

SFIA AISI S230-26-C



SFIA STANDARD

Commentary on the Standard for Cold-Formed Steel Framing— Prescriptive Method for One- and Two-Family Dwellings

2026 Edition

COMMENTARY ON THE STANDARD FOR COLD-FORMED STEEL FRAMING — PRESCRIPTIVE METHOD FOR ONE- AND TWO-FAMILY DWELLINGS

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DISCLAIMER

The material contained herein has been developed by the Steel Framing Industry Association (SFIA) Standards Committee. The Committee has made a diligent effort to present accurate, reliable, and useful information on cold-formed steel framing design and installation. The Committee acknowledges and is grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. Specific references are included in this *Commentary*.

With anticipated improvements in understanding of the behavior of cold-formed steel framing and the continuing development of new technology, this material will become dated. It is anticipated that SFIA will publish updates of this material as new information becomes available, but this cannot be guaranteed.

The materials set forth herein are for general purposes only. They are not a substitute for competent professional advice. Application of this information to a specific project should be reviewed by a *registered design professional*. Indeed, in many jurisdictions, such review is required by law. Anyone making use of the information set forth herein does so at their own risk and assumes any and all liability arising therefrom.

The user is advised to check the availability of specific framing material in the region in which the dwelling is being constructed.

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PREFACE

The Steel Framing Industry Association (SFIA) Standards Committee has developed this *Commentary on the Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings (Commentary)* to provide the background, supplemental information, engineering assumptions and methods, and detailed calculations for the provisions of SFIA AISI S230-26.

The loads, load combinations, and other design parameters used to develop the provisions in SFIA AISI S230 are based on the *International Residential Code* (ICC, 2018b), the *International Building Code* (ICC, 2018a) (where no provisions are included in the *International Residential Code*) and ASCE 7-16, *Minimum Design Loads for Buildings and Other Structures* (~~ASCE, 2016~~).

The *Commentary* is provided only for those sections of SFIA AISI S230 where background or supplemental information is of benefit to the user. Sections thought to need no explanation are left blank.

This document contains the background, supplemental information and engineering assumptions. In previous editions of the *Commentary*, Section 2, Design Examples, contained detailed calculations that demonstrated how the values in SFIA AISI S230 were derived. These examples no longer apply with the update of the Standard to ASCE 7-16 using ultimate values for wind.

Terms within the body of this *Commentary* that are shown in *italics* indicate that the italicized word is a defined term by SFIA AISI S230 or AISI S240 (~~AISI, 2015b~~).

In 2024, the suite of ANSI-approved standards for cold-formed steel framing that were previously developed and published by the American Iron and Steel Institute (AISI) were transferred to the Steel Framing Industry Association (SFIA). To recognize the new responsibilities of SFIA and the previous contributions of AISI the ANSI designation of this 2026 reaffirmation of the Standard incorporates both SFIA and AISI.

SFIA acknowledges and is grateful for the contributions of the numerous engineers, researchers, producers and others who have contributed to the body of knowledge on the subjects.

COMMENTARY

ON THE STANDARD FOR COLD-FORMED STEEL FRAMING— PRESCRIPTIVE METHOD FOR ONE- AND TWO-FAMILY DWELLINGS

A. GENERAL

A1 Scope

SFIA AISI S230 consists of prescriptive requirements for *cold-formed steel* floor, wall, and roof framing to be used in the construction of one- and two-family dwellings, townhouses, and other attached and detached single-family dwellings not more than three stories in height using *repetitive in-line framing* practices.

A1.1 Limits of Applicability

SFIA AISI S230 is not applicable to all possible conditions of use and is subject to the applicability limits set forth in Sections A1.1 and A1.2. The applicability limits are necessary to define reasonable boundaries to the conditions that must be considered in developing prescriptive construction requirements. The applicability limits should be carefully understood as they define important constraints on the use of **SFIA** AISI S230.

The applicability limits strike a reasonable balance between engineering theory, available test data, and proven field practices for typical residential construction applications. The applicability limits are intended to prevent misapplication while addressing a reasonably large percentage of new housing conditions. Special consideration is directed toward the following items related to the applicability limits.

Building Geometry: The provisions in **SFIA** AISI S230 apply to detached one- and two-family dwellings, townhouses, and other attached single-family dwellings not more than three stories in height. Its application to homes with complex architectural configurations is subject to careful interpretation by the user and therefore, engineering design support may be required. The most common building widths (or depths) range from 24 feet to 40 feet (7.3 to 12.2 m), with axially load bearing wall heights up to 10 feet (3.1 m). The building width as used in **SFIA** AISI S230 is the dimension measured along the length of the *joists* (floor or ceiling) between the outmost structural walls. In 2006, the maximum *mean roof height* was explicitly defined as 33 feet (9.14 m) above *average grade*, since this is what was actually used in the development of the Standard.

Prior to the 2019 edition, the maximum length of building was limited to 60 feet (18.3 m) where the length is measured in the direction parallel to the roof ridge or perpendicular to the *floor joists* or *roof trusses*. In 2019, this 60-foot (18.3 m) building size limitation in Table A1-1 was removed and replaced with *braced wall line* spacing limitations and provisions within Section E8. The original 60-foot (18.3 m) limitation was related to the wall bracing provisions for low wind and low seismic locations first developed as a part of the HUD prescriptive method for cold-formed steel framing.

Site Conditions: Conditions for each site must be established by the user. Local conditions include ground snow loads, *basic wind speeds*, and the *Seismic Design Category*.

Snow Loads: Snow load values are typically given in a ground snow load map such as provided in the building code, ASCE 7 (**ASCE, 2016**) or by local practice. The national model building codes in the U.S. either adopt the ASCE 7 snow map and load requirements or have a similar map published in the code. The 0 to 70 psf (0 to 3.35 kN/m²) ground snow load used in **SFIA** AISI S230 covers approximately 90 percent of the United States, which was deemed to include the majority of the buildings that are expected to utilize this document. Buildings in areas with greater snow loads than 70 psf (3.35 kN/m²) should not use this document without consulting a *registered design professional*.

Basic Wind Speed: In 2006, in recognition that all areas of the U.S. fall within the 90 to 150 mph (3-second gust) (145 to 241 km/hr) range of design wind speeds per ASCE 7 (ASCE, 2005), the maximum *basic wind speed* in the Standard was increased from 130 mph (209 km/hr) to 150 mph (241 km/hr). Also per ASCE 7, the three-second-gust wind speeds were used in the development of SFIA AISI S230. ASCE 7 enables the determination of wind load by either the directional or envelope method. The directional method is used for the development of SFIA AISI S230. In 2019, wind loads were updated to comply with ASCE 7. Wind speed maps were also revised in ASCE 7 (ASCE, 2016) and are directly applicable to determining pressures for strength design. Wind speed and exposure are defined in SFIA AISI S230. *Wind exposure category* is a critical determinant of the wind loads to be expected at a given site, and it should be determined by good judgment on a case-by-case basis. The *wind exposure category* in SFIA AISI S230 tables is limited to *Wind Exposures B* and *C*.

In 2015, provisions were added to allow dwellings sited in *Wind Exposure D* to be designed in accordance with the requirements for *Wind Exposure C*, provided that the *basic wind speed* for the *Wind Exposure D* site is adjusted to an equivalent *basic wind speed* for a *Wind Exposure C* site in accordance with Table A1-3. This means, for example, that the provisions of SFIA AISI S230 for 150 mph *Wind Exposure C* may be used in cases where *Wind Exposure D* is specified by the applicable building code and the *basic wind speed* is not greater than 138 mph.

Seismic Design Category: SFIA AISI S230 covers all residential constructions in *Seismic Design Categories A, B, C, D₀, D₁, D₂ and E* (within the limits of applicability of Tables A1-1 and A1-2).

Loads: Consistent values were established for design loads in accordance with a review of the major building codes and standards. The results of this load review are embodied in the applicability limits table in SFIA AISI S230. Loads and load combinations requiring calculations to analyze the structural components and assemblies of a home are presented in the design examples shown throughout this document. The Load and Resistance Factor Design (LRFD) load combinations as shown in ASCE 7 were used to develop the tables and other provisions in SFIA AISI S230.

SFIA AISI S230, however, does not limit the application of alternative methods or materials through engineering design.

In 2019, the scope of the Standard was expanded to include *accessory structures* to be consistent with the *International Residential Code*.

A1.2 Limitations in High Seismic and High Wind Areas

A1.2.1 Irregular Buildings in High Seismic and High Wind Areas

In *high wind* and *high seismic areas*, additional limitations were considered to be necessary. Plan and vertical offsets are not permitted in this edition of SFIA AISI S230 for simplicity. Where the user wishes to exceed the irregularity limits, a *registered design professional* should be consulted.

A2 Definitions

Many of the terms in SFIA AISI S230 are self-explanatory. Only definitions of terms not self-explanatory or not defined in the referenced documents are provided in SFIA AISI S230 or AISI S240.

A3 Referenced Documents

The design tables contained in previous editions of SFIA AISI S230 were generated at different times and, consequently, were based on different editions of AISI S100, *North American Specification for the Design of Cold-Formed Steel Structural Members*. For example, the *floor joist*, *ceiling joist* and screw connection tables were developed using the 1996 edition with the 1999 Supplement; whereas the wall stud, back-to-back *header*, box *header*, L-*header*, *roof rafter* and gable end wall tables were developed

using the 2001 edition with the 2004 Supplement. The 2012 edition of AISI S100 ~~(AISI, 2012)~~ was used in the development of the 2019 edition of AISI S230.

A4 Limitations of Framing Members

A4.1 General

The *structural members* used in SFIA AISI S230 are standard *C-shapes* produced by roll forming hot-dipped metallic coated sheet steel conforming to AISI S201 ~~(AISI, 2017)~~.

In 2007, AISI S230 recognized that steel sheet in compliance with the requirements of ASTM A653 Type SS or ASTM A792 Type SS complied with the material specification requirements of the AISI framing standards. In 2010, as part of an exercise to synchronize all relevant codes and specifications, provisions that were considered duplicative of the requirements already in AISI standards were eliminated. However, it should be noted that it is no longer the intention of the Standard that steel sheet in compliance with the requirements of ASTM A653 Type SS or ASTM A792 Type SS be deemed to comply with the material specification requirements of the AISI framing standards, including AISI S230. ASTM A1003 Type H steels are used in the construction of braced walls in high seismic areas.

A4.2 Sheathing Span Capacity

In 2015, limitations for the spacing of structural floor, wall, roof and ceiling members based on the *span capacity* of the *structural sheathing* were included. Prior editions did not address *structural sheathing span* requirements for out-of-plane loading such as live load or snow load. These limitations are the same as those given in AISI S240-15, Section B1.2.4, Sheathing Span Capacity.

Member section designations, in accordance with AISI S201 ~~(AISI, 2017)~~, are used throughout SFIA AISI S230. The designation system was developed in 1996 in order to standardize the identification of cold-formed steel framing based on specific shapes and material thickness. The designator consists of four parts: the first value represents the *web* depth, the second value represents the type of steel framing member, the third value represents the *flange* width, and the fourth value represents the minimum base steel thickness.

Web Depth: The actual *web* depths chosen for SFIA AISI S230 are 3-1/2 inches, 5-1/2 inches, 8 inches, 10 inches, and 12 inches (89, 140, 203, 254 and 305 mm). The 3-1/2 and 5-1/2 inch (89 and 140 mm) *web* depths were chosen to accommodate current framing dimensions utilized in the residential building industry (i.e., to accommodate window and door jambs). These sizes can be used directly with conventional building materials and practices; however, the substitution of a slightly larger size member, such as using a 3-5/8 inch (92 mm) or 4-inch (102 mm) stud instead of a 3-1/2 inch (89 mm) stud, are acceptable. The depth of the *web* for 8-, 10-, and 12-inch (203, 254, and 305 mm) members, versus traditional lumber sizes, are not of great significance because they are typically used for horizontal framing members (i.e., headers and joists).

Flange Width: SFIA AISI S230 requires that the standard *C-shape* have a minimum of 1-5/8 inch (41 mm) *flange* with a maximum *flange* dimension of 2 inches (51 mm).

Lip Size and Corner Radii: AISI S201 provides a minimum size for the stiffening *lip* and the corner radii. These dimensions are common in the industry. Decreasing the *lip* size may have a detrimental effect on the structural capacity of structural members in many circumstances.

SFIA AISI S230 requires steel *tracks* to have a minimum *flange* dimension of 1-1/4 inches (32 mm). This dimension ensures a sufficient *flange* width to allow fastening of the *track* to the framing members and finish materials. Steel *track webs* are measured from inside to inside of *flanges* and thus have wider overall *web* depths than the associated standard *C-shapes*. This difference in size allows the *C-shape* to be properly nested into the *track* sections. In SFIA AISI S230, *tracks* are always required to have a minimum steel thickness equal to or greater than the *structural members* to which

they are attached.

The steel thickness indicated by [SFIA AISI S230](#) is the minimum uncoated steel thickness (excluding the thickness of the metallic coating) and is given in mils (1/1000 of an inch). This unit is a deviation from the historic practice, which uses a gauge designation for thickness. The “gauge” is an outdated reference that represents a range of thicknesses and is, therefore, a vague unit of measure when specifying minimums. The practice of using “gauge” as a basis for measurement has been discontinued in the industry. In order to achieve consistency, the *mil* designation was adopted. For example, the 33 mils (i.e., 0.033 inches or 0.84 mm), 43 mils (i.e., 0.043 inches or 1.09 mm), 54 mils (i.e., 0.054 inches or 1.37 mm), 68 mils (i.e., 0.068 inches or 1.73 mm), and 97 mils (i.e., 0.097 inches or 2.46 mm) are specified for the thickness.

The minimum thickness is the minimum delivered thickness that cannot be less than the *design thickness* multiplied by 0.95, which is permitted by the *AISI Specification* ~~(AISI, 2012)~~. The *design thickness* of the flat steel stock, exclusive of coatings, is used in the structural calculations.

The corner bend radius is measured on the inside of bends in cold-formed steel members. Strength increases are realized in the regions of bends due to a phenomenon known as cold working, which locally increases the yield strength of the steel.

A4.4 Material Properties

Prior to 2015, AISI S230 applied to steel with minimum *yield strength* of 33 ksi (230 MPa) or 50 ksi (345 MPa). The 33 ksi (230 MPa) steels are the minimum required for all steel floors, roofs, and header components. Multiple-span *floor joist*, wall *stud*, header and roof *rafter* tables were provided for both 33 ksi (230 MPa) and 50 ksi (345 MPa) minimum *yield strength*. The 50 ksi (345 MPa) *yield strength* steel was included because of the structural benefits.

In 2015, AISI S230 was streamlined to include tabulated solutions for just the more popular material *yield strengths* for each *designation thickness*: 33 ksi is used for 33 mil and 43 mil thick material, and 50 ksi is used for material equal to or greater than 54 mil thickness.

The user is advised to check the availability of specific framing material in the region in which the dwelling is being constructed. Not all material specified in [SFIA AISI S230](#) is expected to be available in all locations.

Strength increase from the cold work of forming (as permitted by the *AISI Specification*) is utilized for the design of *C-shaped* members in [SFIA AISI S230](#) used as flexural members, concentrically loaded compression members, and members with combined axial and bending loads. The reader is referred to the *Cold-Formed Steel Design Manual* ~~(AISI, 2013)~~ for engineering calculations illustrating the application of the strength increase due to cold work of forming.

A4.4.1 Material Properties in High Wind and High Seismic Areas

Further limitations on material properties are imposed for the use of [SFIA AISI S230](#) in high wind and high seismic areas. These limitations were imposed to reflect the material properties used in the available *shear wall* test data.

A4.5 Web Holes

All *structural members* (i.e., floor and ceiling joists, wall studs and headers), except cantilevered portions of framing members, used in [SFIA AISI S230](#) are designed assuming maximum web hole dimensions as shown in Figures A4-1 and A4-2 of [SFIA AISI S230](#). The maximum web hole dimensions are consistent with AISI S201 ~~(AISI, 2017)~~. The design procedure follows AISI S100 ~~(AISI, 2012)~~.

A4.6 Hole Reinforcing

This section provides reinforcing options for web holes violating the requirements of

SFIA AISI S230, Section A4.5 and is based on engineering judgment and research at McMaster University (Siva, 2007).

A4.7 Hole Patching

In 2004, the limitations “that the depth of the hole does not exceed 70% of the flat width of the *web* and the length of the hole measured along the *web* does not exceed 10 inches (254 mm) or the depth of the *web*, whichever is greater” were added along with other editorial changes to better differentiate the permitted use of a patch versus required member replacement or engineering analysis.

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B. CONNECTIONS

B1 Fastening Requirements

Self-drilling screws conforming to the requirements of AISI S240 (~~AISI, 2015b~~) are specified as the fastener for cold-formed steel framing members in SFIA AISI S230. Requirements for sharp point screws connecting gypsum board and sheathing to steel *studs* are found in ASTM C1002 (~~ASTM, 2007~~) and ASTM C954 (~~ASTM, 2010~~). The edge distance and center-to-center spacing of these screws follow industry recommendations and AISI S100 (~~AISI, 2012~~). Although SFIA AISI S230 specifies the use of screws, other fastening methods are permitted to be used provided that the connection capacity can be shown to equal or exceed the connection capacity implied in SFIA AISI S230.

For practical purposes and added capacity in certain applications, No. 10 screws are specified in SFIA AISI S230. Because the point style of the screw may affect constructability, screw manufacturer recommendations should be consulted. For example, a sharp point screw may be efficiently used to connect gypsum board and other panel products to steel framing members that are no thicker than 33 mils (0.84 mm).

Screw capacities are calculated based on the design equations given in AISI S100. These equations are used to calculate the shear, pull-over, and pull-out capacities of a connection based on the thickness and tensile strength of the steel and diameter of the screw.

SFIA AISI S230 also provides a screw substitution factor where larger screws can be used in lieu of the No. 8 screws or when one of the sheets of steel being connected is thicker than 33 mils (0.84 mm). This may result in a reduced number of screws.

B2 Bearing Stiffeners

Webs of cold-formed steel members may cripple or buckle locally at locations of a concentrated load or a bearing support. The allowable reactions and concentrated loads for beams having single unreinforced *webs* depend on *web* depth, bend radius, *web* thickness, *yield strength*, and actual bearing length.

The *floor joist spans* in SFIA AISI S230 were derived assuming that *bearing stiffeners* (also called *web stiffeners*) are located at all support or bearing point locations. *Ceiling joist span* tables were developed for two cases: 1) assuming *bearing stiffeners* are located at all support or bearing point locations, and 2) no *bearing stiffeners*. Where specified, *bearing stiffeners* are to be a minimum of 43 mil (1.09 mm) clip angle or track section, or 33 mil (0.84 mm) *C-shaped* member.

Three types of *bearing stiffeners* are permitted in SFIA AISI S230: *C-shaped*, *track*, and *clip angle*. The requirements for the *C-shaped* and *track bearing stiffeners* are based on engineering judgment, the *bearing stiffener* connection to the rim *track* is optional, and either screw pattern in Figure B2-1 is permitted. The *clip angle bearing stiffener* requirements are stipulated in AISI S240 (~~AISI, 2015b~~).

B3 Clip Angles

All *clip angle* dimensions prescribed are shown as minimums. *Clip angles* that are of a greater *base steel thickness* or have greater overall dimensions, or both, are permitted to be used up to a maximum thickness of 68 mils.

B4 Anchor Bolts

In the *high wind areas* and *high seismic areas*, the requirement for a minimum steel plate washer is based on engineering judgment.

D. FLOOR FRAMING

D1 Floor Construction

Floor *trusses* are not prescriptively addressed in [SFIA](#) AISI S230 but are permitted, in accordance with Section D8, and must be designed by a *registered design professional*. Floor girders are also not addressed in [SFIA](#) AISI S230.

D2 Floor to Foundation or Structural Wall Connection

[SFIA](#) AISI S230 provides several details for connecting floor assemblies to foundations or structural walls. The details reflect common industry practice. In areas where wind speeds exceed 140 mph (177 km/hr) (*Wind Exposure C*) or in *Seismic Design Category* D₁, D₂ or E, additional requirements for hold-downs and anchors are specified in Sections E11, E12 and E13.

D3 Minimum Floor Joist Sizes

[SFIA](#) AISI S230 provides *floor joist* tables with maximum allowable spans for two live load conditions: 30 psf and 40 psf (1.44 and 1.92 kN/m²). The two live load conditions are specified in the *International Building Code* (ICC, 2018a) and the *International Residential Code* (ICC, 2018b). The 30 psf (1.44 kN/m²) is typically specified for sleeping areas, while the 40 psf (1.92 kN/m²) is specified for living areas. The spans shown in [SFIA](#) AISI S230 assume *bearing stiffeners* are installed at each bearing point. *Bearing stiffener* requirements are provided in Section B2 of [SFIA](#) AISI S230.

For the design of *floor joists*, the following design considerations were evaluated:

- Flexural yielding
- Flexural buckling
- Web crippling
- Shear
- Vertical deflection
- Combined bending and shear (for multiple spans only)

All *joists* are considered to have *web holes* (a.k.a. “penetrations,” “utility holes,” and “punchouts”) in accordance with Section A4.5. The compression *flange* (top *flange*) of a *floor joist* is assumed to be continuously braced by the subflooring, thus providing lateral bracing for the top *flanges*.

The *joist span* tables are calculated for a deflection limit of L/480 for live load and L/240 for total loads, where L is the clear horizontal distance between supports. The L/480 limit may be more stringent than the minimum deflection limits established by building codes, but was selected to achieve a satisfactory floor design for serviceability.

Two-span *joists* are commonly used in the residential steel building market. Certain measures are necessary to address the responses of the loaded members. The magnitude of the reaction at the middle support will be greater than the end reactions. The mid-span reaction and also the end reactions may cause a *web crippling* failure at those locations, and consequently, the *bearing stiffener* at the bearing point is required. The second issue with two-span *joists* is the presence of negative moments (i.e., reversed bending) near the middle support resulting in the compression *flange* being at the bottom rather than the top of the *joists*. If left unbraced, this could cause lateral instability and result in premature failure of the *joists* under maximum loading conditions. Furthermore, due to the presence of high shear and bending stresses at the middle reactions, shear and bending interaction is checked for two-span *joists*.

Bottom *flange bracing* at interior supports is provided by ceiling finishes (when present) and by positive connection to the interior bearing wall.

In 2015, as part of a streamlining of AISI S230, tables for multiple spans were deleted and users

were permitted to select two-span members using the tables for single spans, with certain exceptions.

D3.1 Floor Cantilevers

Cantilevers supporting structural walls may create special loading conditions that require an engineering analysis. In [SFIA AISI S230](#), floor cantilevers are limited to a maximum of 24 inches (610 mm) for floors supporting one wall and roof only (one story). This limitation is imposed to minimize the impact of the added load on the *floor joists*. To fully utilize the strength of the *joist*, *web* holes are not permitted in cantilevered portions of a *joist*. [SFIA AISI S230](#) provides details for cantilevered floors. It is essential that *blocking* be installed between cantilevered *joists* at the bearing locations to adequately transfer floor *diaphragm* or *shear wall* loads (refer to Section D5.4).

D4 Bearing Stiffeners

The *floor joist* spans in [SFIA AISI S230](#) were calculated assuming that *bearing stiffeners* (also called *web stiffeners*) are located at all support or bearing point locations. The *bearing stiffeners* are specified to be *C-shaped*, *track* or *clip angle bearing stiffeners* installed in accordance with Section B2. In 2006, language was added to clarify the requirements for *bearing stiffeners* when *floor joists* are lapped over interior bearing supports and to explicitly require that *floor joists* supporting *jamb studs* with multiple members have two *bearing stiffeners*.

D5 Joist Bracing and Blocking

D5.1 Joist Top Flange Bracing

For typical residential floors, it has been assumed that the function of the floor sheathing is to transfer the loads to the *joists*, and to provide continuous lateral *bracing* to the compression *flanges*. Testing has indicated that using a single *joist* for strength calculation agrees with actual behavior when uniform loads are applied (WJE, 1977).

D5.2 Joist Bottom Flange Bracing/Blocking

Bracing the bottom *flanges* of *joists* as specified in [SFIA AISI S230](#) is based on industry practice and engineering judgment. Steel strapping and finished ceilings (e.g., application of gypsum board) are considered to be adequate *bracing* for the tension *flanges*. It is necessary, however, for steel strapping to have *blocking* installed at a maximum spacing of 12 feet (3.7 m) and at the termination ends of all *straps*. Alternatively, the ends of steel *straps* may be fastened to a stable component of the building in lieu of *blocking* (i.e., to a bearing wall or foundation).

D5.3 Blocking at Interior Bearing Supports

Single-span *floor joists* that are lapped over interior supports do not require *blocking* as the lapped sections provide adequate stiffness to prevent lateral movements. Continuous *joists* over interior supports, on the other hand, require *blocking* at every other joist to provide adequate stiffness to prevent lateral movement.

D5.4 Blocking at Cantilevers

Blocking is required for cantilevered supports to transfer shear loads from the floor *diaphragm* or *shear wall*.

D6 Splicing

Splicing of *structural members* is not permitted by [SFIA AISI S230](#); however, there may be some situations where splicing would be useful. Applications may include repair of damaged *joists*, and simplified details for dropped floors. In these situations, a *registered design professional* must be consulted.

The *floor joist spans* provided in [SFIA](#) AISI S230 are based on the assumption that the *joists* are full-length, with no splices. Therefore, splicing of *joist* members in [SFIA](#) AISI S230 requires an *approved* design except when lapped *joists* occur at interior bearing points.

D7 Framing of Floor Openings

In 2015, the limitation for opening size was added to ensure adequacy of the floor *diaphragm*. Also, because the floor system provides the lateral support for a load-bearing *stud* wall, the requirement that the opening be no closer than 2 feet (0.61 m) from the exterior wall was added. In such cases when the floor opening is less than 2 feet (0.61 m) from the exterior wall, an engineered design is required.

Openings in floors are needed for several reasons (such as at stairs, chases, and chimneys). [SFIA](#) AISI S230 limits the maximum width of the floor opening to 12 feet (3.6 m) and provides a provision for reinforcing the members around floor openings. All members around floor openings (i.e., *header* and trimmer *joists*) are required to be box-type members made by nesting *C-shaped joists* into a *track* and fastening them together along the top and bottom *flanges*. These built-up members are required to be equal to or greater in size and steel thickness than the *floor joists*, to which they are connected. Each *header joist* is required to be connected to the trimmer *joist* with a *clip angle* on each side of each connection. The *clip angle* is required to be of a thickness equivalent to the *floor joists*. The members around an opening are designed to support joists that have been displaced by the opening. The perimeter members given in [SFIA](#) AISI S230 do not consider additional stair loads.

D8 Floor Trusses

[SFIA](#) AISI S230 does not contain provisions for floor *trusses*, which must have an *approved* design. This section is included so that pre-engineered floor *trusses* may be used in conjunction with this document. AISI S240 (~~AISI, 2015b~~) should be consulted for the *truss* design.

D9 Diaphragms

Floor *diaphragms* are required to adequately transfer shear loads to the foundation. In steel-framed floors, the shear load transfer is typically accomplished by sheathing the top *flanges* of the *joists* with wood *structural sheathing* (such as OSB or plywood). Shear strength values used in verifying the adequacy of the floor *diaphragms* were taken from AISI S240 (~~AISI, 2015b~~) for oriented strand board (OSB) panels fastened to steel members with No. 8 screws at 6 inch (152 mm) on center spacing at panel edges and 12 inch (305 mm) on center spacing at intermediate supports. Additional requirements for steel floors constructed in *high wind* [140 mph (177 km/hr) or greater] or *high seismic areas* (*Seismic Design Category* D₀, D₁, D₂ and E) are specified in Section D9.1.

D9.1 Floor Diaphragms in High Seismic and High Wind Areas

Shear strength values used in verifying the adequacy of the floor *diaphragms* were taken from AISI S240 (~~AISI, 2015b~~) for oriented strand board (OSB) panels fastened to steel members with No. 8 screws at 6 inch (152 mm) on center spacing at panel edges and 6 inch (152 mm) on center spacing at intermediate supports. The reduced fastener spacing from 12 inches (305 mm) to 6 inches (152 mm) is to ensure that the *diaphragm* adequately transfers shear loads to the foundation.

E. WALL FRAMING

E2 Wall to Foundation or Floor Connection

Historically, the wall *track* was required to be connected through the floor sheathing to a steel member; i.e., the *floor joist* or *track* below. In 2004, Table E2-1 was revised to enable connection of the wall *track* to the floor sheathing alone (Figure E2-4). This revision was based on research by the NAHB Research Center (NAHBRC, 2003) in which five shear tests and six withdrawal tests were conducted where 33-mil (0.84 mm) *track* was connected to 23/32-inch-thick (18 mm) OSB sheathing using No. 8 screws. The average ultimate shear capacity was 412 lb (187 kg) and the average ultimate pullout capacity was 350 lb (159 kg). Considering that the minimum allowable fastener capacities for steel-to-steel connections for No. 8 screws and 33 mil (0.84 mm) material of 164 lb (74 kg) for shear and 72 lb (32.6 kg) for pullout were used to calculate the requirements for AISI S230, the Committee deemed that it would not be necessary to require that every fastener connect to a *floor joist* or *track* member. In 2007, AISI S230 was expanded to include gable endwall to floor connection requirements for *studs* with heights greater than 10 feet, based on a study at the University of Missouri-Rolla (Downey et al., 2005).

Prior to 2015, the uplift wind requirements were permitted to be reduced by 30% for high wind connections to foundations or floor assemblies. Because the Directional Method replaced the previously used Envelope Method, this reduction was no longer applicable.

In 2019, post-installed anchors were added as an acceptable method of wall anchorage, if spaced as required to provide equivalent anchorage to the required anchor bolts and installed in accordance with the manufacturer's requirements.

E3 Minimum Stud Sizes

This section dictates the minimum required thickness of steel *studs* for different wind speeds, *wind exposure* categories, wall heights, supported clear spans, live loads, and ground snow loads. *Stud* selection tables are limited to buildings not greater than three stories with *structural wall* heights up to 10 feet (3.05 m). In 2007, AISI S230 was expanded to include gable endwall *studs* with heights greater than 10 feet, based on a study at the University of Missouri-Rolla (Downey et al., 2005).

The 8-foot (2.44 m) wall height is widely used in residential construction; however, the higher strength of cold-formed steel wall *studs* enable light-steel-framed construction to provide for higher ceilings such as 9- and 10-foot (2.74 and 3.05 m) walls.

The wall *studs* are grouped into three categories:

- *Studs* for one-story or second floor of two-story building or third floor of a three-story building (supporting roof only)
- *Studs* for first story of a two-story building or second story of a three-story building (supporting roof + one floor)
- *Studs* for first story of a three-story building (supporting roof + two floors)

For walls sheathed on both faces with wood structural panels [minimum 7/16 inch (11.1 mm) OSB or minimum 15/32 inch (11.9 mm) plywood], a reduction in thickness of the *stud* is allowed. All *studs* in exterior walls are treated as *structural members* in [SFIA AISI S230](#). The following design assumptions were made in developing the wall *stud* selection tables:

- *Studs* are simply supported beam-columns.
- The exterior *flanges* of the *studs* are braced by *structural sheathing* and the interior *flanges* are braced by mechanical *bracing* [mechanical bracing at mid-height for 8-foot studs (2.4 m), 1/3 point for 9-foot (2.74 m) and 10-foot (3.05 m) and 11'-4" (3.45 m) studs].
- Maximum roof overhang is 24 inches (610 mm).

- Roof slopes are limited to a range of 3:12 to 12:12.
- Deflection limit is $L/240$.
- Ceilings, roofs, attics, and floors span the full width of the house (no interior *bearing* walls).
- Permitted attic live load is limited to 10 psf (0.48 kN/m²).
- Second floor of a two-story building and third floor of a three-story building live load are 30 psf (1.44 kN/m²). Second floor of a three-story building floor live load is 40 psf.
- Unbalanced snow loads are determined in accordance with ASCE 7.

Stud Design

The design of the *studs* was based on the following design checks as stipulated by AISI S240 (AISI, 2015b):

- Combined bending and axial strength using Main Wind Force-Resisting System (MWFRS) wind loads and the bracing as defined by Section E4.
- Bending strength based on Components and Cladding (C&C) loads and the bracing as defined by Section E4.
- Web crippling strength based on Components and Cladding (C&C) loads. Because bending alone was considered, Equation B2.2-1 was used for the development of the *stud* tables.
- Deflection limit based upon 70% of Components and Cladding (C&C) loads.

Wind Design Loads

Components and Cladding (C&C) loads at the ends and corners of walls can be significantly higher than in the middle or field of the wall. However, historically (for residential construction), rather than design the entire wall for these increased corner loads, the loads in the middle of the wall were used to design the *studs*. Thus, the tables in SFIA AISI S230 were developed for field of the wall wind loads.

In 2015, Table E3-19 was developed and added to address minimum connection requirements of the wall sheathing for wind suction from C&C wind loads.

E4 Stud Bracing

Studs in structural walls are laterally braced on each *flange* by either a continuous 1-1/2 inch x 33 mil (38.1 x 0.84 mm) (minimum) *strap* at mid-height [or third points for 9-foot (2.74 m) and 10-foot (3.05 m) studs] or by direct attachment of *structural sheathing* or rigid wall finishes (i.e., structural panels such as plywood, OSB or gypsum board), according to the requirements of SFIA AISI S230. Therefore, for the evaluation of both the bending strength and axial strength, all *studs* were considered to be braced at mid-height [or third points for 9-foot (2.74 m) and 10-foot (3.05 m) studs] for the engineering analysis of the *stud* tables. As previously noted, the benefit achieved from *structurally sheathed* walls (both wall faces) on the required *stud* thickness and the composite wall strength are recognized by the allowance in dropping down a *stud* thickness for 43 mil Grade 33 *studs*.

Temporary *bracing* may be necessary to facilitate safe construction practices and to ensure that the structural integrity of the wall assembly is maintained. Prior to the installation of cladding or bridging, a wall *stud* is free to twist, thus making the *stud* potentially subject to premature failure under heavy construction loads (i.e., stack of gypsum wallboard or roof shingles). In such cases, temporary *bracing* must be provided.

E5 Splicing

The *stud* tables provided in SFIA AISI S230 are based on an assumption that the *studs* are continuous, with no splices. Therefore, *structural studs* shall not be spliced without an *approved* design. *Tracks* are permitted to be spliced according to the requirements and details in SFIA AISI S230.

E6 Corner Framing

SFIA AISI S230 utilizes a traditional three-stud practice for framing corners. The corner cavity should be insulated before the exterior sheathing is applied.

E7 Headers

Headers are horizontal members used to transfer loads around openings in *structural walls*. *Headers* specified in [SFIA AISI S230](#) are allowed only above the opening immediately below the wall top *track* (i.e., *high headers*). In 2007, an exception to this requirement was included in [SFIA AISI S230](#) along with an alternative detail for box and back-to-back *headers* in gable endwalls, based on a study at the University of Missouri-Rolla (Downey et al., 2005). Historically, the two traditional ways of constructing *headers* were to put two *C-shaped* members back-to-back or in a box shape. However, recent testing of single and double L-shaped *headers* has proven that they, as well as inverted L-headers, may be an economical alternative to traditional *headers* in lightly loaded situations.

The following general design assumptions were made in determining *header spans*:

- *Headers* are simply supported beams
- Maximum roof overhang of 24 inches (610 mm)
- Roof slopes limited to a range of 3:12 to 12:12
- Ceilings, roofs, attics, and floors *span* the full width of the house; no interior load bearing walls, except as noted
- Deflection limit of $L/240$

The design of *headers* is based on AISI S240 ~~(AISI, 2015b)~~.

E7.1 Box Headers

Box *headers* are formed from two equal-sized *C-shaped* members placed toe-to-toe in a box-type configuration and fastened to both the wall top *track* and a *track below*. *Tracks* used to frame around openings are required to have a steel thickness equivalent to or greater than the wall *studs*. The orientation of the lower *track* is not critical to the structural performance of the box *header*. Thus, the lower track can be oriented to face either the top or the bottom of the wall. The following design assumptions were used when developing the header selection tables:

- Bending capacity is based on two C-sections alone. The *track* is not considered composite with the C-sections.
- Shear capacity is based on two C-sections alone.
- Interior-one-flange loading web crippling capacity is based on AISI S240 ~~(AISI, 2015b)~~ with a bearing length, $N = 1$.
- End-one-flange loading web crippling capacity is not evaluated because the typical end detail precludes web crippling.
- Bending and web crippling capacities are based on AISI S240 ~~(AISI, 2015b)~~.
- Deflection is based on two C-sections alone. The *track* is not considered composite with the C-sections.

E7.2 Back-to-Back Headers

Back-to-back *headers* are formed from two equal-sized *C-shaped* members in a back-to-back configuration creating an I-section. These *C-shaped* sections are fastened to the wall top *track* and a lower *track* spanning the width of the opening. *Tracks* used to frame around openings are required to have a steel thickness equal to or greater than the wall *studs*. The lower *track* can be oriented to face either towards the top or the bottom of the wall. It is more difficult to install *strapping* around back-to-back *headers* in *high wind areas*. The following design assumptions were made in developing the header selection tables:

- Bending capacity is based on two C-sections alone. The *track* is not considered composite with the C-sections.
- Shear capacity is based on two C-sections alone.
- Interior-one-flange loading web crippling capacity is based on AISI S100 ~~(AISI, 2012)~~ with a bearing length, $N = 1$.

- End-one-flange loading web crippling capacity is not evaluated because the typical end detail precludes web crippling.
- Bending and web crippling capacities are based on AISI S100 ~~(AISI, 2012)~~.
- Deflection is based on two C-sections alone. The *track* is not considered composite with the C-sections.

E7.3 L-Headers

E7.3.1 Double L-Headers

A double L-*header* is shown in Figure E7-5 of A ~~SFIA~~ AISI S230. Tables for gravity and uplift loads are provided for double L-*headers*. Double L-*headers* are easy to install. They can be installed during or after the wall has been framed. They do not require pre-insulation and provide a large surface to apply finishing materials. They also require less material (steel and screws) than back-to-back or box *headers*. Double L-*headers* do not need to be cut to exact lengths; however, they need to lap over a minimum of one *king stud* at each end. The design of the L-*header* is based on AISI S240 ~~(AISI, 2015b)~~, which stipulates that the bending capacity be based on the angles alone. AISI S240 also stipulates that shear and web crippling alone, as well as combinations of shear, bending or web crippling, need not be checked.

E7.3.2 Single L-Headers

A single L-*header* is shown in Figure E7-6 of ~~SFIA~~ AISI S230. Tables for gravity loads only are provided for single L-*headers*. They can be installed during or after the wall has been framed. They do not require pre-insulation and provide a large surface to apply finishing materials. They also require less material (steel and screws) than back-to-back or box *headers*. Single L-*headers* do not need to be cut to exact lengths; however, they need to lap over the required *king studs*. L-*header* strength is usually controlled by wind uplift load since the L-*header* vertical leg is in compression. Inverted L-*headers* (see Section E7.3.3) may be required for wind uplift load. The design of the L-*header* is based on AISI S240 ~~(AISI, 2015b)~~, which stipulates that the bending capacity be based on the angle alone. AISI S240 also stipulates that shear and web crippling alone, as well as combinations of shear, bending or web crippling, need not be checked.

E7.3.3 Inverted L-Headers

An inverted L-*header* is shown in Figure E7-7 of ~~SFIA~~ AISI S230. Tables for gravity and uplift loads are provided for inverted L-*headers*. They can be installed during or after the wall has been framed. They do not require pre-insulation and provide a large surface to apply finishing materials. They also require less material (steel and screws) than back-to-back or box *headers*. Inverted L-*headers* need to be cut to exact lengths. The design of the L-*header* is based on AISI S240. AISI S240 stipulates that for double inverted L-*headers* (double L-*headers* plus inverted double L-*headers*), the bending capacity is determined by summing the double L-*headers*' bending capacities for gravity loading, and summing the inverted double L-*headers*' bending capacities for uplift loading. For the single inverted L-*header* (one L-*header* plus one inverted L-*header*), AISI S240 states that the gravity capacity is equal to the single L-*header* bending capacity, and uplift capacity is equal to the inverted single L-*header* bending capacity. AISI S240 also stipulates that shear and web crippling alone, as well as combinations of shear, bending or *web* crippling, need not be checked.

E7.4 Jack and King Studs

The required number of *jack* and *king studs* was calculated based on the size of the opening. The number was determined by taking the width of the opening, dividing by the *stud* spacing, and rounding to the next higher whole number. The resulting number is further divided into *jack* and

king studs based on the required axial capacity being provided by the *jack studs* only. *King* and *jack studs* are required to be the same size and thickness as the adjacent wall *studs*. *Jack* and *king studs* are interconnected by *structural sheathing* (plywood or OSB) to transfer lateral loads (when multiple *king* and *jack studs* are required).

E7.5 Head and Sill Track

Head and sill *tracks* are those located at top (i.e., head) or bottom (i.e., sill) of window or door openings. Head and sill *tracks* span the full width of the opening and are designed to resist lateral wind loads only. The allowable head and sill *track* spans were calculated using C&C wind loads for a 48-inch (1.22-m) tributary span [i.e., assuming the opening covers the entire height of the 8-foot (2.44 m) wall.] As the tributary *span* decreases, the head and sill *track* will have to resist less wind loads. Therefore, for a 4-foot (1.22-m) opening, the tributary opening width is 2 feet (0.61 m) and hence the allowable head and sill *track* span increases by a factor of 1.75. Similarly, for a 6-foot (1.83 m) opening, the tributary opening is 3 feet (0.92 m) and hence the allowable head and sill *track* span increases by a factor of 1.50.

E8 Wall Bracing

The wall bracing provisions of this section are applicable to buildings classified as *Seismic Design Category* A, B and C and for buildings located where the *basic wind speed* is less than 140 mph (225 km/hr) Exposure C.

In 2019, due to the removal of the building size limits in Table A1-1, Sections E8.1 through E8.3 were included to specify details regarding the construction, location, and quantity of *braced wall lines* and *braced wall panels*.

Four *bracing* methods are recognized in [SFIA AISI S230](#):

- Method A – Continuous wood structural panel sheathing
- Method B – Sheet steel sheathing
- Method C – Continuous structural fiberboard sheathing
- Method D – Continuous gypsum board sheathing

In 2019, the available bracing methods in AISI S230 were expanded to include sheet steel, structural fiberboard sheathing and gypsum board sheathing in addition to structural wood panel sheathing. Reference to *strap bracing* (diagonal X-bracing) was removed in the 2019 edition and it now falls under Section E8.4.2, *Other Approved Bracing Methods*.

E8.1 Braced Wall Lines

The braced wall line provisions developed for this edition of [SFIA AISI S230](#) are compatible with the provisions for light-framed construction prescribed in the 2015 International Residential Code (IRC).

E8.1.1 Braced Wall Line Spacing

The requirements related to *braced wall line* spacing are the major changes in format and approach to determining bracing amounts. The 60-foot (18.3 m) *braced wall line* spacing specified in this section conforms to the prescribed spacing listed in the 2015 IRC. Table R602.10.1.3 in the IRC prescribes 60-foot (18.3 m) maximum spacing for most conditions. However, townhouses in SDC C are prescribed a 35-foot (10.7 m) allowable spacing with the exception of permitted 50-foot (15.3 m) spacing when adjustment factors to the amount of wall bracing are applied. This also necessitates a number of other changes or additions to the bracing provisions of Section E8, including limits on the slenderness of diaphragms spanning between any two

braced wall lines. The term *diaphragm span-to-depth ratio* is defined and used for this purpose. The limitation of a 3:1 *diaphragm span-to-depth ratio* is consistent with the AISI S240-15 for unblocked diaphragms.

E8.1.2 Offsets in Braced Wall Lines

The issue of determining *braced wall lines* and their spacing is one of the more important, yet misunderstood, requirements of the IRC light-framed bracing provisions. Therefore, in 2015 improved illustrations were provided to demonstrate how to handle *braced wall lines* with offsets. The provisions for offsets were unchanged in the 2019 update.

E8.2 Bracing Amount

E8.2.1 Minimum Required Bracing Amount for Braced Wall Lines

Minimum bracing amounts are presented in separate tables for wind and seismic loads. Seismic loads are required to be checked only in SDC C. As in the previous provisions, the greater of wind or seismic bracing amounts determines the amount of bracing required for a *braced wall line*. In addition, the tables are tabulated based on *braced wall line* spacing. Therefore, bracing amounts may be reduced by decreasing *braced wall line* spacing or use of interior *braced wall lines*. Interior *braced wall lines* are required when exterior *braced wall lines* are spaced more than 60 feet (18.3 m) apart. Other requirements are similar to AISI S230-15. Tabulated bracing amounts are subject to a number of adjustment factors provided in Section E8.2.2. Derivation of bracing amounts is discussed later.

E8.2.2 Bracing Amount Adjustments

Tabulated bracing amounts required by Section E8.2.1 are based on a baseline set of conditions. Section E8.2.2 provides adjustment factors to address specific building or site conditions. Thus, all adjustment factors are provided or addressed in this section. The existing adjustment factor for use of hold-downs is retained in new Section E8.2.2.2, but is revised to 0.7 instead of 0.6. This increase is to account for the condition of adding hold-down brackets relative to the bracing amounts analyzed based on the perforated shear wall method and partial restraint (absence of hold-down brackets, but restraint provided by the building assemblies such as corners). The analysis of bracing amounts is discussed later. Finally, bracing adjustment factors relevant to each bracing method are referenced in Section E8.4 because many of these adjustments vary for each bracing method.

E8.3 Braced Wall Panels

E8.3.1 Minimum Length of a Braced Wall Panel

The minimum 4-foot (1.22 m) *braced wall panel* width (length along a *braced wall line*) is retained from the AISI S230-15 provisions. In 2018, exceptions were added for allowable 2-foot (0.61 m) panels for conditions in which another 2-foot (0.61 m) full-height panel is installed at the corner on the adjoining BWL, or there is an 800-lb (3.56 kN) hold-down installed at the edge of the BWP at the end of the BWL. These exceptions are consistent with the provisions for light-framed *braced wall pane* in the IRC.

E8.3.2 Braced Wall Panel Location Requirements

Braced wall panel location requirements are also consistent with accepted practice for light-frame construction in the IRC and AISI S230-15 requirements. In 2018, exceptions were provided for a minimum 2-foot (0.61 m) panel at corners (consistent with AISI S230-15) and for

allowing no panels at the corners when a minimum 800-lb (3.56 kN) hold-down is provided at a *braced wall panel* no more than 10 feet (3.05 m) from the end of the *braced wall line*. The 800-lb (3.56 kN) hold-down is intended to be equivalent to the partial-restraint effect of a corner with minimum 2-foot panels of structural sheathing. This is equivalent to 2018 provisions in the IRC for light-frame construction.

E8.4 Bracing Methods

The wall bracing requirements in [SFIA AISI S230](#) are based on an engineered approach that utilizes available technical knowledge. The allowable shear strength for wood structural panel, sheet steel, fiber board and gypsum board sheathing are based on Table B5.2.2.3-1 through Table B5.2.2.3-4 of AISI S240 ~~(AISI, 2015b)~~ and a safety factor of 2.5 was used for seismic design of Methods A and B. A Response Modification Factor of $R = 2$ was used for Methods C and D and therefore a safety factor of 2.0 was used. The safety factor of 2.5 is appropriate for high seismic areas and is conservative for other cases. The shear strength for assemblies relevant to this document is summarized in Table C-E8.4.

Table C-E8.4
Cold-Formed Steel Framed Walls Shear Strength (AISI S240)

Assembly Description	Nominal Shear Strength (plf)	Allowable Shear Strength (plf)
7/16" OSB APA Rated sheathing w/ panels on one side	910	364
0.027" Steel Sheet w/ min. 33 mil studs	710	284
½" Fiber Board	615	308
½" Gypsum Board	230	115

The intent in [SFIA](#) AISI S230 is to have the entire building fully sheathed (except for door and window openings, as limited by the minimum length of full-height sheathing).

The lateral wind loads were calculated for a range of building surfaces using the orthogonal wind loading approach of ASCE 7 ([ASCE, 2016](#)). Tributary areas consisting of the leeward and windward wall surfaces were assigned to each exterior *shear wall* (i.e., sidewalls and endwalls) to determine the in-plane shear loads to be resisted by the walls.

Using the more conservative allowable shear strength from Table C-E8.2 of 364 plf (5.39 kN/m), [SFIA](#) AISI S230 wall *bracing* requirements were determined. The length of full-height sheathing required was then tabulated as a percentage of wall length for sidewalls and endwalls over the range of building geometries defined in [SFIA](#) AISI S230 applicability limits. The length of wall with full-height sheathing is defined as the sum of wall segments that have sheathing extending from the bottom track to the top *track*, without interruption due to openings (i.e., the total of lengths of wall between window and door openings). The individual wall segments must be 48 inches (1.22 m) in length or greater to contribute to the required length of full-height sheathing for a given wall line, unless permitted otherwise.

As a final step necessary for a basic prescriptive approach, the requirements were conservatively reduced to the minimum percent lengths of full-height sheathed wall shown in the wall-bracing table of [SFIA](#) AISI S230. The only building geometry parameter retained was roof slope due to a significant impact on the wind loads transferred to the *shear walls*. Footnotes to the *shear wall* table provide additional information related to the proper applications of the requirements.

Fastening of *structural sheathing* is typically done at 6-inch (152 mm) spacing at the perimeters and 12-inch spacing (305 mm) in the field. When this spacing is reduced to 4 inches (102 mm) (perimeter spacing only), the percentage of full-height sheathing is permitted to be multiplied by 0.72.

A *hold-down anchor* shall consist of an approved *strap* or bracket adequately attached to the *stud* and anchored to the foundation, floor, or wall below to form a continuous load path to the foundation. *Hold-down anchors* may also be added to reduce the amount of full-height sheathing required, or to increase the shear (racking) strength of the wall.

E8.4.1 Continuous Structural Sheathing Bracing Methods

This section provides overall requirements for four continuous structural sheathing methods. Adjustment factors presented in this section are consistent with the use of the perforated shear wall method to analyze the bracing amounts in Section E8.2. These maximum clear opening height adjustment factors for bracing methods A-D assume the perforated shear wall method and partial restraint effects observed for Method A apply similarly for methods B-D.

E8.4.1.1 Method A – Continuous Wood Structural Panel Sheathing

This section addresses continuous wood structural panel bracing. An adjustment factor for

4-inch (102 mm) edge fastener spacing is retained from AISI S230-15. The more conservative nominal shear value for 7/16" OSB (910 plf (13.5 kN/m) for wind and seismic) was used to analyze bracing amounts and is based on AISI S240-15 as listed in Table C-E8.2.

E8.4.1.2 Method B – Continuous Steel Sheet Sheathing

The continuous steel sheeting bracing method was added in 2019 and is analyzed in the same manner as Method A in terms of using the perforated shear wall equations. The installation requirements are based on AISI S240-15 provisions as well as the nominal shear value (710 plf (10.5 kN/m) for wind and seismic) used to analyze bracing amounts. An adjustment factor for lapping of intermediate horizontal joints is also included and is based on AISI S240-15. The fastener edge distance of 3/8-inch (1/2-inch in Canada) is based on AISI S400-15.

E8.4.1.3 Method C – Continuous Structural Fiberboard Sheathing

The continuous structural fiberboard sheathing method was added in 2019. Installation requirements are based on AISI S240-15. A nominal shear strength of 615 plf (9.1 kN/m) (for wind and seismic) was used to analyze bracing amounts. Similar to Bracing Method A, an adjustment factor is provided for closer edge fastener spacing.

E8.4.1.4 Method D – Continuous Gypsum Board Sheathing (Two Sides)

The continuous gypsum board sheathing bracing method was added in 2019. Gypsum board panels are required on both sides of the wall assembly. Installation requirements and the nominal design value (460 plf (6.8 kN/m) for wind and seismic) are based on AISI S240-15. Adjustment factors are provided for different fastening options as well as placing gypsum board panels on only one side of the wall assembly.

E8.4.2 Other Approved Bracing Methods

In 2019, Section E8.4.2 was added to permit the option for other *approved* bracing methods. Tables E8-5(1) through E8-5(3), or the *applicable* building code, are to be used as the basis to determine the amount of bracing required.

E9 Exterior Wall Covering

It is required that exterior coverings be installed in accordance with the recommendations of the manufacturer. SFIA AISI S230 limits the total exterior envelope dead load (total load = stud framing plus wall coverings) to 10 psf (0.48 kN/m²). If the total exterior envelope dead load exceeds that value, then the walls must be engineered for that load (see Table A1-2 for maximum wall dead loads in high seismic areas).

E11 Braced Walls in High Wind Areas and High Seismic Areas

E11.1 General

This section provides additional *shear wall* requirements for buildings located in *high seismic areas* (i.e., *Seismic Design Categories* D₀, D₁, D₂ and E) or *high wind areas* (i.e., wind speed between 140 to 180 mph (225 to 290 km/hr)). In *high seismic areas*, buildings are required to comply with Sections E11 and E12; and in *high wind areas*, buildings are required to comply with the requirements in Sections E11 and E13.

The following general assumptions and building configurations were used in developing the high seismic tables and high wind provisions:

- Provisions and tables are limited to buildings of no more than two stories.

- Provisions and tables are limited to buildings on slab-on-grade or spread footing with stemwall foundation systems with a single top of slab/top of stemwall elevation.
- Wall clear heights are limited to 8, 9, and 10 feet (2.44, 2.74 and 3.05 m).
- Maximum roof slope is limited to 6.9:12.
- All ceilings are considered leveled (i.e., no offsets or cathedral ceilings).
- Buildings are considered regular (rectangular shape).
- First- and second-story walls are assumed vertically stacked (no offset).

Weights used in calculating the entries of the tables in the *high seismic areas* are as follows:

- Roof/Ceiling dead load = 25 psf (1.2 kN/m²) for heavyweight roofs
= 15 psf (0.72 kN/m²) for normal weight roofs
= 12 psf (0.57 kN/m²) for lightweight roof systems
- Wall dead load = 14 psf (0.67 kN/m²) for heavy walls
= 7 psf (0.34 kN/m²) for light walls
- Floor/Ceiling dead load = 10 psf (0.48 kN/m²)
- Interior wall dead load = 5 psf (0.24 kN/m²) (based on 10-foot (3.04 m) wall)
- Ground snow load = 30 psf (1.44 kN/m²) for normal or lightweight roofs
= 70 psf (3.35 kN/m²) for heavyweight roof systems
- Roof weight includes a 2-foot (610 mm) overhang

The dead loads that were used in determining the seismic mass are given below:

Wall Element	Weight (psf)	
	Lightweight Walls	Heavyweight Walls
Wallboard	1.8	1.8
Steel Framing	0.6	0.6
½" Plywood Sheathing	1.6	1.6
Insulation	1.0	1.0
7/8" Stucco	0	9.0
Exterior Siding	1.5	0
Total	6.5	14.0

For SI: 1 psf = 0.0479 kN/m²

Roof Element	Weight (psf)	
	Flat Roofs	Sloped Roofs (6:12)
Sheathing	1.6	1.63
Roof Framing or Trusses	2.5	2.5
Insulation	1.0	1.0
Miscellaneous	0.6	0.84
Ceiling Covering	1.8	1.8
Subtotal	7.5	7.8
Total with Roof 3.7 psf Covering	11.5	12
Total with Roof 6.4 psf Covering	14.2	15
Total with Roof 15.3 psf Covering	23.5	25

For SI: 1 psf = 0.0479 kN/m²

Roof Category	Roof/Ceiling Weight (psf)
Lightweight Roof	12
Normal Weight Roof	15
Heavyweight Roof	25

For SI: 1 psf = 0.0479 kN/m²

Design assumptions that are used in developing the shear wall and other tables in the high seismic areas are as follows:

- Nominal shear values are taken from Table C-E8.2.
- Seismic Design Category* (SDC) assignments in accordance with Table R301.2.2.1.1 of the *International Residential Code* (ICC, 2018b).
- Seismic base shears were calculated in accordance with ASCE 7 (~~ASCE, 2016~~) using an $R = 6.5$ and $\Omega_0 = 3$. Upper end S_{DS} values are used for each SDC. Previously, an $R = 5.5$ was used in AISI S230. In 2019, the value of R was updated to 6.5 in accordance with ASCE 7-16 (~~ASCE, 2016~~).
- Diaphragms* are flexible. In accordance with ASCE 7 (~~ASCE, 2016~~), Ω_0 was reduced from 3 to 2.5 and accidental torsion was not included.
- $F_u = 45$ ksi (310 MPa) and $F_y = 33$ ksi (230 MPa) were used in determining screw capacities. *Shear wall* test values are based on the 33 ksi/45 ksi (230/310 MPa) steels.
- ϕ factor was used in combination with the Ω_0 , the over-strength factor, to determine screw requirements for chord splices. Chord splice screw requirements are based on the lesser of Ω_0 times $T_{seismic}$ or T_n , divided by ϕV_n . Both the 3-1/2 inch (88.9 mm) and the 5-1/2 inch (140 mm) members were considered, as well as both the 33 mil (0.84 mm) and the 43 mil (1.09 mm) thicknesses.
- ASCE 7 requires the use of 20% of the uniform design snow load if the flat roof snow load, P_f , exceeds 30 psf (1.44 kN/m²). Where the ground snow load is 70 psf (3.35 kN/m²), the heavy roof system criteria applies.

Example: Load due to 70 psf ground snow load for normal weight roofs =
 15 psf + $0.2 \times 0.7 \times 70$ psf = 24.8 psf (1.19 kN/m²) (equals the
 heavyweight roof systems)

E11.2 Braced Wall Lines

Two types of *braced wall lines* are presented in this section: *Type I* and *Type II Braced Walls*. *Type I braced walls* are traditional *shear walls* that have a *hold-down* anchor at each end and have no openings between anchors. *Type II braced walls*, also known as perforated *shear walls*, are *shear walls* that have openings between anchors and there is no design for shear transfer around the openings.

E11.3 Type I (Solid Sheathed) Braced Wall Panels

This section describes the traditional method of sheathing a steel-framed wall where continuous panels have *hold-down* anchors at each end. The aspect ratio (height-to-width) used in the development of these provisions for this wall type is 2:1.

E11.4 Type II (Perforated) Braced Wall Lines

The *Type II Braced Wall*, or perforated *shear wall* method, requires *hold-down* anchors at each end of each wall rather than at each end of continuous panels. The aspect ratio (height-to-width) is also 2:1 for this wall type. For a defined *Type II* (perforated) *shear wall*, the adjustment factors given in Table E11-2 define the magnitude by which the strength of an otherwise solid wall must be divided to get the strength of the *Type II* (perforated) wall. The tabulated values, adopted from wood frame construction, were justified on the basis of a series of full-scale reversed cyclic tests by Vagh, Dolan and Easterling (2000) in which it was demonstrated that the tested wall capacities were greater than the reductions that are required by Table E11-2.

E12 Braced Wall Design in High Seismic Areas

E12.2 Braced Wall Anchorage and Chord Stud Requirements

In 2015, the tabulated values were changed and expressed in allowable loads. Prior to 2015, AISI S230 permitted the tabulated values to be divided by 1.4 when comparing requirements with manufacturers' published strengths expressed as allowable loads. The derivation of this adjustment factor is: $\phi \times \Omega = 0.55 \times 2.5 = 1.4$. In earlier editions of cold-formed steel lateral design provisions, the resistance factor was set at 0.55 to reflect the 1.4 value used in the UBC to compute allowable seismic loads (1.4 approx. = 0.55×2.5).

E13 Braced Wall Design in High Wind Areas

E13.3 Connections of Walls in High Wind Areas

E13.3.2 Uplift Connection – Wall Assembly to Wall Assembly

In 2015, the tabulated values were changed and expressed in allowable loads. Prior to 2015, AISI S230 permitted the tabulated values to be divided by 1.3 when comparing requirements with manufacturers' published strengths expressed as allowable loads. The derivation of this adjustment factor is: $\phi \times \Omega = 0.60 \times 2.0 = 1.3$.

E13.3.3 Header Uplift Connections

For back-to-back *headers* supporting roof and ceiling only, these provisions require that uplift straps be installed on both sides of the *header* beam (inside and outside of the wall) in order to minimize any effect of torsion. This requirement is based on engineering judgment and recognizes that the back-to-back *header* lacks sufficient torsional strength and stiffness. For back-to-back *headers* supporting loads from one floor, roof and ceiling, and for any box and double L-headers, a single uplift strap is permitted and may be installed on either side of the

815 *header beam.*
816

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F. ROOF FRAMING

F1 Roof Construction

Roof *trusses* are not prescriptively addressed in [SFIA](#) AISI S230 and so are roof girders, but both are permitted in accordance with Section F6. Roof trusses or roof girders must be designed by a *registered design professional*.

F2 Ceiling Joists

F2.1 Minimum Ceiling Joist Size

The *ceiling joist* tables in [SFIA](#) AISI S230 provide the maximum allowable *ceiling joist* spans for two loading conditions: 10 psf (0.48 kN/m²) and 20 psf (0.96 kN/m²) attic live loads.

For the design of *ceiling joists*, the following design considerations were evaluated:

- Flexural yielding
- Flexural buckling
- Web crippling (not required if *bearing stiffeners* are specified)
- Shear
- Vertical deflection

The engineering approach used to develop *ceiling joist span* tables for [SFIA](#) AISI S230 is similar to that used for *floor joists*, with the exception of the magnitude of dead and live loads.

F2.2 Ceiling Joist Bearing Stiffeners

Previously, [SFIA](#) AISI S230 enabled the selection of continuous span *ceiling joists* which required the use of *bearing stiffeners*. Continuous *span joist* tables were removed in 2015.

F2.3 Ceiling Joist Bottom Flange Bracing

Gypsum board (i.e., finished ceilings) is considered to be adequate *bracing* for the bottom (tension) *flanges* of the *ceiling joists*. Steel *strapping* can also be used as bottom *flange bracing* for *ceiling joists*.

F2.4 Ceiling Joist Top Flange Bracing

For braced top (compression) *flanges*, it is necessary for steel strapping to have *blocking* (or bridging) installed at a maximum spacing of 12 feet (3.66 m) and at the termination of all *straps*. Moreover, the ends of steel *straps* are to be fastened to a stable component of the building if end *blocking* is not installed. *Ceiling joist* tables provide *spans* for braced, as well as unbraced, top *flanges*. To stabilize *ceiling joists*, the Standard requires that the *strap bracing* be screwed to *blocking* and the ends of the *strap bracing* be anchored. When the *ceiling joist* depth is 3.5 inches (88.9 mm), connection requirements are increased due to the increased forces needed to provide restraint to the shallower members.

F2.5 Ceiling Joist Splicing

Splicing of *ceiling joists* in [SFIA](#) AISI S230 requires an *approved* design except when lapped *ceiling joists* occur at an interior bearing wall.

F3 Roof Rafters

F3.1 Minimum Roof Rafter Sizes

The *roof rafter span* table was designed based primarily on gravity loads, hence the *roof rafter spans* are based on the horizontal projection of the *roof rafter*, regardless of the slope. The gravity loads consist of a 7 psf (0.34 kN/m²) dead load and the greater of a 16 psf (0.77 kN/m²) live load or the applied roof snow load. Unbalanced snow loads in accordance with ASCE 7 were considered.

Wind load effects are developed by a procedure that equates the wind loads to equivalent snow loads as shown in Table F3-2 of [SFIA AISI S230](#). Wind pressures were calculated using the ASCE 7 (~~ASCE, 2016~~) Components and Cladding (C&C) coefficients. Wind loads were examined for both uplift and downward loads, and the worst case was correlated to a corresponding snow load.

Permissible roof slopes range between 3:12 through 12:12 and more importantly, the roof system must consist of both *ceiling joists* (i.e., acting as rafter ties) and *roof rafters*. [SFIA AISI S230](#) does not currently address cathedral ceilings because a prescriptive ridge beam and post design is not provided.

Lapped *ceiling joists* must be connected with the same screw size and number (or more) as the heel joint connection to ensure adequate transfer of tension loads across the spliced joint. The splice must occur over an interior bearing wall.

F3.1.1 Eave Overhang

A 24-inch (610 mm) eave overhang was used when calculating the *roof rafter spans* in [SFIA AISI S230](#).

F3.1.2 Rake Overhang

In 2007, limitations and details were added to AISI S230 to clarify the installation requirements at gable endwalls, based on a study at University of Missouri-Rolla (Downey et al., 2005). In 2019, rake overhang limitations were modified based on the revised C&C wind loads in ASCE 7 (~~ASCE, 2016~~). Table F3-4 was developed to provide the required uplift strength for uplift connectors for the outlooker.

F3.2 Roof Rafter Support Brace

The support brace is used to increase the *span* of a particular member. When the brace is used, the *roof rafter span* is determined from the heel joint to the brace point or from the ridge member to the brace point (horizontal projection), whichever is greater.

F3.3 Roof Rafter Splice

The *roof rafter spans* provided in [SFIA AISI S230](#) are based on the assumption that the members are continuous, with no splices. Therefore, *roof rafters* are not to be spliced without an *approved* design.

F3.5 Roof Rafter Bottom Flange Bracing

The *bracing* requirements provided in [SFIA AISI S230](#) were revised in 2019 to address the unbraced bottom *flange* of the rafter when uplift due to wind loads results in compression in the bottom *flange*.

F4 Hip Framing

Prior to the 2007 edition of this Standard, roof framing was limited to *roof rafters* and *ceiling joists*. Hip and valley framing options were added in 2007, based on research at the University of Missouri-

Rolla (Waldo et al., 2006).

F5 Framing of Openings in Roofs and Ceilings

The requirements of this section are based on engineering judgment.

In 2015, the limitation for opening size was added to ensure adequacy of the *diaphragm*. Also, to preserve the tolerance limits required for in-line framing and transfer the more heavily loaded trimmer *joist* end reactions, requirements were added that in roof or ceiling assemblies supported by wall framing, a built-up trimmer *joist* consisting of at least one pair of *joist* or *track* members must be supported by a pair of wall *studs*.

F6 Roof Trusses

SFIA AISI S230 does not contain provisions for *roof trusses*, which must have an *approved* design. This section is included so that pre-engineered *roof trusses* may be used in conjunction with this document. AISI S240 (~~AISI, 2015b~~) should be consulted for the *truss* design.

F7 Ceiling and Roof Diaphragms

Roof *diaphragms* are required to adequately transfer shear loads to the *braced wall lines* in a structure. The load transfer is typically accomplished by sheathing the roof-framing members with wood structural panels. Shear values used in the design of roof *diaphragms* were taken from AISI S240 (~~AISI, 2015b~~). Additional requirements for steel roof *diaphragms* in *high wind areas* (i.e., 140 mph (225 km/hr) or greater wind speed) or *high seismic areas* (i.e., *Seismic Design Category* D₀, D₁, D₂ and E) are specified in Sections F7.1 and F7.2.

Ceiling *diaphragms* are also required to adequately transfer shear loads to the *braced wall lines* in a structure. The load transfer is typically accomplished by sheathing the ceiling-framing members with gypsum board or wood structural panels. Shear values used in the design of ceiling *diaphragms* were taken from AISI S240 (~~AISI, 2015b~~).

In 2015, Table F2-5 was developed and added to address minimum connection requirements of the roof sheathing for wind suction from C&C wind loads. In 2019, Table F2-5 was revised to reflect the revised roof C&C wind loads in ASCE 7 (~~ASCE, 2016~~).

F8 Roof Framing Connections in High Wind Areas

F8.3 Ridge Strap Connection

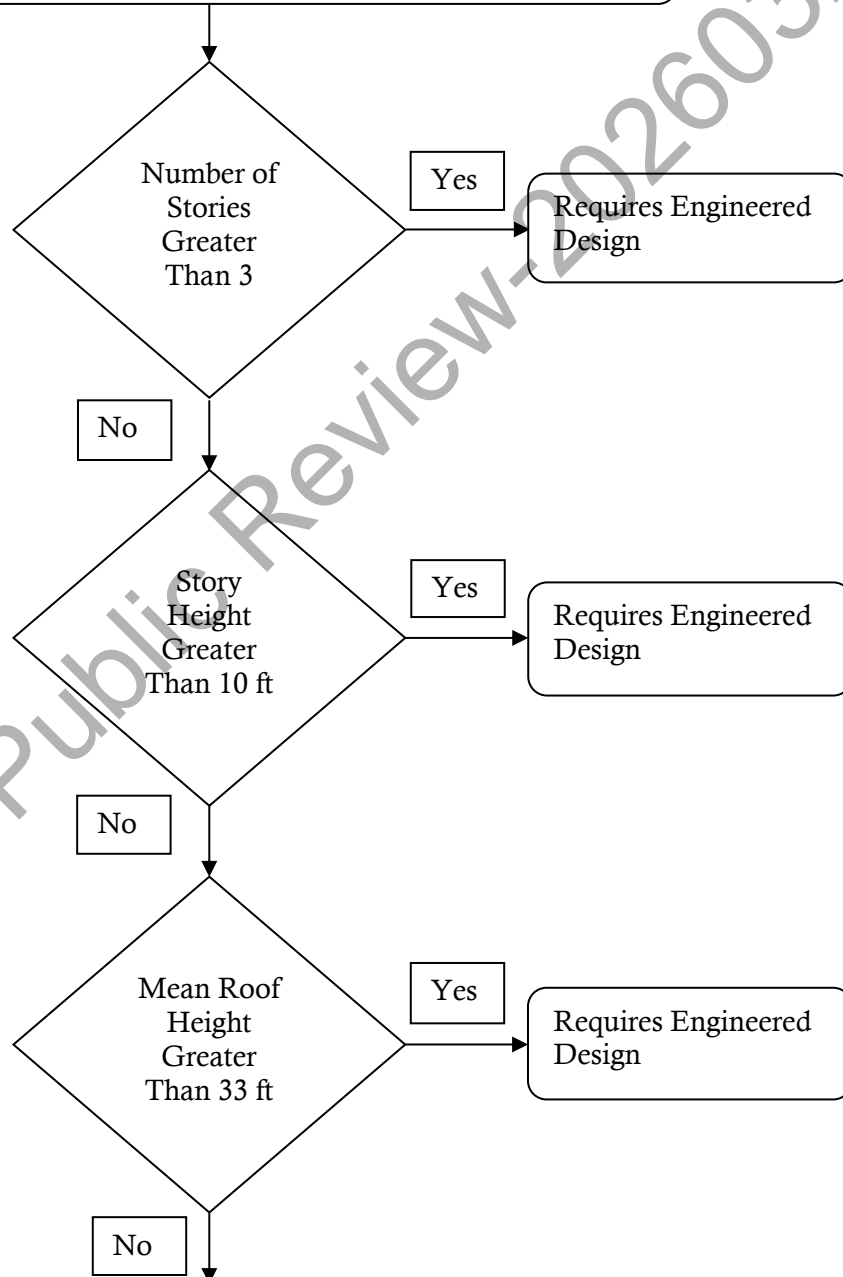
In 2019, Table F8-3 was revised to reflect the revised roof C&C wind loads in ASCE 7 (~~ASCE, 2016~~).

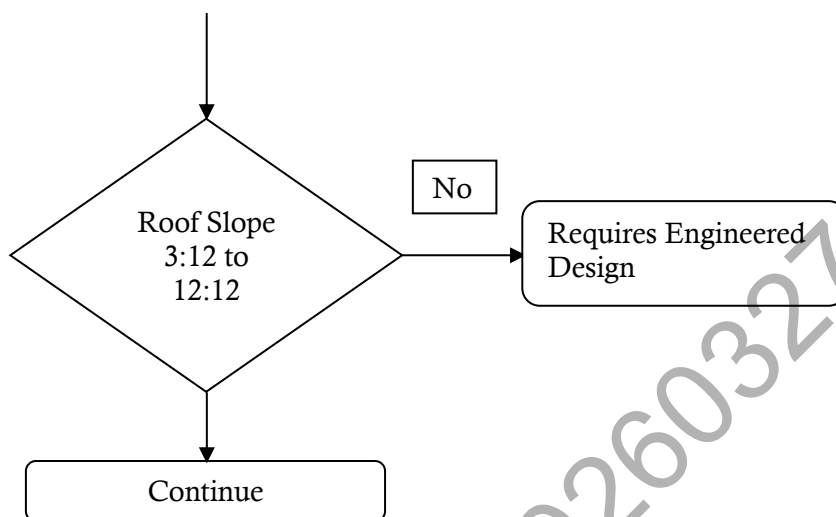
APPENDIX A FLOW CHARTS

The following flow charts provide the flow of designing buildings using SFIA AISI S230.

Applicability Limits – Building Geometry

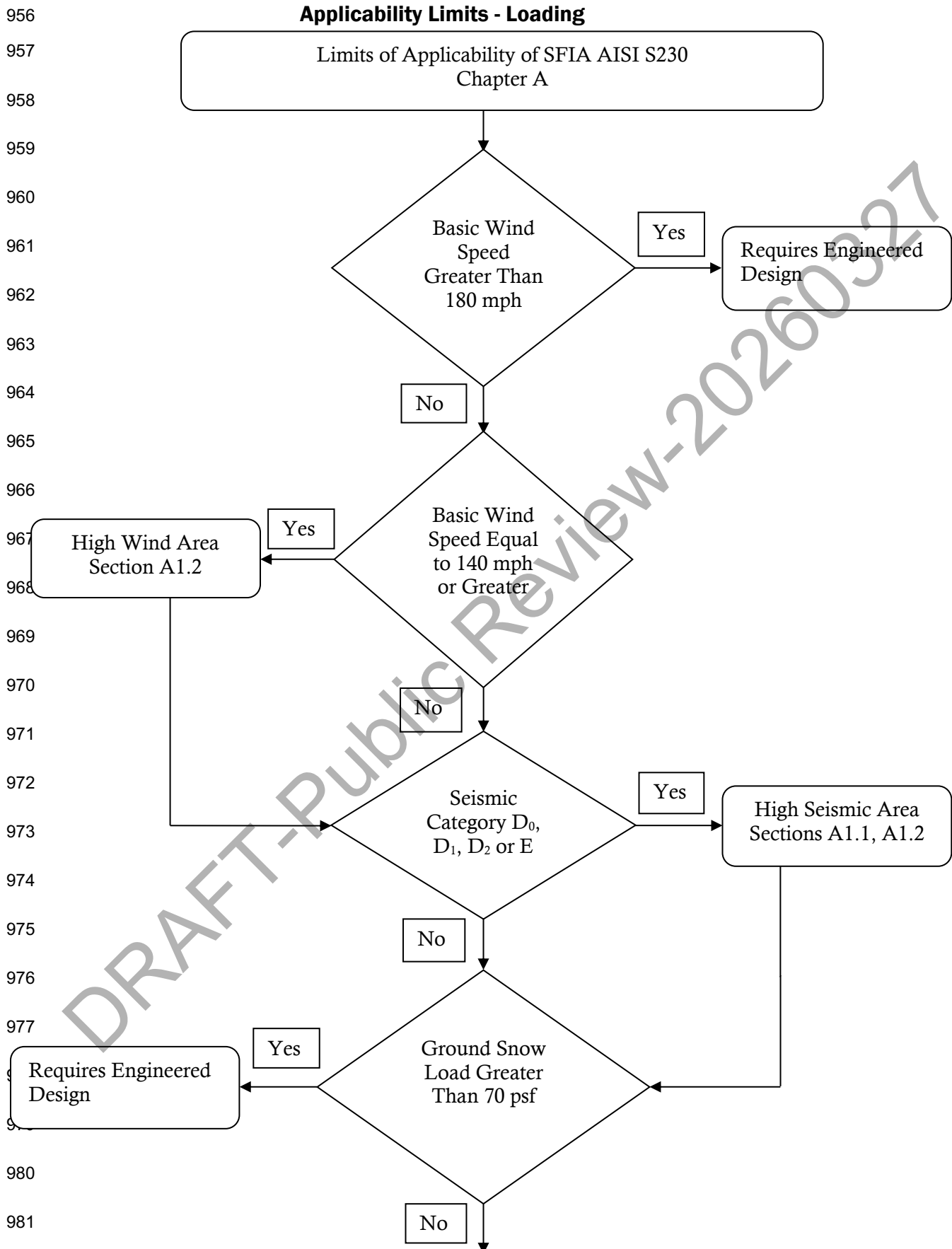
Limits of Applicability of SFIA AISI S230
Section A1.1 - Building Geometry

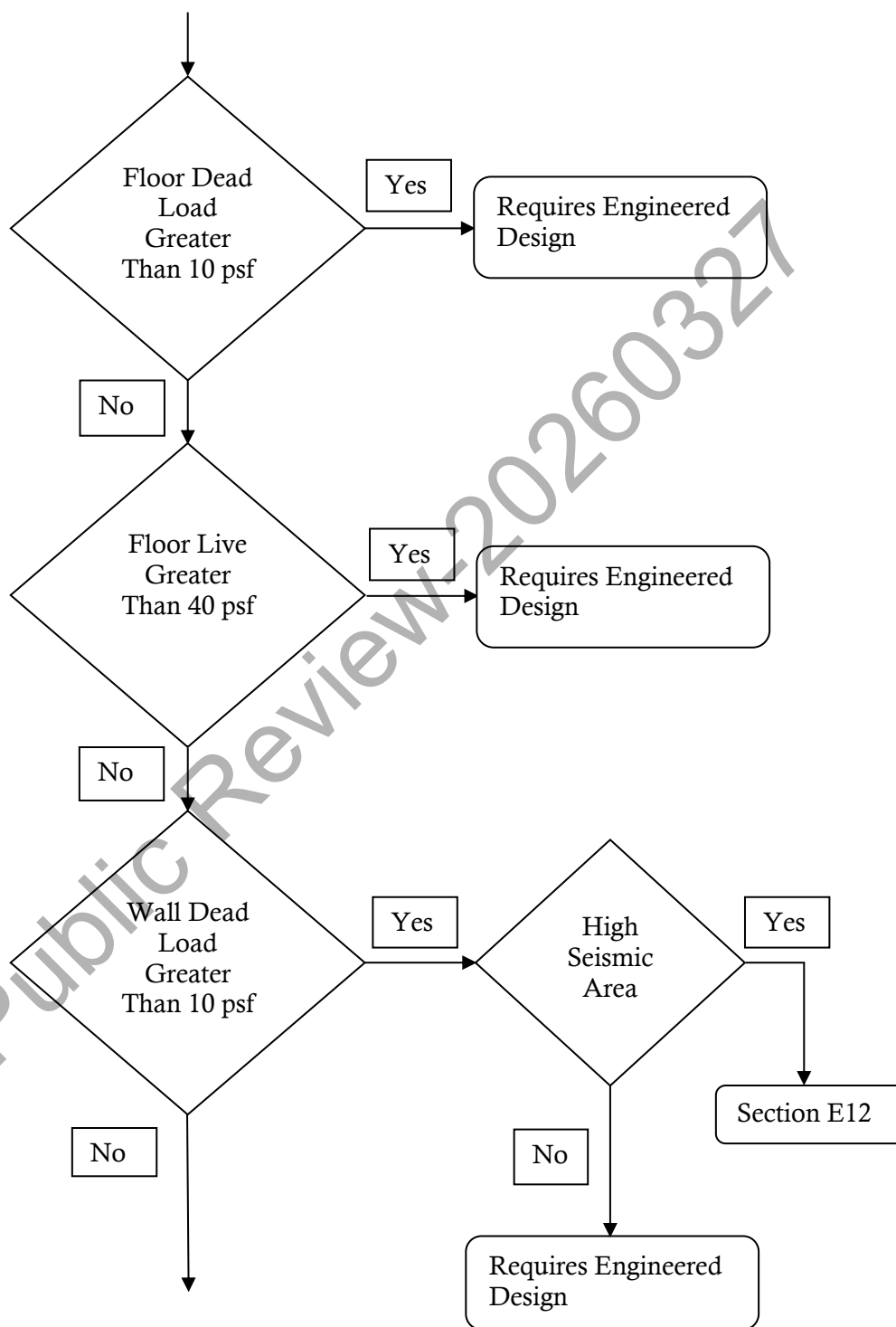


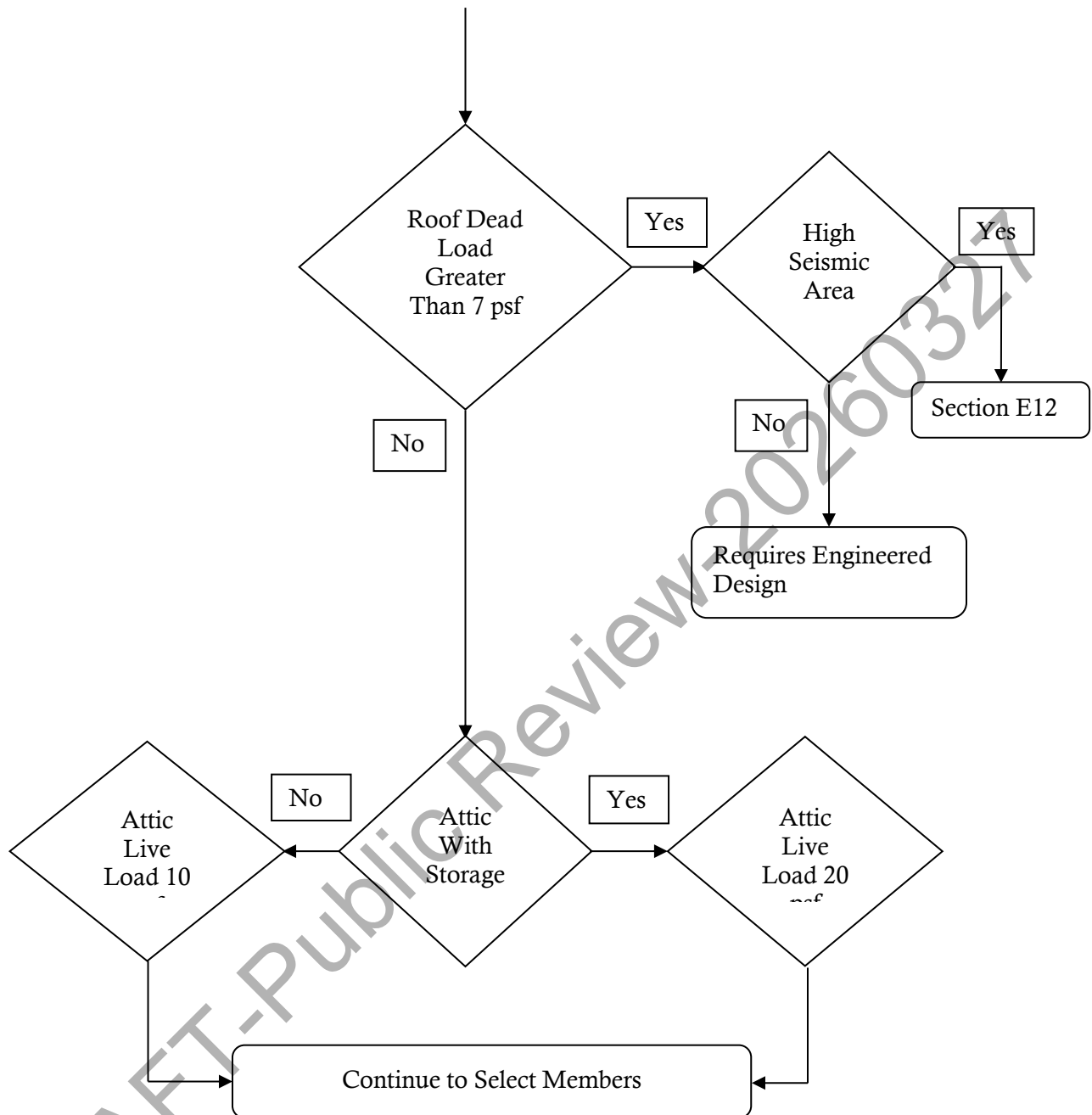


Applicability Limits - Loading

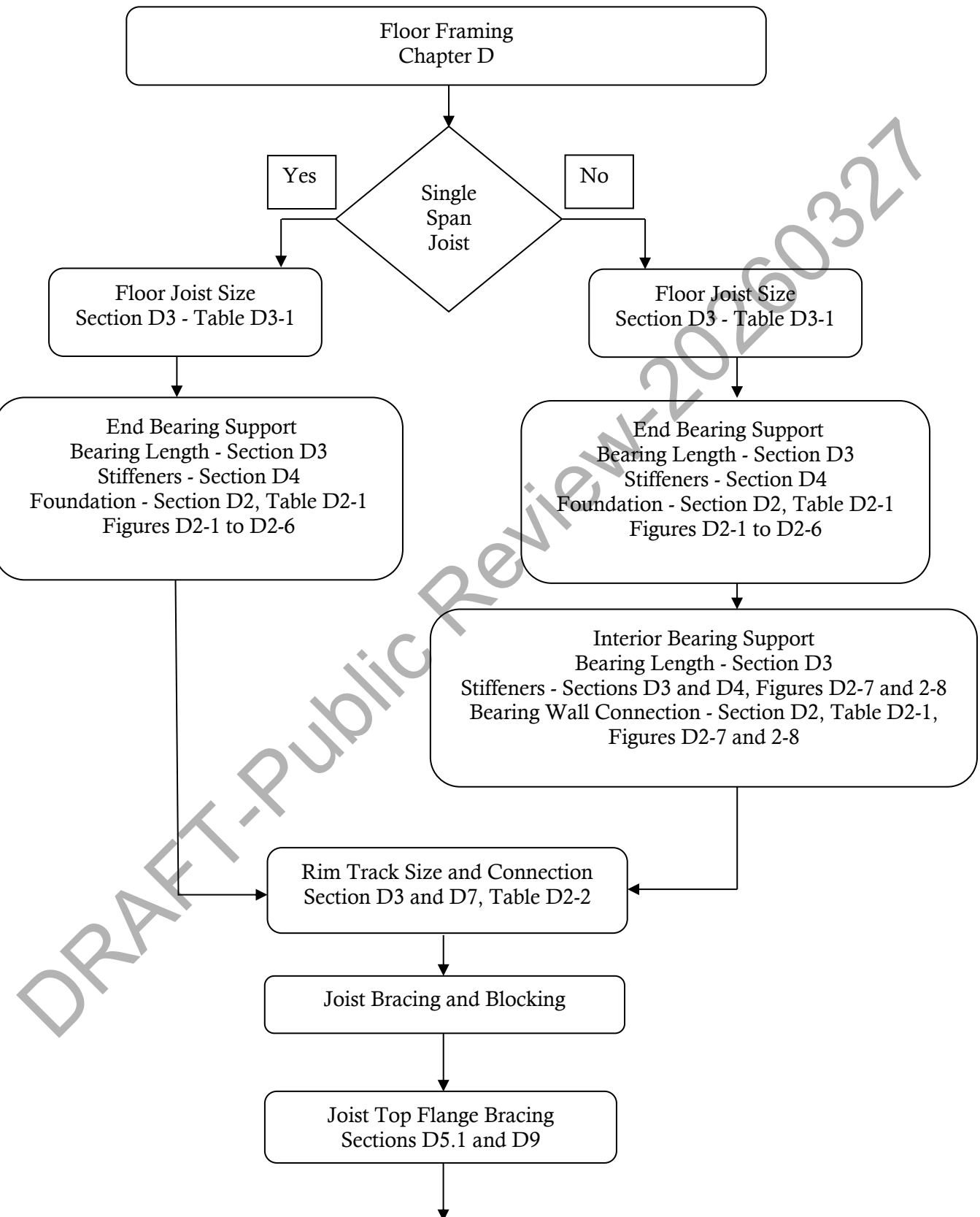
Limits of Applicability of SFIA AISI S230
Chapter A

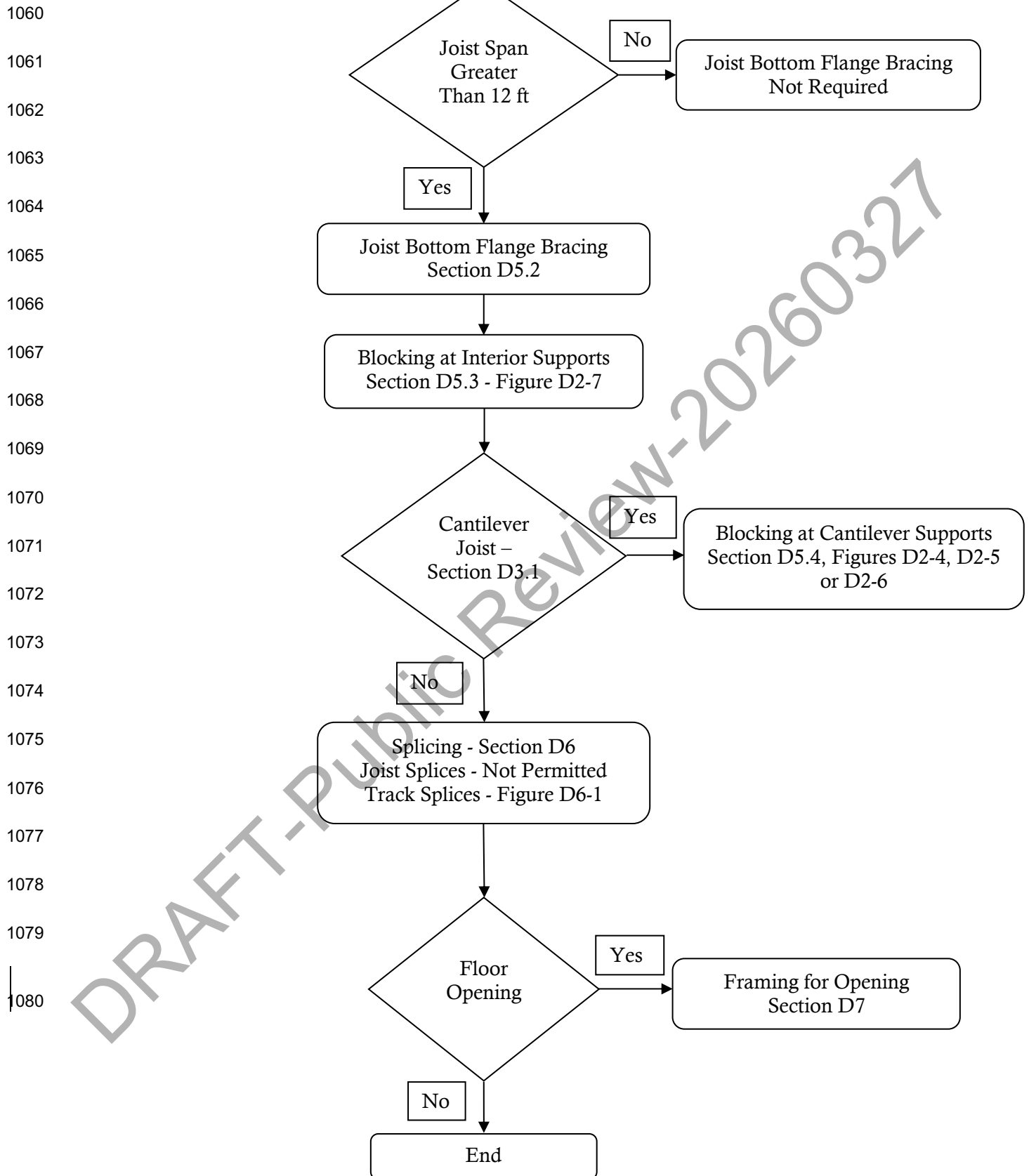




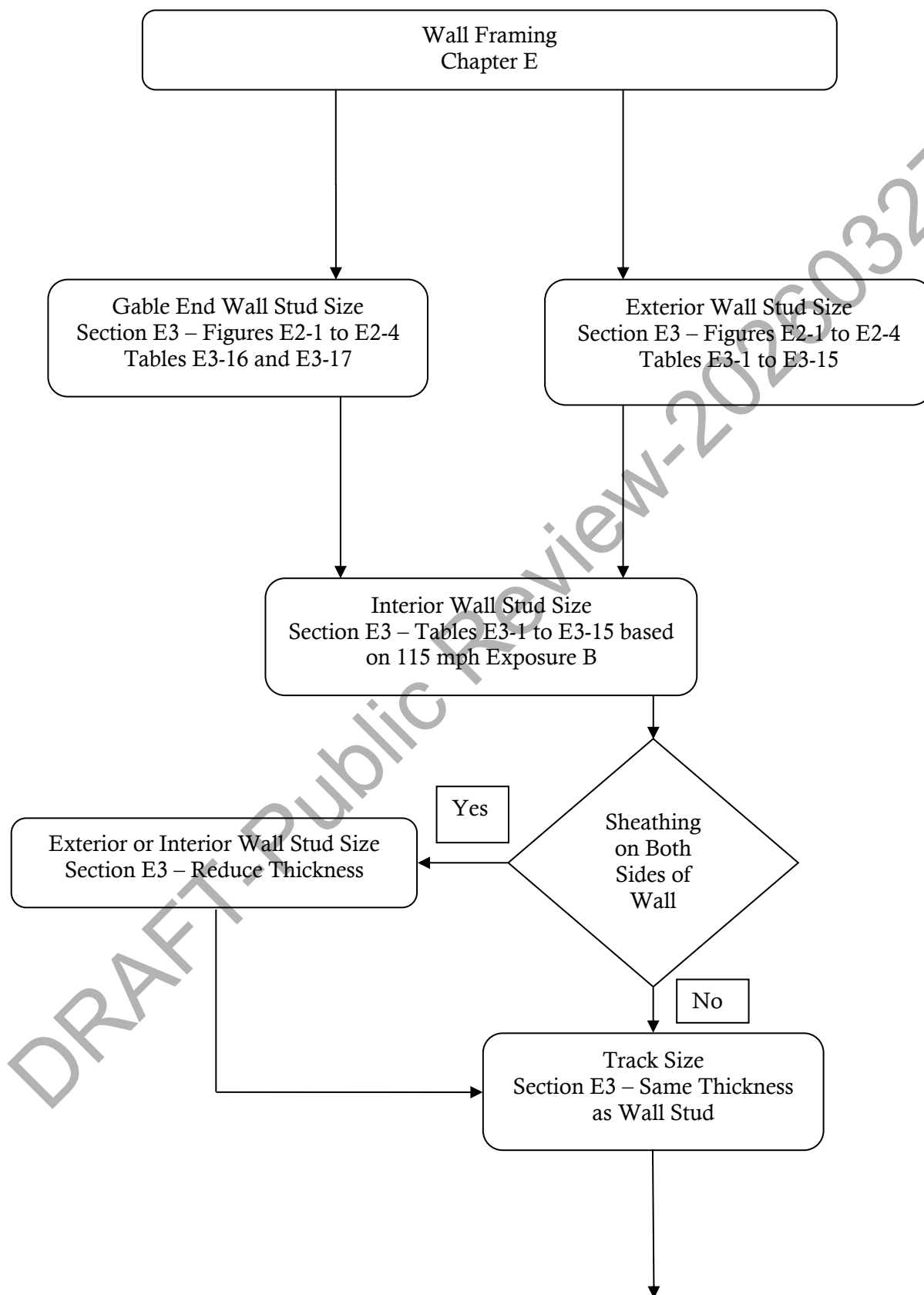


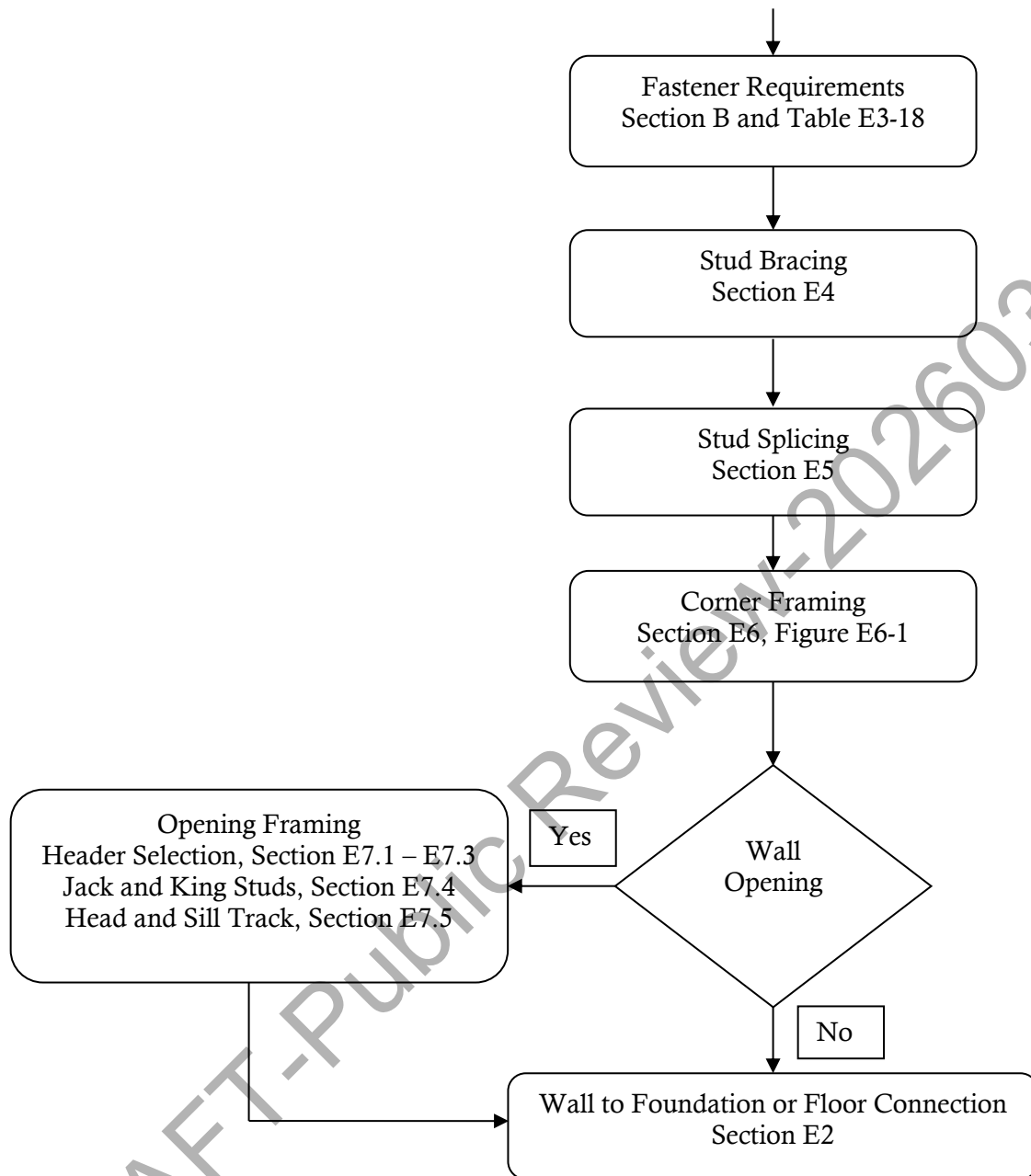
Floor Framing

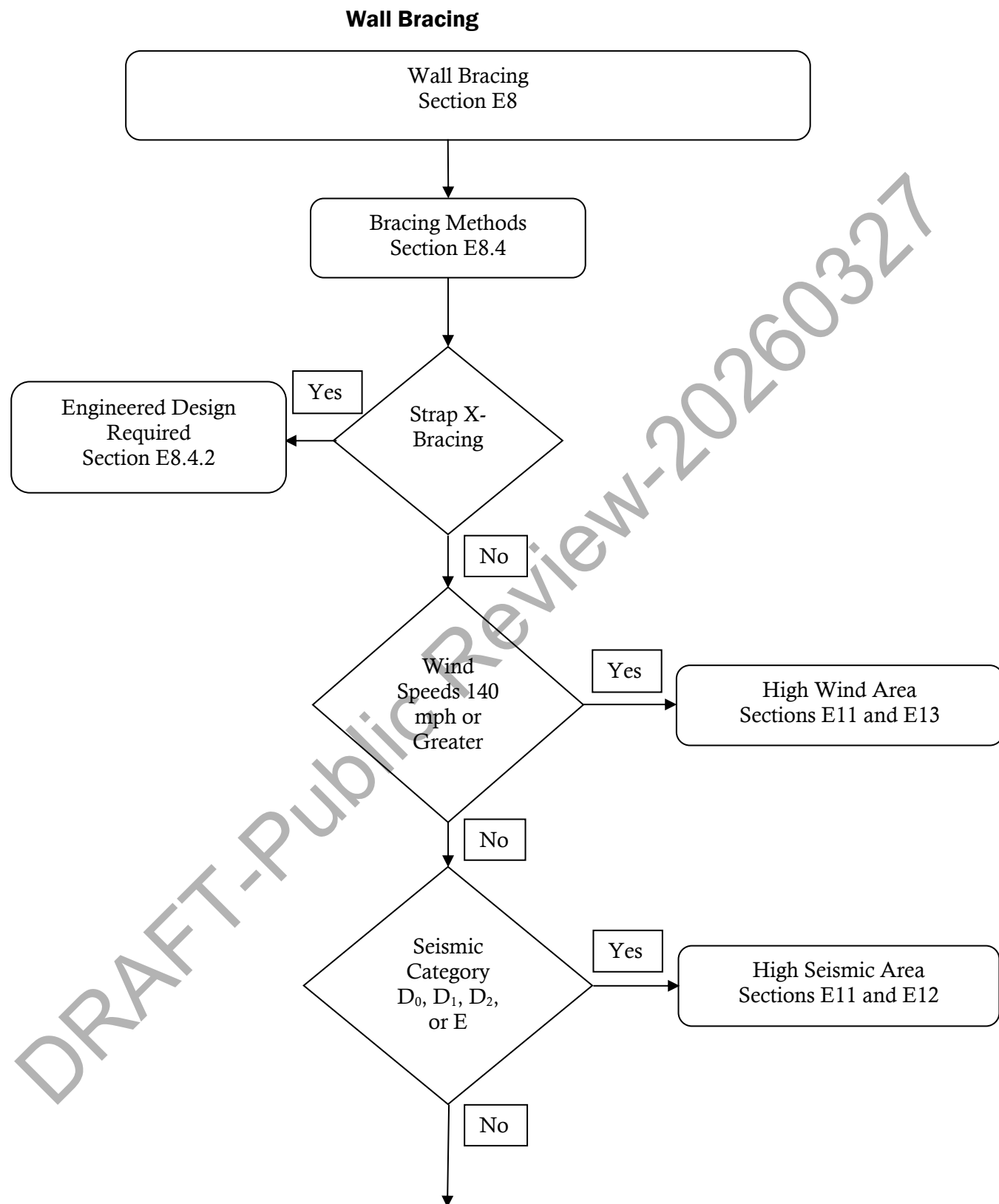




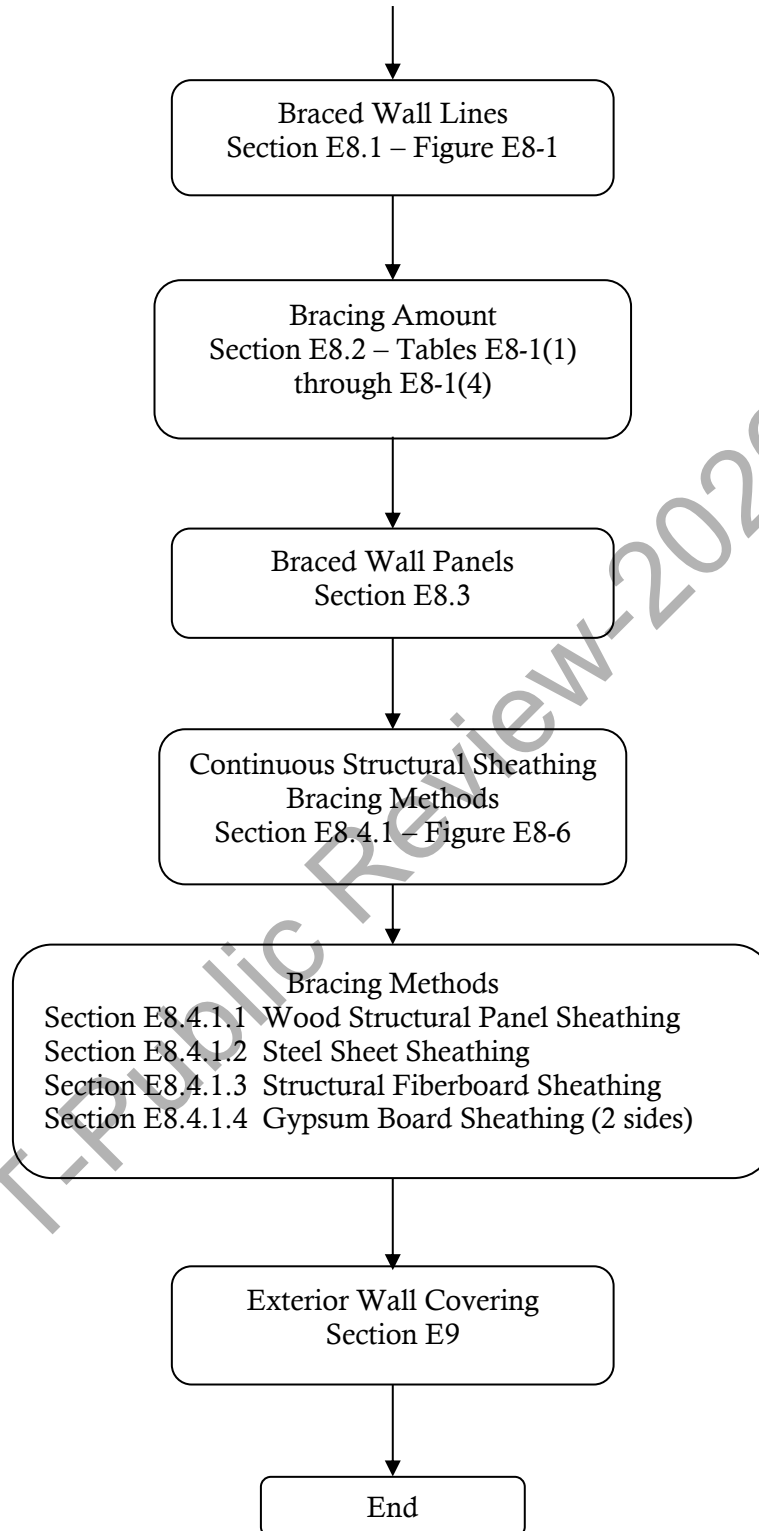
Wall Framing



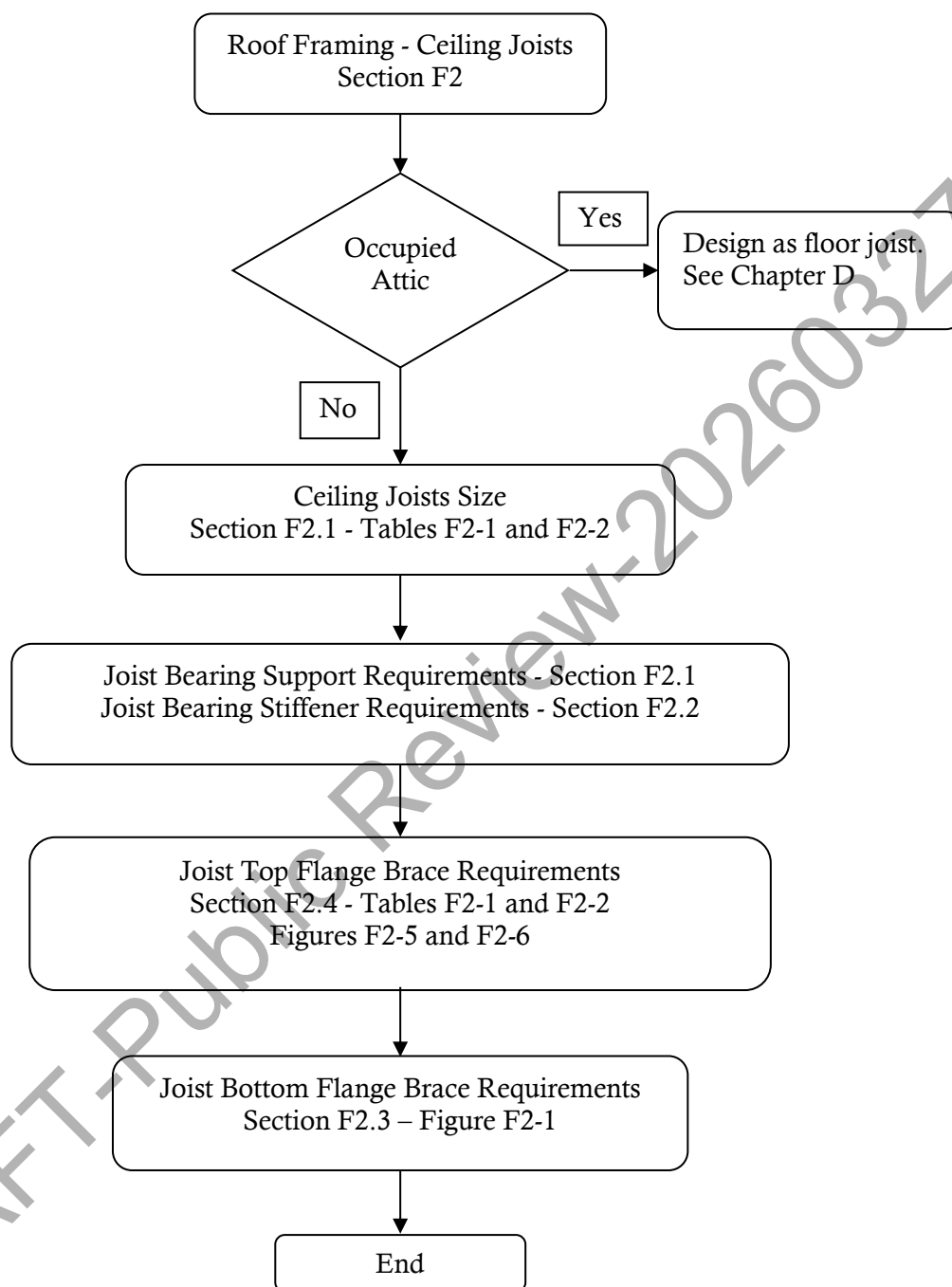




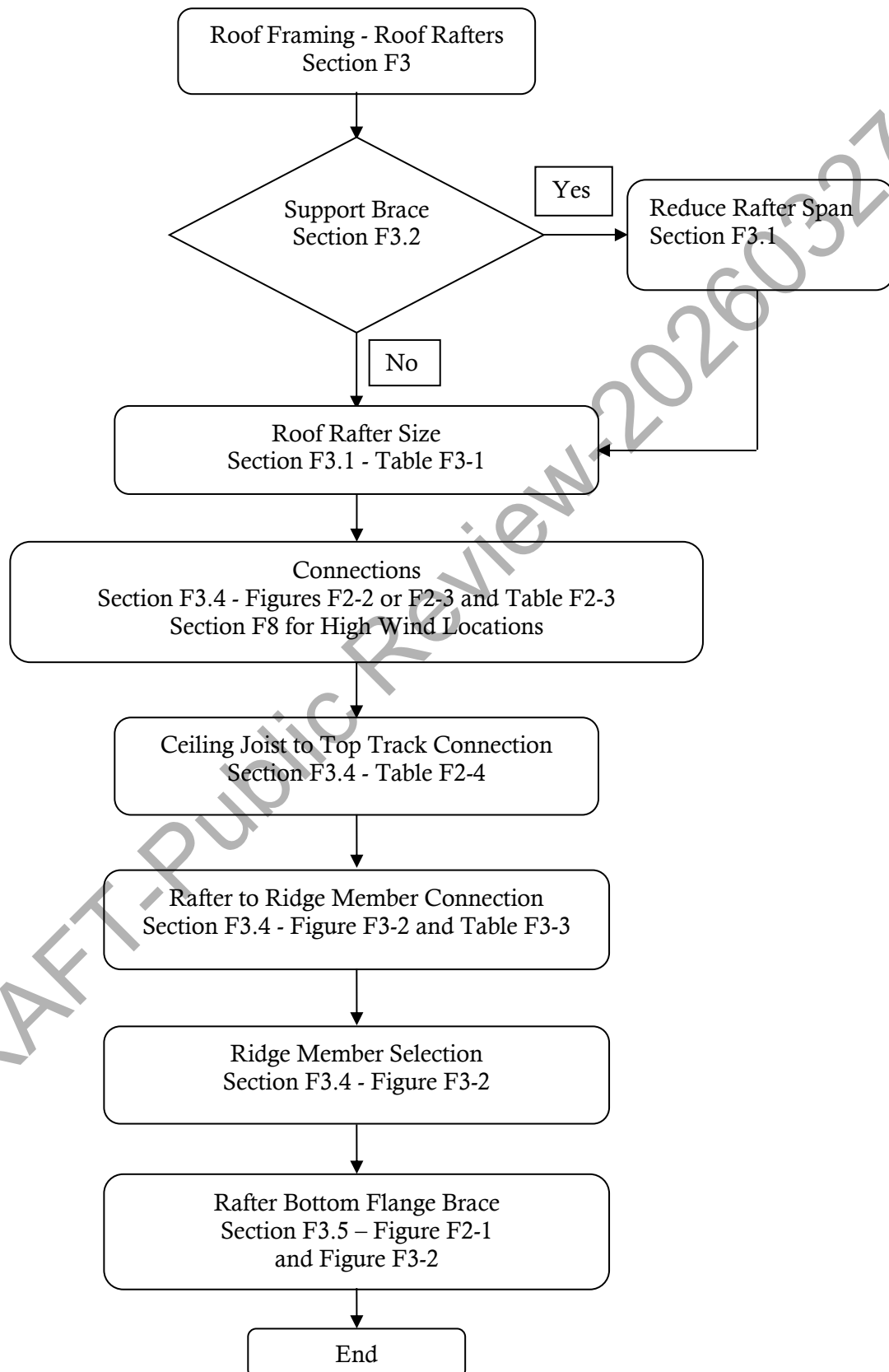
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Roof Framing – Ceiling Joists



Roof Framing – Roof Rafters



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