
Starborn® Structural H23 and F23 Screws: Deck Ledger and Ledger to Stud Applications

Starborn® Industries, Inc.

Product:
Starborn® Structural H23 Screws and Starborn® Structural F23 Screws

Issue Date:
November 7, 2019
Revision Date:
November 2, 2020
Subject to Renewal:
January 1, 2022
1 PRODUCT EVALUATED

1.1 Starborn® Structural H23 Screws
1.2 Starborn® Structural F23 Screws
1.3 ½” galvanized lag screw for comparative, equivalency, and code compliance purposes

2 APPLICABLE CODES AND STANDARDS

2.1 Codes

2.1.1 IBC—12, 15, 18: International Building Code®
2.1.2 IRC—12, 15, 18: International Residential Code®

2.2 Standards and Referenced Documents

2.2.1 AISI S904: Standard Test Methods for Determining the Tensile and Shear Strengths of Screws
2.2.2 ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction

1 Building codes require data from valid research reports be obtained from approved sources. Agencies who are accredited through ISO/IEC 17065 have met the code requirements for approval by the building official. DrJ is an ISO/IEC 17065 ANAB-Accredited Product Certification Body – Accreditation #1131.

Through ANAB accreditation and the [AF MLA], DrJ certification can be used to obtain product approval in any jurisdiction or country that has IAF MLA Members & Signatories to meet the Purpose of the MLA – “certified once, accepted everywhere.”

Building official approval of a licensed registered design professional (RDP) is performed by verifying the RDP and/or their business entity complies with all professional engineering laws of the relevant jurisdiction. Therefore, the work of licensed RDPs is accepted by building officials, except when plan (i.e., peer) review finds an error with respect to a specific section of the code. Where this TER is not approved, the building official responds in writing stating the reasons for disapproval.

For more information on any of these topics or our mission, product evaluation policies, product approval process, and engineering law, visit drjcertification.org or call us at 608-310-6748.

2 See IBC Section 104.11 and IRC Section R104.11.

3 Unless otherwise noted, all references in this TER are from the 2018 version of the codes and the standards referenced therein (e.g., ASCE 7, NDS, ASTM). This material, design, or method of construction also complies with the 2000-2015 versions of the referenced codes and the standards referenced therein.

4 All terms defined in the applicable building codes are italicized.
2.2.3 ASTM A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
2.2.4 ASTM A510: Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
2.2.5 ASTM D1761: Standard Test Methods for Mechanical Fasteners in Wood
2.2.6 ASTM F1575: Standard Test Method for Determining Bending Yield Moment of Nails

3 PERFORMANCE EVALUATION

3.1 Starborn® Structural H23 and F23 screws were tested and evaluated to determine their ability to provide code complying attachment of ledger boards to the building structure in the following applications:

3.1.1 Use for the attachment of deck ledgers to the building structure in accordance with ASTM D1761. This application includes attachments to Spruce Pine Fir (SPF) band joists and Structural Composite Lumber (SCL) band joists.

3.1.2 Attachment of ledger boards to wood framed wall studs in accordance with ASTM D1761. This application includes zero, one or two layers of ⅝" gypsum wallboard (GWB) between the ledger and the wall studs (See Figure 3 through Figure 11).

3.2 For conventionally framed buildings, the ledger is required to be attached to the band joist in accordance with IBC Section 1604.8.3 or IRC Section R507.9 or as applicable.

3.3 Ultimate connection capacities and deflections of typical ledger board connections were match tested and evaluated pursuant to the provisions of the IRC and IBC. See Appendix B: Testing Procedure and Methodology for a description of testing methods.

3.4 Use of fasteners in locations exposed to saltwater or saltwater spray is outside the scope of this evaluation report.

3.5 Any code compliance issues not specifically addressed in this section are outside the scope of this TER.

3.6 Any engineering evaluation conducted for this TER was performed on the dates provided in this TER and within DrJ’s professional scope of work.

4 PRODUCT DESCRIPTION AND MATERIALS

4.1 General

4.1.1 Starborn® Structural H23 and F23 screws are alternate dowel-type threaded fasteners designed for use in wood to-wood connections in ledger applications. The fasteners listed in Table 1 are evaluated in this TER.

<table>
<thead>
<tr>
<th>TABLE 1. STARBORN® STRUCTURAL FASTENER DESIGNATION AND PRODUCT NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Name</strong></td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Structural H23</td>
</tr>
<tr>
<td>Structural F23</td>
</tr>
</tbody>
</table>

SI: 1 in = 25.4 mm
1. Unthreaded shank diameter is measured on uncoated parts. Finished part dimensions are larger due to the thickness of the proprietary coating.

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5 The term “band joist” is used throughout this report. Other regionally used terms that are synonymous with band joist include: rim board, band board, header board and header joist.

6 2015 IRC Section 507.2
4.2 Fastener Material
4.2.1 Starborn® Structural H23 and F23 screws are manufactured with heat-treated carbon steel grade 10B21 wire using a standard cold-forming process. All fasteners are produced in accordance with the approved quality control procedures referred to in Section 9.

4.3 Fastener Coatings
4.3.1 Starborn® Structural H23 and F23 screws are designed for exterior use and may be used where fasteners are required to exhibit corrosion resistance when exposed to adverse environmental conditions and/or in preservative treated wood subject to the limitations of Section 9. These fasteners are alternates to hot-dip-zinc galvanized fasteners. They feature a proprietary coating system that meets or exceeds the corrosion protection of hot dipped galvanizing per ASTM A153 in accordance with IBC Section 2304.10 and IRC Section R317.3.

4.3.1.1 Starborn® Structural H23 and F23 screws were evaluated for use in wood chemically treated with waterborne alkaline copper quaternary, type D (ACQ-D).

4.3.1.2 Starborn® Structural H23 and F23 screws are approved for use in fire-retardant-treated lumber, provided the conditions set forth by the fire-retardant-treated lumber manufacturer are met, including appropriate strength reductions

4.4 Wood Members
4.4.1 Solid sawn wood members connected with Starborn® Structural H23 and F23 screws shall consist of lumber species or species combinations having a specific gravity of 0.42 to 0.55.

4.4.2 Structural composite lumber (LVL, LSL, PSL, etc.) connected with Starborn® Structural H23 and F23 screws shall be recognized in evaluation reports having published equivalent specific gravities for lateral and withdrawal resistance. Equivalent specific gravities for structural composite lumber may be used in the design of connections using the specific gravities of the sawn lumber shown in Table 3.

4.5 Fastener Specifications
4.5.1 The fasteners evaluated in this TER are specified in Table 2 and Figure 1 and Figure 2.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Head Marking</th>
<th>Fastener Length (in)</th>
<th>Thread Length (in)</th>
<th>Unthreaded Shank Diameter¹ (in)</th>
<th>Thread Diameter (in)</th>
<th>Nominal Bending Yield (f_{b, n}) (psi)</th>
<th>Allowable Fastener Strength (lbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D23 4</td>
<td>4</td>
<td>2-⅜</td>
<td></td>
<td>0.229</td>
<td>0.209</td>
<td>183,155</td>
</tr>
<tr>
<td></td>
<td>D23 5</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural H23</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D23 4</td>
<td>4</td>
<td>2-⅜</td>
<td></td>
<td>0.209</td>
<td>0.307</td>
<td>183,155</td>
</tr>
<tr>
<td></td>
<td>D23 5</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural F23</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

SI: 1 in = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa
1. Unthreaded shank diameter is measured on uncoated parts. Finished part dimensions are larger due to the thickness of the proprietary coating.
2. Minor thread diameter is calculated as the average value of upper and lower manufacturing tolerances.

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7 2012 IBC Section 2304.9

SUBJECT TO RENEWAL 1/1/2022
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5 APPLICATIONS

5.1 General

5.1.1 Starborn® Structural H23 and F23 screws are self-tapping fasteners used for attaching the deck ledger to the band joist of a building in accordance with IBC Section 1604.8.3 and IRC Section R507.9. See Section 6 for installation requirements.

5.1.2 The IRC provides prescriptive fastener spacing for the attachment of a deck ledger to a rim joist with \( \frac{1}{2} \)"-diameter lag screws or through bolts as shown in IRC Table R507.9.1.3(1).\(^8\)

5.1.3 Starborn® Structural H23 and F23 screws can be used for attaching ledger boards to wall studs with zero, one, or two layers of GWB between the ledger and the wall studs.

5.1.4 Starborn® Structural H23 and F23 screws are installed without lead holes, as prescribed in NDS.

5.1.5 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.

5.1.6 Design:

5.1.6.1 Design of Starborn® Structural H23 and F23 screws are governed by the applicable code and the provisions for dowel-type fasteners in NDS.

5.1.6.2 Unless otherwise noted, adjustment of the design stresses for duration of load shall be in accordance with the applicable code.

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\(^8\) 2015 IRC Section R507.2

\(^9\) 2015 IRC Section R507.2.1
5.2 Design Values for Deck Ledger

5.2.1 Starborn® Structural H23 and F23 screws are designed specifically for attaching the deck ledger to the band joist of a building in accordance with IBC Section 1604.8.3 and IRC Section R507.910.

5.2.1.1 Where a band joist is not used, as in some truss installations, an engineered design is required. See Appendix A: Code Requirements for Ledger Attachments for additional code requirements for ledger attachments.

5.2.2 The IRC provides prescriptive fastener spacing for the attachment of a deck ledger to a rim joist with ½” diameter lag screws or through bolts as shown in IRC Table R507.9.1.3(1)11.

5.2.3 Table 3 provides the Starborn® Structural H23 and F23 screw spacing required to provide performance at least equivalent to the lag screws found in IRC Table R507.9.1.3(1)12 in accordance with IBC Section 104.11 and Section 1604.8.3, IRC Section R104.11 and Section R507.913, and in accordance with generally accepted engineering practice.

5.2.3.1 Table 3 provides Starborn® Structural H23 and F23 screws spacing for items found in IRC Table R507.914, as well as a wider range of materials commonly used for rim joists.

5.2.3.1.1 In addition, an alternate loading condition (i.e., deck live load = 60 psf, deck dead load = 10 psf) required by some jurisdictions is shown.

5.2.4 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.

10 2015 IRC Section R507.2
11 2015 IRC Section R507.2.1
12 2015 IRC Section R507.2.1
13 2015 IRC Section R507.2
14 2015 IRC Section R507.2
### Table 3. Starborn® Structural H23 and F23 Screw Spacing for Items in *IRC* Table 507.9.1.3(1)\(^{10}\) & Other Materials & Loading Conditions

<table>
<thead>
<tr>
<th>Loading Condition (Live Load + Dead Load)(^1)</th>
<th>Fastener Length(^4) (in)</th>
<th>Rim Joist Material(^5,9)</th>
<th>2x Nominal Ledger Species(^2,8)</th>
<th>Maximum Deck Joist Spans(^3,6,7) (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Up to 6'</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Maximum On-Center Spacing of Ledger Board Fasteners (in)</td>
</tr>
<tr>
<td></td>
<td>40+10</td>
<td>Sawn Lumber</td>
<td>DF/SP</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCL</td>
<td>DF/SP</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Sawn Lumber</td>
<td>DF/SP</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>24</td>
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<tr>
<td></td>
<td></td>
<td>SCL</td>
<td>DF/SP</td>
<td>30</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>60+10</td>
<td>Sawn Lumber</td>
<td>DF/SP</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCL</td>
<td>DF/SP</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sawn Lumber</td>
<td>DF/SP</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCL</td>
<td>DF/SP</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HF/SPF</td>
<td>18</td>
</tr>
</tbody>
</table>

\(\text{SI:} 1\ \text{in} = 25.4 \text{mm}\)

SCL = Structural Composite Lumber, DF = Douglas Fir, SP = Southern Pine, HF = Hem-Fir, SPF = Spruce Pine Fir

1. 10 pounds (psf) added for typical dead load requirements. Additional dead loads not accounted for.
2. Ledger materials assumed to be in wet service condition.
3. Load duration of 1.0. Spacing may be adjusted by the applicable load duration as specified in NDS 2018.
4. Fasteners are required to have full penetration into the band joist.
5. Solid sawn rim joists shall be HF/SPF or DF/SP species (Specific gravity of 0.42 and 0.50 respectively)
6. Fastener spacing based on tested loads. The design values are the lesser of a 1/16” deflection or a factor of safety equivalent to or greater than that of the code compliant lag screw application as defined in Figure 12.
7. A maximum ½” structural sheathing may be installed between the ledger and the band joist.
8. Minimum ledger board requirements: 1.5” thick and 7.25” depth.
9. Minimum rim board requirements: SPF (Specific gravity of 0.42) Solid-sawn rim 1.5” thick and 7.25” depth; SCL rim 1.0” thick and 7.25” depth
10. 2015 IRC Table 507.2

5.2.5 When installed in accordance with the spacing requirements of Table 3, Starborn® Structural H23 and F23 screws provide equivalent performance to *IRC Section R507.9*\(^{15}\).
5.3 Reference Lateral Design Values for Ledger to Stud Attachment with or without Gypsum Interlayer

5.3.1 The reference lateral design values in for the ledger connection to wall studs are specified in Table 4 and Figure 3 through Figure 11.

**Table 4. Starborn® Structural H23 and F23 Screws Allowable Load per Stud Connection With or Without Gypsum (LBS)**

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Head Marking</th>
<th>Fastener Length (in)</th>
<th>Min. Penetration Into Main Member (in)</th>
<th>Layers of GWB</th>
<th>No. of Fasteners Per Stud</th>
<th>Ledger Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural H23 and Structural F23</td>
<td>D23 4</td>
<td>4</td>
<td>2-½</td>
<td>0</td>
<td>2</td>
<td>640 640 710</td>
</tr>
<tr>
<td></td>
<td>D23 5</td>
<td>5</td>
<td>2-¼</td>
<td>2</td>
<td>3</td>
<td>740 740 1,045</td>
</tr>
</tbody>
</table>

SI: 1 in = 25.4 mm, 1 lb = 4.45 N
GWB = Gypsum Wall Board
1. Additional fasteners prohibited.
2. SPF ledger with minimum specific gravity of 0.42.
3. The tabulated values apply where the ledger is installed either directly over the studs or with up to two layers of 5/8" gypsum between the ledger and studs.
4. Allowable loads shall be limited to parallel-to-grain loaded solid sawn main members (minimum 2" nominal studs). Wood side members (ledger) shall be loaded perpendicular to grain.
5. Allowable loads are shown at the wood load duration factor ($C_D$) = 1.00. Loads may be increased for load duration as permitted by the building code up to a $C_D$ = 1.60. All adjustment factors shall be applied per NDS. For in-service moisture content greater than 19%, use Wet Service Factor ($C_M$) = 0.70.
6. Fasteners shall be centered in the stud and spaced as shown in Figure 3 through Figure 11. The stud minimum end distance is 6-¾" when loaded toward the end and 4" when loaded away from the end. The ledger end distance is 6" for full values. For ledger end distances between 2" and 6" use 50% of the table loads. For end distances between 2" and 4", predrill using a 5/32" bit to prevent splitting.
7. For Load Resistance Factor Design (LRFD) values, the reference connection design values shall be adjusted in accordance with the NDS, Section 11.3.
8. Gypsum board must be attached as required per the applicable building code.
Figure 3. 2x6 Ledger with No GWB

Figure 4. 2x8 Ledger with No GWB

Figure 5. 2x10 Ledger with No GWB
Figure 6. 2x6 Ledger with One Layer GWB

Figure 7. 2x8 Ledger with One Layer GWB

Figure 8. 2x10 Ledger with One Layer GWB
Figure 9. 2x6 Ledger with Two Layers GWB

Figure 10. 2x8 Ledger with Two Layers GWB

Figure 11. 2x10 Ledger with Two Layers GWB
6 INSTALLATION

6.1 Installation shall comply with the manufacturer’s installation instructions and this TER. In the event of a conflict between the manufacturer’s installation instructions and this TER, the more restrictive shall govern.

6.2 Installation Procedure

6.2.1 Starborn® Structural H23 and F23 screws shall be installed in accordance with the manufacturer’s installation instructions, applicable code, the approved construction documents, this TER, NDS, and standard framing practice as applied to wood fasteners.

6.2.2 In the event of a conflict between the manufacturer’s installation instructions and this TER, the more restrictive shall govern.

6.2.3 Choose a 4” or 5” Starborn® Structural H23 or F23 screw so that the threads fully engage the rim material and the fastener tip extends beyond the back face of the rim material when fully seated against the installed ledger. Minimum penetration of 1” unless otherwise stated in this TER.

6.2.4 Using a high-torque low speed drill, drive the fasteners through the ledger and sheathing. Continue into the rim joist until the built-in washer head is drawn firm and flush to the ledger board. Do not overdrive.

6.2.5 The screws must be installed using a ¼“ hex or Torx® T-40 star driver bit. Pre-drilling of pilot holes is not required but may be used where lumber is prone to splitting.

6.2.6 All fastener spacing, edge distance, and end distance shall be as shown in Figure 12.

![Figure 12](image)

**Figure 12. Starborn® Structural H23 and F23 Screw Deck Connection**

6.2.6.1 Stagger the fasteners from the top to the bottom along the length of the ledger while maintaining the required edge and end distances, as shown in Figure 3 through Figure 11.

6.2.7 For applications outside the scope of this TER, an engineered design is required.
7 TEST ENGINEERING SUBSTANTIATING DATA

7.1 Deck ledger assembly testing conducted by an ISO/IEC 17025 accredited testing laboratory under contract with Qualtim, Inc. for Starborn® Industries, Inc.

7.2 ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction

7.3 Material properties and design values in accordance with DrJ TER 1703-05.

7.4 DCA 6, Prescriptive Residential Wood Deck Construction Guide; AF&PA; 2010.

7.5 Some information contained herein is the result of testing and/or data analysis by other sources which conform to IBC Section 1703 and relevant professional engineering law. DrJ relies on accurate data from these sources to perform engineering analysis. DrJ has reviewed and found the data provided by other professional sources to be credible.

7.6 Where appropriate, DrJ’s analysis is based on design values that have been codified into law through codes and standards (e.g., IBC, IRC, NDS, and SDPWS). This includes review of code provisions and any related test data that aids in comparative analysis or provides support for equivalency to an intended end-use application. Where the accuracy of design values provided herein is reliant upon the published properties of commodity materials (e.g., lumber, steel, and concrete), DrJ relies upon the grade mark, stamp, and/or design values provided by raw material suppliers to be accurate and conforming to the mechanical properties defined in the relevant material standard.

8 FINDINGS

8.1 When used and installed in accordance with this TER and the manufacturer's installation instructions, the product(s) listed in Section 1 are a suitable alternative to the requirements of the IBC Section 1604.8.3 and IRC Section R507.9.

8.2 When used in accordance with this TER and the manufacturer’s installation instructions, Starborn® Structural H23 and F23 screws are a suitable for the connection of ledger boards to wall studs with zero, one or two layers of gypsum between the ledger and wall studs in accordance with Section 5.3.

8.3 IBC Section 104.11 (IRC Section R104.11 and IFC Section 104.9 are similar) states:

104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material 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, not less than the equivalent of that prescribed in this code...Where the alternative material, design or method of construction is not approved, the building official shall respond in writing, stating the reasons the alternative was not approved.

8.4 This product has been evaluated in the context of the codes listed in Section 2 and is compliant with all known state and local building codes. Where there are known variations in state or local codes applicable to this TER, they are listed here.

8.4.1 No known variations
9 CONDITIONS OF USE

9.1 Starborn® Structural H23 and F23 screws covered by this TER shall be installed in accordance with this report and the manufacturer’s installation instructions.

9.2 Starborn® Structural H23 and F23 screw spacing shall not exceed those listed in Table 4 for code compliance and the installation conditions considered.

9.3 For conditions not covered in this TER, connections shall be designed in accordance with generally accepted engineering practice. When the capacity of a connection is controlled by fastener metal strength rather than wood strength, the metal strength must not be multiplied by the adjustment factors specified in the NDS.

9.4 Use of fasteners in locations exposed to saltwater or saltwater spray is outside the scope of this evaluation report.

9.5 Manufacturer’s installation instructions shall be followed as provided in Section 6.

9.6 Starborn® Structural H23 and F23 screws are produced by Starborn® Industries, Inc. at its facilities located in Edison, NJ.

9.7 Starborn® Structural H23 and F23 screws are produced under a quality control program subject to periodic inspections in accordance with IBC Section 1703.5.2.

9.8 Where required by the building official, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed, this TER and the installation instructions shall be submitted at the time of permit application.

9.9 Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the AHJ for review and approval.

9.10 Design loads shall be determined in accordance with the building code adopted by the jurisdiction in which the project is to be constructed and/or by the Building Designer (e.g., owner or registered design professional).

9.11 At a minimum, this product shall be installed per Section 6 of this TER.

9.12 This product is manufactured under a third-party quality control program in accordance with IBC Section 104.4 and 110.4 and IRC Section R104.4 and R109.2.

9.13 The actual design, suitability, and use of this TER, for any particular building, is the responsibility of the owner or the owner's authorized agent. Therefore, the TER shall be reviewed for code compliance by the building official for acceptance.

9.14 The use of this TER is dependent on the manufacturer’s in-plant QC, the ISO/IEC 17020 third-party quality assurance program and procedures, proper installation per the manufacturer’s instructions, the building official’s inspection, and any other code requirements that may apply to demonstrate and verify compliance with the applicable building code.

10 IDENTIFICATION

10.1 The product(s) listed in Section 1 are identified by a label on the board or packaging material bearing the manufacturer’s name, product name, TER number, and other information to confirm code compliance. Individual fasteners are marked with a head stamp indicating fastener diameter and length as described in Table 2.

10.2 Additional technical information can be found at starbornindustries.com.

11 REVIEW SCHEDULE

11.1 This TER is subject to periodic review and revision. For the most recent version of this TER, visit drjcertification.org.

11.2 For information on the current status of this TER, contact DrJ Certification.
APPENDIX A: CODE REQUIREMENTS FOR LEDGER ATTACHMENTS

For guidance on designing the connection of the deck ledger to trusses where a band joist is not used, see SBCA’s Tech Note, *Attachment of Residential Deck Ledger to Metal Pate Connected Wood Truss Floor System*.

1.1 *IRC Section R507.8* contains the following code requirements (*IBC Section 1604.8.3* is similar):

1.1.1 Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads.

1.1.1.1 Attachment shall not be accomplished by the use of toenails or nails subject to withdrawal.

1.2 *IRC Section R507.9.1* details how vertical loads shall be transferred to band joists with ledgers: *IRC Section R507.9.1.1*

Deck ledgers shall be a minimum 2-inch by 8-inch (51 mm by 203 mm) nominal, pressure-preservative-treated Southern pine, incised pressure-preservative-treated hem-fir, or approved, naturally durable, No. 2 grade or better lumber...

1.2.2 *IRC Section R507.9.1.2*18

Band joists supporting a ledger shall be a minimum 2-inch nominal (51 mm), spruce-pine-fir or better lumber or a minimum 1-inch by 9½-inch (25 mm x 241 mm) dimensional, Douglas fir or better, laminated veneer lumber. Band joists shall bear fully on the primary structure capable of supporting all required loads.

1.2.3 *IRC Section R507.9.1.3*

Fasteners used in deck ledger connections in accordance with Table R507.9.1.3(1) shall be hot-dipped galvanized or stainless steel and shall be installed in accordance with Table R507.9.1.3(2) and Figures R507.9.1.3(1) and R507.9.1.3(2).

![Diagram of deck ledger connection](image)

For SI: 1 inch = 25.4 mm.

IRC FIGURE R507.9.1.3(2):
PLACEMENT OF LAG SCREWS AND BOLTS IN BAND JOISTS

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17 2015 IRC Section R507.1
18 2015 IRC Section R507.2
1.2.4 Tables R507.9.1.3(1) and R507.9.1.3(2) cover the placement of lag screws or bolts in deck ledgers:

The tip of the lag screw shall fully extend beyond the inside face of the band joist.

Lag screws or bolts shall be staggered from the top to the bottom along the horizontal run of the deck ledger in accordance with Figure R507.9.1.3(1).

The minimum distance from bottom row of lag screws or bolts to the top edge of the ledger shall be in accordance with Figure R507.9.1.3(1).

### Table R507.9.1.3(1):
**Deck Ledger Connection to Band Joist**

<table>
<thead>
<tr>
<th>CONNECTION DETAILS</th>
<th>JOIST SPAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6' and less</td>
</tr>
<tr>
<td>1/2-inch diameter lag screw with 1/2-inch maximum sheathing a, b</td>
<td>30</td>
</tr>
<tr>
<td>1/2-inch diameter bolt with 1/2-inch maximum sheathing c</td>
<td>36</td>
</tr>
<tr>
<td>1/2-inch diameter bolt with 1-inch maximum sheathing d</td>
<td>36</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. Ledgers shall be flashed in accordance with Section R703.4 to prevent water from contacting the house band joist.
- b. Snow load shall not be assumed to act concurrently with live load.
- c. The tip of the lag screw shall fully extend beyond the inside face of the band joist.
- d. Sheathing shall be wood structural panel or solid sawn lumber.
- e. Sheathing shall be permitted to be wood structural panel, gypsum board, fiberboard, lumber or foam sheathing. Up to 1/2-inch thickness of stacked washers shall be permitted to substitute for up to 1/2 inch of allowable sheathing thickness where combined with wood structural panel or lumber sheathing.

**TABLE R507.9.1.3(1): Deck Ledger Connection to Band Joist**

**MINIMUM END AND EDGE DISTANCES AND SPACING BETWEEN ROWS**

<table>
<thead>
<tr>
<th>TOP EDGE</th>
<th>BOTTOM EDGE</th>
<th>ENDS</th>
<th>ROW SPACING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ledger a</td>
<td>2 inches b</td>
<td>3/4 inch</td>
<td>2 inches b</td>
</tr>
<tr>
<td>Band Joist</td>
<td>3/4 inch</td>
<td>2 inches b</td>
<td>2 inches b</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm.

- a. Lag screws or bolts shall be staggered from the top to the bottom along the horizontal run of the deck ledger in accordance with Figure R507.9.1.3(1).
- b. Maximum 5 inches.
- c. For engineered rim joists, the manufacturer’s recommendations shall govern.
- d. The minimum distance from bottom row of lag screws or bolts to the top edge of the ledger shall be in accordance with Figure R507.9.1.3(1).

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192015 IRC Section R507.2
TABLE R507.9.1.3(2):
PLACEMENT OF LAG SCREWS AND BOLTS IN DECK LEDGERS AND BAND JOISTS

<table>
<thead>
<tr>
<th></th>
<th>LAG SCREW OR BOLT</th>
<th>LEDGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; MIN.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5&quot; MAX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

STAGGER FASTENERS IN 2 ROWS

5.5" MIN. FOR 2 X 8"
6.5" MIN. FOR 2 X 10
7.5" MIN. FOR 2 X 12

3/4" MIN.

"DISTANCE SHALL BE PERMITTED TO BE REDUCED TO 4.5" IF LAG SCREWS ARE USED OR BOLT SPACING IS REDUCED TO THAT OF LAG SCREWS TO ATTACH 2 X 8 LEDGERS TO 2 X 8 BAND JOISTS.

For SI: 1 inch = 25.4 mm.

FIGURE R507.9.1.3(1):
PLACEMENT OF LAG SCREWS AND BOLTS IN LEDGERS
APPENDIX B: TESTING PROCEDURE AND METHODOLOGY

1.1 To determine the strength and load-deflection performance of the fasteners in a ledger connection, a two-joist assembly with connection of a ledger to a rim board was created. Load was applied to the joists, which transferred load to the ledger via hangers. String potentiometers were placed along the bottom of the ledger to measure vertical deflection during the test, while a load cell attached to an actuator measured load applied. The rim board was fixed to prevent deflection and rotation during the test. To limit the variability, the comparison product was tested simultaneously with the Starborn® Structural H23 and F23 screws with ledgers and rim boards cut congruently from the same piece of lumber. Immediately after testing, a section was cut near each fastener location to determine the moisture content and oven-dry specific gravity of each piece of lumber.

1.2 The performance of the code defined lag screw connection was then compared to the performance of the Starborn® Structural H23 and F23 screws in the ledger application built per the code requirements.

1.2.1 Testing was undertaken to directly compare fastener performance using matched lumber specimen testing where the Starborn® Structural H23 and F23 screw was tested side by side with ½” diameter lag screws (see Figure B1 and Figure B2).

FIGURE B1: SINGLE & THREE-FASTENER SETUPS

FIGURE B2: MATCHED LUMBER SPECIMEN TESTING OF STARBORN® STRUCTURAL H23 AND F23 SCREWS AND ½” LAG SCREW

1.2.1.1 The testing and resulting analysis define comparative performance and the design parameters required for the Starborn® Structural H23 and F23 screws to be considered an equivalent alternative to the specified fasteners required by the building code in accordance with the provisions of IBC Section 104.11 and IRC Section R104.11.