

CHAPTER 16

RETROFITTING

SECTION 1601 GENERAL

1601.1 Intent and purpose. The provisions of this section provide prescriptive solutions for the retrofitting of gable ends of buildings. The retrofit measures are based on engineering calculations and are intended to provide strengthening of gable ends such that the retrofitted gable ends have strength equal to the structural provisions of the latest building code requirements for new buildings. Design for compliance of new buildings and additions to existing buildings shall conform to the requirements of the *Florida Building Code, Building* or *Florida Building Code, Residential*, as applicable.

1601.2 Scope. The provisions of this chapter are intended to provide prescriptive methods for retrofitting buildings to make them stronger or more durable.

SECTION 1602 DEFINITIONS

ANCHOR BLOCK. A nominal 2-inch (51 mm) thick by at least 4-inch (102 mm) wide piece of lumber secured to horizontal braces and filling the gap between existing framing members for the purpose of restraining horizontal braces from movement perpendicular to the framing members.

COMPRESSION BLOCK. A nominal 2-inch (51 mm) thick by at least 4-inch (102 mm) wide piece of lumber used to restrain in the compression mode (force directed towards the interior of the attic) an existing or retrofit stud. It is attached to a horizontal brace and bears directly against the existing or retrofit stud.

CONVENTIONALLY FRAMED GABLE END. A conventionally framed gable end with studs whose faces are perpendicular to the gable end wall.

HORIZONTAL BRACE. A nominal 2-inch (51 mm) thick by at least 4-inch (102 mm) wide piece of lumber used to restrain both compression and tension loads applied by a retrofit stud. It is typically installed horizontally on the top of floor framing members (truss bottom chords or ceiling joists) or on the bottom of pitched roof framing members (truss top chord or rafters).

HURRICANE TIES. Manufactured metal connectors designed to provide uplift and lateral restraint for roof framing members.

NAIL PLATE. A manufactured metal plate made of minimum 20 gauge galvanized steel with factory-punched holes sized for 8d common nails. A nail plate may have the geometry of a strap.

RETROFIT STUD. A nominal 2-inch (51 mm) lumber member used to structurally supplement an existing gable end wall stud.

RIGHT ANGLE BRACKET. A 14 gage or thicker galvanized metal right angle bracket listed by the manufacturer for the material into which they will be attached, masonry (concrete or CMU) or wood, to have a minimum specified load capacity of 350 pounds (159 kg) for uplift and lateral conditions, when the maximum number of fasteners specified by the manufacturer are used.

STUD-TO-PLATE CONNECTOR. A manufactured metal connector designed to connect studs to plates with a minimum uplift capacity of 500 pounds (227 kg).

TRUSS GABLE END. An engineered factory-made truss or site-built truss that incorporates factory-installed or field-installed vertical studs with their faces parallel to the plane of the truss and are spaced no greater than 24 inches (610 mm) on center. Web or other diagonal members other than top chords may or may not be present. Gable end trusses may be of the same height as nearby trusses or may be drop chord trusses in which the top chord of the truss is lower by the depth of the top chord or outlookers.

SECTION 1603 MATERIALS OF CONSTRUCTION

1603.1 Existing materials. All existing wood materials that will be part of the retrofitting work (trusses, rafters, ceiling joists, top plates, wall studs, etc.) shall be in sound condition and free from defects or damage that substantially reduces the load-carrying capacity of the member. Any wood materials found to be damaged or deteriorated shall be strengthened or replaced with new materials to provide a net dimension of sound wood equivalent to its undamaged original dimensions.

1603.2 New materials. All materials approved by this code, including their appropriate allowable stresses, shall be permitted to meet the requirements of this chapter.

1603.3 Dimensional lumber. All dimensional lumber for braces, studs and blocking shall conform to applicable standards or grading rules. Dimensional lumber shall be identified by a grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with DOC PS 20. All new dimensional lumber to be used for retrofitting purposes shall be a minimum grade and species of #2 Spruce-Pine-Fir or shall have a specific gravity of 0.42 or greater. In lieu of a grade mark, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this code shall be accepted.

1603.4 Metal plate connectors, straps and anchors. Metal plate connectors, plates, straps and anchors shall have product approval. They shall be approved for connecting wood-to-wood or wood-to-concrete as appropriate. Straps and nail plates shall be manufactured from galvanized steel with a minimum thickness of 20 gauge. Nail plates shall have holes sized for a minimum of 8d nails.

1603.5 Twists in straps. Straps shall be permitted to be twisted 90-degrees (1.57 rad) in addition to a 90-degree (1.57 rad) bend where they transition between framing members or connection points. Straps shall be bent only once at a given location though it is permissible that they be bent or twisted at multiple locations along their length.

1603.6 Fasteners. Fasteners shall meet the requirements of Sections 1603.6.1 and Section 1603.6.2, and shall be permitted to be screws or nails meeting the minimum length requirement shown in figures and specified in tables. Fastener spacing shall meet the requirements of Section 1603.6.3.

1603.6.1 Screws. Screws shall be a minimum #8 size with head diameters no less than 0.28 inches (7.1 mm). Screw lengths shall be no less than indicated in the figures and in tables. Permissible screws include deck screws and wood screws. Screws shall have at least 1 inch (25 mm) of thread. Fine threaded screws or drywall screws shall not be permitted. Select the largest possible diameter screw such that the shank adjacent to the head fits through the hole in the strap.

1603.6.2 Nails. Unless otherwise indicated in the provisions or drawings, where fastener lengths are indicated in figures and tables as 1¹/₄ inches (32 mm), 8d common nails with shank diameter 0.131 inches (3.3 mm) and head diameters no less than 0.28 inches (7.1 mm) shall be permitted. Unless otherwise indicated in the provisions or drawings, where fastener lengths are indicated in figures and tables as 3 inches (76 mm), 10d common nails with shank diameter

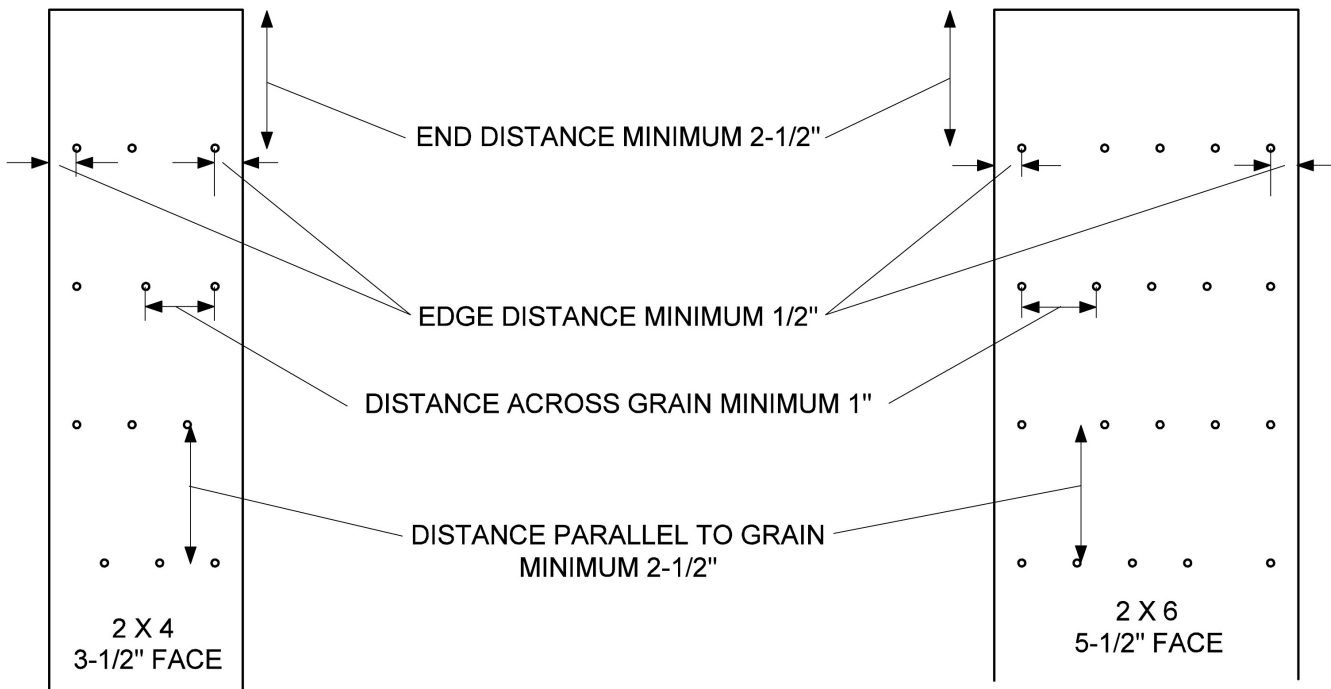
of 0.148 inches (3.8 mm) and head diameters no less than 0.28 inches (7.1 mm) shall be permitted.

1603.6.3 General fastener spacing. Fastener spacing for shear connections of lumber-to-lumber shall meet the requirements shown in Figure 1603.6.3 and the following conditions.

1603.6.3.1 General fastener spacing. Fastener spacing shall meet the following conditions except as provided for in Section 1603.6.3.3.

1. The distance between fasteners and the edge of lumber that is less than 3¹/₂ inches (89 mm) deep in the direction of the fastener length shall be a minimum of ³/₄ inches (19 mm).
2. The distance between fasteners and the edge of lumber that is more than 2 inches (51 mm) thick in the direction of the fastener length shall be a minimum of ¹/₂ inch (12.7 mm).
3. The distance between a fastener and the end of lumber shall be a minimum of 2¹/₂ inches (64 mm).
4. The distance between fasteners parallel to the grain (center-to-center) shall be a minimum of 2¹/₂ inches (64 mm).
5. The distance between fasteners perpendicular to the grain (center-to-center) in lumber that is less

**FASTENER SPACINGS FOR LUMBER TO LUMBER CONNECTIONS
OPERATING IN SHEAR PARALLEL TO GRAIN**



**FIGURE 1603.6.3
FASTENER SPACINGS FOR LUMBER TO LUMBER CONNECTIONS OPERATING IN SHEAR PARALLEL TO GRAIN**

than 3½ inches (89 mm) deep in the direction of the fastener length shall be 1 inch (25 mm).

6. The distance between fasteners perpendicular to the grain (center-to-center) in lumber that is more than 2 inches (51 mm) thick in the direction of the fastener length shall be ½ inch (12.7 mm).

1603.6.3.2 Wood-to-wood connections of two members each 2 inch or less thick. Wood-to-wood connections fastener spacing shall meet the following conditions.

1. The distance between fasteners parallel to grain (center-to-center) shall be a minimum of 2½ inches (64 mm).
2. The distance between fasteners across grain (center-to-center) shall be a minimum of 1 inch (25 mm).
3. For wood-to-wood connections of lumber at right angles, fasteners shall be spaced a minimum of 2½ inches (64 mm) parallel to the grain and 1 inch (25 mm) perpendicular to the grain in any direction.

1603.6.3.3 Metal connectors to wood connections. Metal connectors to wood connections shall meet the following conditions.

1. Fastener spacing to edge or ends of lumber shall be as dictated by the prefabricated holes in the connectors and the connectors shall be installed in a configuration that is similar to that shown by the connector manufacturer.
2. Fasteners in metal straps 1¼ inch (32 mm) wide that are installed on the 1½ inch (38 mm) broad face of lumber shall be a minimum ¼ inch (6.4 mm) from either face that is perpendicular to the 1½ inch (38 mm) edge of the lumber. Consistent with Section 1603.6.3.1 fasteners shall be allowed to be spaced according to the fastener holes provided in the strap.
3. Fasteners in metal nail plates shall be spaced a minimum of ½ inch (12.7 mm) across wood grain and a minimum of 1½ inches (38 mm) parallel to wood grain.

SECTION 1604 RETROFITTING GABLE END WALLS

1604.1 General.

1604.1.1 Scope and intent. The following prescriptive methods are intended for applications where the gable end wall framing is provided by a wood gable end wall truss or a conventionally framed rafter system. The retrofits are appropriate for wall studs oriented with their broad face parallel to or perpendicular to the gable end surface. Gable ends to be strengthened shall be permitted to be retrofitted using methods prescribed by provisions of this section. These prescriptive methods of retrofitting are intended to increase the resistance of existing gable end construction for out-of-plane wind loads resulting from high wind events. The retrofit

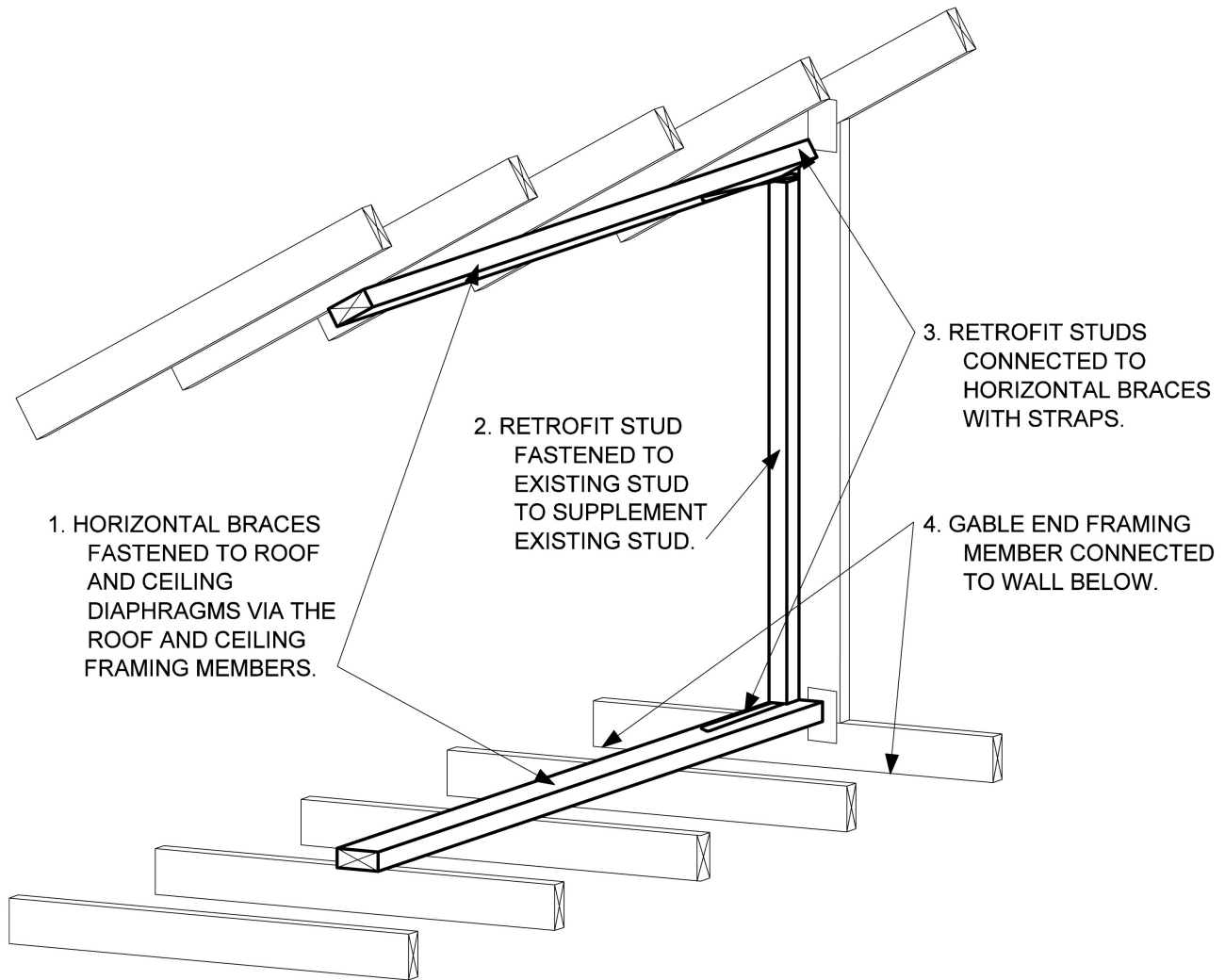
method addresses four issues by strengthening the framing members of the gable end itself with the use of retrofit studs (Section 1604.3), bracing the top and bottom of the gable end so that lateral loads are transmitted into the roof and ceiling diaphragms by the use of horizontal braces (Section 1604.2), making connections between horizontal braces and retrofit studs by the use of straps (see Section 1604.4), and connecting the bottom of the gable end to the wall below to help brace the top of that wall by the use of right angle brackets (Section 1604.5). The minimum ceiling diaphragm shall be comprised of minimum ½-inch (12.7 mm) thick drywall, minimum ⅜-inch (9.5 mm) thick plywood, or plaster. An overview isometric drawing of one kind of retrofit is shown in Figure 1604.1.1.

1604.2 Horizontal braces. Horizontal braces shall be installed approximately perpendicular to the roof and ceiling framing members at the location of each existing gable end stud greater than 3 feet (914 mm) in length. Unless it is adjacent to an omitted horizontal brace location, horizontal braces shall be minimum 2 by 4 dimensional lumber as defined in Section 1603.3. A single horizontal brace is required at the top and bottom of each gable end stud for Retrofit Configuration A, B or C and two horizontal braces are required for Retrofit Configuration D. Maximum heights of gable end wall studs and associated retrofit studs for each retrofit configuration shall not exceed the values listed in Table 1604.2. Horizontal braces shall be oriented with their broad faces across the roof or ceiling framing members be fastened to a minimum of three framing members and extend at least 6 feet (1829 mm) measured perpendicularly from the gable end plus 2½ inches (64 mm) beyond the last top chord or bottom chord member (rafter or ceiling joist) from the gable end as shown in Figures 1604.2(1), 1604.2(2), 1604.2(3) and 1604.2(4).

1604.2.1 Existing gable end studs. If the spacing of existing vertical gable end studs is greater than 24 inches (610 mm), a new stud and corresponding horizontal braces shall be installed such that the maximum spacing between existing and added studs shall be no greater than 24 inches (610 mm). Additional gable end wall studs shall not be required at locations where their length would be 3 feet (914 mm) or less. Each end of each required new stud shall be attached to the existing roofing framing members (truss top chord or rafter and truss bottom chord or ceiling joist) using a minimum of two 3-inch (76 mm) toenail fasteners (#8 wood screws or 10d nails) and a metal connector with minimum uplift capacity of 175 pounds (79 kg), or nail plates with a minimum of four 1¼-inch (32 mm) long fasteners (#8 wood screws or 8d nails).

1604.2.2 Main method of installation. Each horizontal brace shall be fastened to each existing roof or ceiling member that it crosses using three 3-inch (76 mm) long fasteners (#8 wood screws or 10d nails) as indicated in Figures 1604.2(1) and 1604.2.3 for trusses and Figures 1604.2(2) and 1604.2(4) for conventionally framed gable end walls. Alternative methods for providing horizontal bracing of the gable end studs as provided in Sections 1604.2.3 through 1604.2.9 shall be allowed in lieu of this primary installation method.

BASIC GABLE END RETROFIT METHODOLOGY



THIS FIGURE SHOWS A TRUSS GABLE END.
 THE METHODOLOGY FOR A CONVENTIONALLY FRAMED GABLE END IS SIMILAR.
 THE NUMBERS INDICATE A TYPICAL SEQUENCE OF INSTALLATION.
 IN ORDER TO SHOW STRAPS COMPRESSION BLOCKS ARE NOT SHOWN.

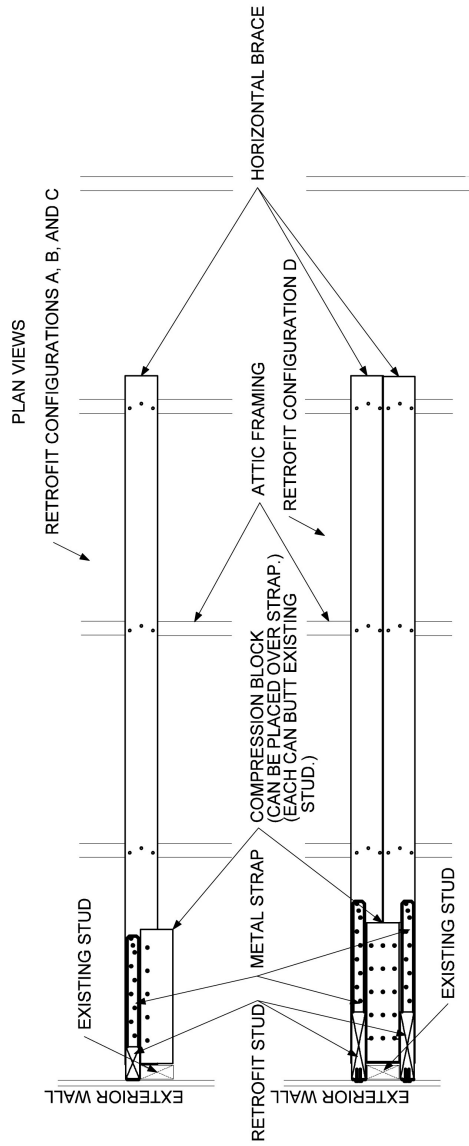
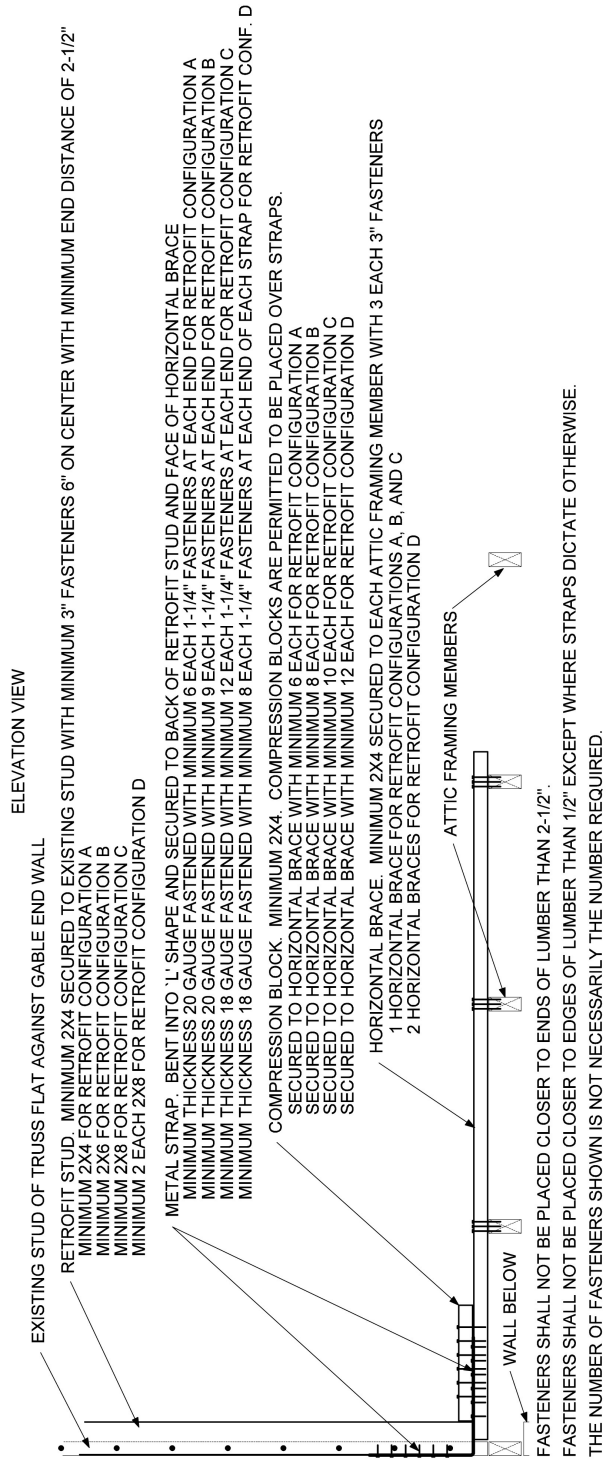
FIGURE 1604.1.1
 BASIC GABLE END RETROFIT METHODOLOGY

**TABLE 1604.2
STUD LENGTH LIMITATIONS BASED ON EXPOSURE AND DESIGN WIND SPEED**

EXPOSURE CATEGORY	MAXIMUM V_{asd} ^{a, d}	MAXIMUM HEIGHT OF GABLE END RETROFIT STUD ^b			
		A	B	C	D
C	110	8'-0"	11'-3"	14'-9"	16'-0"
C	120	7'-6"	10'-6"	13'-6"	16'-0"
C	130	7'-0"	10'-0"	12'-3"	16'-0"
C	140	7'-0"	10'-0"	12'-3"	16'-0"
C	150	6'-6"	8'-9"	11'-0"	16'-0"
B	110	8'-0"	12'-3"	16'-0"	N/R ^c
B	120	8'-0"	11'-3"	14'-9"	16'-0"
B	130	8'-0"	11'-3"	14'-9"	16'-0"
B	140	7'-6"	10'-6"	13'-6"	16'-0"
B	150	7'-0"	10'-0"	12'-3"	16'-0"
Retrofit Configuration —>		A	B	C	D

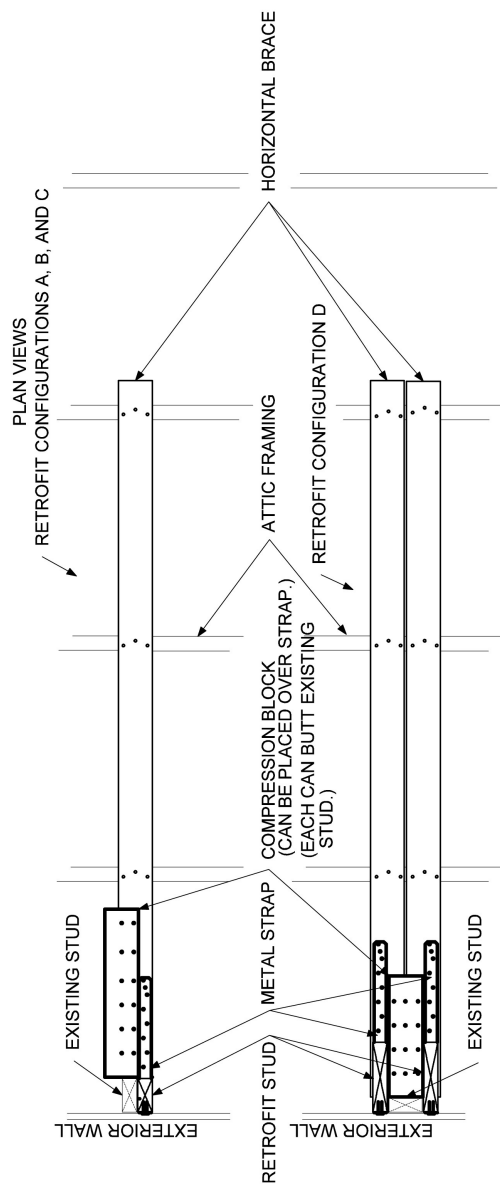
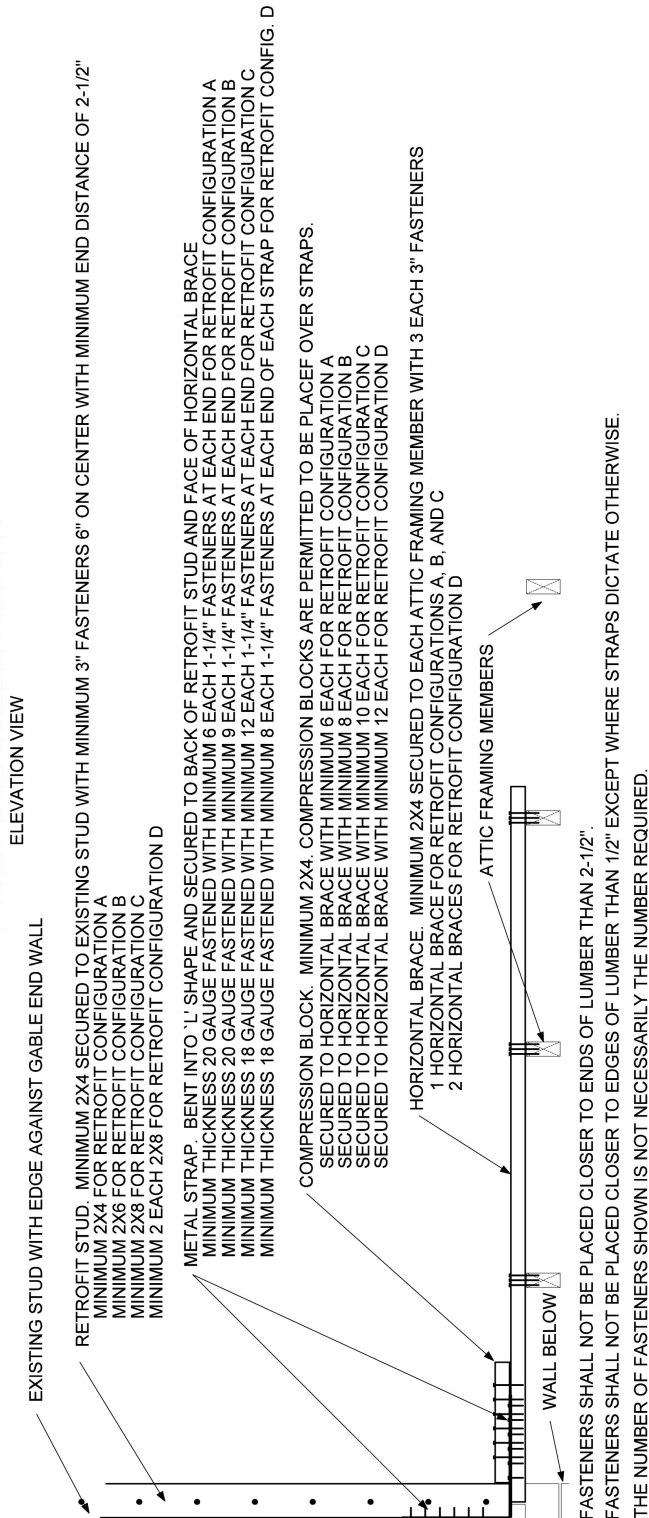
For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm.

- a. Interpolation between given wind speeds not permitted.
- b. Existing gable end studs less than or equal to 3'-0" in height shall not require retrofitting.
- c. N/R = Not Required. Configuration C is acceptable to 16'-0" maximum height.
- d. V_{asd} shall be determined in accordance with Section 1609.3.1 of the *Florida Building Code, Building* or Section R301.2.1.3 of the *Florida Building Code, Residential*.



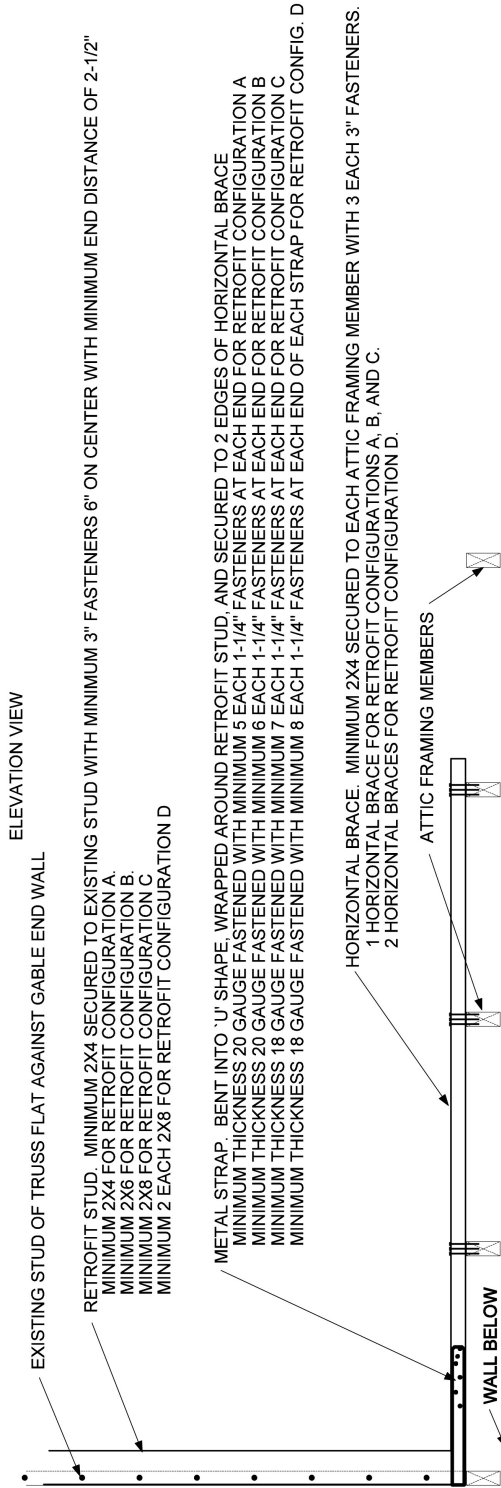
For SI: 1 inch = 25.4 mm.

FIGURE 1604.2(1)
TRUSS FRAMED GABLE END L-BENT STRAP

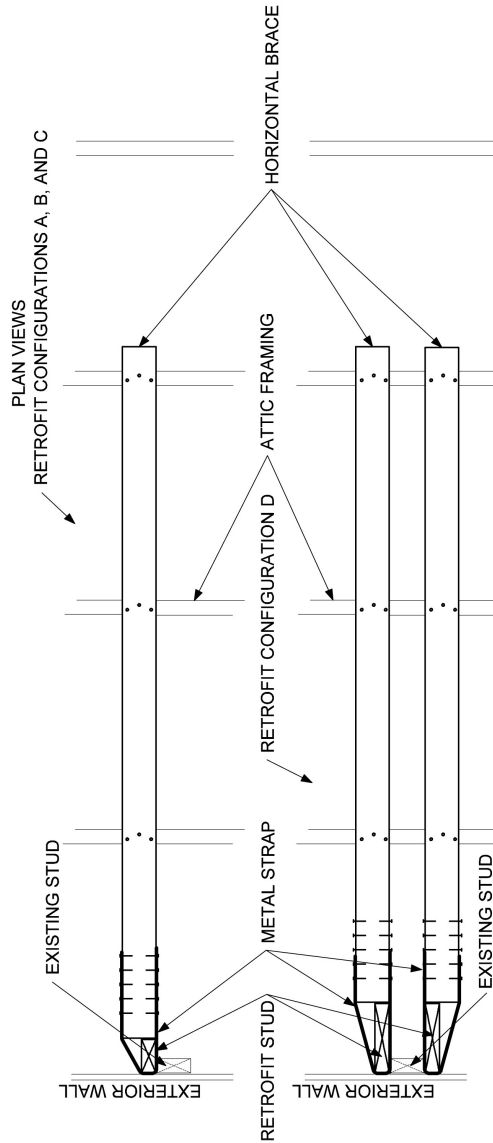


For SI: 1 inch = 25.4 mm.

FIGURE 1604.2(2)
 CONVENTIONALLY FRAMED GABLE END L-BENT STRAP

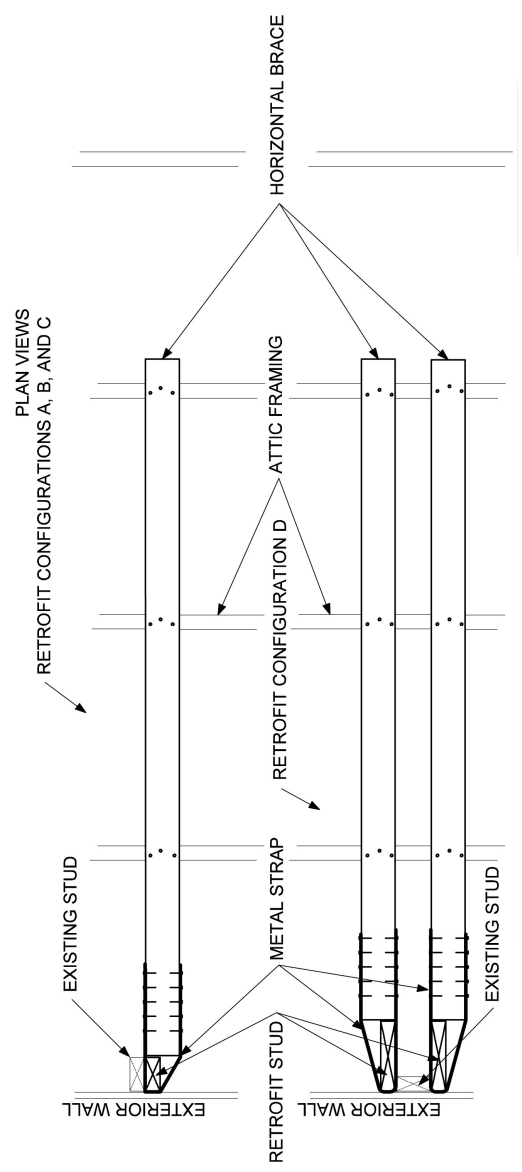
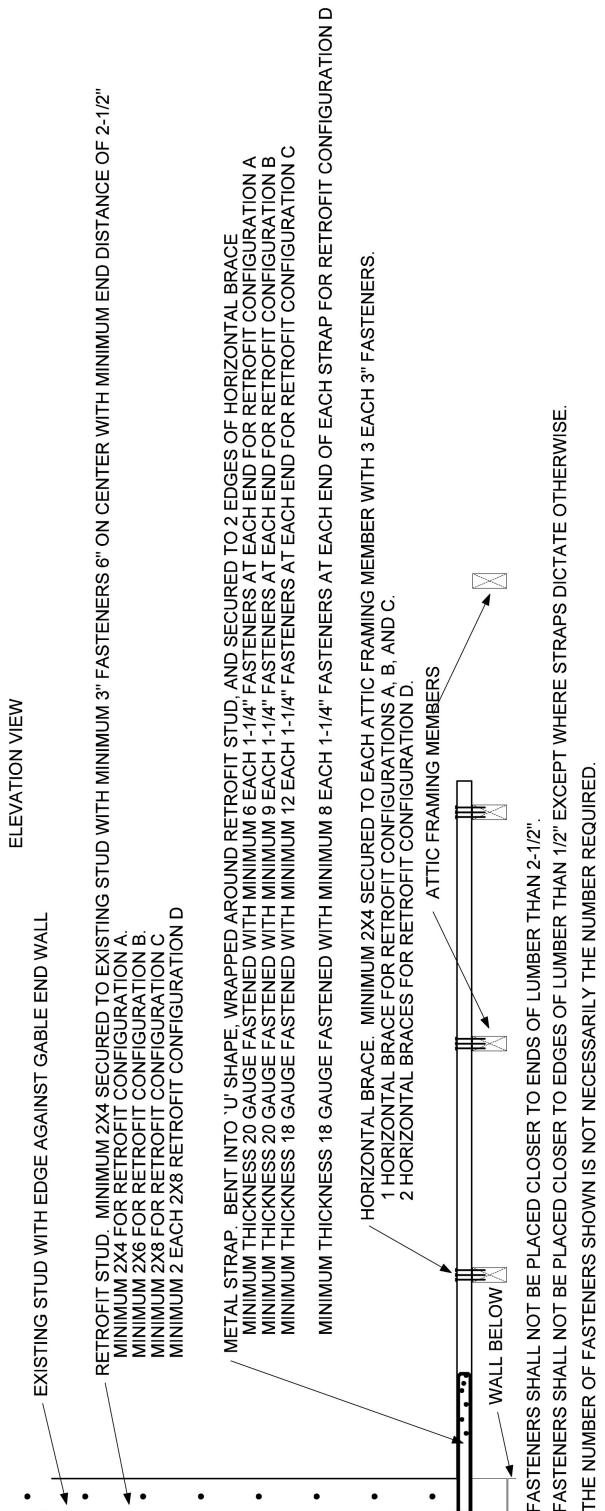


FASTENERS SHALL NOT BE PLACED CLOSER TO ENDS OF LUMBER THAN 2-1/2".
 FASTENERS SHALL NOT BE PLACED CLOSER TO EDGES OF LUMBER THAN 1/2" EXCEPT WHERE STRAPS DICTATE OTHERWISE.
 THE NUMBER OF FASTENERS SHOWN IS NOT NECESSARILY THE NUMBER REQUIRED.



For SI: 1 inch = 25.4 mm.

FIGURE 1604.2(3)
 TRUSS FRAMED GABLE END U-BENT STRAP



For SI: 1 inch = 25.4 mm.

FIGURE 1604.2(4)
 CONVENTIONALLY FRAMED GABLE END U-BENT STRAP

1604.2.3 Omitted horizontal brace. Where impediments, other permanently attached obstacles or conditions exist that prevent installation in accordance with Section 1604.2.2, horizontal braces may be omitted for height limitations corresponding to Retrofit Configurations A and B as defined in Table 1604.2, provided installation is as indicated in Figure 1604.2.3 and provided all of the following conditions are met. This method is not allowed for Retrofit Configurations C or D.

1. There shall be at least two horizontal braces on each side of an omitted horizontal brace or at least one horizontal brace if it is the end horizontal brace. Omitted horizontal braces must be separated by at least two horizontal braces even if that location is comprised of two retrofit studs and two horizontal braces.
2. Horizontal braces adjacent to the omitted horizontal brace shall be 2 by 6 lumber, shall butt against the existing studs and shall be fastened to each existing roof or ceiling member that it crosses using three 3-inch (76 mm) long fasteners (#8 wood screws or 10d nails). For Retrofit Configuration B, four fasteners shall be required on at least one of the connections between the horizontal brace and the existing roof and ceiling framing members. Fasteners shall be spaced a minimum of $\frac{3}{4}$ inch (19 mm) from the edges of the horizontal braces and a minimum of $1\frac{3}{4}$ inches (45 mm) from adjacent fasteners.
3. Where the existing studs on each side of an omitted horizontal brace have their broad face parallel to the gable end wall, the retrofit studs at those locations and the retrofit stud at the omitted horizontal brace locations shall be 2 by 6 lumber for Retrofit Configuration A and 2 by 8 lumber for Retrofit Configuration B.
4. Where the existing studs on each side of an omitted horizontal brace have their broad face perpendicular to the gable end wall, the retrofit studs at those locations and the retrofit stud at the omitted horizontal brace locations shall be sized such that they protrude a minimum of $3\frac{1}{2}$ inches (89 mm) beyond the interior edge of the existing studs for both Retrofit Configurations A and B. The edges of the three retrofit studs facing towards the interior of the attic shall be aligned such that they are the same distance from the gable end wall.
5. Retrofit studs shall be fastened to existing studs in accordance with Section 1604.3.
6. Retrofit studs adjacent to the omitted horizontal brace shall be fastened to the horizontal brace using straps in accordance with Table 1604.4.1 consistent with the size of the retrofit stud. The method applicable to Table 1604.4.2 is not allowed.
7. A strong back made of minimum of 2 by 8 lumber shall be placed parallel to the gable end and shall be located on and span between horizontal braces on the two sides of the omitted horizontal brace and shall extend beyond each horizontal brace by a mini-

imum of $2\frac{1}{2}$ inches (64 mm). The strong back shall be butted to the three retrofit studs. The strong back shall be attached to each of the horizontal braces on which it rests with five each 3-inch (76 mm) long fasteners (#8 screws or 8d nails). Those fasteners shall be spaced a minimum of $\frac{3}{4}$ inch (19 mm) from any edge of lumber and shall be spaced a minimum of $2\frac{1}{2}$ inches (64 mm) from each other. Additional compression blocks shall not be required at locations where a strong back butts against a retrofit stud.

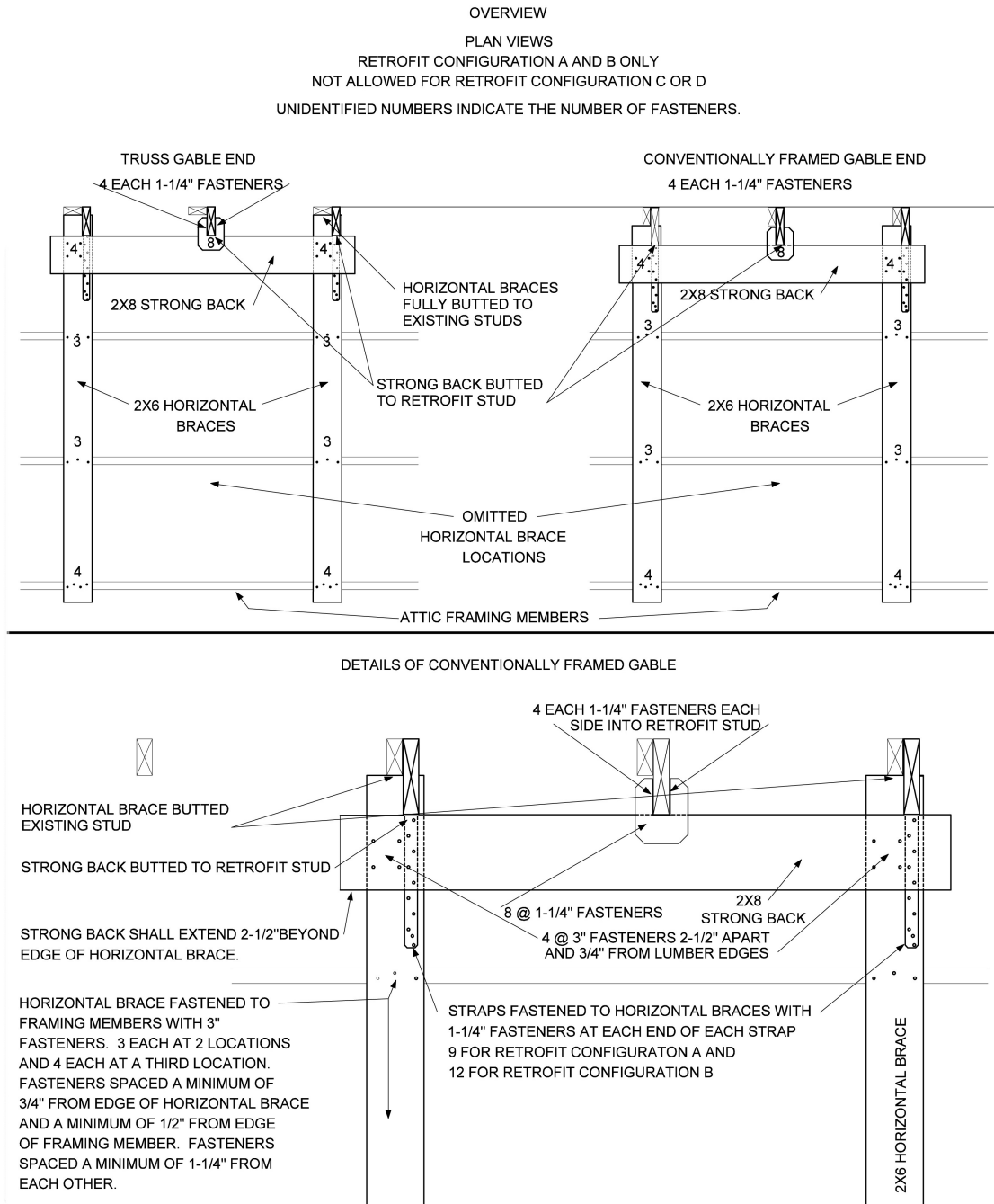
8. The retrofit stud at the location of the omitted horizontal braces shall be fastened to the strong back using a connector with minimum uplift capacity of 800 pounds (363 kg) and installed such that this capacity is oriented in the direction perpendicular to the gable end wall.
9. The use of shortened horizontal braces using the alternative method of Section 1604.2.5 is not allowable for horizontal braces adjacent to the omitted horizontal braces.
10. Horizontal braces shall be permitted to be interrupted in accordance with Section 1604.2.8.

1604.2.4 Omitted horizontal brace and retrofit stud.

Where impediments, other permanently attached obstacles or conditions exist that prevent installation in accordance with Section 1604.2.2 or Section 1604.2.3 by not permitting installation of horizontal braces, retrofit studs and horizontal braces shall be permitted to be omitted from those locations by installation of ladder assemblies for Retrofit Configurations A and B as defined in Table 1604.2 provided all of the following conditions are met. This method is not allowed for Retrofit Configurations C or D.

1. No more than two ladder assemblies are permitted on a single gable end.
2. There shall be at least two retrofit studs and horizontal brace assemblies on either side of the locations where the retrofit studs and horizontal bracing members are omitted (no two ladder braces bearing on a single retrofit stud).
3. Retrofit studs immediately on each side of the omitted retrofit stud shall be increased to the member size corresponding to the next higher Retrofit Configuration indicated in Table 1604.4.1 or Table 1604.4.2 and fastened to the horizontal braces as indicated in that table for the larger member size.
4. Horizontal braces adjacent to the omitted horizontal brace shall be 2 by 6 lumber and be fastened to each existing roof or ceiling member crossed using three 3-inch (76 mm) long fasteners (#8 wood screws or 10d nails) as indicated in Figures 1604.2(1) and 1604.2(3) for trusses and Figures 1604.2(2) and 1604.2(4) for conventionally framed gable end wall. For Retrofit Configuration B, four fasteners shall be required on at least one of the connections between the horizontal brace and the existing roof and ceiling framing members.

5. Ladder rungs shall be provided across the location of the omitted retrofit studs as indicated in Figure 1604.2.4(1) for trusses and Figure 1604.2.4(2) for conventionally framed gable end walls.
6. Ladder rungs shall be made of a minimum 2 by 4 lumber oriented with their broad face horizontal and spaced a maximum of 16 inches (406 mm) on center vertically.
7. Where ladder rungs cross structural members such as the existing stud at the omitted retrofit stud location or gable end vent framing they shall be connected to each other with a metal connector with a minimum capacity of 175 pounds (79 kg) in the direction perpendicular to the gable end wall.
8. Notching of the ladder rungs shall not be permitted unless the net depth of the framing member is a minimum of 3 1/2 inches (89 mm).



For SI: 1 inch = 25.4 mm.

FIGURE 1604.2.3
OMITTED HORIZONTAL BRACE

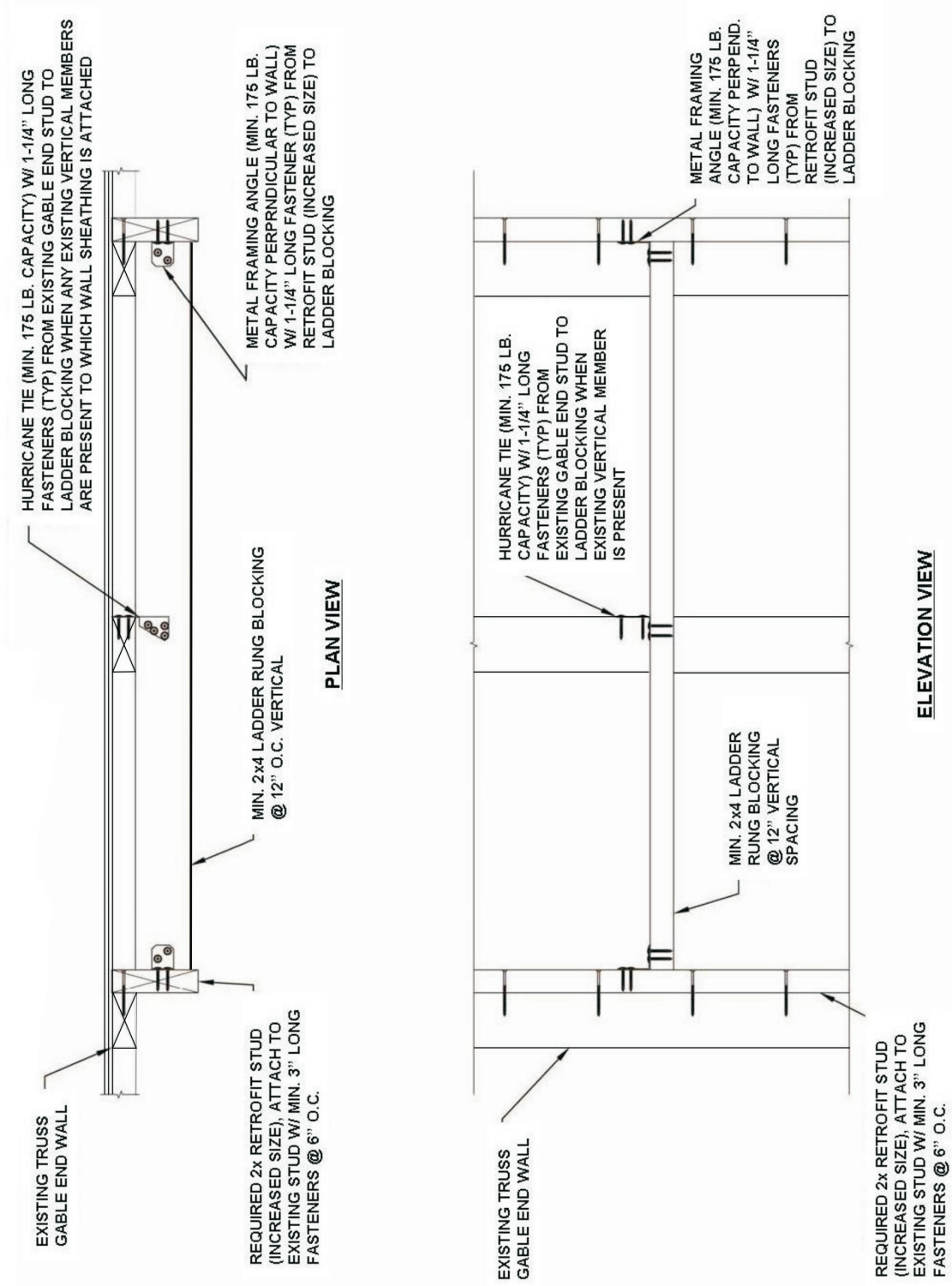


FIGURE 1604.2.4(1)
 DETAIL OF LADDER BRACING FOR OMITTED RETROFIT STUD (TRUSS GABLE END)

For SI: 1 inch = 25.4 mm; 1 pound = 0.454 kg.

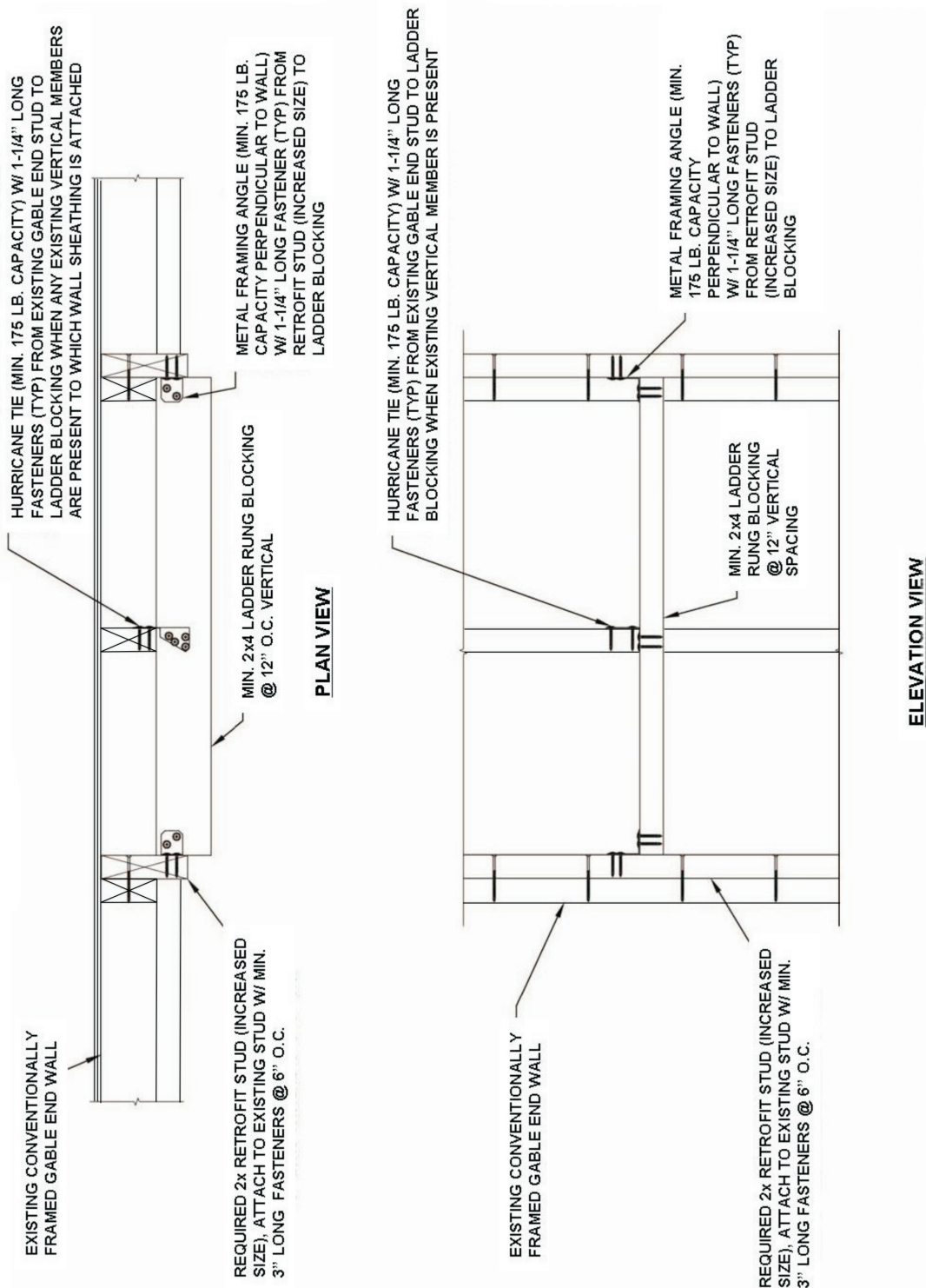


FIGURE 1604.2.4(2) DETAIL OF LADDER BRACING FOR OMITTED RETROFIT STUD (CONVENTIONAL FRAMING)

For SI: 1 inch = 25.4 mm; 1 pound = 0.454 kg.

1604.2.5 Short horizontal brace. Where impediments, other permanently attached obstacles or conditions exist that prevent installation in accordance with Section 1604.2.2, 1604.2.3 or 1604.2.4 by not permitting extension of horizontal braces across the existing framing members such that they can be fastened to a minimum of three framing members and extend at least 6 feet (1829 mm) from the gable end wall plus 2½ inches (64 mm) beyond the last roof or ceiling framing member, the horizontal braces may be shortened provided installation is as indicated in Figure 1604.2.5 and provided that all of the following conditions are met.

1. The horizontal brace shall be installed across a minimum of two framing spaces, extend a minimum of 4 feet (1219 mm) from the gable end wall plus 2½ inches (64 mm) beyond the last roof or ceiling framing member, and be fastened to each existing framing member with three 3-inch (76 mm) long fasteners (#8 wood screws or 10d nails).
2. An anchor block shall be fastened to the side of the horizontal brace in the second framing space from the gable end wall as shown in Figure 1604.2.5. The anchor block lumber shall have a minimum edge thickness of 1½ inches (38 mm) and the depth shall be as a minimum the depth of the existing roof or ceiling framing member. Six 3-inch (76 mm) long fasteners (#8 wood screws or 10d nails) shall be used to fasten the anchor block to the side of the horizontal brace.
3. The anchor block shall extend into the space between the roof or ceiling framing members a minimum of one-half the depth of the existing framing members at the location where the anchor block is installed. The anchor block shall be installed tightly between the existing framing members such that the gap at either end shall not exceed ⅛ inch (3.2 mm).
4. The use of omitted horizontal braces using the method of Section 1604.2.3 is not allowable.

1604.2.6 Installation of horizontal braces onto webs or vertical members of trusses. Where existing conditions preclude installation of horizontal braces on truss top or bottom chords, they shall be permitted to be installed on truss webs or vertical members of trusses provided all of the following conditions are met.

1. Horizontal braces shall be installed as close to the top or bottom chords as practical without altering the truss or any of its components and not more than three times the depth of the truss member to which it would ordinarily be attached.
2. A racking block, comprised of an anchor block meeting the definition of “Anchor block” in Section 1602 or comprised of minimum 15/32 inch (11.9 mm) plywood or 7/16 inch (11.1 mm) OSB, shall be fastened to the horizontal brace in the second framing space from the gable end wall. The racking block shall extend toward the diaphragm (roof or ceiling as appropriate) so that the edge of the racking block closest to the diaphragm is within one-half the depth of the existing framing member from the diaphragm surface. They

shall be attached to horizontal braces using six fasteners (#8 wood screws or 10d nails) of sufficient length to provide 1½ inches (38 mm) of penetration into the horizontal brace.

3. Racking blocks can be fastened to any face or edge of horizontal braces between each web or truss vertical posts to which a horizontal brace is attached. Racking blocks can be on alternate sides of horizontal braces. Racking blocks shall be installed tightly between the lumber of truss members or truss plates such that the gap at either end shall be a maximum of ⅛ inch (3.2 mm).

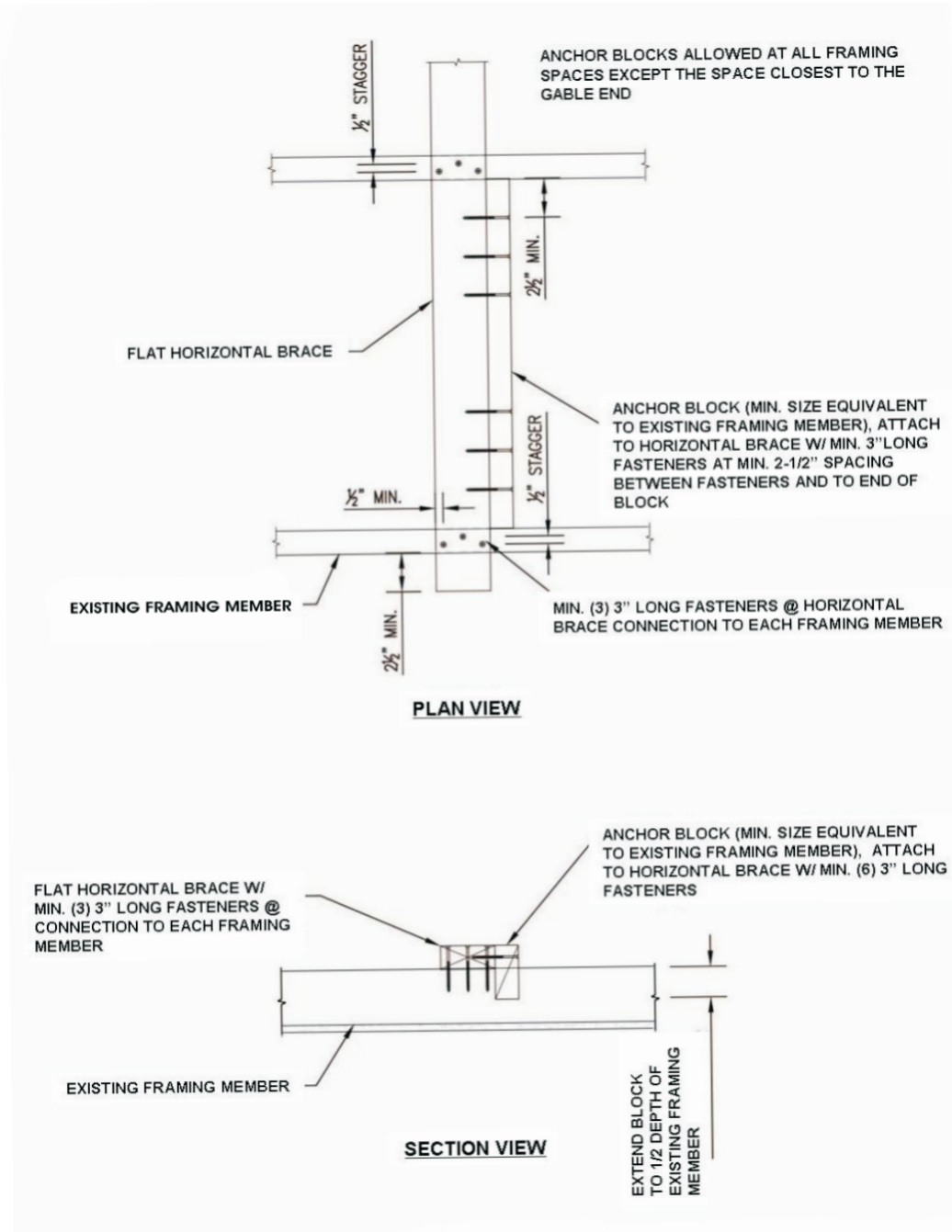
1604.2.7 Alternative method of installation of horizontal braces at truss ridges. Where impediments such as truss plates or access for installation of fasteners limits or restricts installation of horizontal braces near the peak of the roof, ridge ties may be added to provide support for the required horizontal brace. The top of added ridge tie members shall be installed a maximum of 16 inches (406 mm) below the existing ridge line or 4 inches (102 mm) below impediments. The added ridge tie members shall be installed across a minimum of three bays, but no less than 6 feet (1829 mm) from the gable end wall plus 2½ inches (64 mm) beyond the last roof or ceiling framing member to permit fastening of the horizontal brace. A minimum of a 2 by 4 member shall be used for each ridge tie and fastening shall consist of two 3-inch (76 mm) long wood screws, four 3 inch (76 mm) long 10d nails or two 3½ inch (89 mm) long 16d nails driven through and clinched at each top chord or web member intersected by the ridge tie as illustrated in Figure 1604.2.7.

1604.2.8 Interrupted horizontal braces. Where impediments, other permanently attached obstacles or conditions exist that prevent installation of horizontal braces in accordance with Section 1604.2.2 by preventing the installation of a single continuous horizontal brace then horizontal braces shall be permitted to be interrupted using the methods shown in Figures 1604.2.8(1), 1604.2.8(2) and 1604.2.8(3). For interruptions that occur in the attic framing space closest to the gable end, nine 3-inch (76 mm) fasteners shall be used to connect each section of the interrupted horizontal braces. For interruptions that occur in the second attic space from the gable end, six 3-inch (76 mm) fasteners shall be used to connect each section of the interrupted horizontal braces. For interruptions that occur in the attic framing space farthest from the gable end, three 3-inch (76 mm) fasteners shall be used to connect each section of the interrupted horizontal braces. Horizontal braces shall be continued far enough to allow connections to three existing roof framing members as shown in Figure 1604.2.8(1), 1604.2.8(2) or 1604.2.8(3). Fasteners shall be spaced in accordance with Section 1604.3.6. Lumber members used to form horizontal braces shall be the same width and depth as required for an uninterrupted member.

1604.2.9 Piggyback trusses. Piggyback trusses (trusses composed of two members one above the other) shall be permitted to be retrofitted if either of the following cases is true.

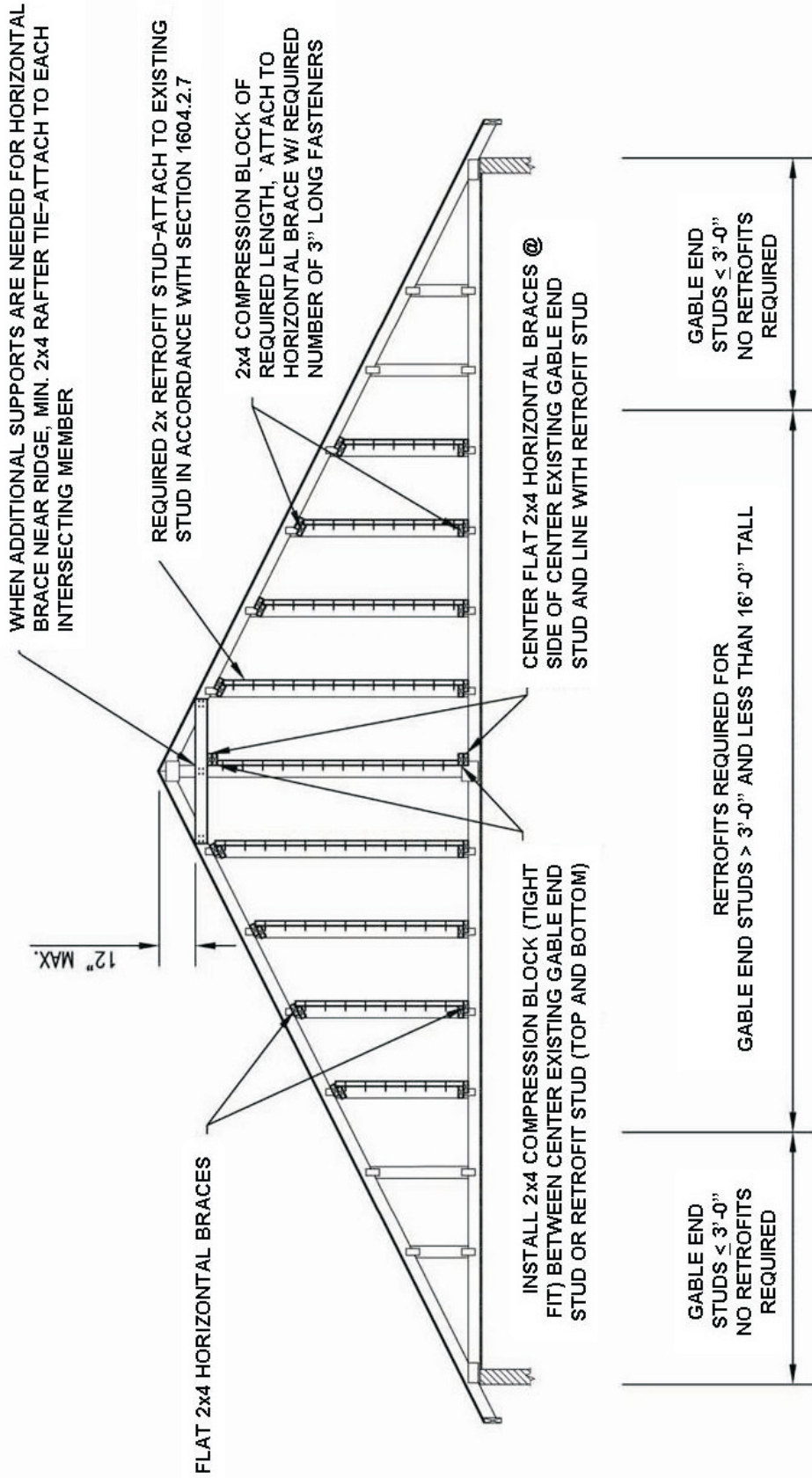
1. The existing studs in both the upper truss and the lower truss to which wall sheathing, panel siding, or other wall facade are attached are sufficiently in line that retrofit studs can be installed and connections made between the two with retrofit stud(s).
2. The same as condition 1 except the studs in the upper truss are not sufficiently in line with ones below and the existing studs in the upper truss are 3 feet (914 mm) or shorter.

For condition 1 both the lower stud and the upper stud shall be retrofitted using the methods of Section 1604.2. For condition 2 the retrofit stud shall be connected to the lower studs using the methods of Section 1604.2 and be continuous from the bottom horizontal brace to the top horizontal brace. No connection is required between the retrofit stud and the upper stud. In both conditions the bottom chord of the piggy back truss section shall be fastened to each retrofit stud using a connector with minimum axial capacity of 175 pounds (79 kg).



For SI: 1 inch = 25.4 mm.

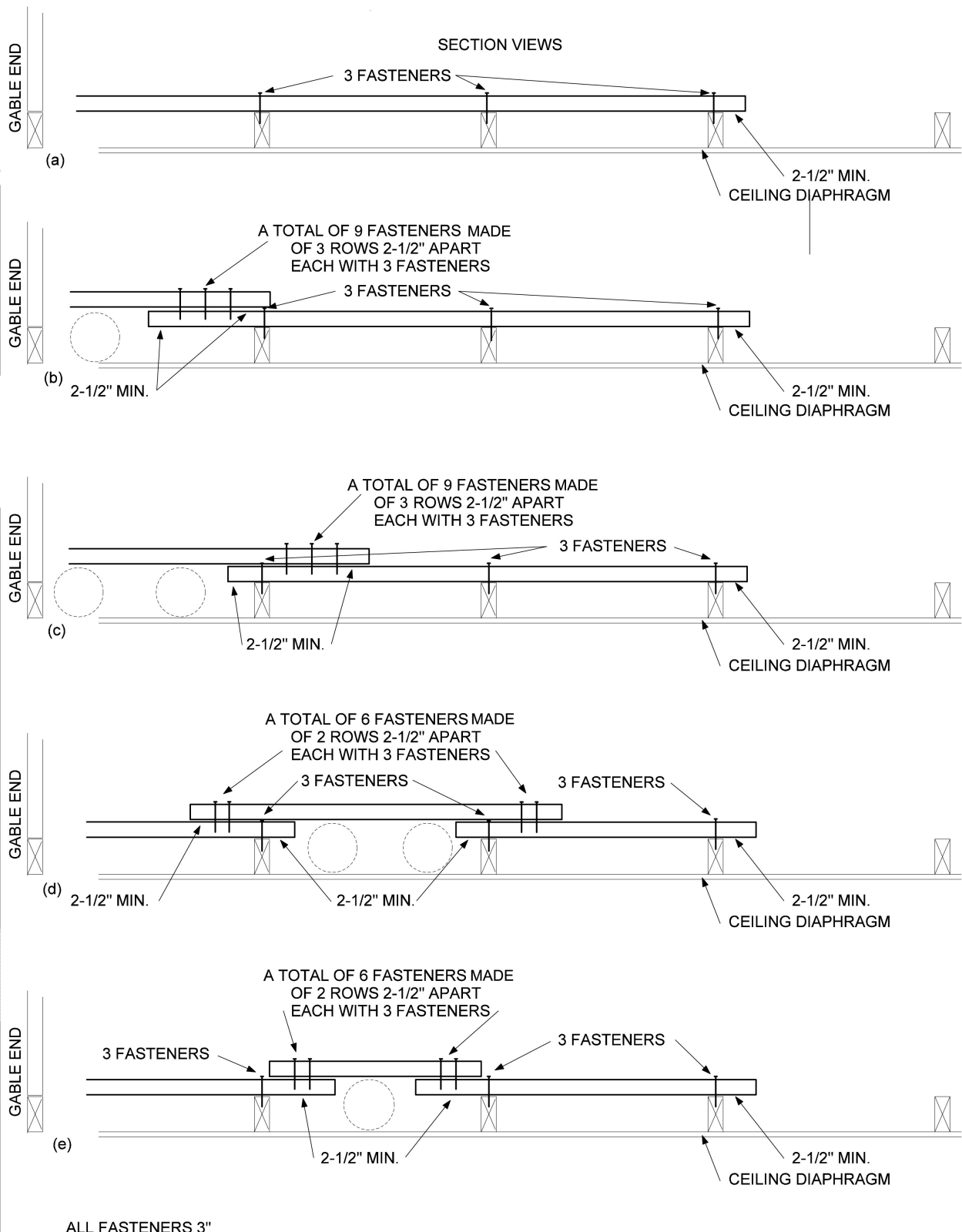
FIGURE 1604.2.5
DETAIL OF ANCHOR BLOCK INSTALLATION



ELEVATION VIEW

FIGURE 1604.2.7
DETAIL OF RETROFIT TIE INSTALLATION

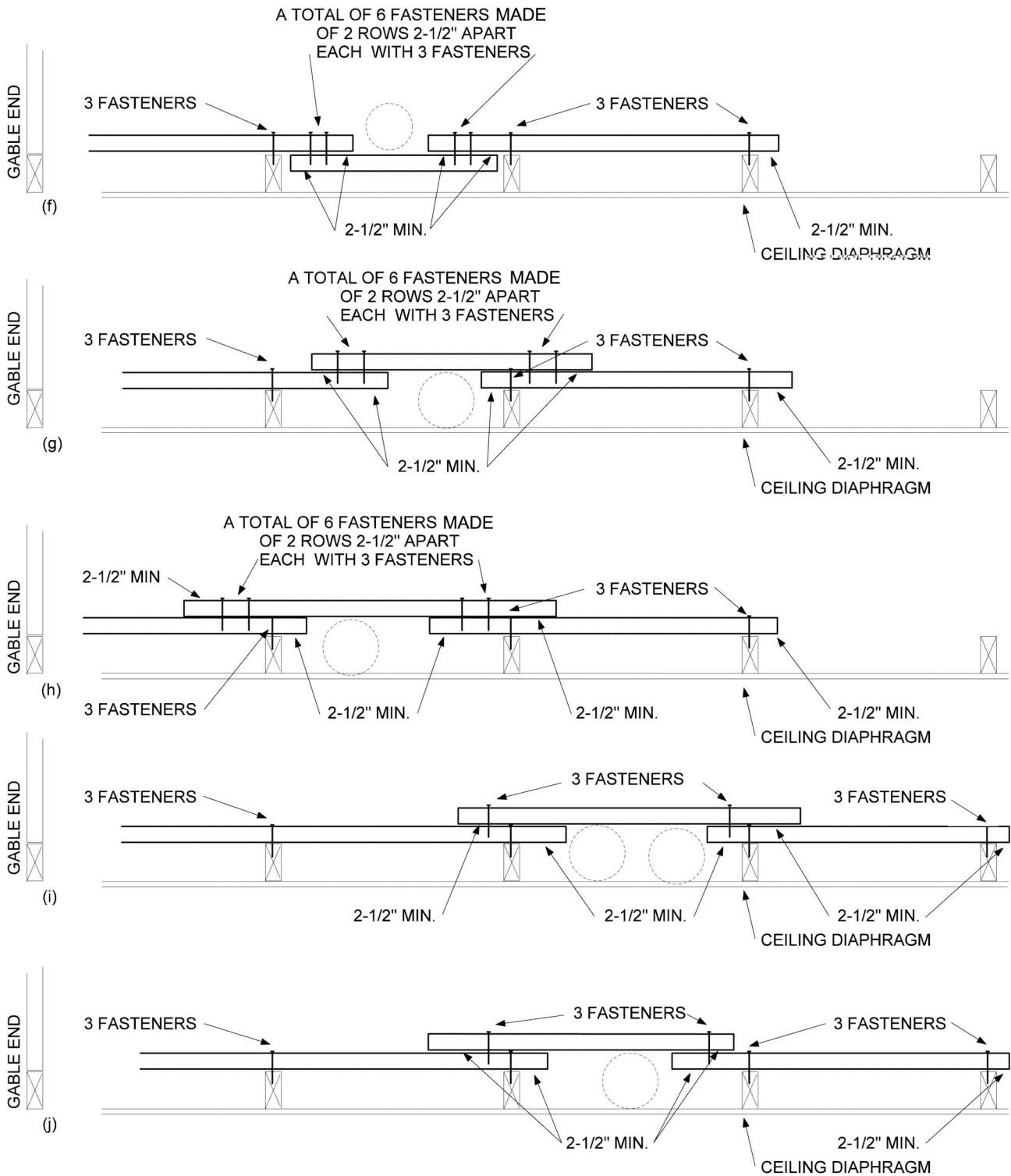
For SI: 1 inch = 25.4 mm.



For SI: 1 inch = 25.4 mm.

FIGURE 1604.2.8(1)
SPLICED HORIZONTAL BRACES

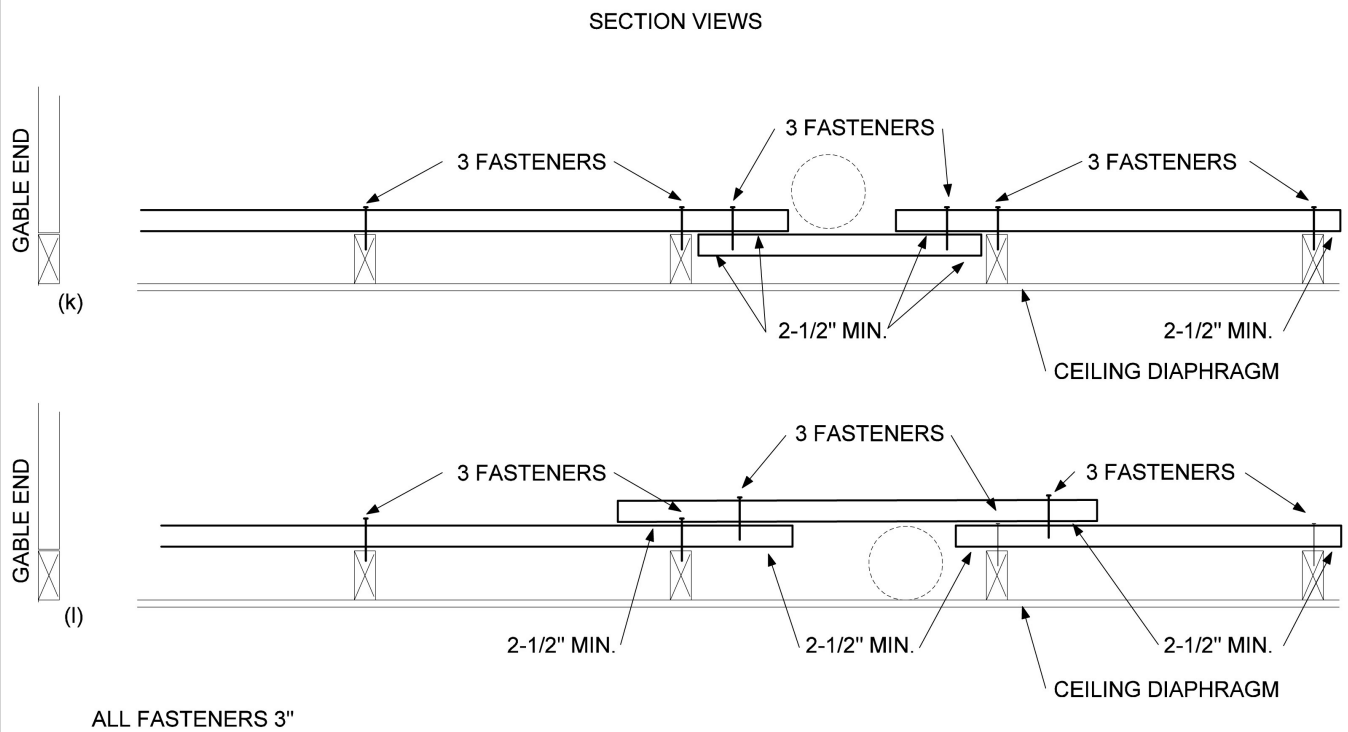
SECTION VIEWS



ALL FASTENERS 3"

For SI: 1 inch = 25.4 mm.

FIGURE 1604.2.8(2)
SPLICED HORIZONTAL BRACES



For SI: 1 inch = 25.4 mm.

FIGURE 1604.2.8(3)
SPLICED HORIZONTAL BRACES

1604.3 Retrofit studs. Retrofit studs shall be installed in accordance with Section 1604.3.1 and using one of the five methods of Sections 1604.3.2, 1604.3.3, 1604.3.4, 1604.3.5 or 1604.3.6. Figure 1604.3 shows these methods of installation. For the retrofit configuration derived from Table 1604.2 the size of retrofit studs shall be as indicated in Table 1604.4.1 or 1604.4.2. Retrofit studs shall extend from the top of the lower horizontal brace to the bottom of the upper horizontal brace except that a maximum gap of $\frac{1}{8}$ inch (3.2 mm) is allowed at the bottom and $\frac{1}{2}$ inch (12.7 mm) at the top. Where wall sheathing, panel siding, or other wall facade is fastened to gable end studs not manufactured into a truss, i.e., are field installed, retrofit studs shall be applied to those field-installed studs in accordance with Section 1604.2.1.

1604.3.1 Fastening. Where nail plates are not used, retrofit studs shall be attached to existing studs using 3-inch (76 mm) fasteners at a maximum of 6 inches (152 mm) on center but no closer than $2\frac{1}{2}$ inches (64 mm) on center with fasteners no closer to ends of members than $2\frac{1}{2}$ inches (64 mm).

1604.3.2 Method #1: Face to edge or to face method. Retrofit studs shall be installed immediately adjacent to existing (Section 1604.2) gable end wall studs as indicated in Figure 1604.3(a). The retrofit studs shall overlap the edge or side of the existing stud by a minimum of $1\frac{1}{4}$ inches (32

mm). Fasteners shall be installed as specified in Section 1604.3.1.

1604.3.3 Method #2: Face to face offset method. Retrofit studs shall be installed against the face of existing studs as indicated in Figure 1604.3(b) such that the faces overlap a minimum of $1\frac{1}{2}$ inches (38 mm) and the edge distance to fasteners is no less than $\frac{3}{4}$ inch (19 mm). Fasteners shall be installed as specified in Section 1604.3.1.

1604.3.4 Method #3: Butted retrofit stud method. Provided that all of the following fastening conditions are met, retrofit studs shall be permitted to be butted by edge or face to existing studs with the addition of nail plates as indicated in Figures 1604.3(c) and 1604.3.4.

1. The $1\frac{1}{2}$ inch (38 mm) edge of retrofit studs shall be installed against the $1\frac{1}{2}$ inch (38 mm) or the broad face of existing studs.
2. A minimum of two nail plates shall be used.
3. Fasteners used to secure nail plates to studs shall be a minimum $1\frac{1}{4}$ inch (32 mm) long (#8 wood screws or 8d nails).
4. Fasteners placed in nail plates shall be a minimum of $2\frac{1}{2}$ inches (64 mm) along the length of lumber. A fastener shall be placed in nail plates a maximum of 6 inches (152 mm) from the ends of the shorter stud.

5. Fasteners shall be placed a minimum of $\frac{1}{2}$ inch (12.7 mm) from the edges of studs. Fasteners shall be placed a maximum of $1\frac{1}{2}$ inches (38 mm) from the abutting vertical edges of existing studs and retrofit studs.
6. There shall be at least three fasteners through nail plates into all existing and retrofit studs to which they are attached.
7. Where there are three fasteners through nail plates onto a single existing or retrofit stud then nail plates shall be spaced a maximum of 15 inches (381 mm) on center.
8. Where there are more than three fasteners through nail plates onto a single existing or retrofit stud then nail plates shall be spaced a maximum of 20 inches (508 mm) on center.
9. In line fasteners used to secure nail plates shall be spaced vertically a minimum of $1\frac{1}{2}$ inches (38 mm) on center. Staggered fasteners used to secure nail plates shall be spaced horizontally a minimum of $\frac{1}{2}$ inch (12.7 mm).

1604.3.5 Method #4: Offset retrofit stud method. Where retrofit studs are placed as indicated on Figure 1604.3(d) retrofit studs may be offset from existing studs by use of nail plates such that the vertical corner of a retrofit stud shall be placed at the vertical corner of an existing stud as indicated in Figures 1604.3(d) and 1604.3.4 provided the fastening conditions of Section 1604.3.4 are met.

1604.3.6 Method #5: Nailer with retrofit stud method. Retrofit studs and existing studs shall be permitted to be connected using noncontinuous 2 by 4 nailers as indicated in Figure 1604.3(e) provided the following conditions are met.

1. Both the existing stud and the retrofit stud shall be butted to nailers and both shall be fastened to the nailer with 3 inch (76 mm) long fasteners (#8 wood screws or 8d nails). Fasteners connecting each stud to the nailer shall be spaced 6 inches (152 mm) o.c.
2. Fasteners into nailers from any direction shall be offset vertically by a minimum of $2\frac{1}{2}$ inches (64 mm).
3. Fasteners into nailers shall be a minimum of $2\frac{1}{2}$ inches (64 mm) but not more than 6 inches (152 mm) from the end of the shorter of the existing stud, and retrofit stud, to which they are fastened.

1604.3.7 Reduced size of retrofit studs. Retrofit studs may be reduced in size by notching, tapering or other methods at any number of locations along their length provided that all of the following conditions are met.

1. The retrofit stud to be notched shall be sized such that the remaining minimum depth of member at the location of the notch (including cross-cut kerfs) shall not be less than that required by Table 1604.4.1 or 1604.4.2.

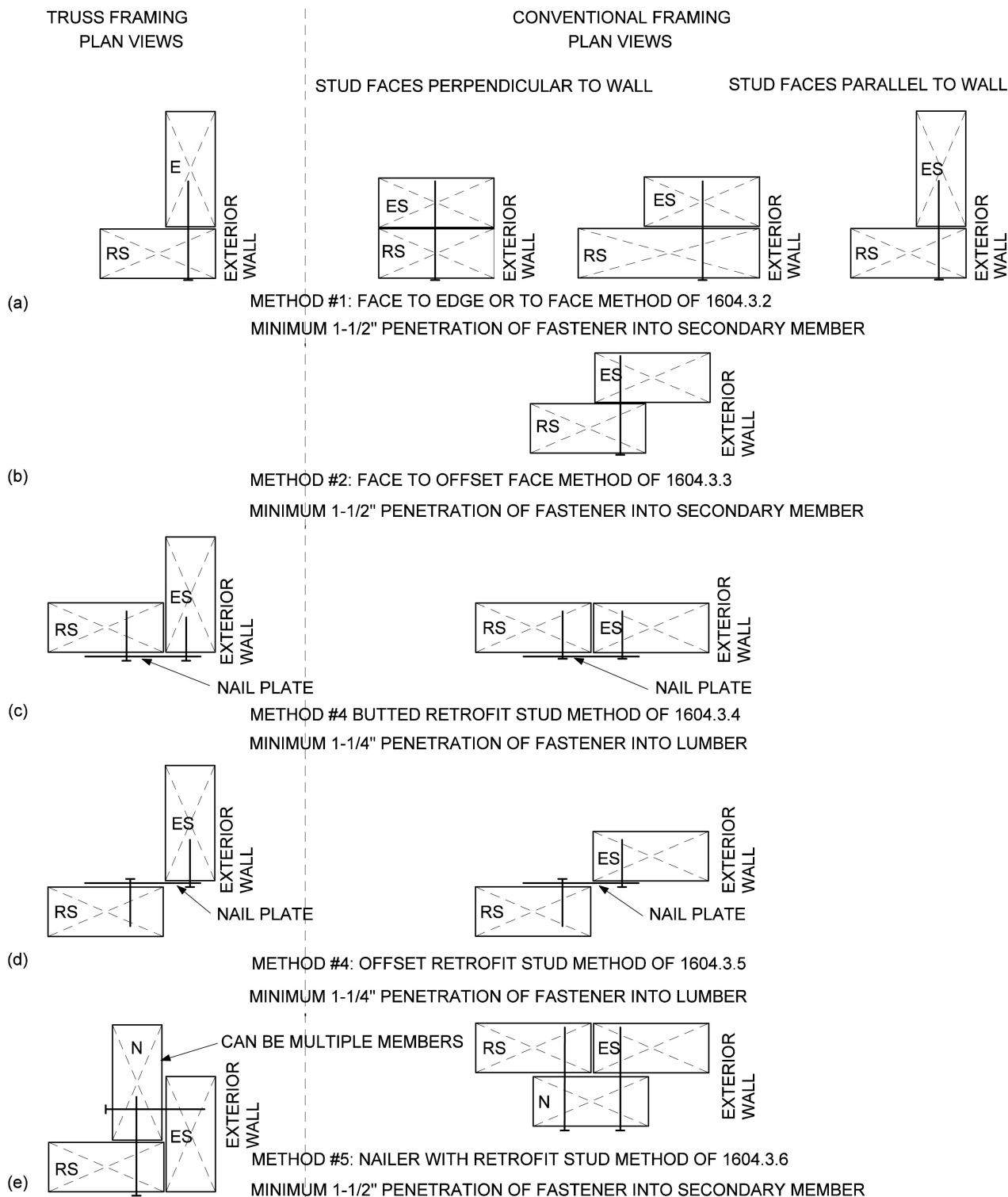
2. The notched retrofit stud shall not be spliced within 12 inches (305 mm) of the location of notches. Splice members shall not be notched.
3. The vertical extent of notches shall not exceed 12 inches (305 mm) as measured at the depth of notches.
4. The notched retrofit stud members shall be fastened to the side of the existing gable end wall studs in accordance with Section 1604.3.1. Two additional 3-inch (76 mm) fasteners (#8 wood screws or 10d nails) shall be installed on each side of notches in addition to those required by Section 1604.3.1.

1604.3.8 Retrofit stud splices. Retrofit studs greater than 8 feet (2438 mm) in height may be field spliced in accordance with Figure 1604.3.8.

1604.4 Connections between horizontal braces and retrofit studs. Connections between horizontal braces and retrofit studs shall comply with Section 1604.4.1 or 1604.4.2. Each retrofit stud shall be connected to the top and bottom horizontal brace members with a minimum of a 20 gauge $1\frac{1}{4}$ inches (32 mm) wide flat or coil metal strap with prepunched holes for fasteners. Straps shall be fastened with $1\frac{1}{4}$ inch (32 mm) long fasteners (#8 wood screws or 8d nails) with the number of fasteners as indicated on Tables 1604.4.1 and 1604.4.2. Fasteners shall be no closer to the end of lumber than $2\frac{1}{2}$ inches (64 mm).

1604.4.1 L-bent strap method. Retrofit studs shall be connected to horizontal braces or to strong backs in accordance with Figure 1604.2(1), 1604.2(2) or 1604.2.3, and shall comply with the following conditions.

1. **Straps:** A strap shall be applied to the edges of a retrofit stud nearest the gable end wall and to the face of horizontal braces using at each end of the strap the number of fasteners specified in Table 1604.4.1. Straps shall be long enough so that each strap extends sufficient distance onto the vertical face of the retrofit stud that the fastener closest to the ends of the studs is a minimum of $2\frac{1}{2}$ inches (64 mm) from the end of the stud. Straps shall be allowed to be twisted to accommodate the transition between the tops of retrofit studs and horizontal bracings following roof pitches.
2. **Compression Blocks:** Compression blocks shall be installed on the horizontal braces directly against either the existing vertical gable end wall stud or the retrofit stud. Figures 1604.2(1) (trusses) and 1604.2(2) (conventionally framed) show the installation of the compression block against the existing vertical gable end wall stud with the strap from the retrofit stud running beside the compression block. Compression blocks shall be allowed to be placed over straps. Compression blocks shall be fastened to the horizontal braces with at least the minimum number of 3-inch (76 mm) long fasteners (#8 wood screws or 10d nails) specified in Table 1604.4.1. End and edge distances for fasteners shall be in accordance with Section 1603.6.3.



THE FIGURES DO NOT REFLECT THE NUMBER OF REQUIRED FASTENERS OR SHOW HORIZONTAL BRACES OR STRAPS. FASTENERS SHALL BE PLACED MAXIMUM 6" ON CENTER AND A MINIMUM OF 2-1/2" FROM ENDS. 3" FASTENERS CAN BE INSTALLED FROM EITHER SIDE OF LUMBER AS LONG AS THERE IS 1-1/2" FASTENER PENETRATION ES INDICATES AN EXISTING STUD. RS INDICATES A RETROFIT STUD. N INDICATES A NAILER.

For SI: 1 inch = 25.4 mm.

FIGURE 1604.3
METHODS OF INSTALLING RETROFIT STUDS

ELEVATION VIEW

1. MINIMUM OF TWO PLATES VERTICALLY CONNECTING THE TWO STUDS

2. NAIL PLATE

3. THE CLOSEST FASTENER SHALL BE A MINIMUM OF 2-1/2" AND A MAXIMUM OF 6" FROM THE END OF THE SHORTER OF THE EXISTING OR RETROFIT STUDS.

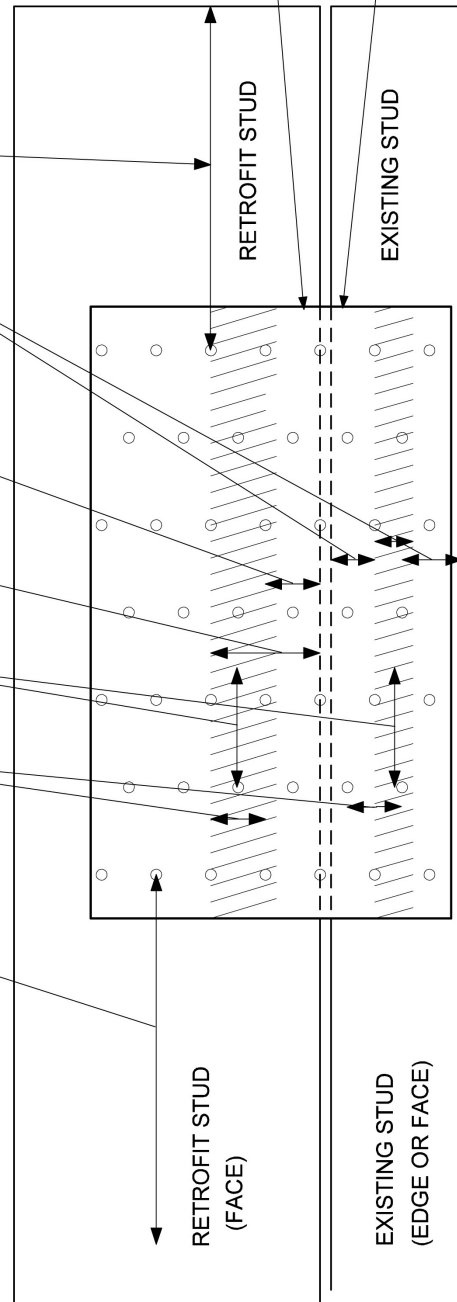
4. FASTENERS ON EXISTING STUD SHALL BE A MINIMUM OF 1/2" FROM EITHER EDGE.

5. A SET OF FASTENERS SHALL BE A MINIMUM OF 1/2" FROM THE EDGE NEAREST THE EXISTING STUD AND A MAXIMUM OF 1-1/4" FROM THE EDGE OF THE RETROFIT STUD NEAREST THE EXISTING STUD. SEE NOTE BELOW.

6. IN LINE FASTENERS SHALL BE SPACED VERTICALLY A MINIMUM OF 1-1/2" ON CENTER. IN LINE FASTENERS SHALL BE SPACED HORIZONTALLY A MINIMUM OF 1/2" AND A MINIMUM OF 2-1/2".

7. THE DISTANCE BETWEEN FASTENERS ON PLATES SHALL BE A MAXIMUM OF 20" ON CENTER.

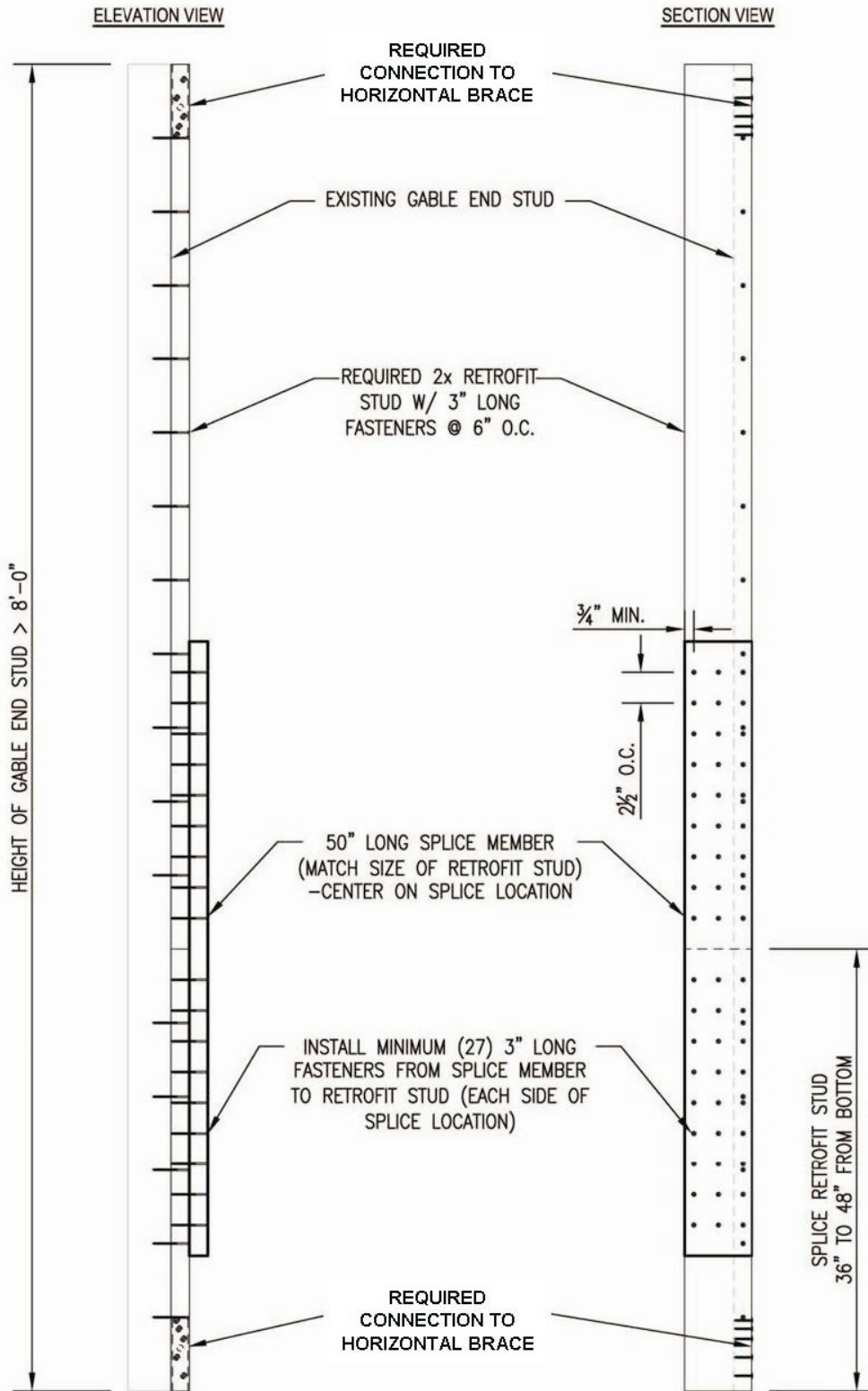
8. FASTENERS SHALL BE MINIMUM 1-1/4" LONG (#8 WOOD SCREWS OR 8D NAILS)



STUD SIZES MAY DIFFER FROM THOSE SHOWN.
 DIAGONAL HATCHES INDICATE ALLOWABLE LATERAL RANGE FOR FASTENERS.
 THE RELATIONSHIP BETWEEN STUDS AND PLATES WILL VARY ACCORDING TO THE PARTICULARS OF THE METHOD USED.

For SI: 1 inch = 25.4 mm.

FIGURE 1604.3.4
 NAIL PLATE FASTENING



NOTE:

SPLICE LOCATION MAY BE REQUIRED AT TOP OF GABLE END STUD IF HEIGHT > 11'-0" TO 12'-0"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 1604.3.8
DETAIL OF RETROFIT STUD SPLICE**

1604.4.2 U-bent strap method. Retrofit studs shall be connected to horizontal braces in accordance with Figure 1604.2(3) or 1604.2(4), shall be limited to Retrofit Configurations A and B (Table 1604.4.2), and shall comply with the following conditions.

1. Straps of sufficient length to meet the requirements for the number of fasteners in accordance with Table 1604.4.2 and meet the end distance requirements of Section 1603.6.3 shall be shaped around retrofit studs and fastened to the edges of horizontal braces. Straps shall wrap the back edge of the retrofit stud snugly with a maximum gap of 1/4 inch (6.4 mm). Rounded bends of straps shall be allowed. One fastener shall be installed that connects each strap to the side of the associated retrofit stud.
2. The horizontal brace shall butt snugly against the retrofit stud with a maximum gap of 1/4 inch (6.4 mm).
3. Straps shall be allowed to be twisted to accommodate the transition between the tops of retrofit studs and horizontal braces that follow the roof pitch.

1604.5 Connection of gable end wall to wall below. The bottom chords or bottom members of wood framed gable end walls shall be attached to the wall below using one of the methods prescribed in Section 1604.5.1 or 1604.5.2. The particular method chosen shall correspond to the framing system and type of wall construction encountered.

1604.5.1 Truss gable end wall. The bottom chords of the gable end wall shall be attached to the wall below using right angle brackets. A minimum of two fasteners shall be installed into the bottom chord. The right angle brackets

shall be installed throughout the portion of the gable end where the gable end wall height is greater than 3 feet (914 mm) at the spacing specified in Table 1604.5.1. Connection to the wall below shall be by one of the methods listed below:

1. For a wood frame wall below, a minimum of two fasteners shall be installed. The fasteners shall be of the same diameter and style specified by the bracket manufacturer and sufficient length to extend through the double top plate of the wall below.
2. For a concrete or masonry wall below without a sill plate, the type and number of fasteners into the wall shall be consistent with the bracket manufacturer's specifications for fasteners installed in concrete or masonry.
3. For a concrete or masonry wall below with a 2× sill plate, the fasteners into the wall below shall be of the diameter and style specified by the bracket manufacturer for concrete or masonry connections; but long enough to pass through the wood sill plate and provide the required embedment into the concrete or masonry below. Alternatively, the bracket can be anchored to the sill plate using four each 1 1/2-inch (38 mm) long fasteners of the same type as specified by the bracket manufacturer for wood connections, provided that the sill plate is anchored to the wall on each side of the bracket by a 1/4-inch (6.4 mm) diameter masonry screw with 2 3/4 inches (70 mm) of embedment into the concrete or masonry wall. A 1/4-inch (6.4 mm) washer shall be placed under the heads of the masonry screws.

**TABLE 1604.4.1
ELEMENT SIZING AND SPACING FOR L-BENT RETROFIT METHOD**

	RETROFIT CONFIG. A	RETROFIT CONFIG. B	RETROFIT CONFIG. C	RETROFIT CONFIG. D
Retrofit elements	A	B	C	D
Minimum size and number of horizontal braces	2 × 4	2 × 4	2 × 4	2 each 2 × 4
Minimum size and number of retrofit studs	2 × 4	2 × 6	2 × 8	2 each 2 × 8
Minimum number of fasteners connecting each end of straps to retrofit studs or to horizontal braces #8 screws or 10d nails 1 1/4" long	6	9	12	8 on each strap
Minimum number of fasteners connecting compression blocks to horizontal braces #8 screws or 10d nails 3" long	6	8	10	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**TABLE 1604.4.2
ELEMENT SIZING AND SPACING FOR U-BENT RETROFIT METHOD**

	RETROFIT CONFIG. A	RETROFIT CONFIG. B	RETROFIT CONFIG. C	RETROFIT CONFIG. D
Retrofit elements	A	B	C	D
Minimum size and number of horizontal braces	2 × 4	2 × 4	2 × 4	2 each 2 × 4
Minimum size and number of retrofit studs	2 × 4	2 × 6	2 × 8	2 each 2 × 8
Minimum number of fasteners connecting straps to each edge of horizontal braces #8 screws or 10d nails 1 1/4" long	6	7	7	6 on side of each strap

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**TABLE 1604.5.1
SPACING OF RIGHT ANGLE BRACKETS**

EXPOSURE CATEGORY	MAXIMUM V_{asd}^a	SPACING OF RIGHT ANGLE BRACKETS ^a
C	110	38 inches
C	120	32 inches
C	130	28 inches
C	140	24 inches
C	150	20 inches
B	110	48 inches
B	120	40 inches
B	130	36 inches
B	140	30 inches
B	150	26 inches

For SI: 1 inch = 25.4 mm.

a. V_{asd} shall be determined in accordance with Section 1609.3.1 of the *Florida Building Code, Building* or Section R301.2.1.3 of the *Florida Building Code, Residential*.

1604.5.2 Conventionally framed gable end wall. Each stud in a conventionally framed gable end wall, throughout the length of the gable end wall where the wall height is greater than 3 feet (914 mm), shall be attached to the bottom or sill plate using a stud to plate connector with minimum uplift capacity of 175 pounds (79 kg). The bottom or sill plate shall then be connected to the wall below using one of the methods listed below:

1. For a wood frame wall below, the sill or bottom plate shall be connected to the top plate of the wall below using 1/4 inch (6.4 mm) diameter lag bolt fasteners of sufficient length to penetrate the bottom plate of the upper gable end wall and extend through the bottom top plate of the wall below. A washer sized for the diameter of the lag bolt shall be placed under the head of each lag bolt. The fasteners shall be installed at the spacing indicated in Table 1604.5.2.
2. For a concrete or masonry wall below, the sill or bottom plate shall be connected to the concrete or masonry wall below using 1/4-inch (6.4 mm) diameter concrete or masonry screws of sufficient length to provide 2 3/4 inches (70 mm) of embedment into the top of the concrete or masonry wall. A washer sized for the diameter of the lag bolt shall be placed under the head of each lag bolt. The fasteners shall be installed at the spacing indicated in Table 1604.5.2.

**TABLE 1604.5.2
SPACING OF LAG OR MASONRY SCREWS
USED TO CONNECT SILL PLATE OF GABLE END
WALL TO TOP OF THE WALL BELOW**

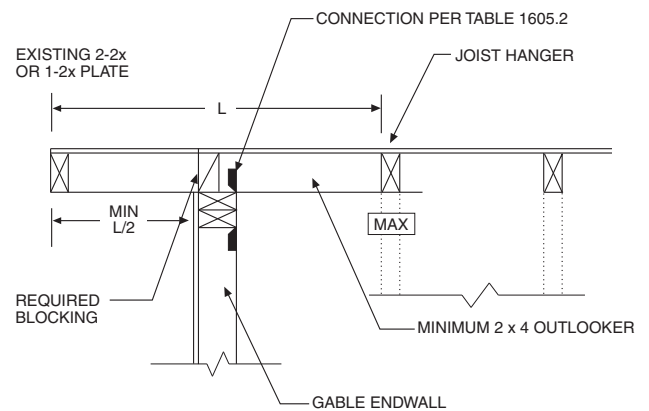
EXPOSURE CATEGORY	MAXIMUM V_{asd}^a	SPACING OF LAG SCREWS OR MASONRY SCREWS
C	110	19 inches
C	120	16 inches
C	130	14 inches
C	140	14 inches
C	150	10 inches
B	110	24 inches
B	120	20 inches
B	130	18 inches
B	140	15 inches
B	150	13 inches

For SI: 1 inch = 25.4 mm.

a. V_{asd} shall be determined in accordance with Section 1609.3.1 of the *Florida Building Code, Building* or Section R301.2.1.3 of the *Florida Building Code, Residential*.

**SECTION 1605
RETROFITTING RAKE OVERHANG
OUTLOOKERS FOR UPLIFT LOADS**

1605.1 Rake Overhangs. Rake overhang outlookers shall be a minimum nominal 2 x 4 lumber and the overhang overhangs shall not exceed 1/2 the total length of the outlooker. See Figure 1605.1.



**FIGURE 1605.1
RAKE OVERHANG OUTLOOKERS**

1605.2 Rake Overhang Outlooker uplift connections. Rake overhang outlookers shall be connected to gable endwalls with a connection capable of resisting the loads specified in Table 1605.2. Rake overhang outlookers shall be connected to the first interior truss or rafter with a joist hanger having a vertical load capacity of $1/2$ the applicable load in Table 1605.2.

**TABLE 1605.2
RAKE OVERHANG OUTLOOKER UPLIFT CONNECTION**

Ultimate Design Wind Speed, V_{ult}	100	110	120	130	140	150
Outlooker Spacing (in.)	Uplift Connection Loads (lbs.)					
12	258	312	372	436	506	581
16	344	417	496	582	675	775
24	517	625	744	873	1012	1162

- a. For Ultimate design wind speeds, V_{ult} greater than 150 mph, uplift connection loads shall be determined in accordance with ASCE 7.
- b. Ultimate Design Wind Speeds determined from Figure 1609A in the *Florida Building Code, Building* or Figure R301.2(4) in the *Florida Building Code, Residential*.