Gable End Retrofit Guide

Siding blown off
Fascia cover blown off
Some shingles over garage blown off.

Some shingles blown off

Gable end wall

The greatest damage and the reason for gable end retrofits.

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1.0
Introduction

Gable ends are those upper triangular walls that rest on rectangular walls. They don't have horizontal eaves; instead their overhangs follow the slope of the roof. The triangles may be of various proportions and may be triangles with a section cutoff. Figures 1 through 6 show a variety of gable ends. The only gable ends for which retrofitting is addressed in this guide are those that include an attic. This guide does not address gable end walls where the room behind the wall has a cathedral or vaulted ceiling. Gable ends with attics that have headroom greater than 3' are the ones that typically need to be retrofitted. Fortunately, retrofitting is usually practical when this amount of headroom is available.

Figure 1.1 House with large and small gable ends

Figure 1.2 Large Gable at end with partially exposed gable where house is wider

Figure 1.3 Gable end with attached chimney

Figure 1.4 Cut off gable over garage with covered entry to side

Figure 1.5 **Gable end with intersecting shed roof**

Figure 1.6 **Gable end over garage and living area**

Who should use this guide? Homeowners whose house has a gable end wall that is 3' or higher above the rectangular wall. Their house may well be at risk in a hurricane, and will almost certainly be at risk if the house was not built to high wind standards. In most of Florida that means anything built before 1997 and some built between 1997 and 2002. Homeowners should scan through this guide to gain an understanding of the methods of gable end retrofitting. Experienced handy homeowners may be up to the task and can perform their own gable end retrofits. Homeowners who hire others to do the work should be familiar with the methods described in this guide and the building code that pertains to gable end retrofits. Why? Because many contractors, architects and engineers may not be familiar with these easy and cost effective methods of retrofitting gable ends. There are some traditional methods, which rely on diagonals that are not completely effective. This guide will also help you determine if the person you hire is performing the work correctly. Another advantage of this guide is that you can give it to your contractor so he knows a code approved method for making gable end retrofits. The methodology is so new that many contractors have never actually done one. Finally, at this point in time, most building inspectors and building departments have not been exposed to this technique. So it behooves the homeowner to be knowledgeable.

Wind Forces on Gable Ends: Many people think of hurricane winds as pushing against buildings; inward, like the wolf did to the house of the three little pigs. However, engineers know that hurricanes push (inward acting) and pull (outward acting) through the wind pressures that are applied to the house. In fact, the outward acting negative pressures can be slightly higher on walls than inward acting pressures, and the outward acting negative pressures that cause uplift on roofs can be much larger than the inward or downward acting pressures. Because hurricanes swirl, a house near the track of the storm will see strong winds from a wide range of directions. If the eye of the hurricane passes over the house, it will be subjected to winds approximately half the time from one direction and half the time from the opposite direction. It is difficult to determine which gable end will see the highest wind pressures and whether the pressures will be

inward or outward. Consequently, it is prudent to retrofit the largest gable ends first and work down towards the smaller ones.

Typical Traditional Construction Practices: Because of a lack of appreciation of outward and inward acting wind pressures on gable ends and periods of low hurricane activity, building codes and carpenters of the past did not pay as much attention to holding gable end walls onto buildings as they do now. Gable end walls were not necessarily built to withstand the pressures that hurricanes can impose. In fact, before air conditioning, a key to comfort in Florida houses was ventilation and in particular attic ventilation. Attics with lots of ventilation were valued because they kept houses cooler. Sometimes gable ends were built to allow cooling of the attic space and consequently they did not have structural wall sheathing. Instead, they had siding boards with horizontal gaps below each board or large louvered gable end vents to facilitate the flow of air while shedding rain.

The belief that nothing could be done to strengthen gable ends further compounded the problem. However, knowledge of weather, increased media coverage of the dangers of hurricanes, advances in building science, and engineering analysis and research have significantly changed things. Efforts to learn more about buildings was accelerated by the devastation wrought by Hurricane Andrew. Building science research has shown that buildings can be built to withstand hurricanes. Something **can** be done. Consequently, building codes were changed to require stronger connections between the parts of the house. Today, building codes are read more carefully, are better understood, and better enforced. Consequently, buildings are being better built.

Gable ends of older homes are vulnerable to the loss of roof sheathing which then expose these houses to severe breaches because gable ends are blown into attics or come off walls. However, Hurricane Charley demonstrated that homes built after 1996 suffered very little structural damage and that their gable ends survived. It is clear that gable ends on older homes can pose a real threat to the welfare of the home, the contents of the home and the safety of its occupants. The good news is that correcting gable ends is relatively easy and affordable.

What Holds Gable End Walls on Houses: In short, there is usually not much holding gable ends on houses. Hurricanes push or pull gable end walls to the point where they separate from the rectangular wall below, resulting in catastrophic damage to the house and rainwater intrusion. For houses not built to high wind standards, the tops of gable end walls are often weakly connected to roof sheathing, and their bottoms are held in place by little more than gravity. At their bottoms there may be 2x4s that extend into the attic and are attached to the gable end walls; but, the attachment to the gable end wall is particularly poor when it comes to resisting outward forces. In newer houses straps may be used to strengthen this connection. However, even these connections may be inadequate unless the houses were built to high wind standards.

Types of Failures: Basically there are three things to be concerned about with gable end walls. First, the most common type of failure is loss of roof sheathing from the

gable end that results in the gable wall losing its attachment along the top edge. This type of failure is shown in Figure 1.7. When winds blow against the gable end, they push it towards the interior of the house and push up on the roof overhanging the gable end. At the same time, the wind flowing over the top of the roof creates large negative pressures (uplift) on the roof sheathing. This combination of loads led to widespread loss of roof sheathing at gable ends and gable end failures in Hurricane Andrew, and has been frequently observed for older homes in other hurricanes. The second most common type of gable end failure is at the connection between the gable end wall and the rectangular wall below. It is rare that you actually find a failure that looks like the one shown in Figure 1.8 because usually the wall below fails and the whole end collapses as shown in Figure 1.9. The third potential weak link is the actual framing members that make up the gable end wall structure. In many houses, these members are simply the structural members of the last roof truss. Consequently, they are 2x4 lumber members installed with the wide flat part of the 2x4s parallel to the wall; the direction in which they are the weakest. In homes with rafters and ceiling joists, the gable end wall will typically be conventionally framed with 2x4s that are usually turned so that wind forces are applied to the narrow face of the 2x4s - the direction in which they are the strongest. However, they may only be toe-nailed to the rafters and ceiling joist.

When is it Important? In general, the taller the gable end triangle the greater the risk of damage in a hurricane. For gable ends with framing members shorter than about 3' (3' of head room), the forces applied by a 140 mph wind gust along the top and bottom edges of the gable end wall will be less than 100 pounds per foot of gable width. Most nailed connections can handle these forces. In addition, if the gable end is less than about 3' tall, it will be difficult for a worker to crawl out to the gable end and do much work. Consequently, it is probably not worth the effort to retrofit the connections if the gable end triangle wall is less than about 3' tall.

In homes built after 2002 to the Florida building code and homes built in the late 1990s in areas where the high wind requirements of the Standard Building Code were being enforced, you may find the gable end wall has already been braced or was built in a way that does not require bracing. In some of these homes the wall studs may continue without a break from the floor below up to the roof. This type of framing is known as balloon framing and is one of the best ways to make a very strong gable end wall. You will be able to recognize balloon framing if you don't see any joints between the gable end wall studs and the wall below. If you see any horizontal plates at the ceiling level where the studs stop and are fastened to the plate, you do not have balloon framing. The masonry alternative to balloon framing is to continue the masonry wall all the way up to the roof and to install reinforcing in the wall that extends throughout the height of the wall. If you find this situation, you will not see a wood frame wall at the gable end.

Figure 1.7 **The most common gable end failure is one where the wall looses support along its top edge because sheathing is blown off at the overhang. The wall may fold outward (see cover picture) or be blown inward.**

Figure 1.8 **The second most common type of gable end failure is at the connection between the rectangular and triangular walls – Here the failure is just at the precipice of coming off the wall. It is the negative pressure of the hurricane that pulled on the gable end wall to compromise this connection when wind blew on other faces of the house to create that negative pressure.**

Figure 1.9 The more usual result of wall connection failures is a completely detached gable end wall and the wall below. This building is in the same project as that shown in Figure 1.8. These occupants were not so lucky. Probably all the possessions in this view were saturated with rain water.

Cost Estimates: Materials needed to retrofit a single gable end range from about $150 for a small gable to about $400 for a large gable. However, material costs need to be added to the time it takes to do the work. For some gable ends it takes about an hour to retrofit a stud location and there can be from one to nine studs for small- to modest-sized gable ends depending on the roof pitch. Furthermore, additional time will need to be added for gable ends that are hard to access.

Gable Ends Not Covered in This Guide: Two types of gable ends are not covered in this guide: those over 16' high and those that are the exterior walls to rooms with vaulted ceilings. Gable ends over 16' high are probably at high risk. Such high gable ends should be evaluated by an engineer to determine retrofit measures. The engineer may prescribe measures similar to those detailed in this guide. You should expose the engineer to these methods because the engineer may not be familiar with them, and will be more comfortable with knowing they are part of the International and Florida buildings codes.

Gable end walls on rooms with vaulted or cathedral ceilings, while common (particularly when facing the coast or water), pose special problems for retrofitting. Unless the wall was provided with the bracing needed to stand up to strong winds, it is likely to fail. The structural solutions usually involve beams that either span across the width of the wall

or columns that span from floor to ceiling. In many cases, when the wall was originally constructed, the builder could have used continuous members that run from the floor to the ceiling and avoided the weakness. If you have a conventionally framed gable end wall on a room with a cathedral ceiling, you probably can push on the wall and see it deflect (move). If so and you want to strengthen the wall, you need to hire a structural engineer to develop a solution for your particular situation.

Determine whether you can do a gable end retrofit: Some gable ends are inaccessible through the attic due to construction details. There may be air conditioning ducts blocking access to the gable end, or there may not be access to this part of the attic. In the latter of the two cases, you should consider making an attic access. They are frequently easy to make via a closet ceiling. In some attics it might be a challenge to get the long lumber pieces up through an access if the headroom at the access is too low. To be reasonably efficient, you need to be able to snake 8' 2x4s into the attic. With sufficient patience you can feed a 2x4 into the attic. Once in the attic, it is easy to move lumber to a gable end. If you have to replace the siding on the gable, you will find access from the outside is particularly nice because you have plenty of light and you do not have to climb through the attic.

Building codes: An earlier version of the gable end retrofit methodology is written into the *2007 Florida Building Code for Existing Buildings*. Since then the methodology has been expanded to allow retrofitting gable ends that account for a greater variety of construction conditions found in attics that would have otherwise precluded adherence to that building code. Plus, it includes an additional method for retrofitting. The expanded methods have been incorporated into the final draft of the *2012 International Building Code for Existing Buildings* and it is expected that Florida will adopt the International code in 2012 or 2013.

You may also want to read about gable end retrofit in the building code because this guide does not give all the details contained in the code; especially where the code gives alternate solutions for locations where there are impediments. The Florida building code is available on line.

2.0
Overview of the Gable End Retrofit Process

How does a gable end retrofit work? A gable end retrofit works by making the wall itself stronger, securely connecting gable ends to the rest of the house and sharing the load imposed by hurricanes over a larger area of the house.

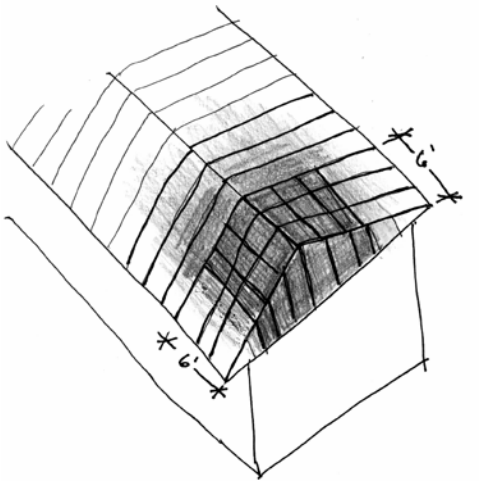


Figure 2.1 The darkest area is the area of the retrofit and so it is the strongest. However, because roof sheathing, especially plywood or OSB, has great capacity to distribute forces over broader areas, via the diaphragm effect, the gable end retrofit really shares its load over a much boarder area as indicated by the progressively lighter shading.

Gable ends have two principal weaknesses: they are not well fastened to the rest of the house, and they can be subject to bending and coming apart. The connections to the rest of the house were discussed above in the section '***What Holds Gable End Walls on Houses****'*.

Retrofitting gable ends entails **two main retrofits**. The first main retrofit involves two sub-retrofits: retrofitting the wall itself to make it stronger, and connecting the gable end wall to the house so it does not get pulled off or get pushed inward. This retrofit is done by connecting the top of the wall to the roof plane structure and the bottom of the wall to the ceiling plane structure. The first main retrofit makes the whole gable end wall above the rectangular wall quite strong. So strong, in fact, it can lend some of its strength to the top of the rectangular wall below. The second main retrofit is the **Wall-to-Wall connection** which involves connecting the gable end wall to the exterior wall below. It is frequently easier to carry out the gable end retrofit step first and then use the horizontal braces installed in that process as a platform of sorts from which to work to tie the two walls together. If the gable end wall is a conventionally framed wall and the wall studs are not connected to the top and bottom framing members using straps or plates (frequently they are just toe-nailed in place), then you will need to install straps or right angle brackets to anchor each of the studs longer than 3' to the upper and lower framing members. If you choose to attach the studs to the top and bottom plates using brackets that have to be nailed to the edge of the top and bottom plates, then you will need to install them before the horizontal braces are installed as the horizontal braces

will block access to the nail holes in the straps. **Figures 9.1 and 10.1** provide examples of typical combinations of gable end wall framing with variations of framing in the wall below. They also illustrate some of the typical bracket installations that can be made to anchor the walls together. You will have a better idea of which to do first after you have looked at the details of the wall-to-wall connection.

Strengthening the gable end wall and connections to the roof framing: **Figures 2.2 and 2.3** illustrate the components involved in strengthening a gable end wall using the L-bent strap method of retrofitting. **Section 6** provides detailed construction instructions for the method shown in those two figures. **Figure 2.2** is a photograph of a completed gable end retrofit taken from an angle that is similar to that drawn in **Figure 2.3**. An important step in strengthening and bracing the gable end is to install 2x4 horizontal braces that butt up against the gable end and extend at least 6' into the interior of the attic. These 2x4s, called **Horizontal Braces**, distribute the loads to the rest of the house. One horizontal brace is placed at the bottom of the wall so it can distribute its share of the wind load applied to the gable end wall to the larger area of the ceiling over the rooms below (the attic floor). Likewise, a horizontal brace at the top of the wall distributes the wind loads applied to the gable end wall to a larger area of the roof structure so that the house can better absorb the forces applied to the gable end. Pairs of horizontal braces are needed at every gable end wall stud wherever the gable end wall framing members are longer than 3-feet.

It is relatively easy to understand that the plane of the roof is strong if the roof sheathing is well secured and stays in place. But it is less obvious that the interior ceiling plane (the drywall or plaster ceilings) is also good at resisting forces applied to the gable end as long as they can be applied over a relatively large area. The horizontal braces are used to transfer the wind forces applied to the gable end into the roof and ceiling planes, and to distribute these forces over a large enough area to avoid local failures of the roof sheathing or ceiling drywall or plaster. These large surfaces perform the function of what engineers call **diaphragms**, transferring loads from one edge of a plane (ceiling or roof in this case) towards the other three edges. In the case of houses, the forces are distributed well beyond the areas immediately adjacent to the gable end wall.

Because existing gable end studs are usually not strong enough, especially where they are installed with their broad faces parallel to the wall, another step in strengthening and bracing the gable end is to attach additional studs next to the existing studs. These **retrofit studs** attach to the studs already in the gable end wall and to the horizontal braces. Not only are studs installed with their broad face parallel to the wall at risk; but, in many houses edge wise studs are not well enough connected to the house at their tops and bottoms. An essential step in strengthening and bracing the gable end is to connect the retrofit studs to the horizontal braces by providing a **tension restraint** to prevent the gable end wall from being pulled off by wind pressure, and by providing a compression mechanism so the gable end wall is restrained from being pushed into the attic. Tension restraint is provided by straps that are fastened around the ends of retrofit studs and to horizontal braces. **Compression restraint** is provided either by

compression blocks or by the ends of horizontal braces depending on which of the two methods to be described later is selected for retrofitting. The method that uses compression blocks is called the **L-bent strap method** and the one that uses the horizontal brace as the compression block is called the **U-bent strap method**. With the completion of these steps, the gable end wall itself is made stronger and the gable end wall is tied to the rest of the house so that it acts as a much stronger unit. These steps will make the gable end about as strong as one in a house built in accordance with today's building code. With this completed at each stud location where the stud is over 3' long, the first main retrofit is done. That leaves making the wall-to-wall connection between the gable end wall and the wall below.

The two main methods of strengthening the gable end wall and its connection to the roof framing: As mentioned above, there are two methods of bending straps. Each has its advantages. Using the L-bent strap method you can install bottom horizontal braces first which has the advantage of giving you a better attic walking surface for the subsequent installation of the upper horizontal braces and then retrofit studs and compression blocks. Whereas in the U-bent strap method one first installs retrofit studs and then the two sets of horizontal braces. The L-bent method does have the disadvantage of requiring the installation of compression blocks that are not required in the U-bent method because horizontal braces perform the compression function. Where there are outriggers extending over the gable end wall, you will notice that horizontal braces installed using the L-bent method will not work. This is a bit hard to explain in writing, but in the attic when you look at this situation, it will become clear that the L-bent strap won't work, but the U-bent strap does. So the U-bent strap's primary application is where there are outriggers with a shortened gable end wall. The expected performance of the methods is identical. The U-bent method costs a little more, but in the scheme of things the difference is not significant. Because of the advantage of having a better walking surface, the L-bent method is preferred. Incidentally, either method can be used at either end of the retrofit studs. This means that where outriggers force you to use U-bent straps, you can still have a better walking surface by using the L-bent method on the attic floor.

Wall-to-Wall connection: One of the essential steps in retrofitting gable ends is to connect the gable end wall to the wall below. This wall-to-wall connection requires connecting the wall below to the reinforced gable end wall above. It is involves installing straps, brackets or screws between the two walls to make a strong connection. It is much less involved than the other main retrofit. A good connection between a strengthened gable end wall and the wall below will do a great deal to prevent the top of wall below from moving in or out. Usually, making a good connection is relatively easy. The connection method depends whether the wall below is concrete block or wood frame, and whether the gable end wall is conventionally framed or is made of a truss. **Section 9** provides detailed construction instructions for making the wall-to-wall connections where the wall below is wood frame. **Section 10** provides similar detailed instructions for making connections on masonry walls.

Figure 2.2 Photograph of completed gable end retrofit using the L-bent strap method – the light colored wood is the lumber added during the retrofit activity

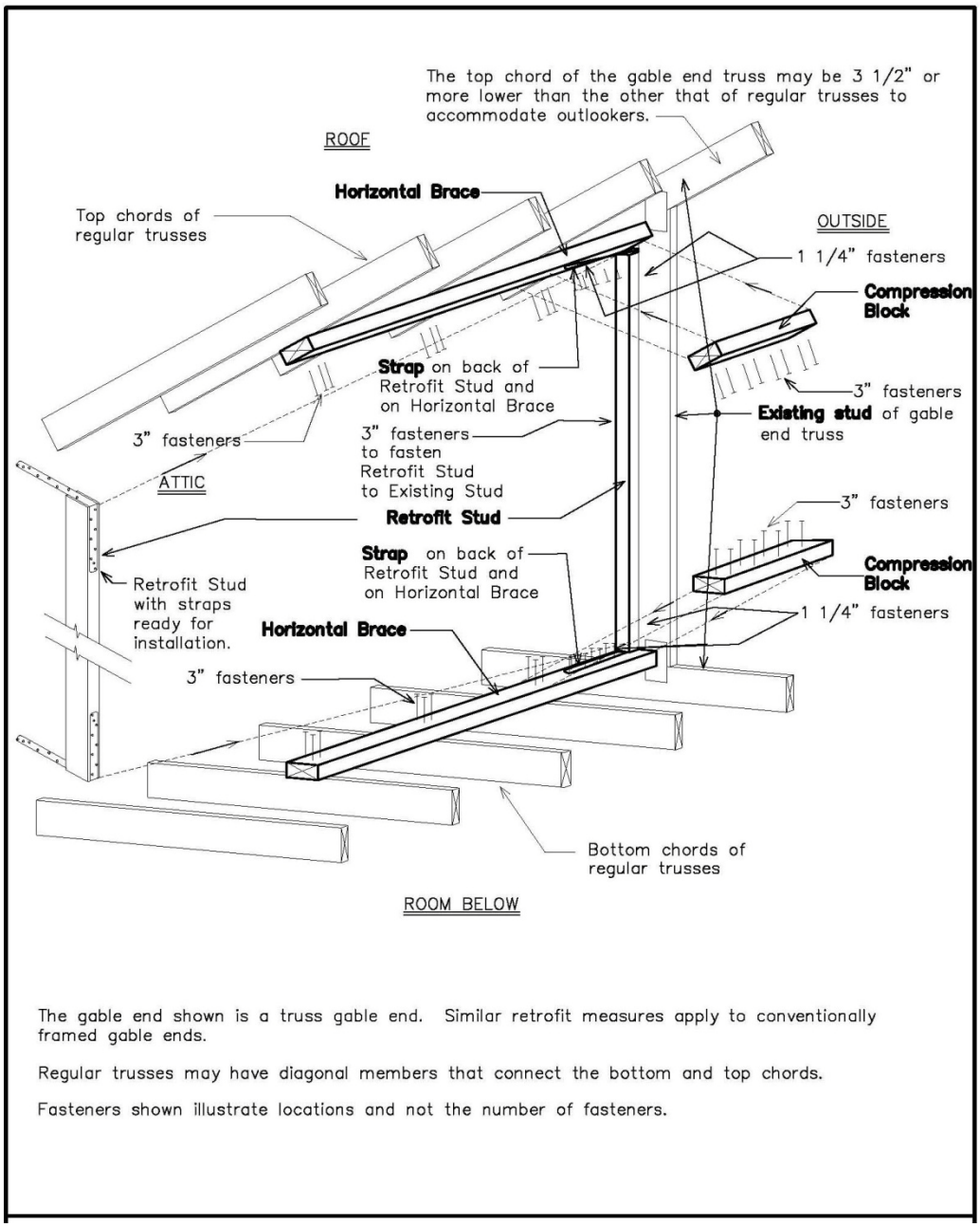


Figure 2.3 Overall drawing showing the concept for strengthening and bracing a gable end wall using the L-bent strap method. You should not get bogged down in studying the details of the drawing. They will be easy to absorb latter.

Figure 6.1on page 25 shows the sequence of steps for making a gable end retrofit using the L-bent method described above.

3.0
Collecting Information from the Building Department

To plan the gable end retrofit, you will need three essential pieces of information:

1. Whether a building permit is required,
2. The **exposure category** for your house, and
3. The **basic design wind speed** for your house's location.

This information was used by engineers to determine the strength of the various retrofit components and is required to extract the correct information from **Tables 10.1 and 11.1**. You will need to learn about and determine the exposure category and the basic design wind speed for your house in order to use these tables.

The exposure category explains the level of exposure your house has to winds. For example, a building surrounded by trees and/or other houses would be exposed to wind that has been somewhat "broken up" and slowed down by these surroundings. Conversely, a building that faces a large body of water, a wide golf fairway or sits atop a prominence will face the full force of the wind. Because the difference in exposure can have a rather dramatic effect on the expected wind forces on your home, the exposure category is an important factor in determining risk and in designing retrofit measures that can be taken. Look at the area surrounding your house. If you live in the middle of a subdivision, are surrounded by trees for a quarter mile or so or live in a wooded area you can probably safely assume exposure B category, the lower risk category compared to category C retrofit information. However, if a 600' wide lake, large open field or golf fairway starts within about 300' or less of your house, it would be prudent to assume exposure C category, the higher risk category.

The other vital information is the basic design wind speed that reflects the likelihood that hurricane winds of some particular wind speed will hit your house. By studying the paths, sizes and intensities of hurricanes going back to 1850, engineers have determined the likelihood of hurricanes of various intensities occurring at any particular area of the hurricane prone coastline of the United States. According to the wind risk maps for hurricane prone areas, there is roughly a 40 percent chance that a hurricane will impact your house with wind speeds equal to or greater than the basic design wind speed during a 50 year period. This map can be found in chapter 3 of the *Florida Building Code - Residential* or a similar map can be found in the *International Residential Code* and in the *International Building Code.* Because these maps can be hard to read and because your building department may have legally defined the exact location of the lines of the map, you will be best served by calling your local building department to learn the design wind speed for your area. While you are doing that you could ask about the wind exposure. However, your local building department may be reluctant to tell you the exposure category because it may think that determination should be made by an engineer.

Do I need a Building permit? It depends on the building department. Once you have determined the need and the possibility of retrofitting you will need to determine if a building permit is necessary. Some building departments require a permit for this work because it is of a structural nature and they want to ensure it is done correctly. Making sure the retrofit is done correctly is for your protection. The Florida building code has a prescriptive method for retrofitting gable ends that if followed is deemed to comply with the building code. That is if the retrofit is done in accordance with the code, the services of an engineer are not needed. The 2012 International Existing Building Code has a similar provision.

4.0
Collecting Information from the Attic
(Making *Gable End Sketches)*

You need to collect information from the attic about each of the two retrofit activities, namely strengthening and bracing each gable end wall and strengthening the wall-to-wall connections. With that information, you can decide on the methods to be used, make a plan and develop a shopping list of materials.

You will need to know the number of studs at each gable end that are 3' or longer. Existing studs less than 3' do not need to be retrofitted because existing connections and strengths are probably already sufficient. In addition, you will need to know within a couple of inches the lengths of the studs that are longer than 3'. Lastly, you will need to look around to determine if there are obstacles that prevent or make installation of horizontal braces difficult or impossible, and you will need to determine if there is anything that prevents installing retrofit studs against the wall sheathing and against the edge of existing gable end studs. To save time and reduce the number of trips into the attic, you should record those observations on paper and with a digital camera. There may be so many details that they are difficult to remember and some may need to be considered in 3D.

How to decide whether to use L-bent or U-bent straps*:* Based on the information you collect in the attic and from the suggested reading below, you can decide on which of the two strap methods to use. Before going into the attic to collect information, it is suggested that you read this section and **Sections 6, 7, 11 and 12**. However, you only need to read Sections 11 and 12 if you find an impediment that prevents using the straightforward retrofit measures discussed in **Sections 6** and **7.** Once you have determined the exposure category and basic design wind speed and collected the information from the attic, you should next turn to **Section 5** for guidance in selecting the sizes of lumber and the number and types of fasteners plus some other necessary and helpful information. **Section 6 and 7 give** step-by-step instructions for doing an L-bent or U-bent strap retrofit, respectively. **Sections 10** and **11** suggest ways for dealing with unusual cases or things that may be in the way. **Section 12** gives detailed instructions for strengthening the wall-to-wall connections. The reason for reading these other sections is that in almost every house, there will be something that requires adapting or altering the straightforward procedures detailed in **Sections 6** and **7**. This guide has anticipated many of these situations and provides work arounds for them. These `little somethings' can be obstructions that prevent following procedures in **Section 6** or **7** for installing horizontal braces on the floor of the attic or installation of retrofit studs at the gable end. The workarounds are presented in the two sections that deal with impediments, **Sections 9** and **10**. The reason for reading or scanning all these sections before going into the attic is so you will have some ideas ahead of time of things to look for and for possible workarounds.

To make collecting information easy, several documents are included to minimize the number of trips that you will have to make into the attic. They can be found in **Section 17**. They include the *Attic Inspection Checklist*; a blank *Gable End Sketch & Worksheet* page for you to record you observations; and some blank *Sample Gable End Sketch & Worksheets.* A helpful document for collecting information about wall-to-wall connections is the *Wall-to-Wall Connection Details*. Notice that at the top of the *Attic Inspection Checklist* there is a list of things to take into the attic. Be advised that there is so much to observe that good notes will reduce the number of trips that you have to make into the attic. Also, take lots of digital photos, if possible. Still, as good as photographs can be, you may find yourself in the attic several times to gather information. Multiple trips may be necessary particularly if there is an unusual detail that needs a work around. Straightforward retrofits are by far most typical and are very easy to gather information about…mainly just the retrofit stud length.

General description of what you will do in the attic: At this point we suggest that you print out the *Attic Inspection Checklist,* the *Sample Gable End Sketch & Worksheet* page and several blank *Gable End Sketch & Worksheets.* The *Attic Inspection Checklist* includes instructions for making inspections. We suggest you read the *Attic Inspection Checklist* before you go into the attic so you have a good idea of the details for which you will be looking. Reading the checklist twice may be beneficial. Do not rely on your memory. Taking good notes and pictures can save you some trips into the attic. In the middle of the left side of the Sketch Page is a brief reminder checklist of observations for you to make and record.

You can make markings on the gable end triangle of the sketch or you can enter data in columns 2, 3 and 4. The advantage of entering data on the table is that the sketch will become less cluttered.

- In column 2 indicate the side of the existing stud where retrofit studs can be placed. Do this by writing in L, or R or LR, where LR means both sides work.
- In column 3 write in the lengths of studs.
- In column 4 indicate if you think you want to use L-bent straps or U-bent straps. Remember you can use either at either end. So if you choose to use L-bent at the bottom and U-bent at the top you might write L/U. Or if you will just use L-bent at both the top and bottom, write in L. Try to use L-bent on the attic floor. For the upper retrofits you can use L- or U-bent, but you will almost always use U-bent when the gable end has an overhang supported by outriggers that extend from within the attic out over the gable end wall to the overhang. The rest of the columns will be filled in later.

As you look at each retrofit stud location you need to decide if you will use the L-bent strap method or the U-bent method. You can use L-bent straps at the bottom by first installing the bottom horizontal brace, adding an L-bent strap to the bottom of the retrofit stud, setting a U-bent strap at the top of the retrofit stud and then fastening the retrofit stud to the existing one. Next, and finally, the top horizontal brace is butted to the top of the retrofit stud and fastened to the roof framing. Don't forget the compression blocks

on the bottom horizontal braces. On this first reading these details may have left you behind; not to worry. As you read on you will better understand what is said here.

A common problem you may see in your attic is where the gable end truss has built-in webs. They prevent retrofit studs from being fastened directly to them. Not to worry. A simple solution is described in **Section 16** where the use of nail plates is described. Briefly, because retrofit studs cannot be placed overlapping existing studs, they are instead placed just outside existing studs where steel nail plates are used to connect the two studs together.

In some instances the wall studs may continue without a break from the floor below up to the roof. This type of framing is known as **balloon framing** and is it one of the best ways to make a very strong gable end wall. If you find balloon framing, what you see in the attic will not match any of the drawings in this guide and you probably do not need to retrofit your gable end except to check the connection of the wall framing to the roof framing. In addition, you still definitely need to evaluate the attachment of overhangs to the gable end wall or truss. When the gable overhang is more than a foot, this is one of the most critical, if not *the* most critical part of gable ends. If the overhang is two feet or more, then attachment is even more critical. Overhangs are addressed in the the Roofs section of the web based retrofit guide. The masonry analog to balloon framing is where the masonry wall below extends all the way up to the roof. Again, if you find this situation, it will not match any of the figures in this guide and you probably do not need to retrofit your gable end, **but** you definitely need to evaluate the overhang as discussed above.

Check every gable end: Every gable end should be evaluated for retrofitting because each may have some differences that will affect how you retrofit. You may be surprised to see the differences in construction methods at one of your gable ends compared to another. You may find one truss gable ends as well as conventionally framed ones. What you are looking for at each gable end are obstructions that might alter the way horizontal braces or retrofit studs can be installed. Good notes and lots of photos will reduce the likelihood of repeated trips.

Check every potential retrofit stud location: Because nearly all houses have something in the attic or a construction detail that prevents retrofitting using straightforward methods, you will want to know how to deal with odd situations. Hopefully, the workarounds presented in this guide will cover nearly every condition you find.

If you have read Sections **6** and **7**, printed the suggested pages and gathered the tools you will need in the attic, you are now ready to make a trip into the attic and collect the information on each gable end to be retrofitted. With the information you collect in the attic and the information that you collected from the building department, you will be set to make a worksheet that includes a sketch of each gable end, develop a list of materials and estimate the cost.

5.0
Planning and Completing *Worksheets*

Polish or redraw the sketch you made in the attic: At this stage you should have collected information from the building department and from your house's attic. In deciding what retrofit measure to use you probably need to redraw the sketches you made in the attic so they are more legible. You will also be adding details that you will collect based on the information in this section and in particular from **Table 6.1 or 7.1**. So first, redraw your sketches if necessary; starting at the left, number each stud to be retrofitted. If you made the decision that one or all retrofit studs would have L- and U-bent straps, then those locations should have two rows allocated to them on the worksheet because the number of fasteners will differ from one end to the other (see the Sample Worksheet in **Section 17**).

Making worksheets from the gable end sketches: To each redrawn sketch page made in the attic, you will add installation details to make each similar to the **sample worksheet** shown in **Section 17**. This revised sketch page becomes your **worksheet,** and it will be used to make a materials list. Once you are in the attic, the sketch page will give you all the information you need about strap lengths, numbers of fasteners in straps and compression blocks, and lengths of compression blocks. You might want to make copies of the redrawn attic sketches before you add retrofitting details to make them into working sketches. When adding details to your **worksheet** it would be best to use a pencil so you can erase easily.

If there are impediments or obstructions that make installation of horizontal braces difficult or impossible now is the time to read **Section 11.** If retrofit studs cannot be installed in a straightforward manner now is the time to read **Section 12**. Most likely these sections will have work arounds which have been anticipated in this retrofit guide and meet building code requirements.

L-Strap Method Specification Table

Requirements that complly with buildng code provisions for the L-Bent Strap method

	Column →	1	2	3	4	5			
	Row number ↓	Exposure Category	Max 3 sec gust Basic wind speed	Spacing for right angle brackets	Spacing for screws sill plate to wall	Maximum Allowable length of Retrofit Stud **Retrofit Configuration** A	B	C	D
Building code requirements	1	C	110	38"	19"	8'-0"	11'-3"	14'-9"	16'-0"
	2	C	120	32"	16"	7'-6"	10'-6"	13'-6"	16'-0"
	3	C	130	28"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	4	C	140	24"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	5	C	150	20"	10"	6'-6"	8'-9"	11'-0"	16'-0"
	6	B	110	48"	24"	8'-0"	12'-3"	16'-0"	NR
	7	B	120	40"	20"	8'-0"	11'-3"	14'-9"	16'-0"
	8	B	130	36"	16"	8'-0"	11'-3"	14'-9"	16'-0"
	9	B	140	30"	15"	7'-6"	10'-6"	13'-6"	16'-0"
	10	B	150	26"	13"	7'-0"	10'-0"	12'-3"	16'-0"
	11	Retrofit Elements				**Size and number of retrofit elements**			
	12	**Horizontal Braces** on attic floor and ceiling, size and numb				2x4	2x4	2x4	2 each 2x4
	13	**Retrofit Studs,** size and number				2x4	2x6	2x8	2 each 2x8
	14	1-1/4" long fasteners to connect straps to retrofit studs and to horizontal brace at each end using #8 screws 1-1/2" long or 8d nails, minimum number				6	9	12	8
	15	Strap length, minimum length (this is not a building code requirement per se, but is is the minimum length to get all the fasteners installed fhat are required in the line above)				24" flat 21" coil	36" flat 31" coil	49" flat 38" coil	30" flat 29" coil
	16	Bend L-bent straps from the middle as indicate in the row				7"	9"	11"	11"
	17	Compression block 3" fasteners secure compression blocks to horizontal braces, each block minimum number				6	8	10	12
	18	Compression block length for 2 fasteners placed side-by-side, minimum length				10"	12-1/2"	15"	17-1/2"
	19	Horizontal Brace all 2x4s 8' long, number				2	2	2	4
	20	Retrofit Stud, range of lengths				3 - 8'	10 - 12'	14 to 16'	16'
	21	Retrofit Stud assumed length for ordering				8'	12'	16'	2 each 16'
	22	Rettofit Stud size				2x4	2x6	2x8	2 each 2x8
Assumed cost each	23	Assumed Horizontal Brace, 2x4x8', cost each				$ 3.00	$ 3.00	$ 3.00	$ 3.00
	24	Assumed Retrofit Stud, cost each				$ 3.00	$ 7.13	$ 12.00	$ 12.00
	25	Assumed Strap, cost each				$ 1.55	$ 2.79	$ 4.00	$ 3.18
	26	Assumed cost of 1-1/4" fasteners, screws assumed each				$ 0.09	$ 0.09	$ 0.09	$ 0.09
	27	Assumed cost of 3" fasteners, screws assumed each				$ 0.08	$ 0.08	$ 0.08	$ 0.08
Costs	28	Cost for 1 retrofit (HB+RS+Sttraps+1-1/2" Fasteners+3" Fasteners)				$ 18.02	$ 26.67	$ 36.00	$ 66.48

Notes

NOT all buiilding code requirements are included in the table or these notes.

Compression blocks are assumed to be made from scraps and lengths are base on 2 fasteners across.

Assumed costs are based on Florida June, 2010 prices without sales tax.

Not included are costs for brackets to make (Gable end wall)-to-(Wall below) connections.

3" fasteners must be 10d nails with minimum diameter of 0.148" and must be 3" long minimum OR #8 3" long screws (drywall or other brittle metal screws are not acceptable)

1-1/4" fasteners must be 8d nails minimum 1-1/4" long OR minimum #8 minimum 1-1/2" long screws

Table 5.1. Specifications for the L-bent strap method which meet building code requirements and other helpful information. Be sure to read the notes below the table. A copy of this table is available for printing in Section 17.

U-Strap Method Specification Table

Requirements that comply with building code provisons for the U-Bent Strap method

	Column →	1	2	3	4	5			
	Row number ↓	Exposure Category	Max 3 sec gust Basic wind speed	Spacing for right angle brackets	Spacing for screws sill plate to wall	Maximum Allowable length of Retrofit Stud **Retrofit Configuration** A	B	C	D
Building code requirements	1	C	110	38"	19"	8"-0"	11'-3"	14'-9"	16'-0"
	2	C	120	32"	16"	7'-6"	10'-6"	13'-6"	16'-0"
	3	C	130	28"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	4	C	140	24"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	5	C	150	20"	10"	6'-6"	8'-9"	11'-0"	16'-0"
	6	B	110	48"	24"	8"-0"	12'-3"	16'-0"	NR
	7	B	120	40"	20"	8"-0"	11'-3"	14'-9"	16'-0"
	8	B	130	36"	16"	8"-0"	11'-3"	14'-9"	16'-0"
	9	B	140	30"	15"	7'-6"	10'-6"	13'-6"	16'-0"
	10	B	150	26"	13"	7'-0"	10'-0"	12'-3"	16'-0"
	11	Retrofit Elements				Size and number of retrofit elements			
	12	**Horizontal Braces** on attic floor and ceiling, size and numb				2x4	2x4	2x4	2 each 2x4
	13	**Retrofit Studs,** size and number				2c4	2x6	2x8	2 each 2x8
	14	1-1/4" long fasteners to connect straps to each of the two 1-1/2" edges of horizontal braces using #8 screws 1-1/2" long or 8d nails, minimum number				6	7	7	6
	15	Strap length, minimum length (this is not a building code requirement per se, but is is the minimum length to get all the fasteners installed that are required in the line above)				30" flat 30" coil	36" flat 37" coil	49" flat 41" coil	36" flat 37" coil
	16	Bend all U-bent straps symmetrically				0	0	0	0
	17	Horizontal Brace all 2x4s 8' long, number				2	2	2	4
	18	Retrofit Stud, range of lengths				3 - 8'	10 - 12'	14 to 16'	16'
	19	Retrofit Stud assumed length for ordering				8'	12'	16'	2 each 16'
	20	Rettofit Stud size				2x4	2x6	2x8	2 each 2x8
Assumed cost each	21	Assumed Horizontal Brace, 2x4x8', cost each				$ 3.00	$ 3.00	$ 3.00	$ 3.00
	22	Assumed Retrofit Stud, cost each				$ 3.00	$ 7.13	$ 12.00	$ 12.00
	23	Assumed Strap. cost each				$ 3.18	$ 2.79	$ 4.00	$ 2.79
	24	Assumed cost of 1-1/4" fasteners, screws assumed each				$ 0.09	$ 0.09	$ 0.09	$ 0.09
	25	Assumed cost of 3" fasteners, screws assumed each				$ 0.08	$ 0.08	$ 0.08	$ 0.08
Costs	26	Cost for column (HB+RS+Sttraps+1-1/2" Fasteners+3" Fasteners)				$ 20.32	$ 24.67	$ 32.60	$ 59.64

Notes

NOT all buiilding code requirements are included in the table or these notes.
Assumed costs are based on Florida June, 2010 prices without sales tax.
Not included are costs for brackets to make (Gable end wall)-to-(Wall below) connections.
3" fasteners must be 10d nails with minimum diameter of 0.148" and must be 3" long minimum OR #8 3" long screws (drywall or other brittle metal screws are not acceptable)
1-1/4" fasteners must be 8d nails minimum 1-1/4" long OR minimum #8 minimum 1-1/2" long screws

Table 5.2. Specifications for the U-bent strap method which meet building code requirements and other helpful information. Be sure to read the notes below the table. A copy of this table is available for printing in Section 18.

You can transform your redrawn attic sketch into a **worksheet** by adding information to columns 4 through 10. You may have already decided from the attic inspection about the information to be entered in column 4 which indicates the L- or U-bent decision for each end of each retrofit stud. The information for rows 5 through 10 comes from **Table 5.1** or **Table 5.2** depending on whether the row is for an L- or U-bent end of a retrofit stud. Columns 9 and 10 apply only to L-bent applications. Let's now fill in this information using the instructions below.

1. L-bent or U-bent / **Column 4 of Worksheet.** For each retrofit stud your first decision is whether you are going to use an L-bent strap or a U-bent strap. When you decide, make an 'L' or 'U' at the end of each retrofit stud. You might want to circle those letters on your working sketch so you see them more clearly. You might well use L-bent on the bottoms and U-bent at the top. If both methods are used on a stud, use two lines in the table part of the worksheet. For each retrofit stud location mark an L or U in column 4 of the table on the worksheet.
2. Retrofit configuration letter (A, B, C or D) / **Column 5 of Worksheet**. Now go to **Table 5.1 for** L-bent strap retrofits or to **Table 5.2** for U-bent retrofits. Here you will find in **Table 5.1** or **5.2** the retrofit configuration letter for each retrofit stud location. Your goal here is to learn for each retrofit stud location the retrofit configuration letter (A, B, C or D). You determine which letter to use by looking down Column 1 to find the exposure category (B or C) of your house. Then you move down in the next column until you find the basic design wind speed row that applies to your house. You might want to highlight or circle that row. Next, look at Column 5 which has four sub-columns. For each retrofit stud length, find the left most column that has a stud length that is equal to or just greater than the retrofit stud length for which you are finding the retrofit configuration letter. You might want to circle those letters on your working sketch so you see them more clearly. Note the configuration letter in column 5 for each retrofit stud on your Worksheet.
3. Retrofit stud width / **Column 6 of Worksheet**. Go to **Table 5.1** or **5.2** as appropriate for L- or U-bent. Knowing the configuration letter from column 5 of your worksheet, go to the appropriate configuration sub column of column 5 of the appropriate table. Then go to row 13 where the size of retrofit studs is given. Mark that size in column 6 of the worksheet, for example 2x4, 2x6, 2x8 or 2-2x8.
4. Straps / **Columns 7 & 8 of Worksheet**. Go to **Table 5.1** or **5.2.** Looking in the appropriate configuration column read down to row 14 to find the minimum length of the strap. Mark that number in column 7 of your worksheet. Similarly, find the number of fasteners to be placed at each end of each strap in row 15 and mark that in column 8 or your worksheet.
5. Compression blocks / **Columns 9 &10**. If you have chosen U-bent strap, you are finished with this part of the worksheet. If you have chosen the L-bent method you will need to use a compression block with a minimum length that can accommodate the number of fasteners necessary to anchor it to the horizontal brace. Minimum lengths will vary according to the number of fasteners that are needed which depends on the configuration letter. Using the same methods as before find in row 18 of **Table 5.1** the compression block length. Enter that in

column 9 of the worksheet. Finally, in row 17 find the number of fasteners for each compression block and enter it in column 10.

Planning for the two major gable end retrofitting tasks (making the gable end strong and making the wall-to-wall connection) should be relatively easy now with the information gathered from the previous steps.

This essential information will set you on the path to effectively strengthening of your gable end. Section **9** gives you step-by-step retrofit implementation details.

First approximation of cost: The costs of gable end retrofits can vary. The cost estimates below are for each stud location. The majority of retrofits will fall into configurations A and B. Assuming A or B, a rough cost estimate to retrofit a gable end over a typical two-car garage would be $140 and probably require that seven stud locations to be retrofitted. A 40' wide gable end in a category B or C exposure area and 130 mph wind speed would cost about $340 for materials. These estimates do not include making the wall-to-wall connections that are necessary. HGA and HGAM connectors with their fasteners cost about $6 each.

Table 5.3

Estimate of material costs for each retrofitted stud location		
Configuration	**Cost for L-bent**	**Cost for U-bent**
A	$18	$24
B	$27	$28
C	$36	$36
D	$67	$66

One needs to bear in mind that in areas with winds less than 140 mph with Exposure B and gable ends less than 11' high, most retrofits will be configuration A with a few configuration B so the costs will average $22 for L-bent and $25 for U-bent.

The cost for the garage example would be about **$41** and about $**77** for the 40' wide gable example. On the one hand these costs may seem high. On the other hand they can save your house.

6.0
Implementation:
Retrofitting Gable End Walls with L-Bent Straps

Order of presentation: To give you a better appreciation of what is involved in doing a gable end bracing retrofit, the first section of this chapter will cover the steps involved in the installation. After that we explain how to determine the materials you need, how to make a shopping list, how to decide on what materials to select (**Section 14**) and what tools you may need (**Section 15**).

Bear in mind that you may want to make the wall-to-wall connections before strengthening and bracing the gable end. This will depend on how you will be making wall-to-wall connections. Generally, it is better to retrofit the gable end wall first so the HGA or HGAM connectors will not be in the way of that work. To help you decide which to do first, see **Section 9** for frame walls and **Section 10** for masonry walls.

There are two types of obstructions addressed in this retrofit guide and that are incorporated in the *2007 Florida Building Code for Existing Buildings* and the *2012 International Building Code for Existing Buildings*. Specific guidance is provided for ways to work around these obstructions without reducing the effectiveness of the retrofits. One type is where there are obstructions that prevent the effective installation of a retrofit stud. These include gable end vents where the existing framing (existing studs have been cut so that a gable end vent could be installed), pipes or other objects are in the way. The alternative measure for this is discussed in **Section 11**. The other type of obstruction is where there are impediments on the floor or ceiling of the attic that prevent the installation of horizontal braces that extend the minimum of 6' into the attic. Alternative measures for this are discussed in **Section 10**.

Gable end retrofit installation steps using L-bent straps

Step 1. Install bottom horizontal braces. For Step 1 **Figure 6.1** shows installation of a 2x4 horizontal brace 6' feet plus 2-1/2" long or whatever additional length is required to cross three framing members and extend 2-1/2" past the last member. The horizontal brace must be fastened to at least 3 framing members, and it must be fastened any other framing member(s) it crosses that are at the same elevation. The brace must extend beyond the last framing member by at least 2-1/2" so that the fasteners don't pull out of the brace when wind pressure pulls the wall outward and so the fasteners do not split the end of the brace when they are installed. The fasteners on the horizontal braces should be placed at least a 1/2" from the edges of the brace and 1" from each other. Those spacings do not leave much margin for error of placement. Just do the best you reasonably can. Most people will find it easiest to work in the attic by first installing all the braces on the attic floor. That gives a broader walking surface. Remember you can run the brace at an angle to avoid an obstacle, but you must maintain the 6' length and attachment to three framing members. If you have many gable end studs to retrofit, you are apt to make the mistake of installing a brace on the wrong side of an existing stud.

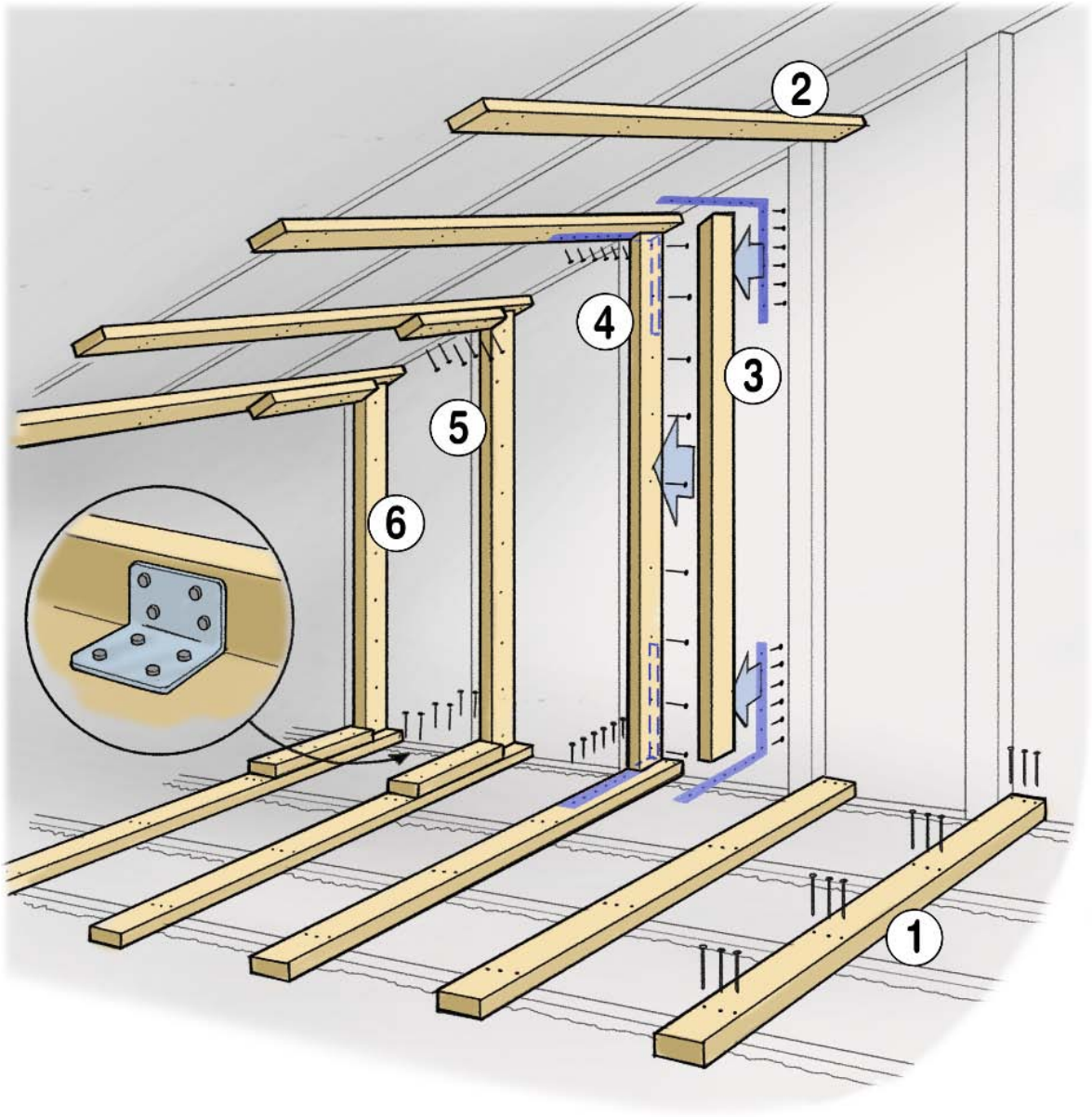


Figure 6.1 The L-bent strap installation steps

When you install horizontal braces onto attic floor framing members you may notice that some floor framing members are lower or higher than the rest resulting in gaps between the horizontal brace and one or more flooring members. Gaps need to be filled with wood shims. Gaps tend to be more of problem with block walls than frame walls. Start installing fasteners at the wall end to ensure that the brace will be on the correct side of the existing stud and jammed against the existing stud. Install fasteners to attach the horizontal braces to every framing member over which the brace passes. Fastening to a rafter used solely to support ceiling material, and located next to the exterior wall

below, is not necessary. Nevertheless, fastening needs to be made to at least three primary framing members unless blocking or decking is used.

Step 2. Install top horizontal braces. With the bottom braces installed, one or all of the top horizontal braces can be installed. Remember to place the top ones on the same side of the existing stud as the bottom brace.

Step 3. Straps on retrofit stud.
Step 3a. Cut retrofit stud to length. Measure the length for each retrofit stud. Measure the length of the existing stud along the side where you intend to install the retrofit stud and the maximum allowable length of the retrofit stud 1-1/2" away from the existing stud on the side where the retrofit stud is to be connected. Use the shorter of the two lengths for each retrofit stud. The top of the stud can be cut square and does not need to match the pitch of the roof. Cut the stud.

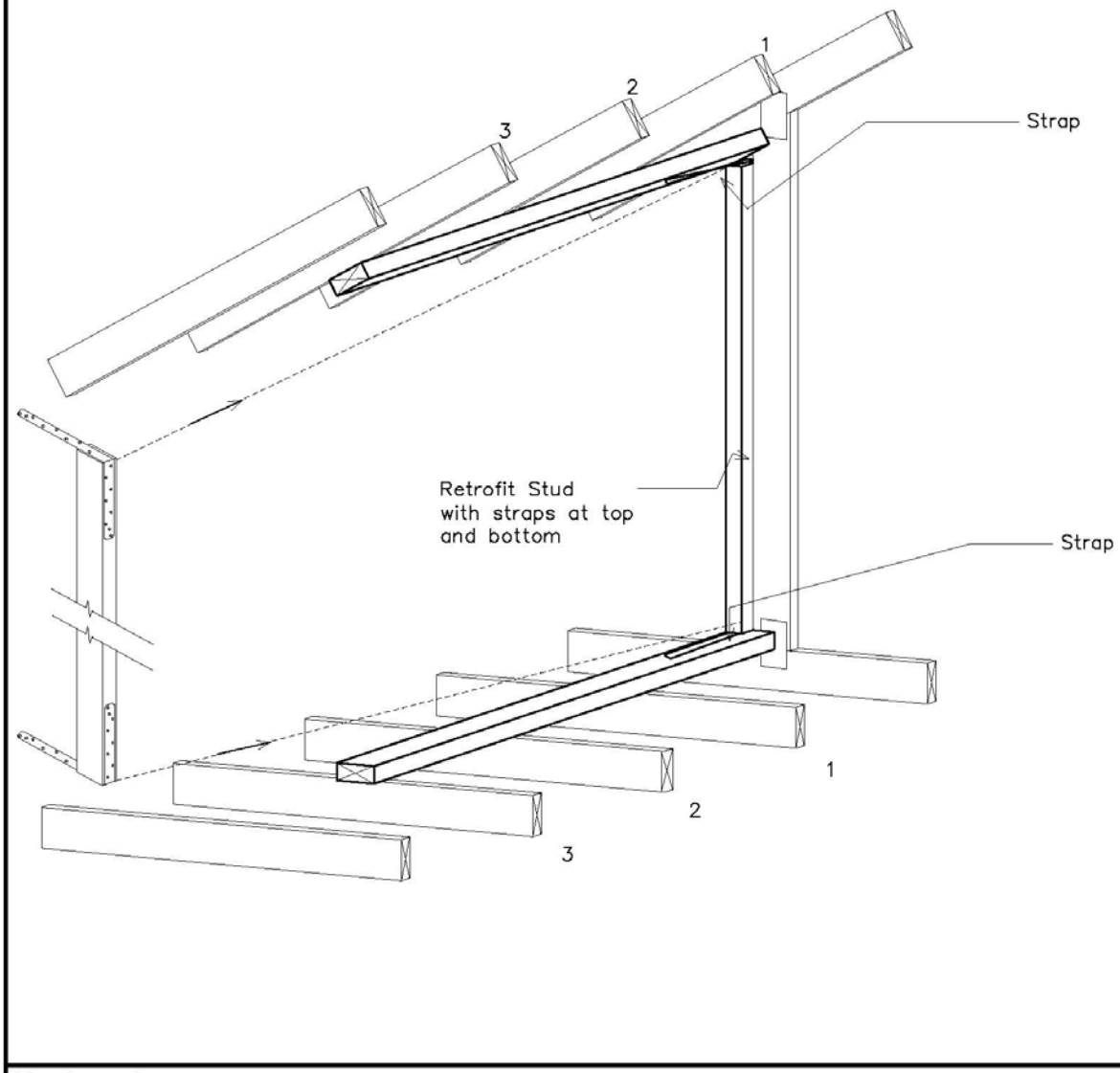
Step 3b. Bend and attach straps. Select the appropriate strap by referring to row 15 of **Table 5.1**. L-bent straps need to be bent, BUT NOT in the middle, so that the fastener closest to the end of the retrofit stud is at least 2-1/2" from the end of the stud. By selecting the strap length from the table one can bend the strap at the point determined by counting the number of fastener holes from the end of the strap and adding 2-1/2". Row 16 of the table states the number of inches from the center to bend the L-strap. This ensures there will be enough holes for fastening to the horizontal brace. Install a strap to each end of the retrofit stud. One can bend the strap using a bench vice or install a strap on the stud so the bend point is at the end of the stud, fasten the strap and then bend the strap by hand and making the bend tighter by finishing the bend with a hammer. Remember that the fastener closest to the end of the brace must be at least 2-1/2" from the end of the brace.

Step 4. Install retrofit stud. With the retrofit stud having a strap attached to the edge of each end, it is ready to be fastened to the existing stud. If the attachment of wall sheathing or siding is at all suspect, a best practice is to apply a heavy bead of AFG-01 rated construction adhesive on the sheathing where the edge of the retrofit stud will be placed. **See page 44 in Section 8 for more details about this best practice.** Push the stud in place against the sheathing and against the existing stud. Fasten the retrofit stud to the existing one in that position by using 3" fasteners no closer than 2-1/2" from the ends of the retrofit stud and no farther apart on the stud than 6" and no closer than 2-1/2" to each other. With the completion of this step you have made the existing stud at least twice as strong as it was, and if the existing stud is flat on the wall, you have made the stud almost three times stronger. Finish fastening the retrofit stud by fastening the straps to the horizontal braces. These straps restrain the retrofit stud from being pulled out by wind pressure. They provide the tension connection.

Step 5. Install compression blocks. Place compression block on the bottom horizontal brace and butt the block snuggly up against the retrofit stud. Secure the block to the brace using the number of 3" fasteners indicated on row 17 of the table. The compression blocks restrain the gable end wall from being pushed into the attic.

With all retrofit studs completed at a gable end you are done except for making the wall-to-wall connections.

Figure 6.2. **Installation of retrofit stud. The retrofit stud for this L-bent strap installation has straps already attached to the back edge. Construction adhesive has been applied to the wall where the retrofit stud will be butted.**



Requirements

- The number and size of retrofit studs shall be as specified in the Table 1.
- The retrofit stud must fit so snuggly between framing members that the gap should not exceed 1/2".
- Carefully center the strap on the edge of the retrofit stud to minimize chances of splitting the stud.
- Fasteners must be 10d nails or #8 screws.
- Fasteners must be a minimum of 1–1/4" long, but should be no longer than 1–5/8" to minimize chances of splitting the stud.
- The fasteners at the far ends of the retrofit stud must be no closer than 2–1/2" from the end of the stud.

Retrofit Studs

Figure 6.3

Gathering materials

Table 6.1 along with your worksheets will make determining the number of each kind of material very easy. Notice that at most 10 different kinds of materials are used. For most gable ends, only eight kinds are required. Instructions for using the table are given immediately below it in the notes.

Table 6.1. Materials takeoff form for the L-bent strap method. Instructions for use are given immediately above this caption and below the table.

	L-Bent Strap Method Materials Takeoff								
	Retrofit Configuration								Grand Total Number Needed
	A		B		C		D		
Item	Num @	X @	Num @	X @	Num @	X @	Num @	X @	
2x4x8' for Horizontal Braces	2		2		2		2		
2x4x8' for Retrofit Studs	1		---	---	---	---	---	---	
2x6x12' for Retrofit Studs	---	---	1		---	---	---	---	
2x8x16' for Retrofit Studs	---	---	---	---	1		2		
24" straps 20 gauge	2		---	---	---	---	---	---	
30" straps 20 gauge	---	---	---	---	---	---	4		
36" straps 20 gauge	---	---	2		---	---	---	---	
49" straps 20 gauge	---	---	---	---	2		---	---	
1-1/4" fasteners	24		36		48		64		
3" fasteners	47		59		71		150		
Pounds 1-1/2" screws	0.14		0.21		0.28		0.37		
Pounds 3" screws	0.62		0.78		0.94		1.98		
Number of retrofits for this Configuration -->	# =		# =		# =		# =		

To use this table to determine quantities:

First, in the bottom row enter the number of retrofits for each of the Configurations.
Next, multiple that number by Num @ for each row entry.
Finally, total the numbers across each row and enter that number in the Total column.
Screw weights will vary according to the particular brand and model selected.

Right and wrong: Figure 6.4

Wrong: Retrofit stud so weakened by bevel cut that is it not very effective.
The compression blocks do not bear on the full width of the retrofit studs.
Right: The horizontal brace does make up for the ineffective compression block.
An H10 connector is in place to hold down the outrigger/outlooker. Great!

Wrong: Those nails that hit straps don't do anything. Maybe there are enough good nails.
Right: The plywood that was already on the floor of the attic is a very valuable way to distribute the loads imposed by the gable end wall to the rest of the floor system. The compression block butts the retrofit properly. It is assumed that the white wire at the end of the horizontal brace is really not being compressed by the brace.

Wrong: Some of the fasteners for connecting the compression block to the horizontal brace do not penetrate the brace by the gap between the two.

7.0
Implementation:
Retrofitting Gable End Walls with U-Bent Straps

Order of presentation: To give you a better appreciation of what is involved in doing a gable end retrofit, we will first review the installation steps. After that we will tell you how to determine the materials you need and how to make a shopping list. We explain how to decide on what materials to select **Section 14** and what tools you may want in **Section 15.**

Bear in mind that you may want to make the wall-to-wall connections before strengthening and bracing the gable end. This will depend on how you will be making wall-to-wall connections. Generally, it is better to retrofit the gable end wall first so that the HGA or HGAM connectors will not be in the way of that work. To help you decide which to do first, see **Section 9** for frame walls below the gable end and **Section 10** for masonry walls below the gable end.

Two types of obstructions are addressed this retrofit guide which are also incorporated in the Florida Building Code and the *2012 International Building Code for Existing Buildings*. Specific guidance is provided for ways to work around these obstructions without reducing the effectiveness of the retrofits. One type is where there are impediments that prevent the effective installation of a retrofit stud. These include gable end vents where the existing framing (existing studs have been cut so that a gable end vent could be installed) or where pipes or other objects are in the way. The alternative measure for this is discussed in **Section 11**. The other type of obstruction is where there are obstructions on the floor or ceiling of the attic that prevent the installation of horizontal braces that extend the minimum of 6' into the attic. Alternative measures for this are discussed in **Section 10**.

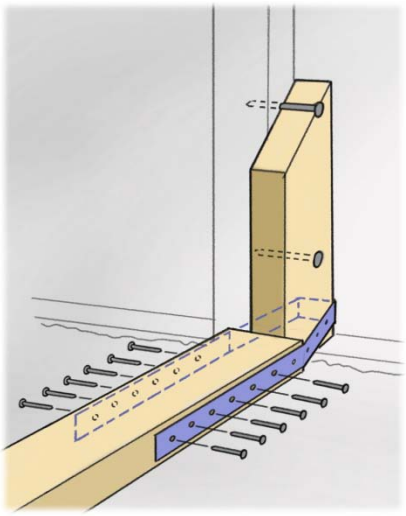


Figure 7.1 This shows the strap of the U-bent method. First install the Retrofit Stud with the top and bottom with the already bent straps set behind it. Next install the two Horizontal Braces. And finally fasten the straps to the edges of the braces.

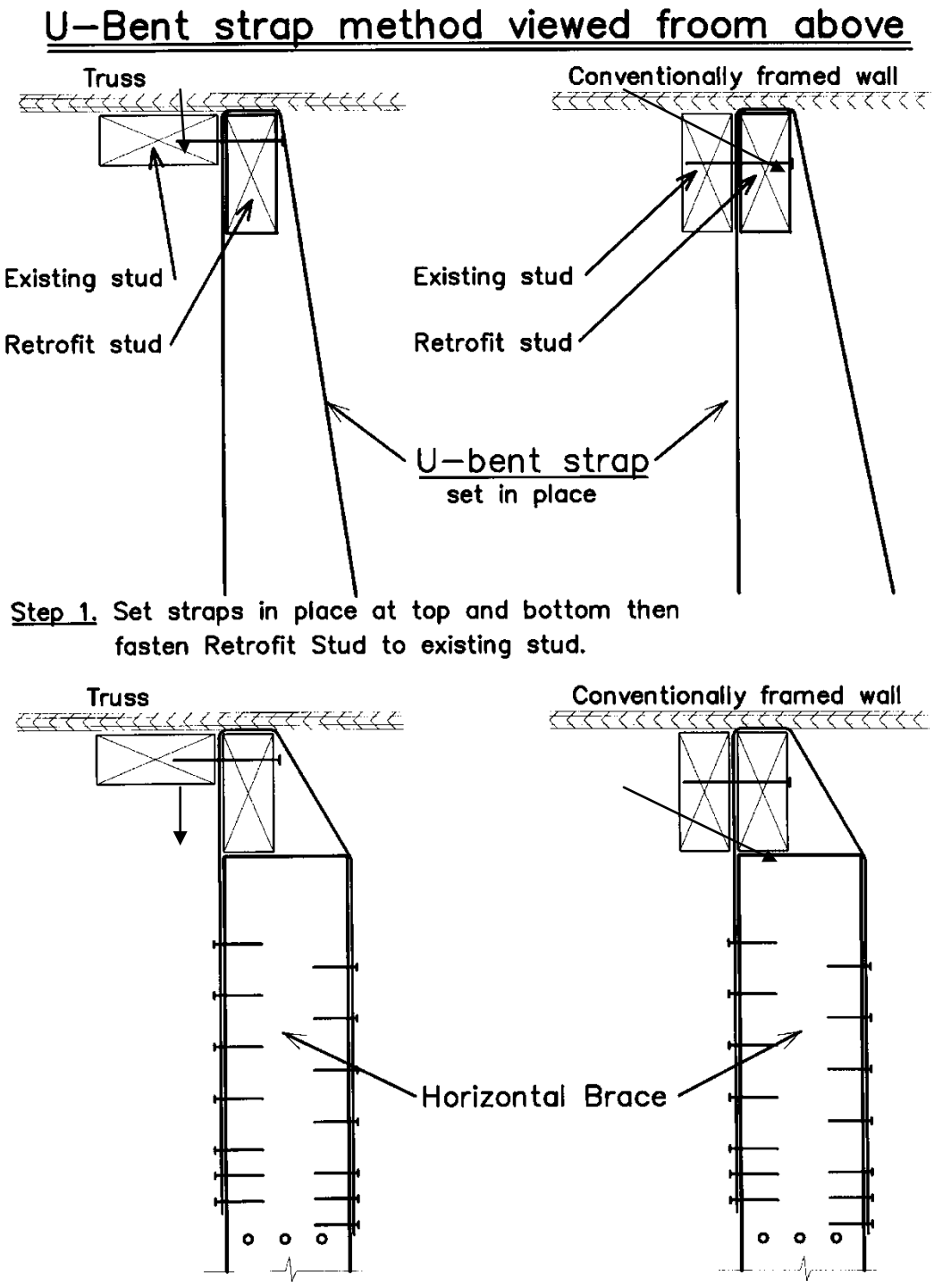


Figure 7.2 **The two rows in this figure show in two steps the method of installation of U-bent straps. The two on the left side show a truss gable end and the two on the right show a conventionally framed wall. The only difference is the orientation of the existing studs. Do note that one edge of the Horizontal Brace lines up with one edge of the Retrofit Stud. In the L-bend strap method the Horizontal Brace can butt up to the middle of the retrofit stud.**

Gable end retrofit installation steps using U-bent straps

You can start and finish one retrofit location or install several or all the retrofit studs and then install at least the horizontal braces. The choice is yours. It will require less moving around at the gable end, and it is probably easiest to install a couple retrofit studs then their bottom horizontal braces. Then you will have the choice of installing the upper braces or moving to install more retrofit studs and their bottom braces. The advantage is that there will be more to stand on when installing the upper braces.

Step 1. Cut retrofit stud. Determine the length for each retrofit stud. Measure the length of the existing stud on the side where you plan to install the retrofit stud and 1-1/2" away from the existing stud on the side where you plan to install the retrofit stud. Use the shorter of the two lengths. The stud needs to extend from the top of the ceiling joists or truss bottom chord up to the bottom of the rafters or truss top chord. Make the stud as long as it can be and still be placed against the wall. Its top end can be cut square. It is not necessary to match the pitch of the roof. Cut the stud.

Step 1b. Set retrofit stud with it loose strap in place. Select the strap appropriate for the retrofit configuration by referring to row 15 of **Table 5.2** or refer to your worksheet. U-bent straps need to be bent symmetrically so the legs will be of equal length. Set the straps in place, one at each end. Until the retrofit stud is secured in place the straps may fall or slip out of place elevation wise. Not to worry.

If the attachment of wall sheathing or siding is at all suspect, apply a heavy bead of AFG-01 rated construction adhesive on the sheathing where the edge of the retrofit stud will be placed. **See page 44 in Section 8 for more details about this best practice.** Push the stud in place against the sheathing and existing stud. Fasten the retrofit stud to the existing one using 3" fasteners. The fasteners should be no closer than 2-1/2" to the ends of the retrofit stud, no farther apart on the stud than 6" and no closer than 2-1/2" to each other. With the completion of this step you have made the existing stud at least twice as strong and if the existing stud is flat on the wall, you have made the stud almost three times stronger. Finish fastening the retrofit stud by fastening the straps to the horizontal braces. These straps restrain the retrofit stud from being pulled out by wind pressure. They provide the tension connection.

Step 2. Install retrofit studs. You may find it easiest to fasten the retrofit stud to the existing one by starting with the top fastener because you can hold and install that strap without having to hold the bottom strap in place. After installing the first fastener you need to make sure the bottom strap remains at the proper elevation.

Step 3. Install bottom horizontal braces. Place the bottom horizontal brace on the attic floor and press it tightly against the retrofit stud. The 2x4 brace must be 6' feet plus 2-1/2" long or whatever additional length it may takes to cross three framing members and extend 2-1/2" beyond the last framing member. The horizontal brace must be fastened to at least 3 framing members, and it must be fastened to any other framing member(s) it crosses that are at the same elevation. The brace must extend beyond the last framing member by at least 2-1/2" so that the fasteners don't pull out of

the brace when wind pressure pulls the wall outward and so the fasteners do not split the end of the brace when they are installed. The fasteners on the horizontal braces should be placed at least a 1/2" from the edges of the brace and 1” from each other. This spacing does not leave much margin for error of placement. Just do the best you reasonably can. Most people will find it easiest to work in the attic by first installing all the braces on the attic floor. That gives a broader walking surface. Remember you can run the brace at an angle to avoid an obstacle but you must maintain the 6’ and three attachments. With the horizontal braces snuggly butted to the retrofit stud and fastened to the attic floor framing, the bottom of the gable end is restrained from being pushed into the attic by wind. It serves the same compression function as the compression blocks for the L-bent method.

When you install horizontal braces onto attic floor framing members you may notice that some floor framing members are lower or higher than the rest resulting in gaps between the horizontal brace and one or more flooring members. Gaps need to be filled with wood shims. Gaps tend to be more of problem with block walls than frame walls. Start installing fasteners at the wall end to ensure that the brace will be on the correct side of the existing stud and jammed against the existing stud. Install fasteners to attach the horizontal brace Attach a fastener to every framing member over which the brace passes. Fastening to a rafter used solely to support ceiling material, and located next to the exterior wall below, is not necessary. Nevertheless, fastening needs to be made to at least three primary framing members unless blocking or decking is used.

Step 4. Install top horizontal braces. With the retrofit studs and bottom braces installed, the top horizontal braces can be installed. This brace restrains the top of the gable end wall from being pushed into the attic. When you install horizontal braces onto roof framing members you may notice that some roof framing members are lower or higher than the rest resulting in the horizontal brace not making contact with one or more members. Gaps need to be filled with wood shims. Gaps tend to be more of problem with block walls than frame walls. Start installing fasteners at the wall end to help assure that the brace will be on the correct side of the existing stud and jammed against the existing stud. Fasten the horizontal brace to every framing member over which the brace passes. Fastening needs to be made to at least three primary framing members unless blocking is used.

Step 5. Fasten straps. Refer to row 14 of **Table 5.2** for the configuration letter of this stud to determine the number of fasteners to place into each end of the straps. Fasten the straps to the edges of the horizontal braces. Remember the fastener closest to the end of the brace must be at least 2-1/2” from the end of the brace. You have now made the tension connection for the gable end wall. The connection that keeps the gable end wall from being pulled off the house by negative wind pressure.

You will see on **Figure 15** that the three fasteners used to secure a brace to a framing member are offset 1/2" from adjacent ones. In practice this means that one fastener should be placed about 1/2" from the edge of the brace and about ½” from the edge of the framing member. The second fastener should be placed about in the middle of the

brace (sideways) and about 1/2" from the other edge of the framing member. The third fastener should be placed in line with the first one and about 1/2" from the edge of the brace. This minimizes the chance of splitting the framing member which, because of it narrow 1-1/2” width, is susceptible to splitting. When a fastener splits wood its effectiveness will be significantly reduced. Adding more fasteners is apt to further weaken the connection instead of making it better.

If the ceiling material is drywall, plaster or another brittle or fragile finish, screws are usually a better choice for fastening down the braces on the ceiling framing members. Installing screws produces negligible impact loads as compared to installing nails, especially when the nails are driven with a hammer.

Gathering materials

Table 7.1 below along with your worksheets will make determining the number of each kind of material very easy. Notice that at most 10 different kinds of materials are used. For most gable ends there are only eight.

Table 7.1. Materials takeoff form for the U-bent strap method. Instructions for use are given immediately above this caption and below the table.

	U-Bent Strap Method Materials Takeoff								
	Retrofit Configuratiion								Grand Total Number Needed
	A		B		C		D		
Item	Num @	X #	Num @	X #	Num @	X #	Num @	X #	
2x4x8' for Horizontal Braces	2		2		2		4		
2x4x8' for Retrofit Studs	1		---	---	---	---	---		
2x6x12' for Retrofit Studs	---	---	1		---	---	---	---	
2x8x16' for Retrofit Studs	---	---	---	---	1		2		
24" straps 20 gauge	---	---	---	---	---	---	---	---	---
30" straps 20 gauge	2	---	---	---	---	---	---	---	
36" straps 20 gauge	---	---	2	---	---	---	4		
49" straps 18 gauge	---	---	---	---	2		---	---	
1-1/4" fasteners, screws	24		28		28		48		
3" fasteners, screws	75		83		91		182		
Pounds 1-1/4" screws	0.14		0.16		0.16		0.28		
Pounds 3" screws	0.99		1.09		1.20		2.40		
Number of retrofits for this Configuration -->	# =		# =		# =		# =		

To use this table to determine quantities:
First, in the bottom row enter the number of retrofits for each of the Configurations.
Next, multiple that number by Num @ for each row entry.
Finally, total the numbers across each row and enter that number in the Total column.
Screw weights will vary according to the particular brand and model selected.

8.0
General Instructions and Requirements for Installing L- and U-bent Components

Though it may be a bit late to give notes and hints, you may find that they answer questions that may have occurred to you as read the installation steps. You may want to refer back to these bullet points. There is a fair amount of repetition which is intentional so if you just read about one of the topics below, you won't miss something that ties in with another. That is why it is in both places.

Retrofit stud installation requirements and hints:

- Fastening of retrofit studs to existing ones shall be done with 3" long fasteners spaced at least 2-1/2" from the ends of the stud and spaced on average 6" from each other, but no closer than 2-1/2". The fasteners should be spaced a minimum of 1/2" from the edge of any retrofit or existing studs.
- Retrofit stud/existing stud assemblies must be no farther than 24" apart. If existing studs are spaced 16" apart, then each one will have to be retrofitted or else the retrofit spacing would be 32" exceeding the 24" maximum.
- Retrofit studs can be placed on either side of existing studs. Once the two are well fastened together they act as a single unit.
- The fasteners should be at least 1/2" from the edges of existing or retrofit studs.
- Retrofit studs do not need to be pushed firmly against the outside wall. However, they should overlap existing studs so that fasteners can be placed a minimum of 1/2" from the edges of existing and retrofit studs.
- Horizontal braces need not be perpendicular to the gable end wall which means they can be run at angles to the wall to avoid an obstacle.
- The size of retrofit studs can be 2x4, 2x6, 2x8, or 2-2x8s depending on the configuration letter A, B, C, D, respectively.
- If a retrofit stud needs to be notched less than 2", then use the next size lumber. For example if a 2x6 retrofit stud is required to be used, you can use a 2x8 so you do not notch it more than 2". The idea is to always meet the minimum depth of the **Tables 5.1 and 5.2** requirements.
- If the attachment of wall sheathing or siding is at all suspect apply a heavy bead of AFG-01 rated construction adhesive on the sheathing where the edge of the retrofit stud will be place. **See page 44 in Section 8 for more details about this best practice.** Push the stud in place against the sheathing and against the existing stud.
- Where to cut retrofit studs? It will probably be easier to cut the studs first and then carry them into the attic.
  You should save the cut off section to use as a compression blocks.

Horizontal brace installation requirements and hints:

- Horizontal braces are at a minimum always 2x4s but wider ones are fine. Buy 8-foot boards. There is no need to cut them to length unless you need short compression blocks.

- Horizontal braces must be attached to at least three framing members, ceiling joists or trusses, and they must be attached to all framing members at the same elevations over which they cross.
- Horizontal braces must extend into the attic at least 6’ plus 2-1/2”.
- Horizontal braces can be run at angles to avoid obstacles, but they still must extend far enough that they meet the two conditions above.
- Horizontal braces must be attached to framing members with 3” fasteners at each location. The fasteners should be at least 1/2" from the edges of either piece of lumber and at least 1/2" from each other.
- Fasteners must be at least 2-1/2” from the ends of the braces.
- If you were going to go the extra mile on any of the retrofit measures, probably the most effective thing you could do would be to make the horizontal braces on the attic floor a couple feet longer and fasten them appropriately. Longer braces are much more effective than wider ones and cheaper.
- For L-bent applications you have some flexibility in placing horizontal braces. Horizontal braces can be installed on either side of existing studs as long as that is where a retrofit stud can be installed. Horizontal braces can be run at an angle to avoid obstacles, and they can be fished under some obstacles. If need be, they can be shortened 2’ if blocking is added, and they can be shortened even more if a plywood deck is installed that spans the area blocked by the obstacle.
- Braces do need to be secured to each framing member over which they cross, unless the member is near the wall and its only function is to be deadwood to support ceiling drywall.
- For L-bent applications, select which side of an existing stud is the best place to install a retrofit stud. The retrofit studs don’t have to be consistently on the same side. So you don’t make a mistake by forgetting which side you have decided to use you might consider using a black marking pen to place an arrow on each existing stud. It is okay to angle a brace so it runs at an angle from the wall to skirt obstructions. Just be sure that by running it at an angle that the brace is still long enough to extend at least 2-1/2” beyond the framing member most distant (about 6’) from the gable end wall. If you angle them you need not angle the end cut of the brace so that it fully butts the existing stud or retrofit stud. However you do need to make an angle cut on the compression block so that its end pushes against the retrofit stud and fully butts against the existing or the retrofit stud. This is so that the compression function will be fully effective.
- Horizontal braces used at U-strap locations must snuggly butt a retrofit or existing stud, and have a contact area with each other of at least 1-1/2” by 1-1/2” or its equivalent.
- When you install horizontal braces onto attic floor framing members you may notice that some floor framing members are lower or higher than the rest resulting in gaps between the horizontal brace and one or more flooring members. Gaps need to be filled with wood shims. Gaps tend to be more of problem with block walls than frame walls. Start installing fasteners at the wall end to ensure that the brace will be on the correct side of the existing stud and jammed against the existing stud. Attach horizontal braces by installing fasteners that connect the horizontal brace to every framing member over which the brace passes. Fastening to a ceiling joist used

solely to support ceiling material, and located next to the exterior wall below, is not necessary. Nevertheless, fastening needs to be made to at least three primary framing members unless blocking or decking is used.

- Horizontal braces can be attached to plywood on an attic floor if the plywood itself is well secured to framing.
- Rat runs located where you need horizontal braces can be used provided they are structurally sound and can be secured to attic floor framing with three fasteners on at least three framing members into the attic. However, a rat run for U-bent applications is not apt to be made to butt the retrofit stud snuggly as is required.
- Rat runs not located where you need them, are still beneficial to the gable end retrofit because they can further distribute the gable end loads to the attic floor/roof ceilings. If practical, install 3" fasteners at each framing member trying to have three at each location yet not splitting the wood.
- Rat runs routed at angles that are in the way of horizontal braces can be cut to allow braces to be routed properly. Again, whenever practical use rat runs to provide additional bracing.
- Where to cut braces:
- Where to cut retrofit studs? It will probably be easier to cut the studs first and then carry them into the attic. You should save the cut off section to use as a compression blocks. The cuts do not have to be pretty except for the cut that butts retrofit studs in the U-bent method. You may want to cut the upper brace at the same time because the length will likely be the same. In fact, while you are at it, you may want to cut all the horizontal braces, both lower and upper unless there is an odd one or two that need to be longer because they need to skirt an obstruction.
- ***Horizontal braces attached to the bottom edges of rafters or bottom edges of the top chords of trusses members:*** Installing upper horizontal braces is not as easy as installing lower ones. It is difficult to hold a 6' brace lengthwise against the roof framing members while trying fastening it. It seems to take three or four hands. That sounds impossible, but actually is not nearly as hard as it sounds. Some hints will be offered in paragraphs below. Aside from having to hold the brace the installation procedure is the same as for the bottom brace.

Figure 8.1. Installation of upper horizontal brace by having started screws before lifting the brace up to fasten it.

Compression blocks installation requirements and hints:

- Compression blocks must snuggly butt retrofit studs or existing studs.
- Where compression blocks butt retrofit studs or existing studs they need only have contact area about 1-1/2” by 1-1/2”.
- Compression blocks can be wider and longer than the absolute minimum suggested in Table **5.1** on **row 17**. There is no need to cut them to the lengths in the table.
- The lengths of compression blocks given in Table **5.1** on **row 17** are the absolute minimums and assume two fasteners side by side distributed 2-1/2” from others and 2-1/2” from the ends. Longer blocks are recommended in case fasteners cannot be made to penetrate straps.
- **Table 5.1 row 17** tells the number of 3” fasteners required to hold the blocks to horizontal braces.
- Fasteners must be spaced 2-1/2” apart along the length of blocks and 2-1/2” from the ends of the compression blocks.
- Fastener must be at least 1/2" from the edges of the blocks and the horizontal braces.
- It is fine if fasteners penetrate straps.
- Most people place fasteners side by side, one a minimum of a 1/2" from the edges and one similarly located across a compression block. Straps can interfere with this method so longer compression blocks are recommended just in case.

Strap hints:

- Strap lengths are specified in **Tables 5.1 and 5.2 in row 15**.
- The number of fasteners to secure each end of straps is given in **Tables 5.1 and 5.2 in row 14**.

- Straps can be fastened with 8d nails or #8 x 1-1/4” screws. Do not use drywall screws.
- Fasteners for straps must be a minimum of 2-1/2” from the ends of lumber whether retrofit studs or horizontal braces.
- Strap gauge shall be 20 gauge. Heavier straps are not recommended because of the difficulty of bending them sharply.
  Model numbers include LSTA24, MSTA24, LATA30, LSTA36, MSTA49, and LSTI49 are supplied by both Simpson and USP. The last two numbers indicate the length. LSTA30 is mentioned because it can be used instead of 24” straps.
- Fourty-nine-inch straps will probably have to be special ordered.
- You may want to consider ordering 20 gauge strap in coil form. Straps supplied in 25’ or longer coils can be used and cut to length as needed.
- Straps cannot be spliced together.
- Longer than minimum length straps can be used.
- Heavier than minimum straps can be used, but are harder to bend to get nice sharp bends while minimizing slack.
- Straps can be bent multiple times, but only once at each location.
- Straps should be kept as taught as practical. Heavier straps are harder to bend sharply to keep taught. Bending straps over a sharp edge or in a vice helps assure a tighter bend. L-bent straps can be bent over the ends of retrofit studs and then made tighter by being hit with a hammer.
- Compression blocks can be fastened down through straps though nails may deflect and screws may break or just stop. This is why using compression blocks longer than the minimum is a good idea so that all the compression block fasteners can be installed while respecting minimum edge and spacing dimensions.
- For L-bend straps, **Tables 5.1** and **5.2 row 16** tells where to bend straps compared to the middle of straps. The distances from center given were based on bending so the leg that will be on horizontal braces will be longer than the leg on the retrofit stud by the width of the retrofit stud (2x4, 2x6, or 2x8 as the case may be) plus about 1/2". The half inch is so you have sufficient space to place the fastener that will be closest to the retrofit stud.
- U-bent straps should be bent symmetrically so they wrap the sides of horizontal braces with approximately equal lengths.

Fastener hints:

- Easy to remember hints: make strap-to-wood connections with fasteners 1-1/4” long, and make wood-to-wood connections with 3” long fasteners.
- Strap-to-wood fastenings must be made with 8d nails or 1-1/4” #8 screws. Although 8d nails are usually 2-1/2” long, for gable end retrofits they need only be 1-1/4” long. 8d nails must have shanks 0.131” in diameter and must be at least 1-1/4” long. Drywall screws cannot be used because they are too brittle.
- Wood-to-wood fastenings must be made with 10d nails or 3” #8 screws. 10d nails must have shanks 0.148” in diameter and must be 3” long so that they fully penetrate both pieces of lumber. Drywall screws cannot be used. Deck screws are a good choice because of their availability and pricing plus some have heads that

are particularly easy to drive. #9 diameter screws can be used equally well and may be all that is available at reasonable price in 3" lengths.

- Fasteners spaced closer than specified are apt to split the wood.
- Screws have the advantage of not causing impacts when they are installed.
- Short screws require only one hand when they are being driven.
- Screws cost more than nails.
- Screws take longer to install than nails.
- Screws with sharp points especially those with chisel or cutting type points are easier to start than duller ones. It can make a big difference when working overhead.
- Using the same head drive type for the 1-1/4" and 3" length screws will save you time because you won't have to change drive bits.
- Screws with square or star heads tend to stay on the driver tip better than Philips and they do not strip out as easily. Combination heads seem to work fine and best when not used with Philips drivers.
- Nails are cheaper and sometimes faster to install than screws.
- Driving nails has the potential to damage drywall or plaster ceiling and stucco ways.
- Nails driven with a hammer require two hands.
- Nails driven with pneumatic drivers can certainly be installed fastest, but in some attics dealing with compressor hoses can make pneumatic drivers not worthwhile. Using a palm type pneumatic nailer that feeds nails is a great alternative.
- **Table 8.1** below illustrated nicely the minimum distance for placing fasteners.

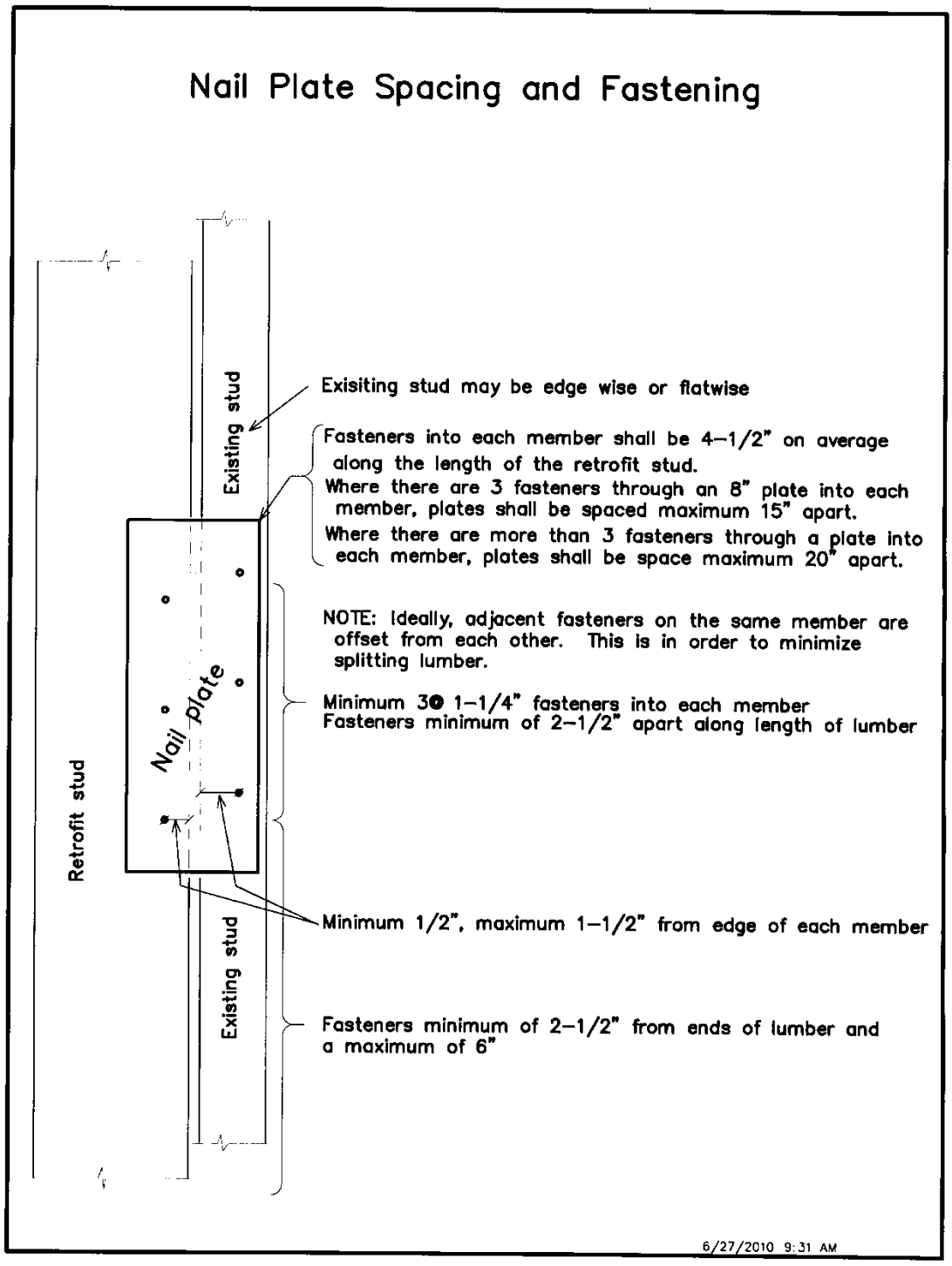


Figure 8.2 **This shows the plated spacing and fastening requirements.**

Lumber hints:

- Retrofit studs can be 2x4, 2x6, 2x8, or 2 2x8 depending on the load conditions as shown in **Tables 5.1** and **5.2** on **row 12**.
- Retrofit fit studs can be spliced if necessary to get them into the attic.

- Horizontal braces are always 2x4s at least 6' long.

Lumber must be stud grade or better. #2 is good. Terms like choice and select are not well defined in terms of strength characteristics so they should be avoided. Likely, they are softer and will not hold fasteners as well.

Installation hints:

- Lighting from two directions eliminates shadows.
- Headlamps provide good lighting where you need it.
- Making a permanent or temporary walkway out of 2x4s laid on the attic floor can be a worthwhile investment in materials and time when an attic is particularly difficult to navigate.
- On hot days do all the cutting and prep work you can outside of the attic. All the work can be done by one person. The most difficult aspect is holding the horizontal braces to the roof structure while attempting to fasten it. That is why the horizontal brace jig is so handy.
- Making a horizontal brace jig mentioned in **Section 15** is a worthwhile investment in time. Short of the jig you can temporally hold the brace in place and mark where it crosses the roof framing member closest to the gable end and a second framing member about 4' farther away from the gable end wall. Start one fastener at each mark. Position yourself so that you can reach each of these fasteners and then lift the brace into place and drive the fasteners into the roof framing members starting with the fastener closest to the gable end. This will minimize the time required to hold the brace in place and allow anchoring the brace without having to hold the fasteners in addition to the brace and fastening tool. Usually one can hold the brace into place with one hand especially if fasteners have been started. If the brace is particularly heavy or long you may want to devise some help. One suggestion is to hang the far end from the last framing member with a rope by installing a fastener to the framing member.
- Using the L-strap method at least on the attic floor makes working easier. Horizontal braces can be installed first giving you a 3-1/2" surface to walk on that is at right angles to just the 1-1/2" edge of the ceiling faming. Another advantage where the ceiling below is fragile is that the braces being at right angles distribute your weight over more than just a single framing member lessoning the risk of cosmetic ceiling damage.

BEST PRACTICE

It is safe to assume that wall sheathing installed on houses not built to high wind standards is inadequately fastened to the wall. Adding nails on the outside is usually not an aesthetically acceptable solution. Applying construction adhesive on the attic side of sheathing might help. One of the unanswered questions about adhesive is how long it lasts in hot attics. It is bound to help for several years. The large tube shown in **Figure 8.2** is clearly the cost effective way to buy it. It is recommended to apply a good size bead on the wall sheathing where retrofit studs will be butted to the wall. If one is concerned about the attachment of their sheathing they can go the extra mile by applying a bead of adhesive along both edges of all studs that butt the sheathing.

Figure 8.2 **Applying construction adhesive where retrofit stud will make contact with the sheathing because it was assumed the sheathing was not sufficiently nailed. An L-strapped retrofit stud is shown about ready to be installed.**

9.0
Implementation:
Wall-to-Wall Connections for Frame Walls Below

Hurricanes have demonstrated that many walls below gable end walls move in or out under the pressures created by hurricane winds. Unless your house meets the requirements of the 2001 or later Florida Building Code or your community was enforcing the high wind provisions of building codes, then it is highly likely the wall is inadequately restrained.

Strengthening the wall-to-wall connection keeps the lower wall from moving in or out by tying the top of the lower wall to the strengthened gable end wall above. In other words the goal is keep the gable end wall on the house. It may seem strange that the upper wall could help hold the lower one. However, the strengthening occurs because the upper retrofitted gable wall is tied back at least 6' into the interior roof structure where forces can be dissipated over the roof and ceiling planes. To a lay person this may not seem significant, but engineers readily understand its effectiveness.

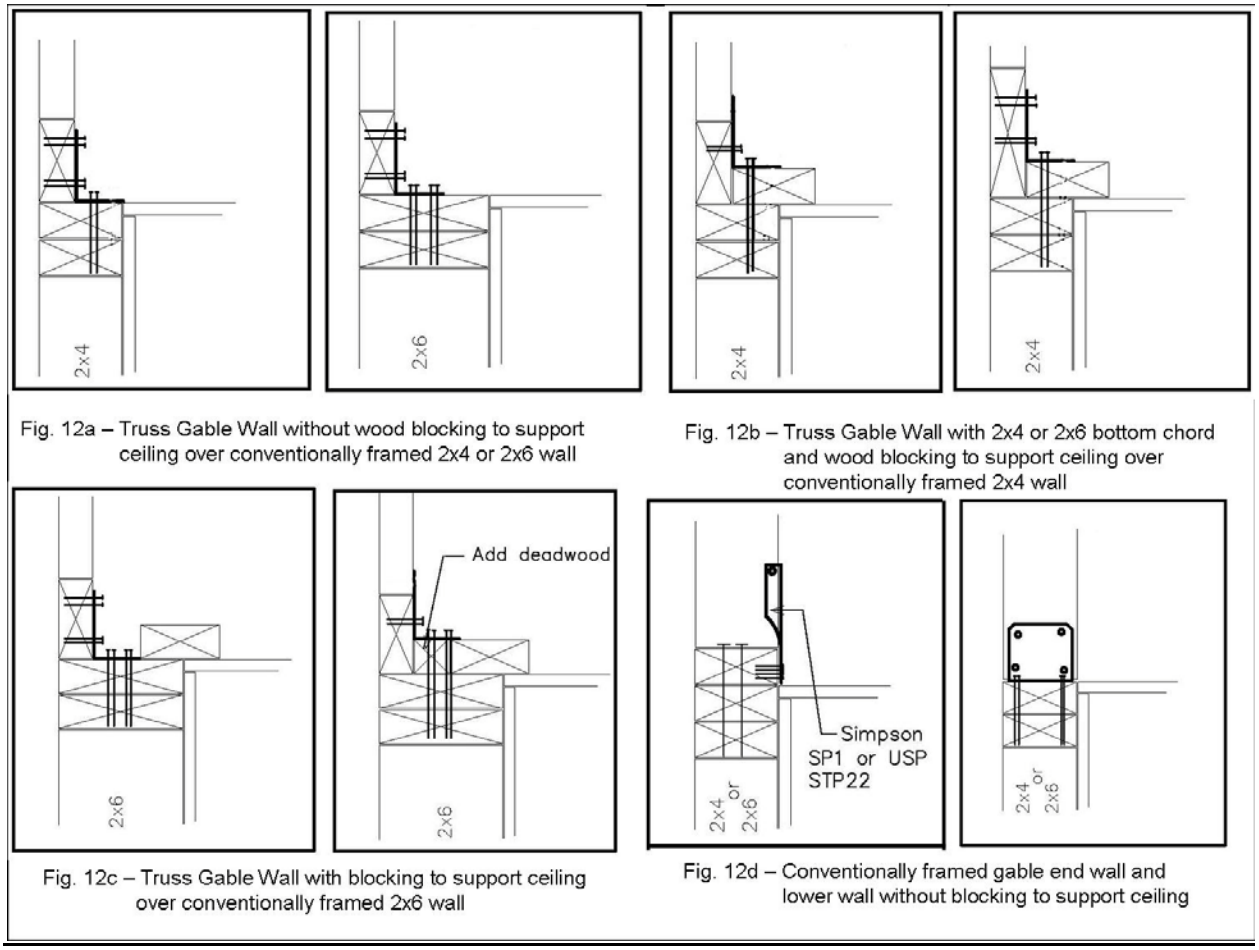


Figure 9.1. These drawings show just some of the methods of making Wall-to-Wall connections on frame walls. Ignore the `12' shown in the Fig identifications.

Figure 9.2. This shows an HGA installed on top of deadwood for the ceiling drywall below. It can be seen that if the HGA had not been installed on the stud of the truss, the top two screws would have missed penetrating the bottom chord. Sometimes one can drive the quarter inch screw though plates because they just happen to hit a hole in the plate. Otherwise, one needs to drill a starter hole. Doing this does not compromise the truss or the plate. From the other figures, you can see that the two outer vertical screws really are not doing much because they only penetrate the deadwood. 1-1/2" screws were used here so they did not penetrate the deadwood and the ceiling drywall. 4-1/2" screws were used for the other two so that they would penetrate the deadwood and the two top plates to make a much better connection.

In Figure 9.1 Figures 12a through 12c show truss type gable end walls resting on conventional wood frame lower walls. Figure 12d shows conventionally framed gable end walls resting on conventional wood frame lower walls. If your initial inspection of your roof framing led you to brace your gable end, it is a safe and reasonable assumption that the two walls are also not sufficiently connected together. This means that you should connect them. You just need to select the appropriate method. There are two methods. The one covered specifically in the building code is the one that uses HGA connectors as shown in a), b) and c). The method for case d) is covered in the code by the requirement that the connectors must have at least 175 pounds of uplift capacity.

Wall-to-Wall Connection for drawings a), b) and c) by use of right angle brackets, HGA. These $6 brackets are easy to install and are highly effective. **Tables 5.1** and **5.2** in column 3 rows 1 to 10 give the maximum spacing of brackets along the wall. They are not needed where the studs are less than 3' though if you can reach out another foot closer to the corner, it would be best to install one there because it is corners of houses that experience some of the greatest roof uplift forces. These connectors will help hold the walls together and that is most important in the middle of the wall. The building code requires that only two fasteners need to be placed horizontally through the vertical leg of the bracket into the gable end wall, but all four through the horizontal leg. Of course four into the gable wall is better than two.

Impediment and solution: The right angle bracket is so high that only two screws can be driven through the top leg of the bracket. The best solution is to move the bracket to

where a truss plate is on the bottom chord because the wood is high enough that all four screws can be installed. You can install brackets through truss plates without compromising anything. You may be lucky when starting a screw to find it hits a hole in the plate. Otherwise, you can drill a 3/16” or 1/4" hole starter hole through the plate. Although the code specifies a maximum spacing, it is perfectly reasonable to make that the average spacing along the wall if a truss plate exceeds that distance a bit. Another code acceptable solution is to use only 2 screws.

Screws closer than about 3/4" from either the top or bottom edge of the bottom chord are ineffective because they split the lumber. If these close fasteners also penetrate a truss plate, then the closer spacing is fine because the effective part of the fastener connection will be made to the plate which distributes the load over the larger area of the plate.

Impediment and solution: The outer two screws on the horizontal leg are too long: This is the case where deadwood is on the top of the top plate where the supplied 3” screws would stick through the ceiling. You can use 1-1/2” screws here. To compensate for using the shorter screws, use 4-1/2” screws for the other two holes. That helps make up for the shorter ones ties the gable end wall to the bottom top plate. The reason that is important is that exterior plywood may not extend above that plate so screwing to that plate makes a good connection from the gable end wall down to the bottom plate of the wall below. Another advantage of using 4-1/2” long screws is that it is highly unlikely that the deadwood is attached to the top plate very well. The longer screw will sandwich the deadwood between the bracket and the top plate while connecting through both top plates. This is a great solution that solves all problems.

The gable end wall is conventionally framed: No problem. By using Simpson SP1 or USP TP22 connectors one meets the 175 pound uplift requirement of building codes. These connectors are readily available at home supply stores. Other kinds of connectors might work as well. HRG right angle brackets attached to the face of studs work well too, but cost more than SP1 or TP22 connectors. SP1 or TP22 connectors must be used at every existing stud or retrofit stud location that is over 3’ long. For these connectors simply follow the fastening instructions provided by the manufacturer. You can substitute #8x1-1/4” screws for 1-1/2” nails; and #8x3” screws for 10d nails.

Final check: Before you leave the gable end it would be a good idea to make sure that you did not forget to install some fasteners. Ones that sometimes get overlooked are those in horizontal braces so check each brace to make sure that you did not skip attaching it to a framing member. Check that you have not left any tools or stashes of parts such as fasteners. Then reset batt or blown insulation and fluff up blown insulation. When you have finished retrofitting the gable end you should be pleased with yourself for having strengthened your house in a permanent and effective way that makes your house both stronger and safer.

10.0
Implementation:
Wall-to-Wall Connections for Masonry Walls Below

Hurricanes have demonstrated that many walls below gable end walls move in or out under the pressures created by hurricane winds. Unless your house meets the requirements of the 2001 or later Florida Building Code or your community was enforcing the high wind provisions of building codes, then it is highly likely the wall is inadequately restrained.

Strengthening the wall-to-wall connection keeps the lower wall from moving in or out by tying the top of the lower wall to the strengthened gable end wall above. In other words the goal is keep the gable end wall on the house. It may seem strange that the upper wall could help hold the lower one. However, the strengthening occurs because the upper retrofitted gable wall is tied back at least 6' into the interior roof structure where forces can be dissipated over the roof and ceiling planes. To a lay person this may not seem significant, but engineers readily understand its effectiveness.

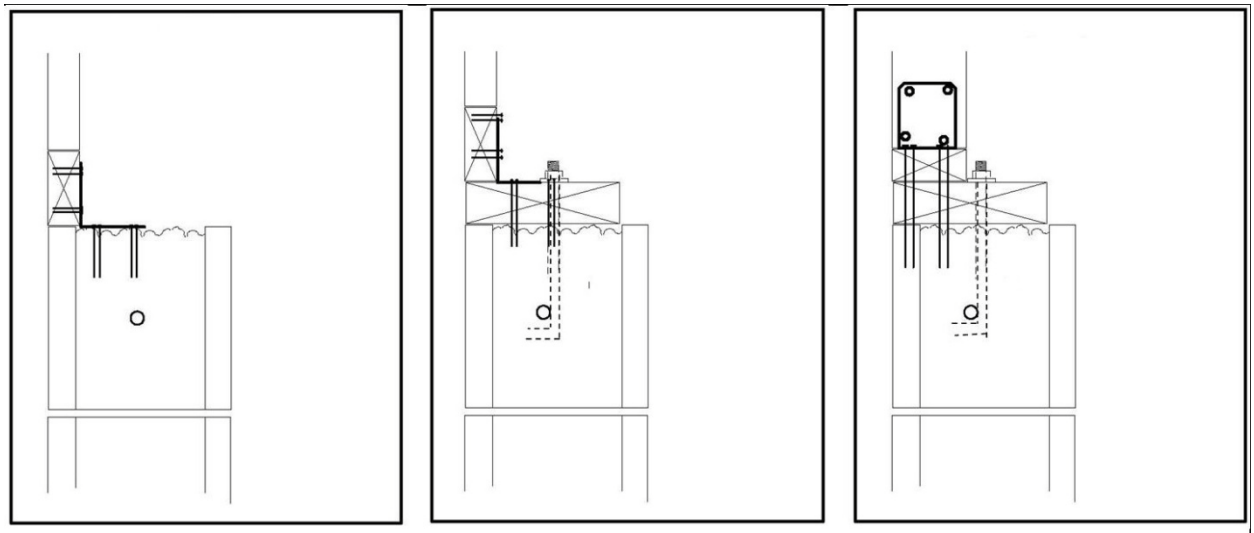


Fig. 13a – Truss gable wall over masonry wall

Fig. 13b – Truss gable wall with wood plate anchored to masonry wall below

Fig. 13c – Conventionally framed gable wall with wood plate anchored to masonry wall below

Figure 10.1. These drawings show the most common situations where the lower wall is made of masonry. Ignore the `12' shown in the Fig identifications.

Figure 13a shows the case of a gable end truss bearing directly on the masonry wall. Figures 13b and 13c show the gable end wall, truss or conventionally framed wall, bearing on a plate that is usually a 2x8.

***Wall-to-Wall Connection for HGAM connected directly to masonry wall*:**
This connection method uses HGAM connectors. These $6 brackets are easy to install and are highly effective. **Tables 5.1** and **5.2** in column 3 rows 1 to 10 give the maximum spacing of brackets along the wall. They are not needed where the studs are less than 3' though if you can reach out another foot closer to the corner, it would be best to install one there because the corners of houses experience the greatest roof uplift forces. These connectors will help hold the roof down. The building code requires that two fasteners be placed horizontally through the vertical leg of the bracket into the gable end wall, but all four through the horizontal leg. Of course four into the gable wall is better than two. HGAM should be installed according to the manufacturer's instructions.

Figure 10.2. This shows an HGAM being installed directly to the top of the masonry wall. Here the elevation of the bottom chord was just fine as well as the grout in the concrete block being fine too.

Impediment and solution: When drilling into the wall for concrete screws, the drill bit hits steel (rebar): This is a relatively common problem with an easy solution. Typically, two screws will hit rebar. That leaves the other two just fine but inadequate in number. Moving the HGAM along the wall is not likely to solve the problem because the rebar runs parallel to the wall. The solution is to add another HGAM nearby and rely on two of its screws to not hit steel. That way there is at least four good screws and maybe six. If the drill bit does not hit steel until the hole is drilled to nearly its full depth, a shorter concrete screw can be used. Of course the HGAM is not as effective so the spacing will have to be proportionally adjusted.

Impediment and solution: The grout is so low that the top two screws miss hitting the top chord of the truss or are too close to the bottom edge of the truss bottom chord: This is a common problem. One solution is to accept that the building code requires only two of those four are necessary. Another solution is to place a block under the HGAM to raise it. That would require using longer concrete screws in order that they penetrate the concrete the distance the manufacturer specifies.

Impediment and solution: The truss is floating above the wall so the bottom screws miss hitting the bottom of the bottom chord of the truss or are too close to the bottom edge of the truss bottom chord: This condition is caused by the presence of grout that spilled out when the blocks were filled. The solution is the same as the situation addressed immediately above.

Impediment and solution: The grout is so high that the top two screws miss hitting the top chord of the truss or are too close to the top edge of the truss bottom chord: One solution is to try to knock off some of the excess grout. It may only be few pebbles that are causing the problem, or it may be the spill of concrete on top of the partitions of the block. Another solution is to accept that the building code requires that only two of those four are necessary.

Impediment and solution: The grout is so rough that the HGAM does not rest flat on the top of the wall, tilts, is unstable or some fasteners into the wall have air between the HGAM and the wall: A hammer to chisel away some of the bumps might take care of the problem. It may well be that moving the connector over a few inches solves the problem. Bear in mind that it is the average spacing along a wall that is important. Otherwise, you may just have to live with the condition and install the HGAM as best you can and if you are uncomfortable you can decrease the spacing between HGAM.

***Wall-to-Wall Connection for HGAM connected to 2x8 plate*:**
See drawings b) and c) in **Figure 10.1**. This is a straightforward installation if the 2x8 plate is adequately connected to the wall by anchor bolts or straps that are effective and spaced close enough together. The 2x8 can be regarded as adequately connected if all of the following conditions are met:

1) If it has 1/2" diameter anchor bolts less than 48” apart and the 2x8 has not been gouged or chiseled out so the washer and nut could be installed,
2) If the bolt does not protrude more than 1-1/2” above the top of the 2x8,
3) If there is an anchor bolt within 12” of the end of the 2x8 and there is an anchor bolt within 12” of an existing or retrofit stud, and
4) If a washer is in place.

If all of these conditions are not met, the 2x8 should be considered inadequately anchored.

Impediment and solution: The 2x8 plate is inadequately connected: In this case there are two solutions. The first is to disregard the connection between the 2x8 and the wall by making your retrofit connections through it and directly into the concrete below. You do that by using concrete screws that are long enough to penetrate the 1-1/2” thickness of the 2x8 plate, and penetrate the concrete to the depth specified by the HGAM manufacturer. That is the easy and perfectly good solution., Another solution is to anchor the 2x8 to the wall better independent of HGAM connectors. You can pretty easily anchor it better simply by adding 1/4" diameter masonry screws that penetrate at least 1-3/4” into the top of the concrete block wall. One such fastener should be placed within 12” of each existing or retrofit stud.

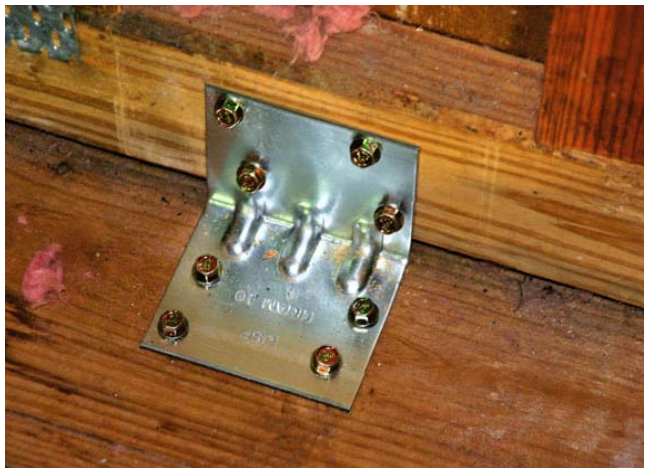


Figure10.2. HGAM right angle gusset bracket connected to 2x8 on top of masonry wall. Vertical fasteners can be attached just to the wood 2x8 using 1-1/2" wood or screws or optionally all the through the plate and anchored to the masonry wall using masonry screws.

Final check: Before you leave the gable end it would be a good idea to make sure that you did not forget to install some fasteners. Ones that sometimes get overlooked are those in horizontal braces so check each brace to make sure that you did not skip attaching it to a framing member. Check that you have not left any tools or stashes of parts such as fasteners. Then reset batt or blown insulation and fluff up blown insulation. When you have finished retrofitting the gable end you should be pleased with yourself for having strengthened your house in a permanent and effective way that makes your house both stronger and safer.

11.0
Impediments to the Installation of Horizontal Braces

Skirtable impediments: In many instances impediments such as recessed lights, AC ducts or ceiling supplies or inlets and bathroom exhaust fans can simply be skirted by installing a horizontal brace at an angle. Be sure that the brace is long enough so that the fasteners to the framing member at the end of the brace from the gable wall are at least 2-1/2" from the end of the brace.

Fishing horizontal braces: A wire or an air conditioning duct in the way may require you to fish a horizontal brace under the obstruction. There must be enough space to maneuver the horizontal brace and enough clearance. There must be a gap of at least 1-1/2" in order for the 2x4 horizontal brace to slip under the obstruction.

Splicing lower horizontal braces: If an obstruction prevents installing a horizontal brace, then it may be possible that a splice can be made under braces in a manner similar to that just described.

Splicing upper horizontal braces: If there is insufficent space to fish a full 6' long brace under an obstacle, then the brace can be spliced as long as it is done properly. Each side of the splice must have the total number of fasteners to be applied in any framing members beyond the splice (measured away from the gable end). For example, if the splice is made between the first and second framing member away from the gable end, then the part beyond the splice would cross two framing members and would have a total of six fasteners. Consequently, six fasteners would be required between the horizontal brace and the splice block on both sides of the splice.

Thinner horizontal bracing: If a 2x4 horizontal brace cannot be fished under an obstruction, but 1/2" or thicker plywood will fit, then a solution is to use a 1' to 2' wide strip of plywood that is as thick as possible and long enough to span three framing members. Attach the plywood with 1-1/2' long #8 screws at a 5" to 6" spacing along each framing member crossed. Similarly, if an obstruction prevents you from running a horizontal brace 4' from the gable end (see 4' blocking below), then you can use plywood running parallel to the gable end and spanning across adjacent horizontal braces to help distribute the wind loads into the ceiling or roof structure. Make the plywood strip as wide as possible and anchor it to all of the horizontal braces that it crosses including the short one installed at the obstruction with 1-1/2" long #8 screws at 5" to 6" spacing.

Four foot long horizontal braces: If 6' long horizontal braces cannot be installed but 4' or longer braces that rest on two interior framing members can be installed, then blocking can be used to safely transfer the loads. Figure A **-**11 shows a remedial method that can be used in this situation in Appendix A. The essence of it is the installation of a block of the same depth as the framing members. By depth we mean the larger face of the framing member and not the 1-1/2" edge. The anchor block helps

transfer the load that a retrofit stud applies to a horizontal brace to the plane of the ceiling. The figure makes it pretty clear how the block is to be installed. For the block to function effectively, it must be precisely cut so there is little gap between it and the framing members. The gap should be limited to 1/8" at each end. The anchor block also helps prevent framing members from twisting.

Obstructions that prevent installation of 4' long horizontal braces or sheathing (see thinner horizontal braces above): Where there are obstructions that prevent installation of 4' long horizontal brace and a plywood strip cannot be installed, then a retrofit stud cannot be installed because it would not be secured at one end. In that case read the next section about impediments to the installation of retrofit studs. What needs to be done to compensate for the missing retrofit stud is to strengthen the retrofit studs on each side of the missed one and to build a ladder between the two that spans over the missed retrofit stud.

Truss plates: Truss web plate locations may prevent installation of horizontal braces onto framing members precisely where they would ordinarily be placed. In the typical case where the plate is at the peak, the method shown in the Appendix Figure A- 15 can be used. You may be able to install the brace by offsetting it a bit.

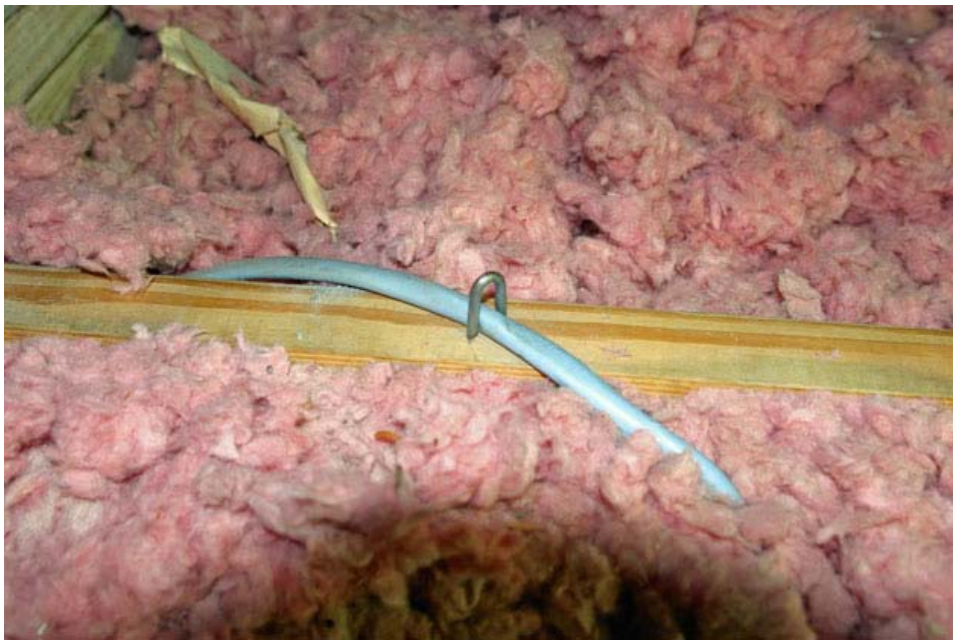


Figure 11.1. Electrical wiring running over ceiling joist. If the wire were to potentially to be under a horizontal brace, the brace could be routed under it or the staple carefully removes and moved aside to avoid the conflict. Wires should NEVER sandwiched between horizontal braces and other framing members.

Wiring: You may encounter electrical wiring running over the top of ceiling framing members (Figure 16). DO NOT sandwich a wire between a brace and a framing member. That creates a fire hazard! To move a wire or to gain enough slack so that you can fish a Horizontal Brace under a wire, you may need to remove a staple or two

that secures the wire to a framing member. Tools for that purpose include the claw part of a hammer, a medium sized slot (flat) screw driver, a pair of pliers or nippers. Pull the staple up WITHOUT compressing the wire cable itself. Pliers and nippers should only be used to carefully grab and pry out the staple. Be very careful not to damage the wire or its protective cover. In some cases, it may be necessary to fish or needle the brace under wires as opposed to just moving the crossing point to a location that is not under the brace. You may also need to fish or needle a brace under an AC duct. Be gentle with AC ducts so as not to create costly leaks.

Once you have installed all the lower and upper horizontal braces, you will be about two thirds of the way through strengthening the gable end wall, and you have completed the hardest part of installing the upper horizontal braces.

12.0
Impediments to the Installation of Horizontal Braces

Do not get discouraged if you cannot install a retrofit stud every place one is required. The methods suggested in this section and the preceding one have workarounds for installation of most of the necessary retrofit studs or provide an alternative means of achieving the strengthening you are seeking.

Truss Webs - Can't place a retrofit stud against an existing stud: The most common problem you may see in your attic is where the gable end truss has built-in webs. They prevent retrofit studs from being fastened directly to them. Not to worry. There are two work arounds. One involves just notching the retrofit stud where webs are in the way which requires using a deeper retrofit stud So, if a 2x4 retrofit stud was required, then notch a 2x6 retrofit stud the 1-1/2" so the retrofit stud can be placed against the wall. Likewise if a 2x6 is required, use a 2x8; if 2x8, use 2x10. Then fasten the retrofit and existing stud in the usual manner recognizing that perhaps there will not be the full complement of fasteners as there would have been if the truss did not have webs.

The other work around is done by placing the retrofit stud against the outside of the existing stud. Then fasten nail plates to connect the two studs together. This is simple and does not require cutting notches. This nail plate method requires more fasteners. The requirements for attaching the nail plates and their spacing along the studs are indicated on Figure C104.3. Acceptable Simpson tie plates include TP37 and all that are wider or longer than the TP37. Acceptable USP mending plates include NP37 and all that are wider or longer than the NP37. The longer they are the easier they are to install.

Single missed retrofit stud: The way to compensate for a missing retrofit stud is to make the retrofit studs on each side stronger, and install 2x4s horizontally between them that are spaced 12" apart vertically. The horizontal 2x4s are secured using h-ties at their ends to the retrofit studs and to the missed existing stud. See Figures A – 13 and A – 14 in the Appendix. The shape is not unlike a ladder. This solution is limited to a single missed retrofit stud and there must be at least two successfully installed retrofit studs between any missed retrofit studs. This prevents doubling up the loading on a single retrofit stud, albeit a larger one than normally required. It is certainly possible to increase member sizes and span greater distances, but the engineering has not been worked out and it is expected to be fairly rare that the solutions presented here cannot be made to work.

Figure 12.1. These show nail (nail, tie, mending) plates along the lengths of the retrofit and existing studs to bridge around webs on the truss.

Splicing retrofit studs* or *Can't get long enough retrofit studs into attic: When retrofit studs need to be spliced the method shown in Figure A - 12 in Appendix A can be used. Notice that this method requires 54 fasteners to secure the splice member. It might be easier to make more effort to fish a sufficiently long retrofit stud into the attic to prevent the need for a splice. By using patience one can get much longer studs into the attic than one would suppose or at first think possible.

Retrofit studs longer than Table 1 allows: Gable ends higher than 16' most likely are made of two trusses with one over another. Such trusses are called **piggy back**

trusses with each member not being much higher than 8'. Such high trusses should be evaluated by an engineer to determine retrofit measures. The engineer might regard the two trusses as separate entities and call for retrofitting them individually while providing additional measures where the two meet by extending horizontal braces into the interior. Photographs of the gable end will help the engineer understand the gable end situation before the engineer visits the attic.

Retrofit studs that need to be notched: If there are obstructions such as diagonal truss webs or pipes running horizontally, then the studs can be notched around them. It is critical that the retrofit stud is left with enough depth at the notch that it meets the depth requirement of **row number 3 in Table 1.**

No apparent solution? If none of the methods described above work in your situation it is advised that you have a structural engineer develop a solution.

13.0
Other Retrofits to Reduce Risks of Damage and Water Intrusion

We would have liked to give a strict listing of priorities for other risks to houses, but it is not that simple because priorities really depend on the particular house and the characteristics of the hurricane that hits the house. The risks are listed below with a semblance of priority.

Figure 13.1. Missing siding pulled off by negative pressure or by wind that got into the house and pressurized it causing the siding to pop off. . If the wind shifted direction to blow rain into that opening, the damage to the rooms nearby could have been dramatic. Note plywood (or whatever) on the lower roof on the right.

Gable end siding: The siding on the gable ends is critical to protecting your house. It makes the wall stronger and keeping water out of the attic. If it is deteriorated, water damaged, has delaminated or is not adequately fastened, then you need to consider siding retrofit measures. Figure 13.1 provides an example of inadequate attachment for which applying construction adhesive from within the attic might have prevented the damage.

If the siding comes off, there is nothing to prevent rain from blowing into the attic and damage ceilings.. Another risk is that good plywood or OSB sheathing is necessary for a sound gable end wall. If you don't know what type of sheathing you have, look behind the water barrier to see what is there. If it is not plywood or OSB your gable end, and possibly your whole house, is at risk.

In order to be structurally sound gable ends need to have plywood or OSB on them with a decorative exterior finish such as boards, vinyl siding or aluminum siding or have siding plywood sheets (4'x8' sheathing) such as T1-11. Anything less is insufficient because it does not provide enough structural strength, and is apt to be torn off by wind. Most of those materials are not strong enough to resist hurricanes and are very difficult to attach well enough to withstand wind. But plywood, OSB and particularly plywood type siding (for example T1-11) can deteriorate over the years with water and sun exposure. Signs of deterioration are delamination of the plywood, wide cracks and peeling of layers of plywood. Pine plywood siding and hardboard are particularly apt to have deteriorated.

When you are considering a gable end retrofit, it might be an ideal time to replace siding. Although nothing is cheap any more, replacing siding may not be a major cost factor. Sheet siding over a two car garage of an average older house might require only three sheets of siding. The advantage of replacing siding while retrofitting a gable end is that it gives you a great access for making the retrofit and you will have a well lit work area. If there is no plywood or something structurally similar or if the plywood has deteriorated, then you really have to consider replacing it so that there is structural sheathing in place. If the gable end has just boards, simulated boards foam or tarpaper then you definitely need to remove the siding and install wood structural panels and a decorative façade or just plywood siding such as T1-11. See **Section 14** for a more detailed discussion of gable end siding.

Roof sheathing: Making sure the roof sheathing stays attached to the roof structure is a very important part of reducing damage at gable ends. If you have re-roofed your house and had the roof sheathing re-nailed to the latest code requirements or following the recommendations in the retrofit guide, you have gone a long way towards reducing the likelihood that your gable end will fail. However, bracing of gable ends is also very important for larger gable ends and this guide focuses on ways to accomplish that bracing. If you have not had your roof deck re-nailed, you can reduce the risk of losing your gable simply by applying beads of AFG-01 rated structural wood adhesive along the joints between the roof sheathing and the roof framing members using directions provided in the web based retrofit guide. This will reduce the chance of the top of the gable end wall releasing from the roof sheathing.

Fastening of roof decking is vital to the building's ability to survive high winds. Most materials used on roofs are structurally adequate if they are nailed well enough and are not deteriorated by water or termites. If the house was not built to the *2002 Florida Building Code* or its successors, then it is highly unlikely the roof decking is adequately

fastened. If staples are used then there is no question, the fastening is inadequate regardless of the spacing. If you see two legs about 3/8" to 1/2" apart coming through the roof near the framing then staples were used. Staples with legs 1" apart were used to fasten roof felt or shingles. Fastening is vital to the survival of a roof. Replacing the covering is a a great opportunity to nail the roof decking in accordance with today's building codes. So important is the adequacy of roof decking fastening onto existing buildings is that the *Florida Building Code* in effect in October first 2007 requires that roof decking be adequately fastened when the roof covering is replaced. If you are not ready to re-roof, there are some adhesive options you can look at. These are covered in the web based retrofit guide.

Overhang and outlookers: Overhangs and outlookers at gable ends are like sore thumbs sticking out to catch wind and consequentially peeling off roof sheathing. The key concern is when overhangs come off gable ends that have not been retrofitted lose their top attachment to the house. Typically overhangs are under designed for the pressures to which they are exposed. Some of them lend themselves to strengthening. The web based retrofit guide provides some directions for anchoring the outlookers. If you have them, check out those recommendations. You need to strap them down where they cross the gable end and also restrain the end that butts up against the second truss or rafter. If the overhangs on your house are 2' or longer then you should read more about them. In the Hurricane Retrofit Guide go to Structure, then Roofs.

Gable vents: Vents at gable ends are bound to let wind-driven rain into the attic. If you look in the attic just below a gable end vent you are apt to find water stains from rain driven into the attic from thunderstorms. Hurricanes produce much stronger winds. There is no known method of louvers or baffles that will keep enough water out of an attic during a sustained wind driven rain event to prevent substantial damage. Evidence of water penetration through gable end vents has been observed following most hurricanes. Preparing shutters and installing permanent hardware so that every gable end vent can be easily protected is an effective way to prevent water intrusion through the gable vents. The advantage of blocking them off permanently is that just before a hurricane you don't have to deal with blocking them off. It is best to block gable end vents off from the outside to minimize chances of water getting into the wall that can lead to mold or water getting inside the house. However, before you permanently block off your gable end vents, you need to make sure that sufficient attic ventilation will remain to meet building code requirements or the requirements of your roofing system.

Water intrusion: Any place you can see light coming into an attic is a place that water can come in as well. Soffits at gable ends where the gable end truss is below the roof sheathing 4" have been demonstrated by numerous hurricanes to allow damaging amounts of water into an attic. Even though they are under the overhang roof, strong winds can easily drive rain horizontally and even upwards to penetrate any hole in the wall. New homes built to hurricane standards rarely suffered structural damage from hurricane Charley, but many suffered substantial damage from water driven into attics. Other sections of the web based Hurricane Retrofit Guide discuss remedial measures you can and should consider.

14.0
Selecting Materials

Material takeoff, using Tables 6.1 and 7.1: From the worksheets you have developed you know the number of each kind of retrofit you will be doing. With that information you can complete the tables below to help you make up a shopping list. These tables are also available for easy printing in **Section 17.** At the bottom of the table where #= appears, you enter in the number of retrofits stud locations for each of the Retrofit Configurations, A, B, C and D. Then you multiply that number by the number in the Num @ (which is intended to mean `number each') and enter that calculated number in the X # (that means `times the number (#)) column'. Do that for each row and each configuration. Then in the right most column total the numbers in each of the X # columns. Do that for each row. Now you know the number of each item you will need. Because 3" screws are supplied in boxes by the pound, the table has a rough estimate of the number of pounds of screws that will be needed. There is a printable version of these two tables in **Section17**.

You may want to purchase just the materials you will need for a single gable end because as you work you may find you will make some changes that might affect the lengths of lumber.

Purchasing materials: Everything you need is available at most home improvement supply stores except 49" straps, HGA and HGAM connectors and maybe 30" straps. Read farther down for more discussion about these items.

Fasteners and Tools for Fasteners: **Table 14.1** is intended to help you determine if you want to use nails or screws. Then you can determine which methods of installation you want to use. Most people will find using screws has the most advantages especially if they have a good cordless driver/drill. Experienced carpenters who have pneumatic nailers made for use with straps may well prefer to use their nailers. Last on the list of preference is the use of a hammer. A cord operated drill screw driver is a perfectly good choice especially if it has a clutch. More discussion follows the table.

Selecting fasteners: The table tells you of the advantages and disadvantages of screws and nails. You can mix and match between screws and nails. Most people will be better off using screws. Experienced carpenters may prefer nails for some applications. Care should be taken when using nails on lumber that has brittle or fragile finishes applied to it such as stucco on outside walls or on ceilings, drywall or plaster. Being able to accurately position fasteners is important for the fasteners to be effective and reduce the chance of splitting wood. Screws cost three to four times more than hand driven nails cost. Screws can be easier to install especially when working above one's head and working in very tight quarters where swinging a hammer is difficult. Pneumatic nailers are somewhat bulky and require hoses. The cost difference between nails and screws is about $25 for a medium size gable end. The extra time and extra cost of screws may well be worth the reduced risk of damaging ceiling finishes.

TABLE 14.1. Comparison of fasteners and tools. This table is intended to help you decide what type of fasteners to use.

COMPARISON OF FASTENERS AND TOOLS

	Precision of fastener placement	Ease of use	Ease over-head	Negatives	Number of hands	Speed	Cost	Risk of damaging ceiling or wall finish
Screws with cordless	Very good	Best	Best	Battery charging	1 maybe 2	Slowest	3 to 4 times nails	Low
Screws with chorded	Very good	Good	Very good	Power chord	1 maybe 2	Slowest	3 to 4 times nails	Low
Nails with pneumatic nailer	Very good to worst	Good	Good, but heavy	Hose and compressor	1	Fastest	Low	Middle
Nails with hammer	Very good	Worst	Worst	Can be tiring	2	Slow	Low	High

Fastener requirements: Only two lengths of fasteners for gable end retrofits are required -1-1/4" and 3". For fastening straps to wood use 1-1/4" and for fastening wood to wood use 3". More fastener requirements are given below in the discussion about nails and screws.

Nails: The 1-1/4" nails for fastening straps to wood must be 8d diameter. 8d refers to nails with 0.131" diameter with typical lengths of 2-1/2". However, for gable end retrofitting, they only need to be 1-1/4" long. The minimum diameter is still required. The most commonly available shorter 8d nail is actually 1-1/2" which is just fine and even better. The 1-1/2" nails are much easier and faster to install compared to the 2 ½" 8d nail. The extra strength provided by nails longer than 1-1/2" simply is not needed. The 1-1/2" 8d nails are readily available even at home supply stores. The short Simpson model number for these nails is N8. The USP equivalent is N11. Both brands are packed in large economical quantities.

The 3" long nails for fastening wood to wood must be minimum 10d nails with 0.148" diameter. These are not special nails. Just get 10d common nails of the correct diameter and length.

Screws:

Requirements: The screws for fastening straps to wood must be minimum 1-1/4" long #8 in diameter. Longer screws are fine. Screws longer than 1-1/2" will take more time to drive. The next size larger diameter, #9, is fine as well and still screw into the holes in straps. Regular screws should be used and not drywall type screws which are too brittle for gable end retrofits. The 3" long screws for fastening wood to wood also need to be minimum #8 in diameter. Again, #9 screws will also work and provide a little extra strength without splitting wood. The several considerations when selecting screws are discussed below.

Selecting screw head shape: The shape of screw heads is not important when selecting screws. They can be flat under the head or beveled/wedge shape.

Selecting the type of screw head driver: The two important issues for selecting the type of screw head are 1) that they are easy to drive; and 2) that they have the same type of drive (Philips, square or star) so that one does not have to change driver bits when going from one length to the other.

Most people that use screws with a star head drive or a combination Phillips-square head are convinced that they are easier to install than screws with just Phillips heads. Don't get confused by the term Phillips-square head. It means that either kind of driver bit can be used. Experience with some brands of Phillips-square heads has shown them to be just as good as square head screws. A significant advantage to screws, especially square and star head ones, is that they can be placed on the tip of the driver/drill and stay there while starting a screw into wood. For the last several years, the drive style of deck screws has evolved so that they are getting easier to drive. For shorter screws this makes installation really easy by freeing up a hand. Driving three inch screws may well require two hands, one for the driver/drill and another to keep the screw from wobbling until it gets started into wood. It is still easier than a hammer and nail. If you have a choice select the drive type for both 1-1/4" and 3" screws to be the same because it will save you time changing drive tips. However, using 3" screws with just Philips head drive so that you do not have change tips to drive 1-1/4" screws is probably not a good tradeoff. Simpson now has #9 by 1-1/2" screw (SD9112R100) with a hex head. The hex head would probably be a good head to drive albeit it would mean changing tips. The advantage of using a deck screw for the 1-1/4" fastener is that you might be able to match head drive types with the 3" screws. The catch is that these screws might only be available in lengths longer than 1-1/4". It is OK if they are longer. It will just take longer to drive them, but not having to change drive tips may make it worthwhile. Incidentally, #9 screws are just fine. They do fit into the holes in straps. They don't fall into the holes, but they do drive through quite nicely.

Shape of screw tips and chisel type shanks: Try to find screws that are sharp and fairly small diameter for the first 1/8" inch or so because these screws will start driving much more easily than fat ones with dullish tips. When trying to start screws in hard wood or the hard grain, using screws with sharp points will save time. Screws that have sort of a chisel deformation that extend up from the tip about 1/4" seem to drive more easily than regular screws. This is not nearly as much of a consideration as the sharpness of the tip and having screw with good driving heads.

Buying screws: The best deals and the best types of 3" screws are those used for wood decks. Purchasing 3" screws in 5 pound quantities will usually result in significantly better pricing. Usually, the boxes that 3" screws come in give just the weight. This is why the tables include weights for screws. Be warned that the weights are just a first approximation because the weights of these types of screws vary so much from brand to brand and style of screws. Three-inch screws are not always available in the #8

diameter but #9 size works just as well. The smallest screws that can be used are #8 diameter.

Straps:
Straps used for hanging plumbing pipes are absolutely not acceptable. The straps must be those manufactured for making structural connections. Straps must be at least 20 gauge, although using lower gauge straps (which are thicker) is acceptable. You may find that some stores do not stock 20 gauge straps but only the heavier and stronger 18 gauge ones. That is fine. They don't cost much more. Heavier straps are harder to bend sharply. It is recommended that 18 gauge straps be bent out of the attic so a vice or other means can be used to make nice sharp turns. Sloppy turns create slack that makes them less effective.

Straps are available as both precut flat strap form and in coil form. Coil straps have to be cut to length and straightened out.. Flat straps and coil straps have different hole spacing for fasteners. Holes in flat straps are spaced 1-1/2" along the length whereas the holes for coil straps are spaced in groups of two that are 2" apart. Flat straps have an extra hole for fasteners at each end. This explains why the suggest strap lengths for flat and coil may not at first make sense.

Splicing Straps. Straps used to connect members can never be spliced for gable end retrofits.

Bending Straps. There are two issues related to bending straps. One is where to make the bend and the other is how to make the bend. U-bent straps are installed nearly symmetrically so they can be bent in the middle, but to be perfectly symmetrical they need to be bent 3/4" from the middle. For L-bent you can't just make the bend in the middle of the strap unless you use one that is considerably longer than you actually need. Since part of L-bent straps wrap under retrofit studs and you can't effectively install fasteners in this area you need a longer length of strap. L-bent straps need enough length to accommodate the number of fasteners needed on the back of retrofit studs. That is 2-1/2" end of retrofit distance, under retrofit stud (the depth), about an inch of length on horizontal braces so one get fasteners attached, and finally enough length to accommodate the same number of fasteners on horizontal braces as on the back of retrofit studs. **Tables 5.1** and **5.1** have done all this arithmetic for you as you can see in rows 16**.**

Bend in attic or out? Ideally the bends would be sharp and not too rounded. You may find it difficult to make sharp bends in heavy gauge straps without using a vise or something to safely bend the strap over. One suggestion is to bend them out of the attic where you can make the bends more carefully and sharper using a vise or a substitute. Another suggestion is to apply them to the retrofit stud and then bend them using a hammer to make the bend sharper. NEVER make a bend and then undo it. If a strap cannot be used because the bend is at the wrong place the strap cannot be re-bent. That weakens the strap too much. Thin straps are pretty easy to bend over the ends of retrofit studs after they have been fastened. After bending with one's hand, a

hammer can be used to make a sharp bend. **Figure 18 illustrates the installation of the retrofit stud.**

How many times to bend straps? The answer is both once and any number of times. It depends. At any one location straps can be bent only once. That means you cannot bend a strap back and forth at the same place because that weaken the metal. However, you can bend a strap at as many locations along its length as you need to. The only caveat is that more bends means more slack which does not make for tight connections. Loose connections are more easily weakened by gusts associated with hurricanes. L-bent straps at the tops of retrofit studs need a right angle turn and one that follows the roof pitch. You can make a nice right angle turn and then when fastening a strap to the horizontal brace twist it as needed. That is fine.

Flat straps: Flat straps are available at most home supply stores. Model numbers for flat straps used by several manufacturers are LSTAxx or MSTAxx where xx is a number that indicates the length. Some manufacturers add Z to the end of the model number to indicate that the connector is more rust resistant. The width of these straps is 1-1/4". They have properly spaced punched holes for fasteners.

Factory made flat straps are available at most home supply stores in most of the sizes needed except for the 49" length required for Retrofit Configuration C. For these retrofits you can either order (MSTA49) 49" long straps or use coil strap.When you need to retrofit using configuration C, you will need to make an analysis of the whether to order 49" flat straps or to buy off the shelf or order coil strap. Part of the decision will be based on the number of those straps you need.

Some stores carry 30" straps that are wider and stronger than 24" and 36" straps, BUT they do not have enough holes so longer straps would be necessary to install all the necessary fasteners. So if you can't get regular 30" straps, buy 36" ones.

Coil straps: The minimum thickness Simpson coil strap is model CS20 (20 gauge). It is available only in 250' coils. Simpson does supply coil strap in shorter lengths, but it is heaver gauge, some so heavy as to be impractical for these retrofits. USP supplies 20 gauge coil in 250' foot coils and 25' with model numbers RS250 and RS20-R, respectively. Heavier than 18 gauge is too hard to bend in the attic. A vise would almost be a necessity for making sharp (not rounded) bends. Remember that the lower the gauge the thicker the metal. The strength of thicker straps simply is not needed. Straps of gauge heavier than 20 may require a hacksaw to cut because most snips won't cut steel that thick.

A 250' roll of Simpson CS20 coil strap costs about $130. That would bring the cost for each 49" strap down to about $2.10 each assuming you used them all. For contractors who will be retrofitting several houses, this might well be a good way to go. Bear in mind that regular LSTA and MSTA strap have an extra hole at each end and that holes on flat straps are closer together than the holes on coil strap. You may have to cut coil straps to longer lengths than regular flat strap in order to get the number of holes for

fasteners that are needed. One has to be careful to count the number of holes that are needed along with allowing strap length in the no man's land span where fasteners are not installed.

Lumber: The lumber that was specified by the engineer for these retrofits was assumed to be at least as strong as Spruce Pine Fir (SPF) and that its quality level or grade was No. 2 or better. This means that ordinary studs of `Stud' grade are not acceptable because they are weaker than #2. Southern Yellow Pine (SYP) or Southern Pine (SP) is stronger than SPF and is fine to use No. 2 is better than No. 3 and stud grade. No. 1 and Select grades are stronger than No. 2 and so better. The grade and wood species are stamped on each piece of lumber. Because some lumber comes from other countries the SPF designation for the species of the wood may not be used. Instead the identifications may be on the price label. Select lumber that is not excessively twisted, cupped or crowned. The easiest way to judge this is to look down the length of each piece of lumber because that tends to reveal all the flaws. Because wood is a product of nature one cannot expect perfection. In conclusion it is important when buying lumber that you make sure it is at least as good as SPF and has a grade of No. 2 bearing in mind that No. 2 is better than No. 3.

HGA and HGAM connectors: Home supply stores do not stock HGA or HGAM connectors. In high wind areas, suppliers to contractors may well stock HGA and HGAM. If not they can get them in two or three days in most areas. These connectors along with their fasteners are solid in kits of 10 connectors each. The precise model numbers are HGA10KT and HGAM10KTA. A kit of 10 cost about $60. Both connectors are about the same price. In the discussions of **Sections 9** and **10** mention was made of the use of different length 1/4" diameter wood screws, namely 1-1/2" for use on some deadwood situations and 4-1/2" long screws for penetrating both deadwood and double top plates. You may find these screws in stock at places that stock HGA and HGAM connectors. Otherwise, you can order them. Their Simpson model numbers are SDS25112 and SDS25412, respectively. Corresponding USP models are WS15 and WS45. They are packed in reasonable sized containers.

15.0
Selecting Tools

The following is a list of the tools that can be used. Don't worry you don't need them all because the list includes some optional tools.

Concise list of pretty essential tools

- Hammer
- Driver/drill, battery (cordless) or cord operated. Spare battery.
- Driver bits (Philips, square head, or star)
- Skill saw
- Tape measure
- Screw driver, for flat head screws
- Lights, flashlight, head light, LED
- Extension cords
- Parts and tool carrier
- Wrenches or drivers for hex nuts 3/8" and maybe 5/16"
- Ratchet socket wrench

List of optional tools

- Jig for holding horizontal braces up
- Pneumatic nailer(s)
- Fan
- Knee pad
- Cell phone or cordless phone
- Water bottle

Discussions about tools and their use:

Fastening tools: A hammer is the cheapest if for no other reason than you probably already have one. An electric drill/screw driver is another tool that almost every one owns. A battery-powered (cordless) drill/screw driver is also a tool many people have. The issue with a cordless drill is the capacity of its batteries. Most homeowner cordless drills do not have batteries with enough staying power to allow continuous work in attics. A pneumatic nailer is a tool that few people have and it requires dealing with dragging a trailing hose behind you and having a compressor. Some nailers made especially to drive 1-1/4" long nails into straps do not have the ability to drive the 3" long nails required for fastening Horizontal Braces, Retrofit Studs, and Compression Blocks.

Hammer: A hammer can cause damage to brittle or fragile wall or ceiling finishes. Pneumatic nailers impose less impact. Screw drivers impose practically no impact. Using a hammer to drive nails into the bottom of an overhead Horizontal Brace is not easy because you are trying to it over your head in an attic. Starting a couple nails before lifting a Horizontal Brace overhead does make the task easier. Read about the Horizontal Brace jig later on in this section. You will probably want to keep a hammer nearby if no other reason than to bend straps and optionally drive nails.

Pneumatic nailers: Pneumatic nailers are unquestionably the fastest tools. Their disadvantages are the cost of the nailers, hoses and compressor, and having to deal with a compressor hose in an attic. Two lengths of fasteners are used in this retrofit work: 1-1/4" ones used to secure straps and 3" ones to secure lumber to lumber (Horizontal Braces to framing members, Retrofit Studs to Existing Studs, and Compression Blocks to Horizontal Braces). Pneumatic nailers are great tools for both lengths. For the 1-1/4" nails used in straps it would be best to have a nailer that is designed for use with metal connectors because they facilitate lining up nails with holes in connectors. Some of these nailers do not drive longer nails such as the 10d 3" long (0.148" diameter) ones needed.

Drill/screw driver, battery or cord operated: Table 4 and the discussion below it may have helped you decide whether you want to use nails or screws. The discussion immediately below further describes the issues involved.

Battery (cordless) driver/drill: If you choose to use a cordless driver/drill, choose one with two good batteries with staying power to drive screws for several hours of work. Such a driver/drill driver can be costly, well over $100. The drill does not need to be that powerful, but you will tax the batteries and need to have ones that charge fairly quickly so charging time does not hold you up. Ordinary battery-powered screw drivers simply won't hold a charge long enough to be efficient to use. If your battery screw driver cannot hold a charge for very long and does not recharge fast enough you can use a combination of corded and cordless screw drivers. Battery screw drivers in the less than $150 range and lower simply are not up to the task of driving screw after screw especially when the screws are 3" long. However, for some people a good driver/drill's advantages may be more than offset by its cost and may provide the excuse one has been looking for to purchase such a handy tool. The battery voltage

should be 14 volts minimum and 18 is better. As of this writing lithium batteries are regarded as the best.

Corded electric drill: Practically any cord operated electric drill can serve the purpose quite well. However, you have to route extension cords to where you will be working and keep them untangled from things in the attic and your body to be sure you don't trip on them. A disadvantage of some corded drills is the lack of of a clutch.

Tips for screw drivers: Even magnetic screw drivers tips can fall out so and you could lose them in if they fall into insulation. Screw driver tips tend to chip or dull, especially Phillips drives, and tips tend to develop rounded edges, especially Phillips ones making them ineffective at driving. For these reasons having a half a dozen spares in the attic with you is a good idea. They cost less than $1.50 apiece so keep them on hand. Again, square head and star head screws tend to cause fewer problems.

Other Tools:

Skill saw: An electric or cordless power saw is a necessity. A battery one is handier because you won't have to fight extension cords, but a line powered one will cut faster. The cost of a battery saw is probably not justified. The saw is necessary to cut Retrofit Studs to length. Compression Blocks can be cut out of the attic and most will end up being droppings from Retrofit Studs. Their length is not critical just so they are long enough.

Tape measure: A tape measure with tape that is less than 3/4" wide tends to be so flimsy that it is not handy to use. You don't need a long tape measure. A 12' or 16' one is long enough.

Screw driver, flat: A medium sized screw driver for flat head screws is handy for prying up staples that hold wires the may be in the way of placing Horizontal Braces on the framing of the attic floor.

Lights: In the attic you will want some general illumination and some focused light where you are installing fasteners. Because you will be working against the gable end wall your body will tend to create shadows exactly over the area where you will be installing nails or screws. Light coming from a couple of sides really makes fighting shadows less of a problem. There are a number of different kinds of lights that can be used none of which have clear advantages over the others. Halogen lights with clamps provide very good lighting but get very hot and are a potential fire hazard should they come into contact with combustibles. Because of the fire hazard it is recommended that halogen light fixtures always be turned off or disconnected when leaving the attic. This discussion is not to discourage you from using halogen fixtures because they do provide excellent lighting. But you must take precautions with halogen lighting. Fluorescent power line operated or battery operated lights provide good illumination if a bit on the dull side. Line powered ones tend to be fragile. Incandescent bulbs (100 watt) mounted in shrouds with clamps provide good illumination, but the bulbs are subject to

burning out when bumped and the clamps tend to not be very secure. If you choose to use incandescent bulbs, then keep spares in the attic. Experience has shown that bulbs made for high shock use are simply bulbs designed to work at lower temperatures which is a disadvantage to you because they don't produce as much light.

Flashlights of the ordinary kind are not too helpful for working. Most require a hand to keep them in position, provide general illumination and have very limited battery life. This is not to say that a flashlight is not handy to have in an attic especially when attempting to view one's immediate work area. Halogen or high intensity flashlights as they are sometimes called are excellent for investigating things in an attic like roof leaks or the existence of straps or hurricane ties at eaves. They are heavy, bulky and don't hold a charge long.

Headlamps provide light where you need it. Most people prefer the LED types, and some like to use LED lights that come on a head band. They provide direct light focused on where one is working, do not require a hand, batteries last long enough to work, they are light weight and relatively inexpensive ($20 range). Buy one that has several LEDs in it so you get enough illumination to be effective. An advantage of such a light is that even though you may have flood lights of some sort broadcasting light from a couple of directions you can still be working in a shadow that your body creates. They are not good for providing lighting in other than in immediate work areas so general illumination is still necessary.

In summary experienced gable end retrofitters we know prefer one or two incandescent clamp on light fixtures and a LED head band light.

Extension cord: Likely you will need an extension cord for lights, a saw and possibly a drill and a fan. If using more than one of these, you will want a 3-way plug for the cord and probably a branch cord.

Tools for Wall-to-Wall connections: If the wall below is concrete or concrete block, then you will appreciate having a hammer drill. To install the Simpson brand of HGAMs in concrete you will need to drive 5/16" hex head bolts, Tapcon-like concrete screws. If you install USP brand of HGAMs in concrete you will need to drive 3/8" hex head bolts. If you install either brand of HGA or HGAMs you will need a 3/8" hex head driver for the 1/4" diameter hex wood screws. One way to drive is with a socket for a cordless drill. In addition, you may need a socket wrench to drive screws that are not accessible with a cordless drill. When applying HGA or HGAM connectors onto the truss plates, you will probably need a 3/16" drill bit for metal to make a starting hole in the plate.

Tool and parts carrier: A compartmentalized parts tray can be helpful to store nearly everything you need. Having nearly everything in one container makes transporting materials much easier. As the figures show, the carrier is attached to a ½" piece of plywood that is long enough to bridge ceiling joists or truss bottom chords. You can secure the carrier to the plywood a few short screws through the bottom of carrier into the plywood. The carrier in Figure 15.1 was made with cleats to help prevent it from

sliding off faming members. They are spaced 26-1/2" apart which is the typical maximum framing spacing of 24" plus the 1-1/2" thickness of a framing member plus another inch to spare. The plywood needs to be wide enough so the carrier does not tip over easily. This one is 7-1/2" although 9" would have made it a bit more stable from tipping sideways. A five gallon bucket also works OK. The parts carrier will be much handier than a tool belt most of the time for most people.

Figure 15.1. This shows the tool carrier with its skid. Who cares if it sags?

Tool/parts belt or pouch: Some people will find a tool belt difficult to use in the attic because it can catch on truss members, and its contents of screws or nails may dump out as a result of the frequent crouching you will be doing during installation.. If the attic is high this may not present problems and a tool belt may be handy. Because not many different kinds of tools that are necessary, a tool belt will likely be used primarily to hold fasteners.

Jig for Horizontal Brace: If you are going to be working alone, and have more than a dozen or so studs to retrofit, you may find it worthwhile to make a jig (Figure 15.2). It is made from 16 gauge strap and a Simpson H6 or a USP LFTA6, so it will require a vice and ideally some flat vice grips to make sharp right angle turns. All these materials are available at most home supply stores and lumber suppliers to contractors. The rounded end was formed over a quarter inch diameter drill bit. After it was shaped, the excess

end that slips under roof sheathing was cut off with a hacksaw and beveled to give it a wedge shape. You should budget about an hour to fabricate the jig. A hole was drilled to tack it in place in case the space between the sheathing and the rafter was loose. With plywood and OSB decking we have found that the bracket consistently stays in place.

Figure 15.2. On the left the jig is shown support the Horizontal Brace under the rafter. By hitting the jig with a hammer it is wedged between the roof sheathing and the top of the rafter. The left figure shows the jig that was fabricated from a twist strap like the one shown, a Simpson H6 or a USP LFTA6. The wedge part of the jig is about 3/4" long.

Fan: A fan can circulate air in the attic. It does not need to be powerful enough to clear the attic of hot air. Just circulating the air in the general vicinity of the work area makes a big difference. A box fan has the advantage of being able to span framing members thus making its positioning easy, and it can move air over a large area.

Knee board: When it comes to making the wall-to-wall connection, a knee board can help spare some stress on your knees and provides a place to rest tools and parts. It can be a piece of 1/2” or 5/8" plywood about 12” or wider. It should be long enough to span framing members but not so long as to be cumbersome to position. A good length is 30”. Adding a 1x2 cleat across the short face of the bottom near each end will minimize the chances that the board will slip off framing members. A Cadillac version would have some padding on the top surface. A hole for gripping it would be handy.

Cell phone or cordless phone: A cell phone or cordless phone allows you to call for help without leaving the attic.

Nippers or wire cutters (optional): When pushing a retrofit stud against gable siding, nippers or wire cutters capable of cutting nails may be handy to to cut off nails that missed the existing studs. This is not an essential tool. Usually, a hammer is a sufficient tool to knock nails out of the way.

Heavy duty snips or hacksaw (optional): If you use a heavy gauge coil strap, a hacksaw can be used to score the face of the strap making it easier to bend and snap off.

Step stool or ladder: For high attics you will need some way to reach up to fasten horizontal braces, strap and compression blocks.

Magnet: Having a small magnet might be worthwhile to have access to help find something dropped into blown insulation.

16.0
Working in attics

The two most important issues in working in attics are travel and safety. Travel is discussed below and safety in **subsection, 16.2.**

16.1 Travel and Working in Attics

Walk lightly. If the ceiling framing members are bouncy you need to walk gently to avoid flexing them which could cause cracks in drywall ceilings (especially at tape joints) and/or cause drywall texture to fall off or crack plaster. Most ceiling finishes are brittle and fragile. The advantage of installing bottom horizontal braces first is that they will help distribute your weight over several ceiling members (a large area) and reduce deflection on a single member. If you do not install horizontal braces on the floor right away, you may want to set them crosswise on the attic floor framing members. Crosswise 2x4s will reduce the chance of causing cosmetic damage to ceilings. Still, one should tread softly. If any boards or plywood are already in place, then be sure it is secured so it does not slide from under foot or flip up when you walk on an unsupported end.

How many people? One person can do all the work efficiently **if** they have a horizontal brace jig. Without the jig, one person can install upper horizontal braces alone, but it is certainly more difficult.

Getting materials into attics: There are four ways to get lumber into an attic. 1) directly through an attic access, 2) through a gable end vent, 3) through a temporary hole you make in the gable end and then patch (not too practical), or 4) through a gable end whose siding you have decided to replace with new stronger sheathing. Even if there is not much headroom you can usually feed at least 8' long lumber through the opening. You might be surprised to find that you can feed 14' long lumber into just a little more forgiving access. It may take some weaving but it may well be possible. The advantage of being able to feed long lumber in is that the long lumber is ideal for making walking paths should you decide to make them. For gable ends that require long retrofit studs it will save a lot of effort if full length studs can be used because that will spare having to make splices. Splices are easy to execute, but they do take time and additional materials.

Another option for getting boards and lumber into the attic is through a gable end vent that you can remove. This requires an investment in time to remove and then replace the gable end vent. However, it may be worth doing when the option is traversing an attic with materials in hand. It may be especially worthwhile if the gable end vent is to be blocked as described in **Section 13**. Making a temporary hole to feed boards and lumber into an attic likewise requires an investment in time and requires patching afterwards.

Travel in Attics, a Walking Path: Air conditioning or heating duct work, air conditioning equipment, possessions, collar ties, webs of trusses and diagonal braces can all compound the problem of accessing a gable end. You may find 1x4 boards or pieces of plywood that carpenters used during the construction of the house, and you will find that these boards do make it a lot easier and less risky to walk. You will especially appreciate them when you are carry tools or lumber. A common term used for 1x4 or 2x4 walkways in attics is rat runs. If the rat runs are not loose you will find them even easier and safer to walk on than just the framing. Be extremely careful when walking near the ends of rat runs, because they may be not have support under them so you may find yourself at the end of a diving board about to fall through the ceiling. It is worth taking the time to secure loose rat runs. They are a lot easier to walk on than the 1-1/2' edge of attic floor framing members and they reduce the chance of your foot slipping off.

Making a walking path: If you are going to make a lot of trips into an attic that is not easy to walk in, you should consider adding walk boards. You should use walk boards in areas that are hard to walk in like around air conditioning ducts. If you expect to have to walk back and forth a number of times, you might want to consider having the path two boards wide instead of single width staggered boards. A walking path two boards wide also means you won't have to balance yourself so carefully. However, making a path is not inexpensive and takes time. Nevertheless, if you have to carry a lot of materials to a far end, you may find it well worthwhile. A path made of 1x4 boards is strong enough and wide enough for most people in most situations.
Each end of a walk board should rest solidly on a framing member so that it will not slip off. When adding walk boards, one end of them will likely have to be trimmed so that it doesn't extend past the last framing member. Lay the 1x4s along a path in line with each other. If you do this, we recommend that you add a 2x4 member to the side of the roof framing member where the two pieces meet so that each end of the 1x4s are well supported by a 1-1/2" wide support. Aligning the boards will minimize and the chances of putting your foot or worse.

Although 1x4 boards may not seem very thick, they only have to bridge about 2' so they should be strong enough unless someone jumps on them is particularly big. You can use 2x4s, but they cost more, are heavier to transport and usually their additional strength is not required. However, 2x4s could be worthwhile if the floor is particularly bouncy or you are big. When you have finished retrofitting a gable end you can leave them in place for future use, salvage them for use on another path or salvage them for other purposes. Be sure to secure any existing loose walk boards and plywood to minimize the chance of their slipping under foot. When carrying things it is fairly easy to slip off. The chances of damaging ceilings below will be reduced if screws, are used to secure the boards. Just a few fasteners are sufficient to secure the boards and using just a few makes it faster to salvage the boards for another use. A disadvantage of using 1x4 walk boards is that they will not distribute one's body weight over as many ceiling members as 2x4 would. However, unless one walks with a heavy foot this probably would not be an issue. An advantage of using screws to anchor walk boards is that it is easier to salvage the boards for other purposes.

Carrying materials in the attic: A plastic carrying tray is handy to carry tools and fasteners and straps. Having such a container where you are working will give you a place to store tools without having to put them on the floor where they can get lost in insulation. See the discussion in Section 15 about how to make a tool carrier.

When carrying boards or lumber through an attic with obstructions that force you to climb over things, it might be helpful to have a place to set the lumber down. If there are truss webs nearby, you might be able to make a resting place by adding screws or nails that would serve as stops to restrain boards and lumber so you have two hands free to maneuver over obstructions.

Be respectful of AC ducts that you may have to climb over or under because the ducts and their joints can be fragile. If you create leaks by moving them around it will cost you in electric bills unless you find and correct the leaks.

16.2 Safety

Attics are places to use caution while working because of heat, falling and tripping hazards, protruding nails and electrical shock hazards. Other hazards include head bumps, head scratches from nails from roof decking, fatigue, wear and tear of knees and puncture wounds from pneumatic nailers. A little caution and awareness will go a long ways to minimize these hazards. Bear in mind that if you get into trouble in an attic it may be very difficult for people in the remainder of the house or even in another part of the attic to hear your call for help. A cell phone or cordless phone is a valuable safety device should you need help. Another technique for seeking help from someone else in the house is to repeatedly tap or rap on something.

When to do retrofit work: In the summer or on an overcast day, it is likely that one can work in attic only until about 10 a.m. when temperatures can reach the mid 90s or higher. Working in such temperatures for very long will cause fatigue. By 3:30 p.m. in the summer temperatures can soar to be in the 125 degree range. It's best to plan to get work done early in the day or to work in cooler seasons. However, even in spring and fall, attics can be oppressively hot in the afternoon on a sunny day. For homeowners doing retrofit work, it is not impractical and maybe even desirable to work just a few hours every day or on weekends.

Heat Hazard: Heat exhaustion can be a real danger and a serious health threat that you should not ignore. When working in an attic, especially when starting when it is cool, one may not fully appreciate the cumulative effect of heat and dehydration. When the attic is cooler one tries to get just a little more work done, to not take breaks to cool off and to not hydrate adequately. These can be dangerous tendencies that you should be on guard against. There are two aspects of heat in attics that affect you. One is the temperature that registers on a thermometer, and the other harder to measure is that of radiant energy that can add another 20 degrees to your body.

Heat stroke: Heat stroke can make you very sick and can affect your balance and ability to think clearly. Water does not replace the electrolytes lost through perspiration and missing electrolytes are a key issue in heat stroke. You should hydrate before going into the attic and stay hydrated by drinking sports drinks with electrolytes. You should take breaks out of the attic. Try to complete retrofits before hurricane season so that you do them in a cooler season, or budget time to work in the mornings. If you are working in the summer, stop working by roughly 10 or 11 am at the latest.

Ventilation: Ventilation can do a lot to make it more comfortable but it does not solve the hydration issue. Strangely we have found that a fan does not need to blow directly on one to help make one more comfortable. Just air circulating in the general vicinity makes a big difference.

Fall Hazard: The likelihood of falling can be reduced by being careful. Having good walk paths and having good lighting reduces the risk.

Electric Shock Hazard: Shock hazards can come about because of frayed wires, wires damaged by vermin, nicked or frayed extension cords, open electrical boxes, existing staples or nails that have penetrated wiring and your moving wires. Caution and prudence are the keywords when around wiring.

17.0
Printable Pages: Documents, Forms, And Current Drawings

L-Strap Method Specification Table

Requirements that complly with buildng code provisions for the L-Bent Strap method

	Column →	1	2	3	4	5			
	Row number ↓	Exposure Category	Max 3 sec gust Basic wind speed	Spacing for right angle brackets	Spacing for screws sill plate to wall	Maximum Allowable length of Retrofit Stud **Retrofit Configuration** A	B	C	D
Building code requirements	1	C	110	38"	19"	8'-0"	11'-3"	14'-9"	16'-0"
	2	C	120	32"	16"	7'-6"	10'-6"	13'-6"	16'-0"
	3	C	130	28"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	4	C	140	24"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	5	C	150	20"	10"	6'-6"	8'-9"	11'-0"	16'-0"
	6	B	110	48"	24"	8'-0"	12'-3"	16'-0"	NR
	7	B	120	40"	20"	8'-0"	11'-3"	14'-9"	16'-0"
	8	B	130	36"	16"	8'-0"	11'-3"	14'-9"	16'-0"
	9	B	140	30"	15"	7'-6"	10'-6"	13'-6"	16'-0"
	10	B	150	26"	13"	7'-0"	10'-0"	12'-3"	16'-0"
	11	Retrofit Elements				**Size and number of retrofit elements**			
	12	**Horizontal Braces** on attic floor and ceiling, size and numb				2x4	2x4	2x4	2 each 2x4
	13	**Retrofit Studs,** size and number				2x4	2x6	2x8	2 each 2x8
	14	1-1/4" long fasteners to connect straps to retrofit studs and to horizontal brace at each end using #8 screws 1-1/2" long or 8d nails, minimum number				6	9	12	8
	15	Strap length, minimum length (this is not a building code requirement per se, but is is the minimum length to get all the fasteners installed fhat are required in the line above)				24" flat 21" coil	36" flat 31" coil	49" flat 38" coil	30" flat 29" coil
	16	Bend L-bent straps from the middle as indicate in the row				7"	9"	11"	11"
	17	Compression block 3" fasteners secure compression blocks to horizontal braces, each block minimum number				6	8	10	12
	18	Compression block length for 2 fasteners placed side-by-side, minimum length				10"	12-1/2"	15"	17-1/2"
	19	Horizontal Brace all 2x4s 8' long, number				2	2	2	4
	20	Retrofit Stud, range of lengths				3 - 8'	10 - 12'	14 to 16'	16'
	21	Retrofit Stud assumed length for ordering				8'	12'	16'	2 each 16'
	22	Rettofit Stud size				2x4	2x6	2x8	2 each 2x8
Assumed cost each	23	Assumed Horizontal Brace, 2x4x8', cost each				$ 3.00	$ 3.00	$ 3.00	$ 3.00
	24	Assumed Retrofit Stud, cost each				$ 3.00	$ 7.13	$ 12.00	$ 12.00
	25	Assumed Strap, cost each				$ 1.55	$ 2.79	$ 4.00	$ 3.18
	26	Assumed cost of 1-1/4" fasteners, screws assumed each				$ 0.09	$ 0.09	$ 0.09	$ 0.09
	27	Assumed cost of 3" fasteners, screws assumed each				$ 0.08	$ 0.08	$ 0.08	$ 0.08
Costs	28	Cost for 1 retrofit (HB+RS+Sttraps+1-1/2" Fasteners+3" Fasteners)				$ 18.02	$ 26.67	$ 36.00	$ 66.48

Notes

NOT all buiilding code requirements are included in the table or these notes.

Compression blocks are assumed to be made from scraps and lengths are base on 2 fasteners across.

Assumed costs are based on Florida June, 2010 prices without sales tax.

Not included are costs for brackets to make (Gable end wall)-to-(Wall below) connections.

3" fasteners must be 10d nails with minimum diameter of 0.148" and must be 3" long minimum OR #8 3" long screws (drywall or other brittle metal screws are not acceptable)

1-1/4" fasteners must be 8d nails minimum 1-1/4" long OR minimum #8 minimum 1-1/2" long screws

Table 5.1. Specifications for the L-bent strap method that meet building code requirements and other helpful information. Be sure to read the notes below the table. A copy of this table is available for handy printing in Section 17.

	L-Bent Strap Method Materials Takeoff								
	Retrofit Configuration								Grand Total Number Needed
	A		B		C		D		
Item	Num @	X @	Num @	X @	Num @	X @	Num @	X @	
2x4x8' for Horizontal Braces	2		2		2		2		
2x4x8' for Retrofit Studs	1		---	---	---	---	---	---	
2x6x12' for Retrofit Studs	---	---	1		---	---	---	---	
2x8x16' for Retrofit Studs	---	---	---	---	1		2		
24" straps 20 gauge	2		---	---	---	---	---	---	
30" straps 20 gauge	---	---	---	---	---	---	4		
36" straps 20 gauge	---	---	2		---	---	---	---	
49" straps 20 gauge	---	---	---	---	2		---	---	
1-1/4" fasteners	24		36		48		64		
3" fasteners	47		59		71		150		
Pounds 1-1/2" screws	0.14		0.21		0.28		0.37		
Pounds 3" screws	0.62		0.78		0.94		1.98		
Number of retrofits for this Configuration -->	# =		# =		# =		# =		

To use this table to determine quantities:

First, in the bottom row enter the number of retrofits for each of the Configurations.
Next, multiple that number by Num @ for each row entry.
Finally, total the numbers across each row and enter that number in the Total column.
Screw weights will vary according to the particular brand and model selected.

Table 6.1. **Materials takeoff form for the L-bent strap method. Instructions for use are given immediately above this caption and below the table.**

U-Strap Method Specification Table

Requirements that comply with building code provisons for the U-Bent Strap method

	Column →	1	2	3	4	5			
	Row number ↓	Exposure Category	Max 3 sec gust Basic wind speed	Spacing for right angle brackets	Spacing for screws sill plate to wall	Maximum Allowable length of Retrofit Stud **Retrofit Configuration** A	B	C	D
Building code requirements	1	C	110	38"	19"	8'-0"	11'-3"	14'-9"	16'-0"
	2	C	120	32"	16"	7'-6"	10'-6"	13'-6"	16'-0"
	3	C	130	28"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	4	C	140	24"	14"	7'-0"	10'-0"	12'-3"	16'-0"
	5	C	150	20"	10"	6'-6"	8'-9"	11'-0"	16'-0"
	6	B	110	48"	24"	8'-0"	12'-3"	16'-0"	NR
	7	B	120	40"	20"	8'-0"	11'-3"	14'-9"	16'-0"
	8	B	130	36"	16"	8'-0"	11'-3"	14'-9"	16'-0"
	9	B	140	30"	15"	7'-6"	10'-6"	13'-6"	16'-0"
	10	B	150	26"	13"	7'-0"	10'-0"	12'-3"	16'-0"
	11	Retrofit Elements				Size and number of retrofit elements			
	12	**Horizontal Braces** on attic floor and ceiling, size and numb				2x4	2x4	2x4	2 each 2x4
	13	**Retrofit Studs**, size and number				2c4	2x6	2x8	2 each 2x8
	14	1-1/4" long fasteners to connect straps to each of the two 1-1/2" edges of horizontal braces using #8 screws 1-1/2" long or 8d nails, minimum number				6	7	7	6
	15	Strap length, minimum length (this is not a building code requirement per se, but is is the minimum length to get all the fasteners installed fhat are required in the line above)				30" flat 30" coil	36" flat 37" coil	49" flat 41" coil	36" flat 37" coil
	16	Bend all U-bent straps symmetrically				0	0	0	0
	17	Horizontal Brace all 2x4s 8' long, number				2	2	2	4
	18	Retrofit Stud, range of lengths				3 - 8'	10 - 12'	14 to 16'	16'
	19	Retrofit Stud assumed length for ordering				8'	12'	16'	2 each 16'
	20	Rettofit Stud size				2x4	2x6	2x8	2 each 2x8
Assumed cost each	21	Assumed Horizontal Brace, 2x4x8', cost each				$ 3.00	$ 3.00	$ 3.00	$ 3.00
	22	Assumed Retrofit Stud, cost each				$ 3.00	$ 7.13	$ 12.00	$ 12.00
	23	Assumed Strap. cost each				$ 3.18	$ 2.79	$ 4.00	$ 2.79
	24	Assumed cost of 1-1/4" fasteners, screws assumed each				$ 0.09	$ 0.09	$ 0.09	$ 0.09
	25	Assumed cost of 3" fasteners, screws assumed each				$ 0.08	$ 0.08	$ 0.08	$ 0.08
Costs	26	Cost for column (HB+RS+Sttraps+1-1/2" Fasteners+3" Fasteners)				$ 20.32	$ 24.67	$ 32.60	$ 59.64

Notes

NOT all buiilding code requirements are included in the table or these notes.
Assumed costs are based on Florida June, 2010 prices without sales tax.
Not included are costs for brackets to make (Gable end wall)-to-(Wall below) connections.
3" fasteners must be 10d nails with minimum diameter of 0.148" and must be 3" long minimum OR #8 3" long screws (drywall or other brittle metal screws are not acceptable)
1-1/4" fasteners must be 8d nails minimum 1-1/4" long OR minimum #8 minimum 1-1/2" long screws

Table 5.2. Specifications for the U-bent strap method that meet building code requirements and other helpful information. Be sure to read the notes below the table. A copy of this table is available for handy printing in Section 18.

	U-Bent Strap Method Materials Takeoff								
	Retrofit Configuratiion								Grand Total Number Needed
	A		B		C		D		
Item	Num @	X #	Num @	X #	Num @	X #	Num @	X #	
2x4x8' for Horizontal Braces	2		2		2		4		
2x4x8' for Retrofit Studs	1		---	---	---	---	---		
2x6x12' for Retrofit Studs	---	---	1		---	---	---	---	
2x8x16' for Retrofit Studs	---	---	---	---	1		2		
24" straps 20 gauge	---	---	---	---	---	---	---	---	---
30" straps 20 gauge	2	---	---	---	---	---	---	---	
36" straps 20 gauge	---	---	2	---	---	---	4		
49" straps 18 gauge	---	---	---	---	2		---	---	
1-1/4" fasteners, screws	24		28		28		48		
3" fasteners, screws	75		83		91		182		
Pounds 1-1/4" screws	0.14		0.16		0.16		0.28		
Pounds 3" screws	0.99		1.09		1.20		2.40		
Number of retrofits for this Configuration -->	# =		# =		# =		# =		

To use this table to determine quantities:

First, in the bottom row enter the number of retrofits for each of the Configurations.
Next, multiple that number by Num @ for each row entry.
Finally, total the numbers across each row and enter that number in the Total column.
Screw weights will vary according to the particular brand and model selected.

Table 7.1. Materials takeoff form for the U-bent strap method. Instructions for use are given immediately above this caption and below the table.

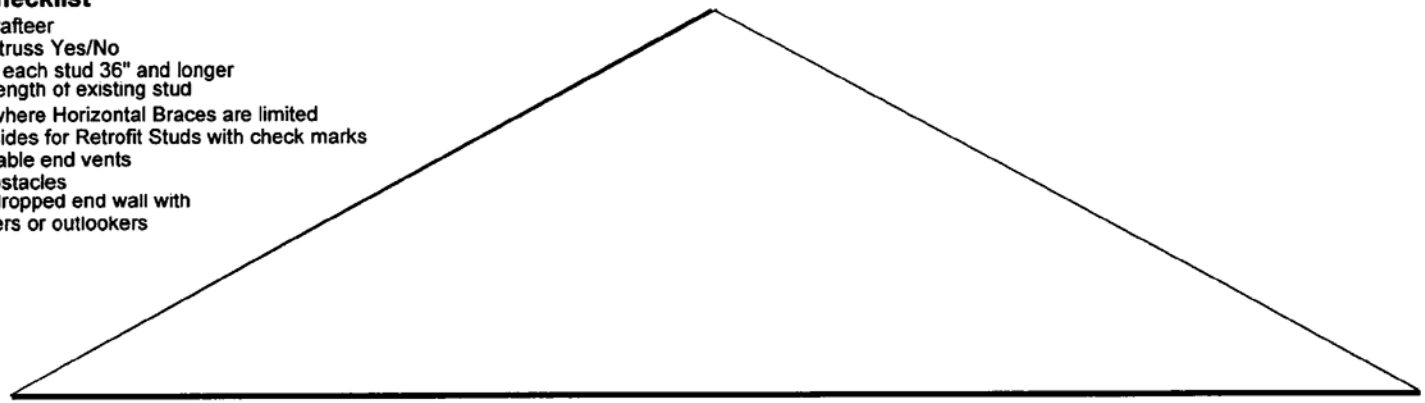
1	2	3	4	5	6	7	8	9	10	11
						Strap			Compression Block	
Stud Num	Retrofit Stud on Left / Right	Retrofit Stud length	L-bent or U-bent	Config A, B, C, or D	Retrofit Stud width	Strap Length	Bend L from middle	# of fasteners for straps	Minimum Length	# of fasteners

Wall-to-Wall connections

Spacing from Table 1 or 2 = _____"

Sketch checklist

1. Truss or rafteer
2. Webs on truss Yes/No
3. Sketch in each stud 36" and longer
4. Indicate length of existing stud
5. Indicate where Horizontal Braces are limited
6. Indicate sides for Retrofit Studs with check marks
7. Indicae gable end vents
8. Inicate obstacles
9. Indicate dropped end wall with outriggers or outlookers



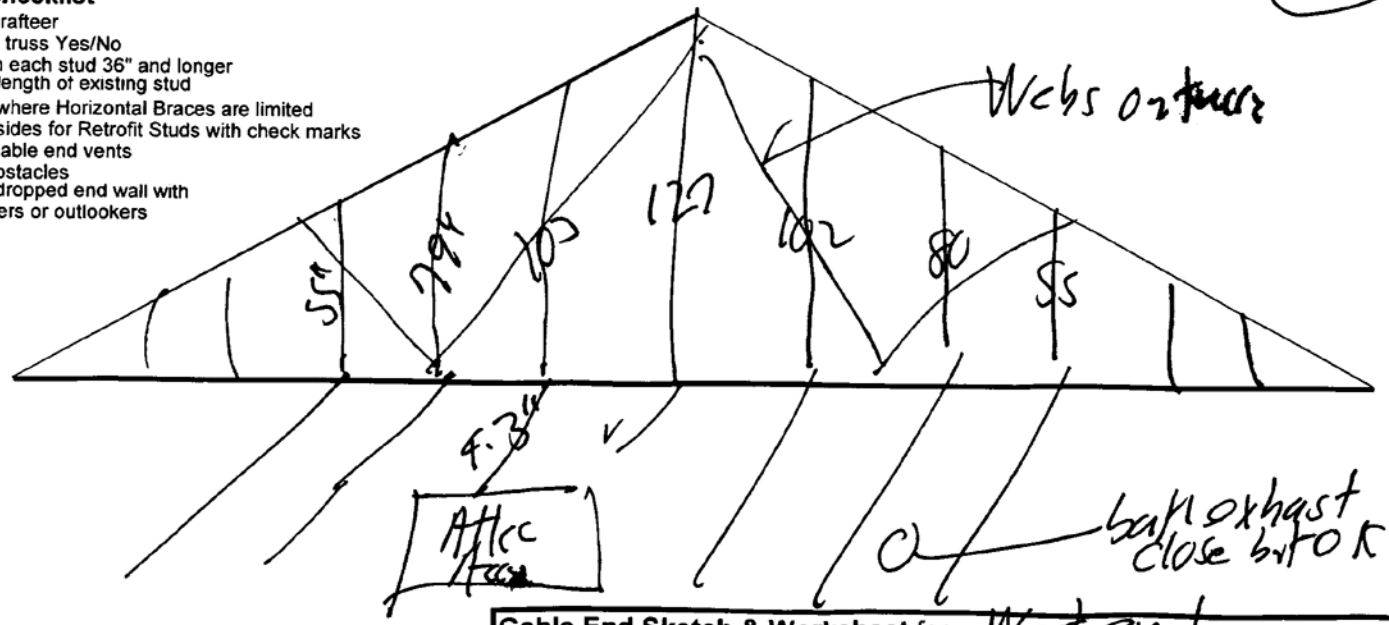
Gable End Sketch & Worksheet for _____ gable end

1	2	3	4	5	6	7	8	9	10	11
						Strap			Compression Block	
Stud Num	Retrofit Stud on Left / Right	Retrofit Stud length	L-bent or U-bent	Config A, B, C, or D	Retrofit Stud width	Strap Length	Bend L from middle	# of fasteners for straps	Minimum Length	# of fasteners
1	L/R	55	L	A						
2	"	79	L	"						
3	"	103	L	"						
4	"	127	L	"						
5	"	102	L	"						
6	"	80	L	"						
7	"	55	L	"						

Wall-to-Wall connections
Spacing from Table 1 or 2 = "

Example of sketch made in attic

Sketch checklist
1. Truss or rafteer
2. ~~Webs~~ on truss Yes/No
3. Sketch in each stud 36" and longer
4. Indicate length of existing stud
5. Indicate where Horizontal Braces are limited
6. Indicate sides for Retrofit Studs with check marks
7. Indicae gable end vents
8. Inicate obstacles
9. Indicate dropped end wall with outriggers or outlookers



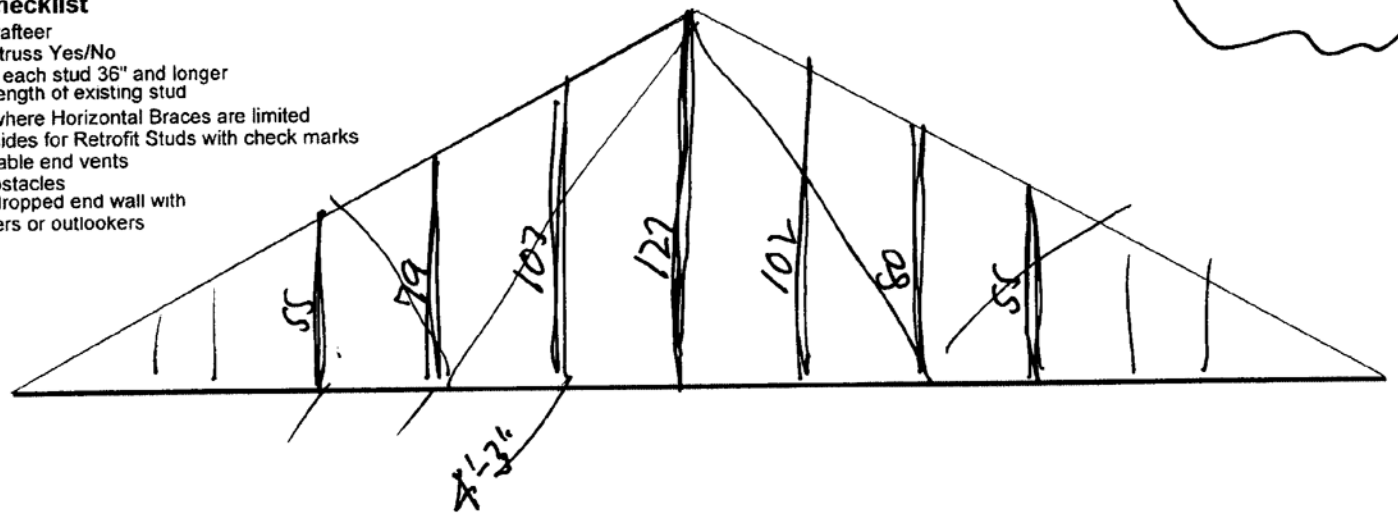
Gable End Sketch & Worksheet for Wert end gable end

1	2	3	4	5	6	7	8	9	10	11
						Strap			Compression Block	
Stud Num	Retrofit Stud on Left / Right	Retrofit Stud length	L-bent or U-bent	Config A, B, C, or D	Retrofit Stud width	Strap Length	Bend L from middle	# of fasteners for straps	Minimum Length	# of fasteners
1	L/R	55	L	A	2x4	24	7	6	10	6
2	"	79	L	A	2x4	24	7	6	10	6
3	"	103	L	B	2x6	36	9	9	12½	8
4	"	127	L	B	2x6	36	9	9	12½	8
5	"	162	L	B	2x6	36	9	9	12½	8
6	"	80	L	A	2x4	24	7	6	10	6
7	"	55	L	A	2x4	24	7	6	10	6

Wall-to-Wall connections
Spacing from Table 1 or 2 = 36 "

Example of Worksheet

Sketch checklist
1. Truss or rafteer
2. Webs on truss Yes/No
3. Sketch in each stud 36" and longer
4. Indicate length of existing stud
5. Indicate where Horizontal Braces are limited
6. Indicate sides for Retrofit Studs with check marks
7. Indicae gable end vents
8. Inicate obstacles
9. Indicate dropped end wall with outriggers or outlookers



6·28·10

Gable End Sketch & Worksheet for Westend gable end

ATTIC INSPECTION CHECKLIST

Gable end location on house. [**Front**], [**Back**], [**Left**], [**Right**], _____

========== Checklist of things to take into the attic==========

1. Print the *Wall-to-Wall Connection Details* figure so you can use it as a guide to what you may find.
2. Print the *Sample Gable End Sketch* page
3. Print several copies of the *Gable End Sketch* page, at least one for each gable end. Taking more than one page up for each gable end will be helpful so that when a sketch becomes too cluttered you can just use another page to finish up.
4. Tape measure
5. Flashlight (battery halogen is ideal) or other lighting
6. Pad of paper for making notes
7. Pen for taking notes
8. Clip board so you have firm surface for writing and a way to keep papers together.
9. Digital camera, if you have one.

========== Observations in the attic ==========

First step: General observations

101. Roof system. Circle one [**Truss**] or [**Rafters**/ceiling joists]
     (Trussed gable ends have studs flat wise to the wall. Trusses have metal plates connecting the component pieces of lumber together. Usually the lumber is 2x4 except that sometimes the top one will be 2x6 or bigger.)
     (Raftered gable ends have studs with their edges to the wall. Rafters are usually bigger than 2x4s. Rafters usually have collar ties, i.e. horizontal 1x4s or 2x4s that run between rafters on opposite side of the peak and are located within a few feet of the peak. There may be diagonal members that connect rafters and ceiling joists. Most likely they will not be attached with metal plates, but instead just with nails.
102. Studs: Circle all that apply
     [Flat face] (usually 3-1/2" wide) against the gable end wall] or
     [Edge] (1-1/2" narrow edge) against wall]
     [Both with one flat and the other on edge] There may be both types where there are two studs at a location with one flat and other edge wise.
     [No studs] Siding may be just nailed to diagonal members of webbed trusses.
103. Truss webs are present? **YES** / **NO**
104. Stud spacing on gable end wall. Circle one: **16**", **24**", **32**", **48**"

Second step: Sketch in general information

201. Sketch all the studs 3' and longer by drawing a simple vertical line as suggested on *Sample Gable End Sketch* page. The precise locations are not important.
202. For each existing stud that is 3' or longer measure its length accurate to within a couple inches. Measure from the bottom of the stud to its highest point.
203. If webs are present on truss sketch them. Very rough approximate locations are good enough. The *Sample Gable End Sketch* page will help give you an idea about what you need to draw and note on your sketch page

204. It is optional to note the slope of the roof. Slope: _____ : 12 or _____ vertically by _____ horizontally

Third step: Sketch information about feasibility of installing retrofit studs

301. For each existing stud location: can retrofit studs be installed?. If not place an `**X**' on the side or sides that prevents installation of a retrofit stud. Note the reason, e.g. electrical pipe, plumbing pipe, bathroom exhaust pipe, gable end vent. Bear in mind that retrofit studs can be placed on either side of existing studs.
302. If an existing stud is not full length because it has been interrupted make a note of that and the reason for the interruption, e.g. gable end vent. If an existing stud has been cut for some reason, it is relatively ineffective, but the day can be salvaged by regarding it just as something to nail a retrofit stud AND another stud, a third stud. At each stud location there need to be two structurally sound studs.

Fourth step: Sketch information about feasibility of installing horizontal braces

At each location where studs are 3' or longer look for obstructions and impediments. The *Sample Sketch* suggests ways of making your sketch and of taking notes.

401. At each location draw in a diagonal line to represent each horizontal brace top and bottom. The reason for doing this is it intended to force you to evaluate for each horizontal brace (top and bottom and at each stud location) whether there is anything to prevent a horizontal brace from being installed in a straightforward way.
402. Evaluate each such existing stud to determine if horizontal brace that is at least 6-feet plus 2-1/2" long can actually be installed that will line up with both the existing stud and the location of the retrofit stud. Remember that the retrofit stud can be installed on either side of the existing stud. If a brace can be installed then indicate it with a little √ checkmark. This includes braces that may take some work to fish them under a wire, air conditioning duct, or something, or running the brace a bit non perpendicular to the wall to skirt something like a recessed light. As a reminder you might add a little note to yourself indicating what the obstruction was. Take a few pictures of the situation.
    - Can a 6' horizontal brace be installed? **YES** / **NO.** If no, then answer the 2 questions below.
    - If **NO**, take pictures. How long can the brace be? _____ inches and how many framing members can it be secured to? **0**, **1**, **2**, **3**. Indicate the number on the *Sketch Page*.
    - If the horizontal brace will have to be less than 4-feet long, how long can it be and can you install a piece of plywood decking that would span across the short brace and reach to longer braces on either side? Can plywood decking be added? **YES** / **NO.**
    - If a 6' Horizontal Brace cannot be installed, can a brace that is 4-feet long be installed? **YES** / **NO.** If yes, then circle:

Fifth step: Wall-to-Wall connection observations of lower wall

501. The lower wall is **Wood frame** / **Concrete block or concrete**

502. Lower wall: Observe construction of wall below. Find the drawings on **Figure 101 and 201** that closely matches what you see.
503. Upper wall. Observe the construction of the gable end wall above. Find a drawing found in the previous step that best reflects what you see. Circle it.
504. Take photos to show and remind you of what you see.
505. Note and photograph any existing fastening between the gable end wall and the wall below. Again, photos will help refresh your memory.
    - **Straps in concrete** are **16", 24", 32", 48" o.c.**
    - **Wood frame straps or hurricane ties** are **16", 24", 32", 48" o.c.**
    - **Bolts on top plate** are **2", 4', 6', or _____ o.c.**
        - All bolts have washers and nuts? **YES** / **NO.**
        - All bolts extend all the way to the top of the plate without the plate having to be chipped out? **YES** / **NO.**

Sixth step: Type of wall siding.

601. Circle what kind of material is applied to the outside of the gable end wall: Don't worry about whether there is felt paper, Tyvek®, or some other water barrier.
- Plywood siding.
- Plywood with an exterior finish on the outside such as board, vinyl, or aluminum.
- Hardboard in 4x8' sheets
- Thermo-ply®
- Just board or hardboard type siding made of numerous individual pieces about 8 to 12" wide (high)
- Just vinyl or aluminum siding
- Other _____

Before leaving this gable end: When you have gotten to this point, a review of your observations may save you another trip into the attic. It is recommended that for each existing stud that is to be retrofitted you look carefully to determine that horizontal braces can be installed and that a retrofit stud can be installed. An effective way to do this is to simply start at one end of the attic, starting where the existing stud is 3' or longer, and ask yourself 1) can I install a Horizontal Brace on the attic floor in a straight forward manner, 2) can I install a Horizontal Brace on the bottom of the roof framing in a straight forward manner, and 3) can I install a Retrofit Stud in the usual manner. If the answer is yes to all three then that is great. That will be the usual case. However in practically every attic there will be something or another that requires a little adapting. Making notes on the sketch of installation issues will make planning easier and reduce the chance of forgetting details. You can see how that was done on the *Sample Sketch.* And there is nothing like pictures to answer those questions you have after leaving the attic.

Recommended Strap Lengths and Bending Locations for L-Bent Straps

Configuration as shown on Table 1	Number of fasteners at each end of each strap	Minimum length of LSTA or MSTA **flat straps** Table 1	Recommended length of **coil strap** Model Simpson CS20 or USP RS20-R	Bending location This takes into account the 2-1/2" up the retrofit stud, the depth of that stud, and an inch for space to place a fastener on horizontal braces
A	6	24"	21"	Bend 7" from middle
B	9	36"	31"	Bend 9" from middle
C	12	49"	38"	Bend 11" from middle
D	8	30"	29"	Bend 11" from middle

Recommended Strap Lengths and Bending Locations for U-Bent Straps

Configuration as shown on Table 2	Number of fasteners at each end of each strap	Minimum length of LSTA or MSTA **flat straps** Table 2	Recommended length of **coil strap** Model Simpson CS20 or USP RS20-R	Bending location for U-bent straps. This takes into account the 2-1/2" on each side of horizontal braces and wrapping around the retrofit stud, and an inch for the diagonal
A	6	30"	30"	Bend 3/4" from middle
B	7	36"	37"	Bend 3/4" from middle
C	7	49"	41"	Bend 3/4" from middle
D	6	36"	37"	Bend 3/4" from middle

Notes for using the tables.

1. When installing straps the key is to have at least the minimum number of fasteners installed at each end in accordance with the first column of the table.
2. For L-bent straps the bend location is in relation to the stud (not brace) end of the strap. The short leg of a L-bent strap always goes on the retrofit stud.
3. Where a strap is cut compared to where the holes are makes a difference, but the worst case is taken into account in specifying both the needed minimum of length strap and the bend location.
4. Some manufacturers of connectors and straps add `Z' to the end of the model to indicate that the connector is more rust resistant. This is probably not important for straps in attics, but of course it does no harm.
5. Fasteners should not be placed closer than 2-1/2" from the end of a retrofit stud.

Step-by-Step

Installing retrofit studs and straps:

Measure: With the braces in place it is relatively easy to measure the length for the retrofit studs. If you are going to install the retrofit stud along the taller side (side towards the roof's ridge) of the existing stud, measure from the top of the lower horizontal brace along the edge of the existing stud up to the point where that edge lines up with the bottom of the upper horizontal brace. If you are going to install the retrofit stud along the shorter side (the side towards the eave of the roof) of the existing stud, you will need to hold the tape measure 1-1/2 inches away from the shorter edge of the existing stud and measure from the top of the horizontal brace up to the bottom of the upper horizontal brace. If you know the slope of the roof, you can measure along the short side of the existing stud and reduce the length by multiplying the width of the retrofit stud by the slope ratio. For example, if you found that the roof slope was 5 in 12 (5 inches rise in 12 inches width or 5 feet rise in 12 feet of width) you can multiply the width of the retrofit stud (1-1/2") times 5 and divide by 12 to get a length reduction of 5/8". A snug fit at the top is preferred but be sure to leave a little space for the bottom strap. Note that if you are installing retrofit studs on a gable truss with diagonals, you will either have to select the next size up 2x member and notch it around the diagonal, or align the retrofit stud so that its narrow edge butts up against the face of the existing stud and one face of the retrofit stud lines up flush with one of the edges of the existing stud. The second alternative will allow you to attach the retrofit stud to the existing stud using mending plates.

Cut: Cut the stud to length. It will probably be easiest to cut a stud in the attic just after having measured for it. Then, before you install the straps, check the length by placing the retrofit stud in the desired location and make sure that it will fit snuggly against the existing stud.

If you use coil strap you will have to cut it. You can use a tin snips or score the strap with a hacksaw and then bend the strap back and forth until it snaps. With coil strapping you will need to straighten it out somewhat and then make the bend at the appropriate length indicated in Table **5**. Remember that the shorter length of the bent strap is the part that you will attach up the back of the retrofit stud and the longer portion will run under the retrofit stud and extend along the horizontal brace.

Install the straps: Select one of the 1-1/2" wide edges of the retrofit stud and install a strap at each end. If you have pre-bent the strap, make sure the bent leg wraps across the end of the stud as shown in Figure 18. When fastening the strap to the 1-1/2" edge of the stud, it is important that every fastener required by the table is installed and that the strap is centered on the edge of the retrofit stud. There are two critical distances that need to be respected to achieve the full strength of the connection. One is the edge distance between a fastener and the edge of the retrofit stud. That distances needs to be no less than 3/8". Placement of the strap in the middle of the 1-1/2" edge of the stud is critical because the placement of holes in commonly available straps results in the holes being exactly 3/8" from the edge. Installing a fastener closer than 3/8" to the edge of the stud reduces its effectiveness. Installing the fastener too close to the edge can create a split along the edge which would make those fasteners almost completely ineffective. To minimize the chance of splitting it is suggested that fasteners be installed at an angle towards the center of the stud. This will keep most of the fastener away from the edge. The other critical distance is that no fasteners should be closer to the end of a retrofit stud than 2-1/2".

Stud-to-stud connection: Now you are ready to connect the retrofit stud to the existing stud. This will tie the two together so that you double or more than double the strength of the existing stud. To do this you need to place 3" fasteners no more than 6" apart along the length of the retrofit stud. If the existing stud has its wide face parallel to the gable end wall (truss stud) then install the fasteners through the back portion of the retrofit stud and into the middle of the 1-1/2" edge of the existing stud. Keep the top and bottom fasteners at least 2-1/2" from the ends of the retrofit stud in order to minimize chances of splitting the end of the retrofit stud and to make the fastener fully effective when it is stressed by wind loads. The retrofit stud and existing stud combination will increase the strength of the wall and help it resist the wind forces pushing or pulling on the wall. Its effectiveness will be limited in the pull mode unless the wall sheathing is well attached to the existing stud. In homes built prior to 2002 it is likely that the attachment is not adequate. If your gable end wall has plywood siding on it you may be able to spot the nail heads from outside the house and be able to check the nail spacing. Ideally the nails would be on average 6" or less apart.

Applying construction adhesive to the 1-1/2" edge of the retrofit that will be in contact with the sheathing will help restrain the sheathing from getting pulled off (Figure 19). Applying a bead of construction adhesive along the edge of the existing stud where it meets the sheathing on the opposite side from where the retrofit stud is to be installed will help as well. It is not known how many years construction adhesive will be effective in hot attics, but it is so easy and inexpensive to do that one can hardly go wrong. Be warned that some people may find the fumes offensive, but in a hot attic they will dramatically dissipate in a day or two. There is more information about using construction adhesive in Section **14**.

Where you want to push a retrofit stud into place, you may find nails or staples coming through the siding that prevent pushing the stud against the siding. You may be able to

bend them against the sheathing/siding or you may be able to snip them off with a pair of nippers or wire cutters. It is okay if the retrofit stud is as far as 1/4 inch from the siding. It will still be just as effective. However, if the distance can be kept short then you can gain the important structural advantage of being to apply construction adhesive to help hold the wall sheathing/siding onto the wall.

Installing straps on braces: Once the retrofit stud is securely fastened to the existing stud, you are left with the easy task of securing the straps coming from top and bottom of the retrofit stud to the two horizontal braces. The only heads up issue is to route the strap along the horizontal brace, away from the edge of the brace, so that you maintain an edge distance of least 1/2" between the fasteners and the edge of the brace. Experience has shown that to help assure the strap does not wonder off at too great an angle it is a good idea to install the first fastener near the retrofit stud and then install the next one at the end of the strap.

Installation of compression blocks: Installing compression blocks is the final step. The lengths specified in the table are minimum lengths so it is perfectly okay to use scraps of 2x4s, 2x6s, or 2x8s that are longer without having to cut them to precise lengths. The minimum size for lumber used as blocking is a 2x4. A key issue with compression blocks is to butt them snugly against the retrofit studs so they can act in compression with minimum movement of the wall studs. Another key issue is to be sure you install all of the fasteners so they are fully effective. That means positioning them a minimum of ½" from the edge of the block and horizontal brace, at least 2-1/2" apart along the length of the block, and a minimum of 1" apart in the cross block direction (across the grain). Depending on how the strap runs on the horizontal brace you may need longer compression blocks in order to maintain the fastener spacing requirements.

With the installation of compression blocks complete you are finished with the gable end retrofit. That leaves only the wall-to-wall connection, unless you have already done it.

====== **SHOPPING LIST FOR WALL-TO-WALL CONNECTIONS** ========

Special order items

Right angle gusset brackets HGA10KT. (ThereNumber of kits order _____

HGAM10KT. Number of kits to order _____

Off the shelf items

¼" x 4-1/2" wood screws. Lag bolts, Simpson SDS25412, USP WA450

4 are needed for HGA where there are 3 2x4s to go through. Some may be needed to tie walls…..Number needed _____

Connectors

H2.5 or

SP1 or SPT22

Fasteners

Screws: #8 x 1-1/4"

Screws: #8 x 3"

Nails: 8d or 10d 1-1/2", e.g. N8 or NA8 or NA11 or N10 or NA9 or NA10

10d _____

Nails: 10d common (0.148 diameter and 3" long) _____

Screws: ¼" X 4 ½" wood screws (Simpson SDS, USP xxx, lag bolts)

Washers for 1/4" bolts

Washers for 1/2" bolts

Note: Model numbers are suggestive only and are given for several brands.

======= **SHOPPING LIST FOR LADDERS (MISSED RETROFIT STUDS)** =======

Connectors

H2.5

Simpson A21

Lumber

2x4x8' No 2 SPF for the ladder. Reminder: 4' long ladder pieces may not be long enough depending on the sides of the existing studs the retrofit studs will be applied to.

Retrofit studs. Reminder: Retrofit studs will need to be the next larger than what would otherwise be used.

Fasteners

#8 x 1-1/4" screws

#8 x 3" screws

N10

10d

¼" X 4 ½" wood screws (Simpson SDS, USP xxx, lag bolts)

Washers for 1/2" bolts

Current Drawings

The numbering on these drawings correspond to those in the *2012 International Existing Building Code* and are similar to those in the 2012 (or 2013) *Florida Existing Building Code.*

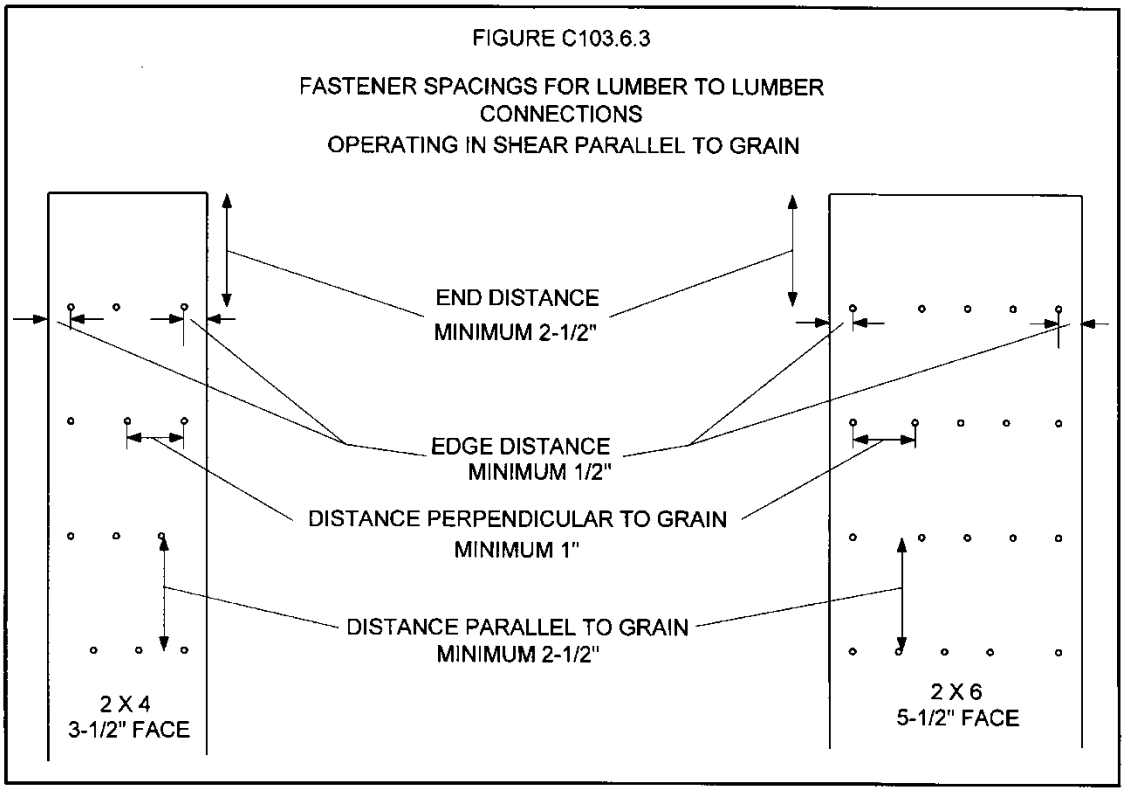
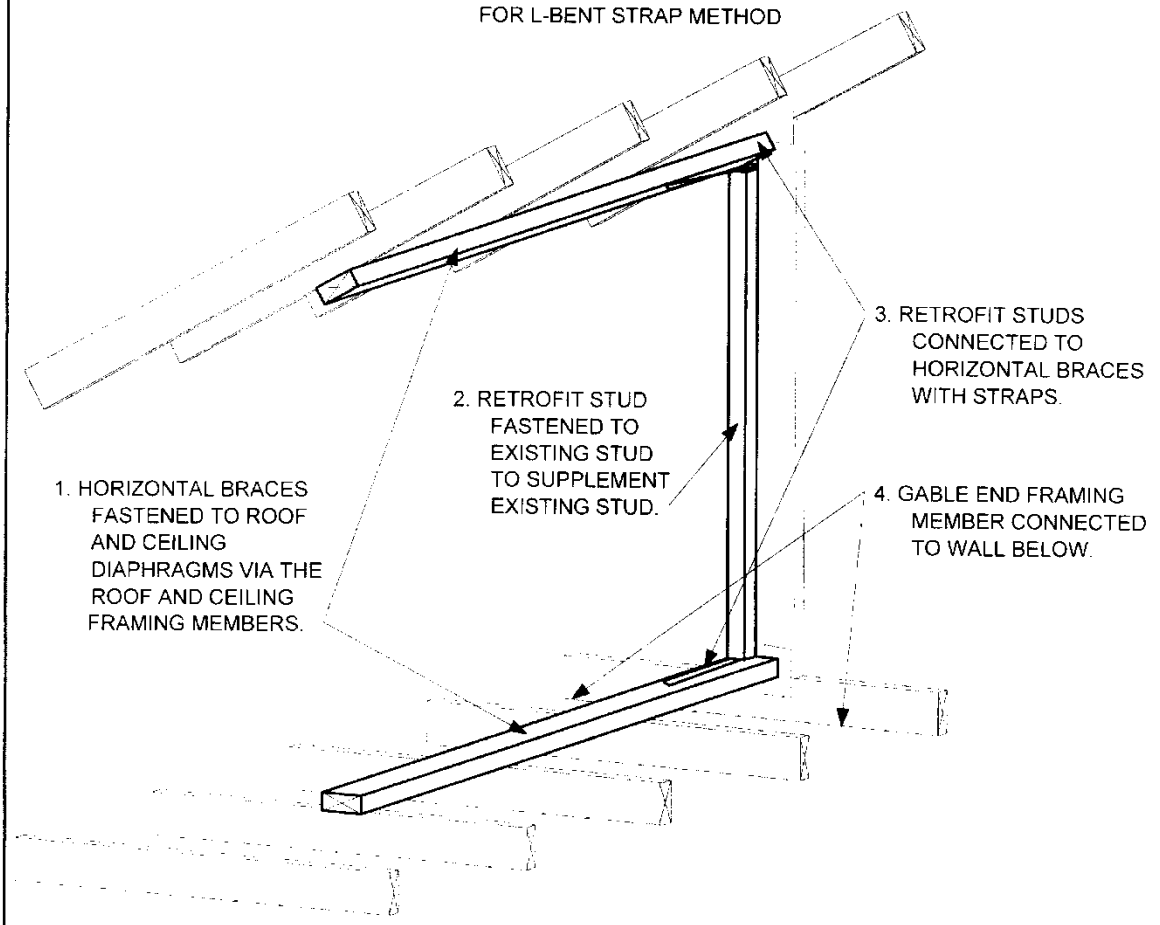


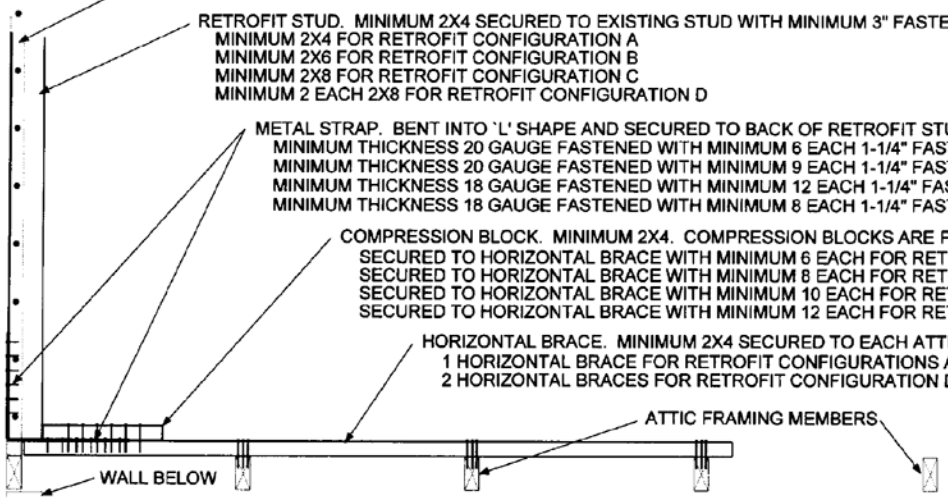
FIGURE C104.1.1
BASIC GABLE END RETROFIT METHODOLOGY
FOR L-BENT STRAP METHOD



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 C104.2 (1)
TRUSS FRAMED GABLE END. L-BENT STRAP

ELEVATION VIEW



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.

PLAN VIEWS

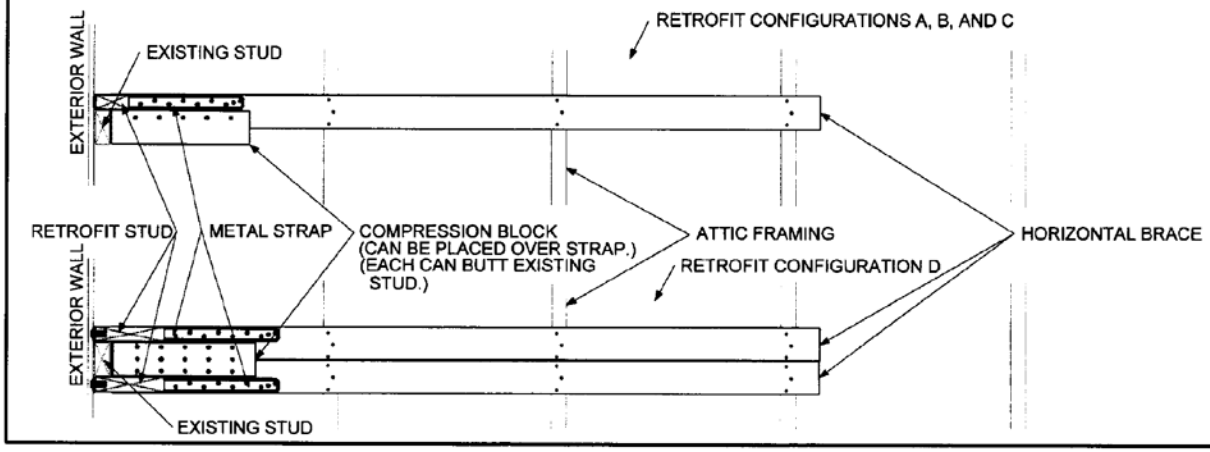
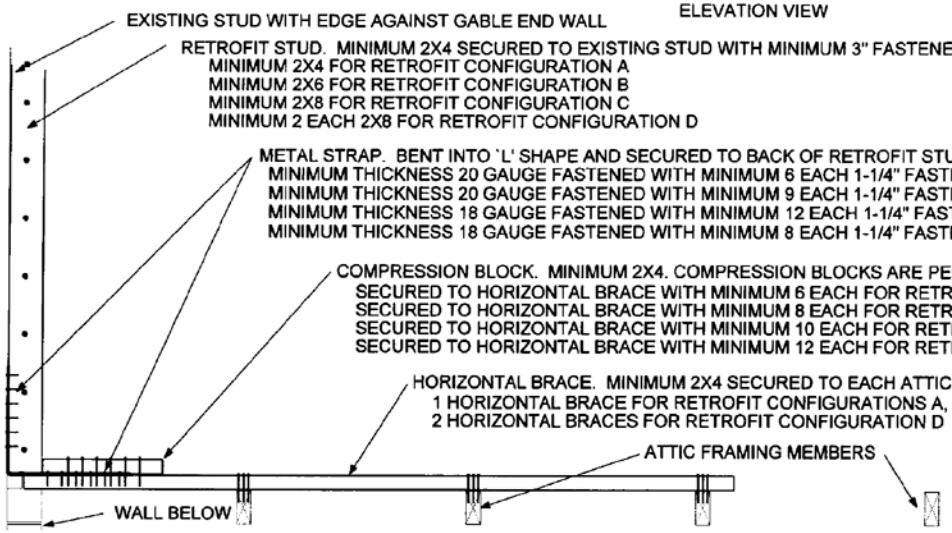


FIGURE C104.2 (2)
CONVENTIONALLY FRAMED GABLE END. L-BENT STRAP
ELEVATION VIEW



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.

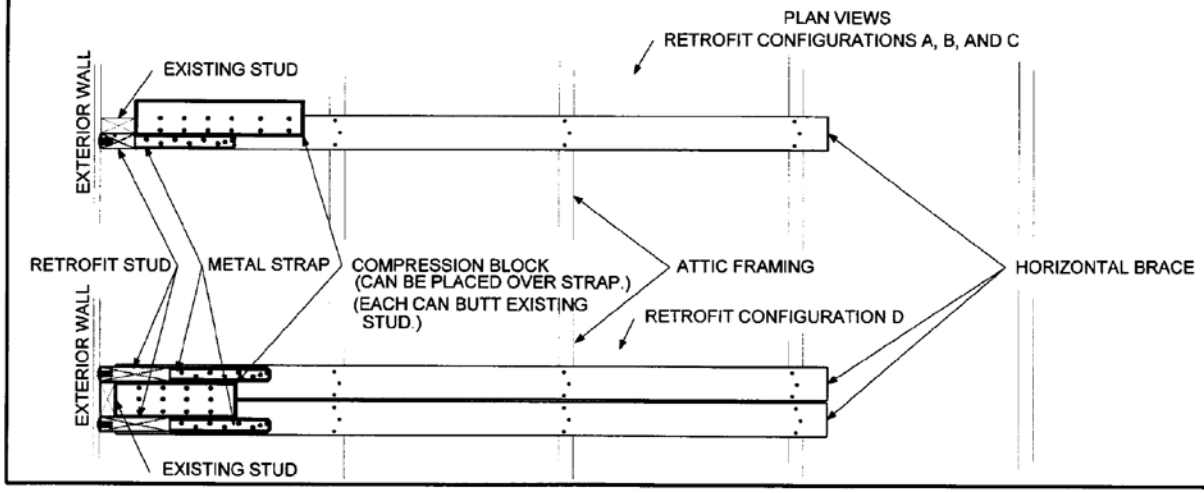
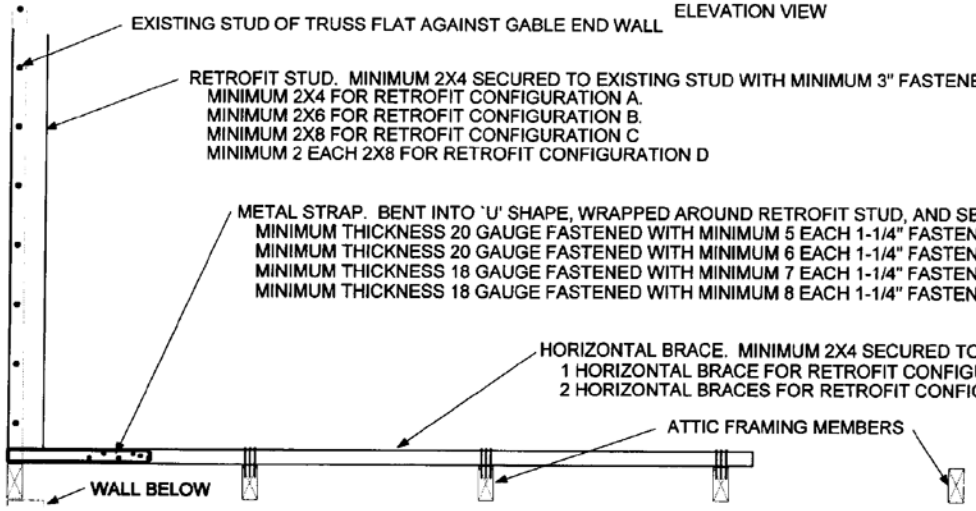


FIGURE C104.2 (3)
TRUSS FRAMED GABLE END. U-BENT STRAP
ELEVATION VIEW



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.

PLAN VIEWS
RETROFIT CONFIGURATIONS A, B, AND C

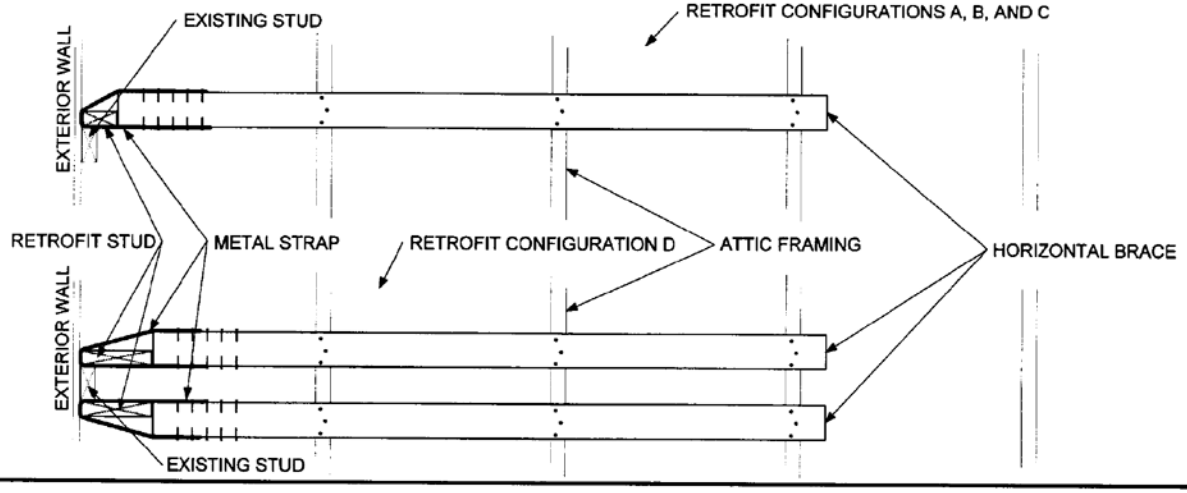
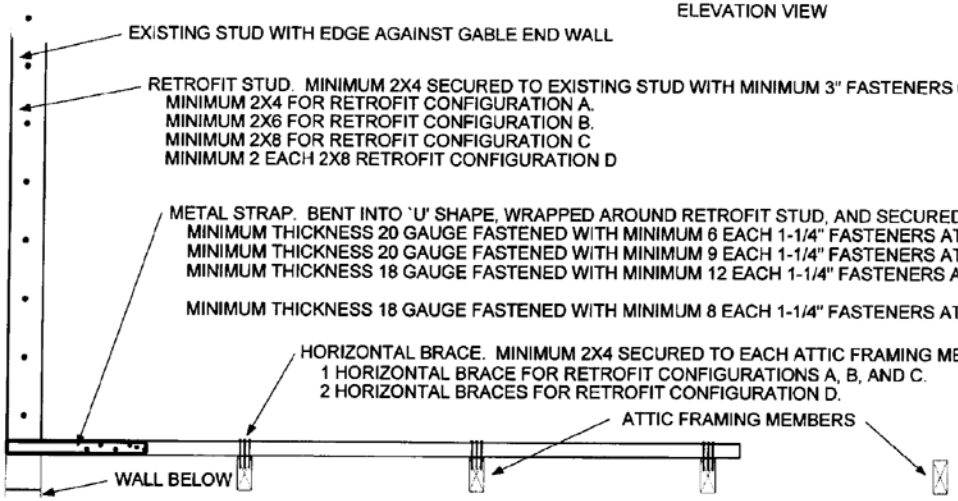


FIGURE C104.2 (4)
CONVENTIONALLY FRAMED GABLE END. U-BENT STRAP

ELEVATION VIEW



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.

PLAN VIEWS

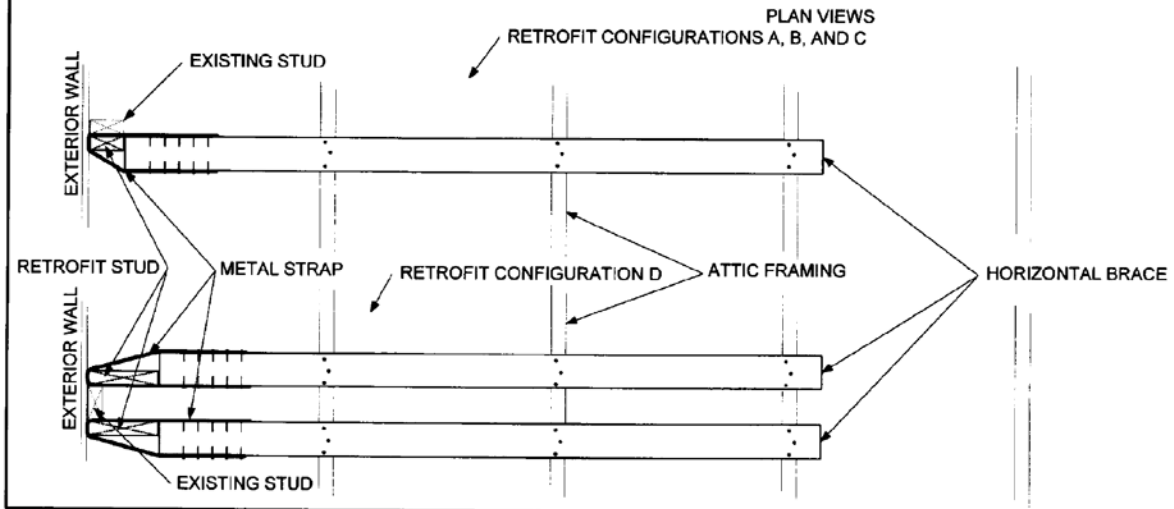
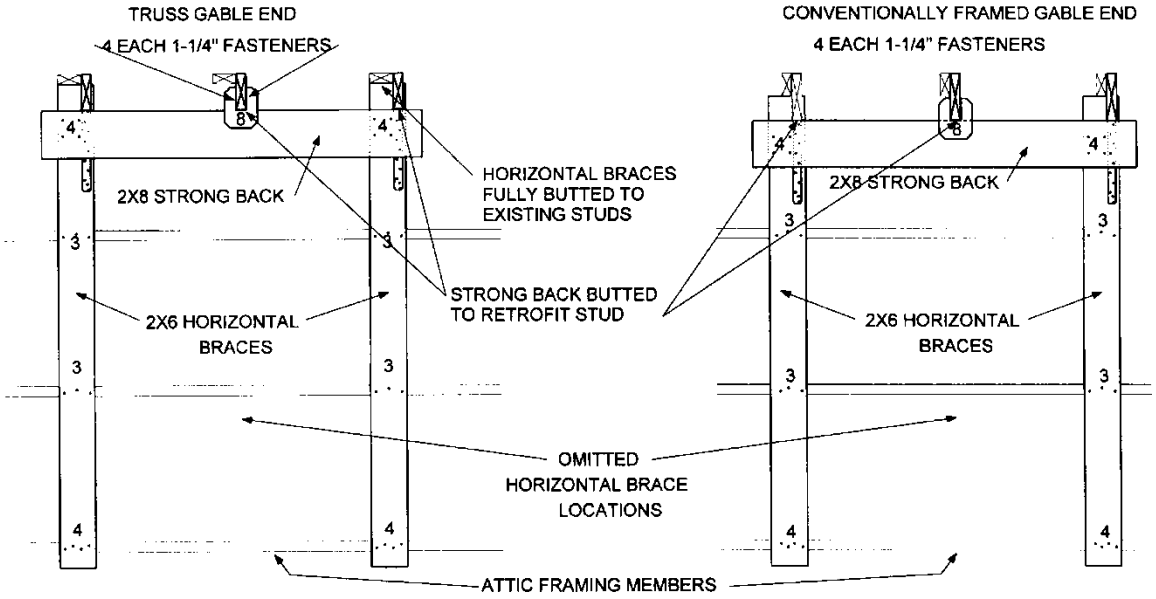


FIGURE C104.2.3
OMITTED HORIZONTAL BRACE

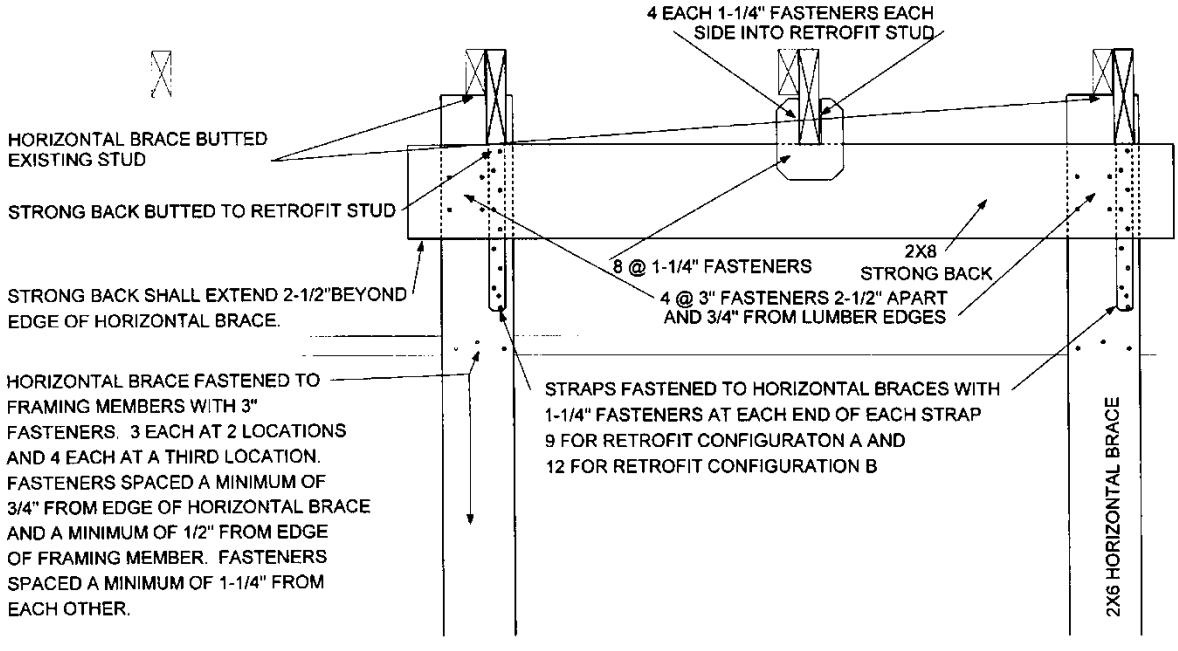
OVERVIEW

PLAN VIEWS
RETROFIT CONFIGURATION A AND B ONLY
NOT ALLOWED FOR RETROFIT CONFIGURATION C OR D

UNIDENTIFIED NUMBERS INDICATE THE NUMBER OF FASTENERS.



DETAILS OF CONVENTIONALLY FRAMED GABLE



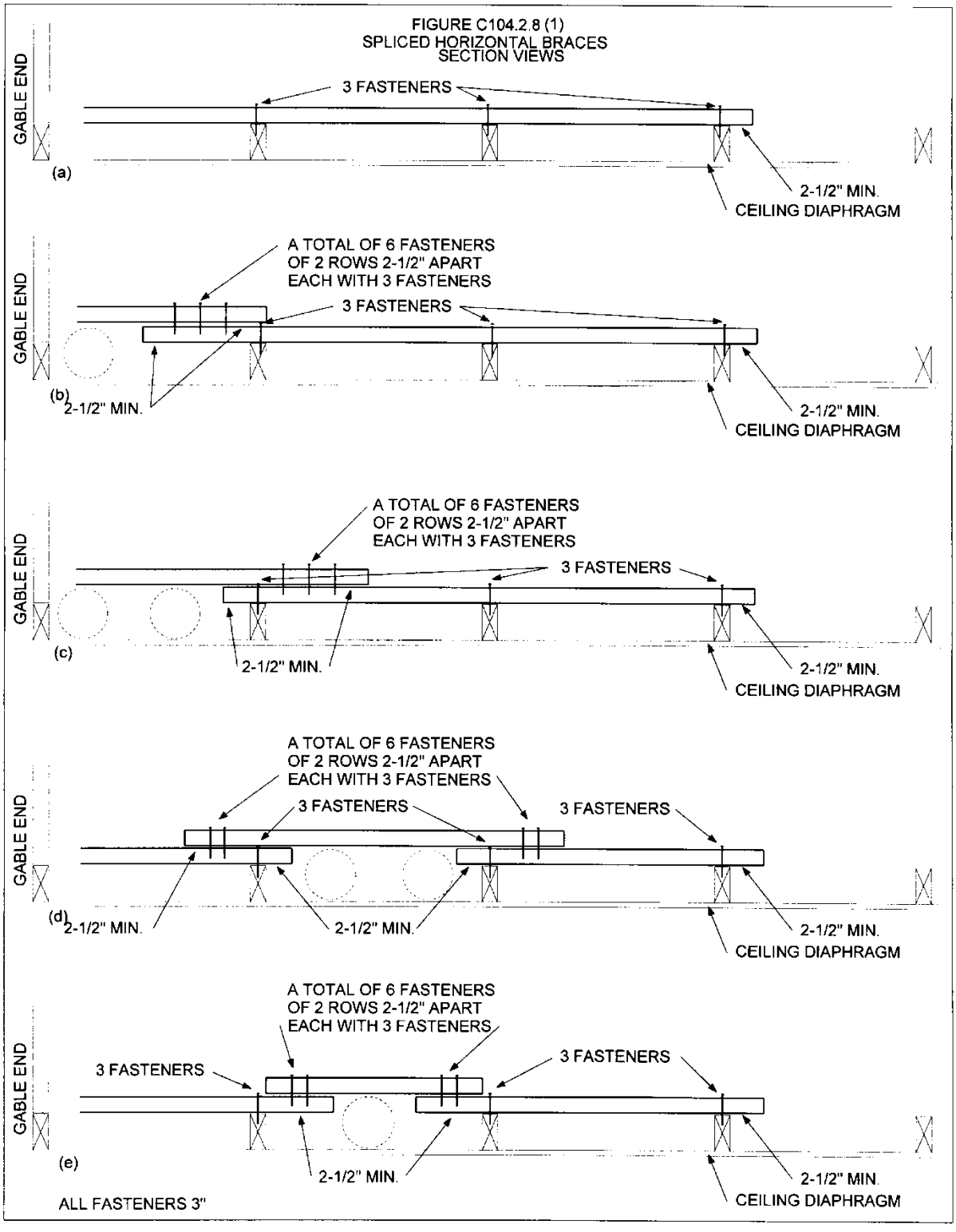
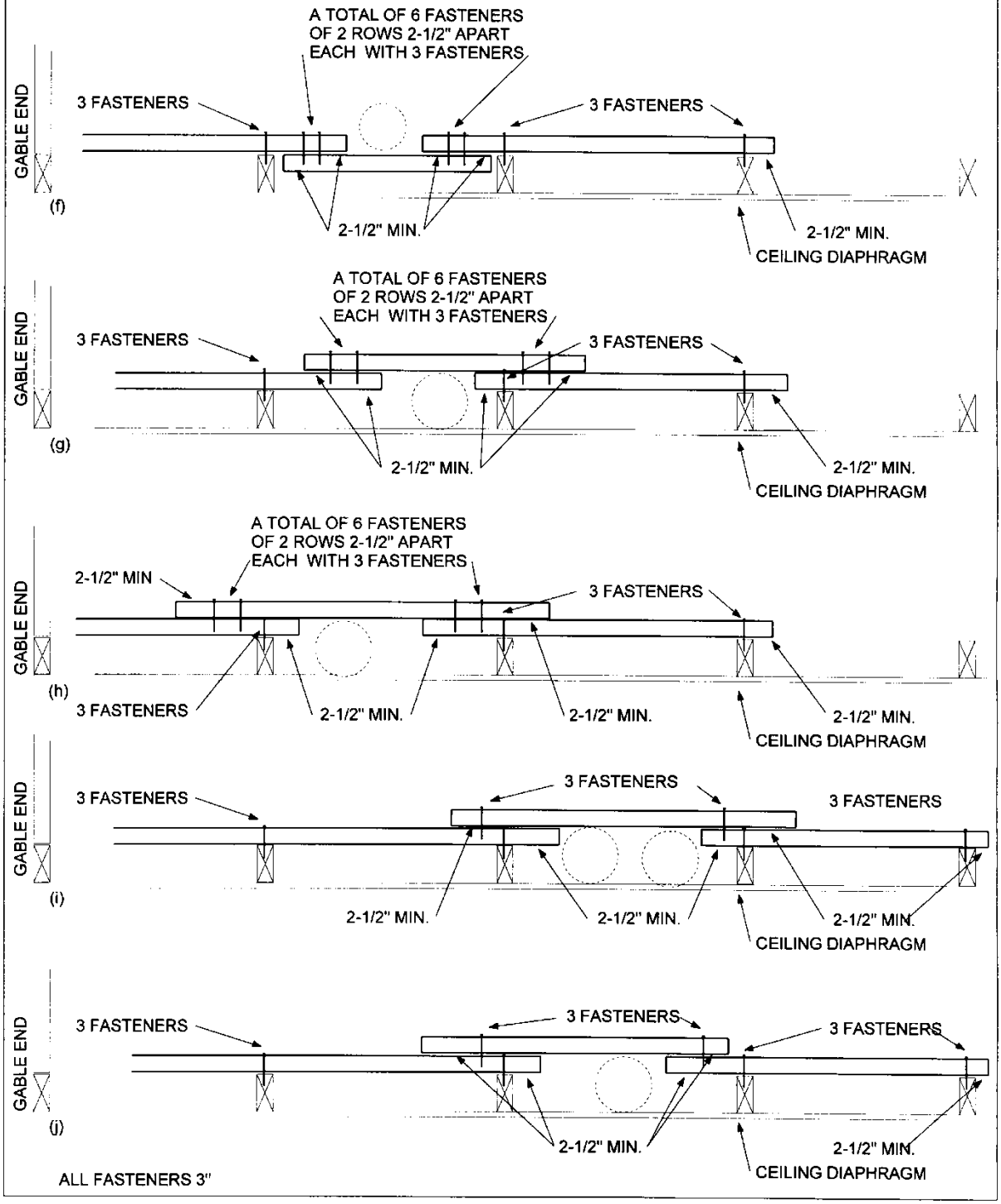


FIGURE C104.2.8 (1)
SPLICED HORIZONTAL BRACES
SECTION VIEWS
GABLE END
3 FASTENERS
(a)
2-1/2" MIN.
CEILING DIAPHRAGM
A TOTAL OF 6 FASTENERS
OF 2 ROWS 2-1/2" APART
EACH WITH 3 FASTENERS
3 FASTENERS
(b)
2-1/2" MIN.
2-1/2" MIN.
CEILING DIAPHRAGM
A TOTAL OF 6 FASTENERS
OF 2 ROWS 2-1/2" APART
EACH WITH 3 FASTENERS
3 FASTENERS
(c)
2-1/2" MIN.
2-1/2" MIN.
CEILING DIAPHRAGM
A TOTAL OF 6 FASTENERS
OF 2 ROWS 2-1/2" APART
EACH WITH 3 FASTENERS
3 FASTENERS
3 FASTENERS
(d)
2-1/2" MIN.
2-1/2" MIN.
2-1/2" MIN.
CEILING DIAPHRAGM
A TOTAL OF 6 FASTENERS
OF 2 ROWS 2-1/2" APART
EACH WITH 3 FASTENERS
3 FASTENERS
3 FASTENERS
(e)
2-1/2" MIN.
2-1/2" MIN.
CEILING DIAPHRAGM
ALL FASTENERS 3"

FIGURE C104.2.8 (2)
SPLICED HORIZONTAL BRACES
SECTION VIEWS



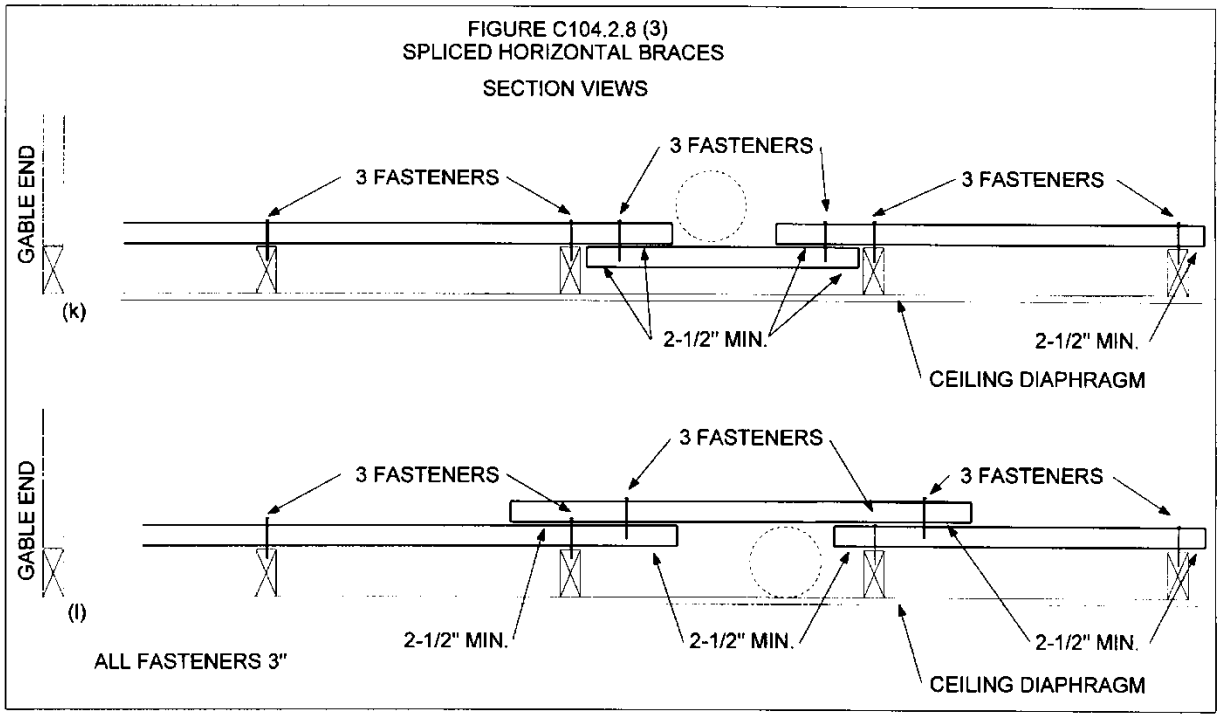


FIGURE C104.2.8 (3)
SPLICED HORIZONTAL BRACES
SECTION VIEWS
GABLE END
(k)
3 FASTENERS
3 FASTENERS
3 FASTENERS
2-1/2" MIN.
2-1/2" MIN.
CEILING DIAPHRAGM
GABLE END
(l)
3 FASTENERS
3 FASTENERS
3 FASTENERS
2-1/2" MIN.
2-1/2" MIN.
2-1/2" MIN.
ALL FASTENERS 3"
CEILING DIAPHRAGM

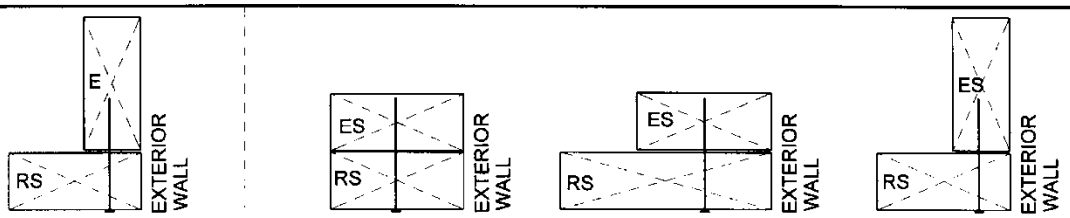
FIGURE C104.3
METHODS OF INSTALLING RETROFIT STUDS

TRUSS FRAMING
PLAN VIEWS

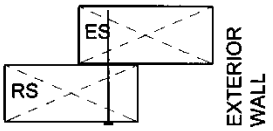
CONVENTIONAL FRAMING
PLAN VIEWS

STUD FACES PERPENDICULAR TO WALL

STUD FACES PARALLEL TO WALL

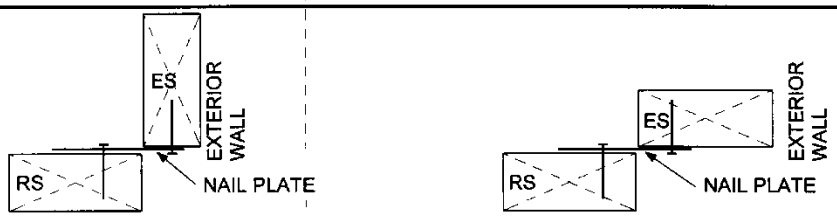


(a) METHOD #1: FACE TO EDGE OR TO FACE METHOD OF C104.3.2
MINIMUM 1-1/2" PENETRATION OF FASTENER INTO SECONDARY MEMBER

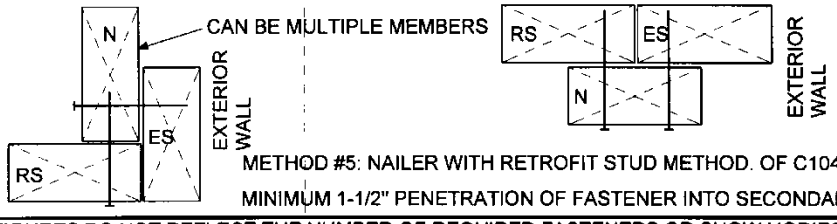


(b) METHOD #2: FACE TO OFFSET FACE METHOD OF C104.3.3
MINIMUM 1-1/2" PENETRATION OF FASTENER INTO SECONDARY MEMBER

(c) METHOD #4 BUTTED RETROFIT STUD METHOD OF C104.3.4
MINIMUM 1-1/4" PENETRATION OF FASTENER INTO LUMBER



(d) METHOD #4: OFFSET RETROFIT STUD METHOD OF C104.3.5
MINIMUM 1-1/4" PENETRATION OF FASTENER INTO LUMBER

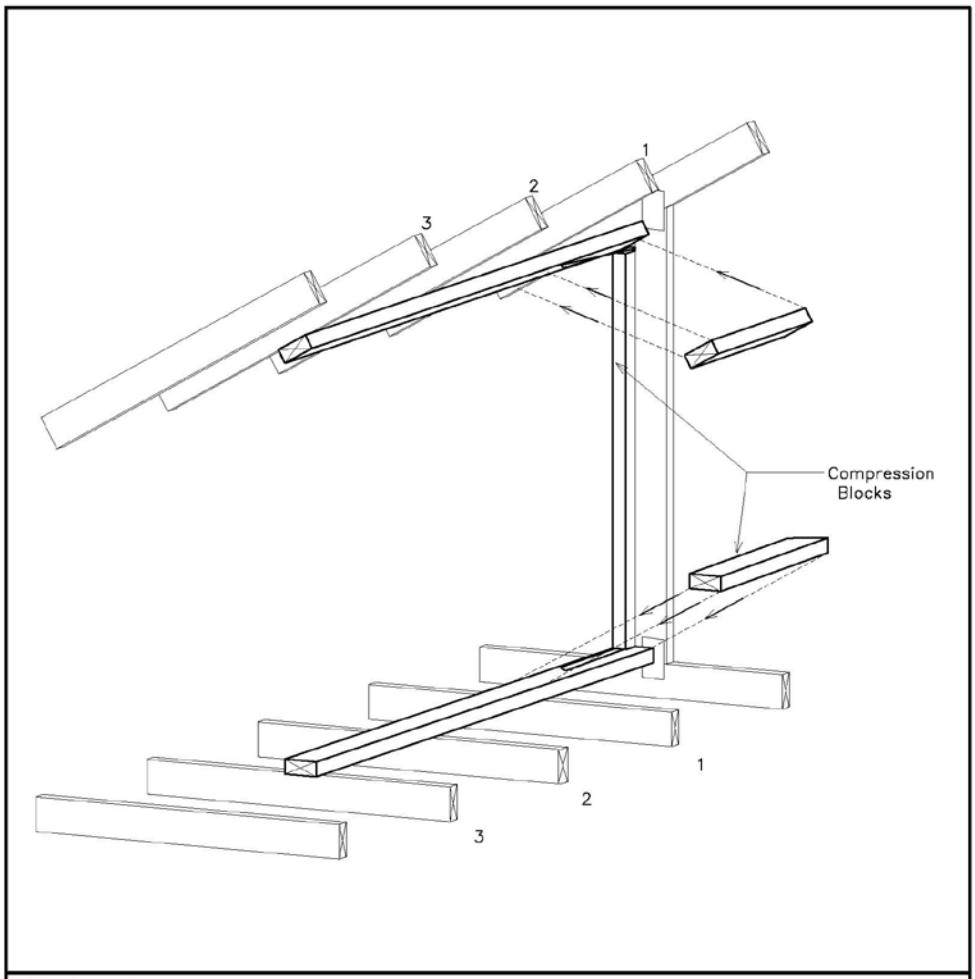


(e) METHOD #5: NAILER WITH RETROFIT STUD METHOD. OF C104.3.6
MINIMUM 1-1/2" PENETRATION OF FASTENER INTO SECONDARY MEMBER

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.

Appendix A
Original Engineering Drawings showing Gable End Retrofit Components and Connections.

WARNING: Some of these drawing have been superseded by others because of refinements in the retrofit measures that evolved since the drawings were made; however, with that warning, they are included because they may lend clarity to some of the topics discussed in the body of this Gable End Retrofit Guide.



Requirements

- The number of fasteners shall be a specified on the table.
- Compression blocks shall be lumber no smaller than 2x4.
- The compression block must be long enough to accommodate the number of fasteners specified in the table.
- Fasteners must be a minimum of 2–1/2" apart along the length of the compression block.
- Fasteners must be a minimum of 1" apart from each other side to side.
- Fasteners must be a minimum of 1/2" from the edge of the compression block and the horiozontal brace.
- Fasteners must be nails 10d in diameter or #8 screws.
- Fasteners must be no closer to the ends of the compression block than 2–1/2"

Compression Blocks

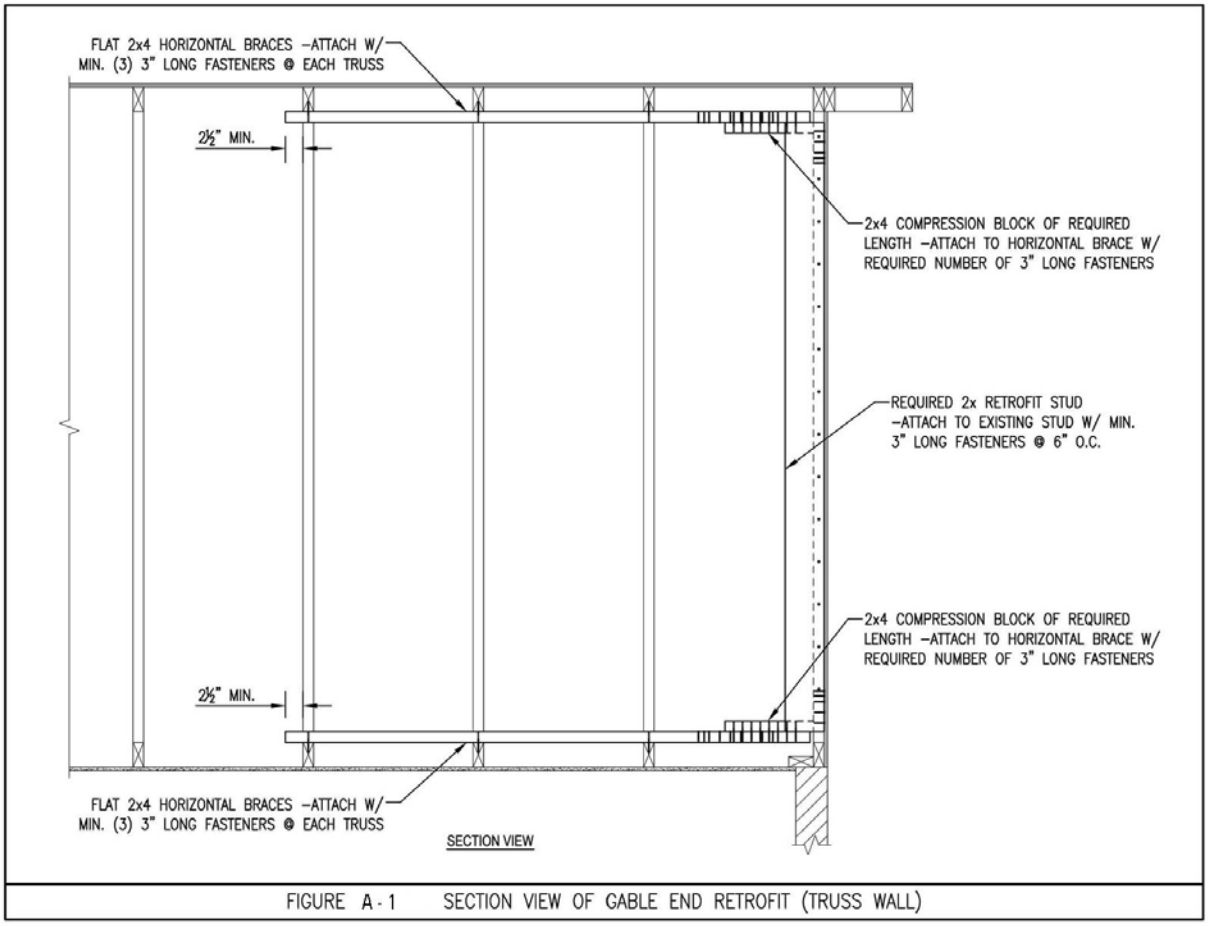


FIGURE A-1 SECTION VIEW OF GABLE END RETROFIT (TRUSS WALL)

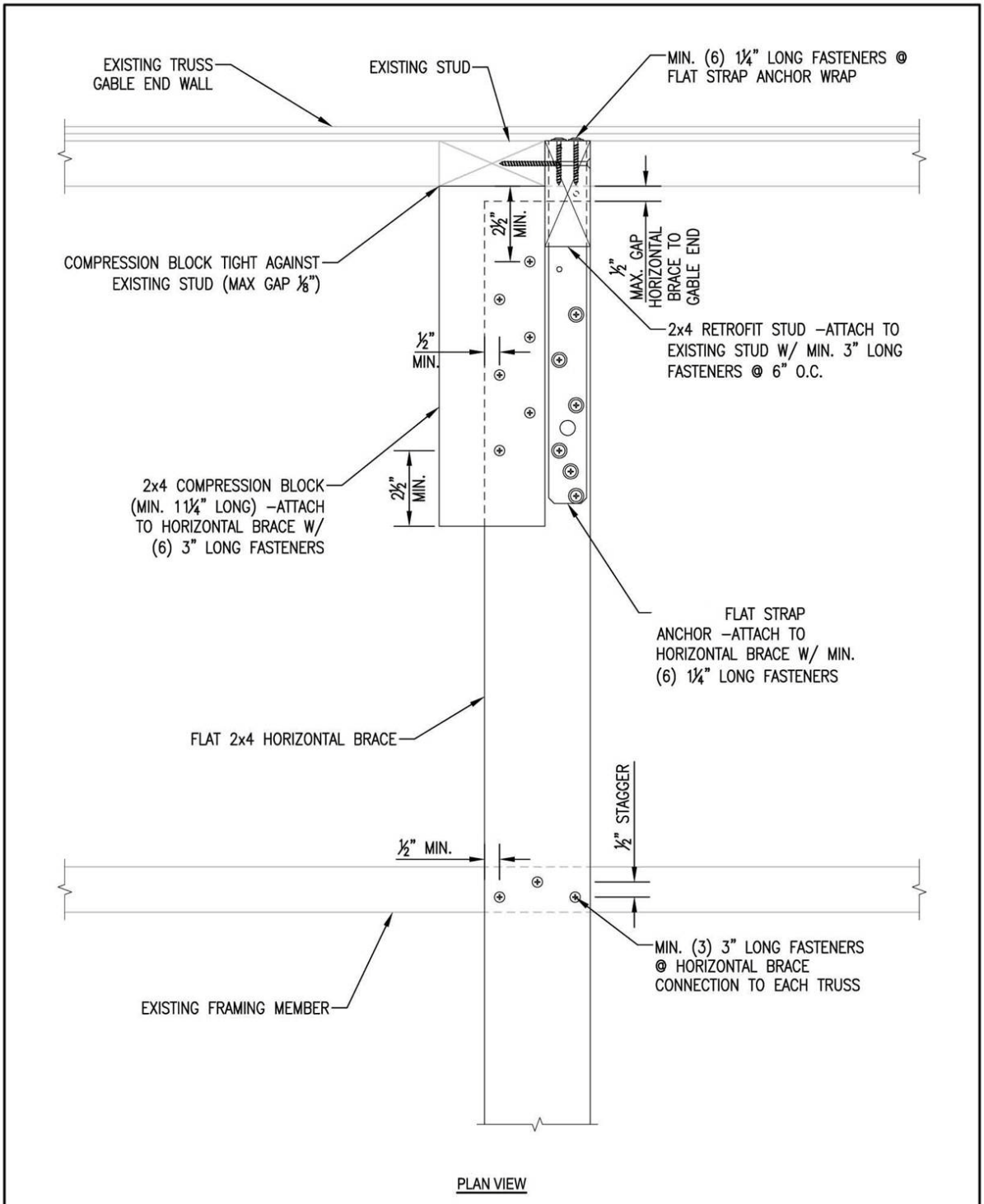


FIGURE A-2 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – 2x4 RETROFIT STUD

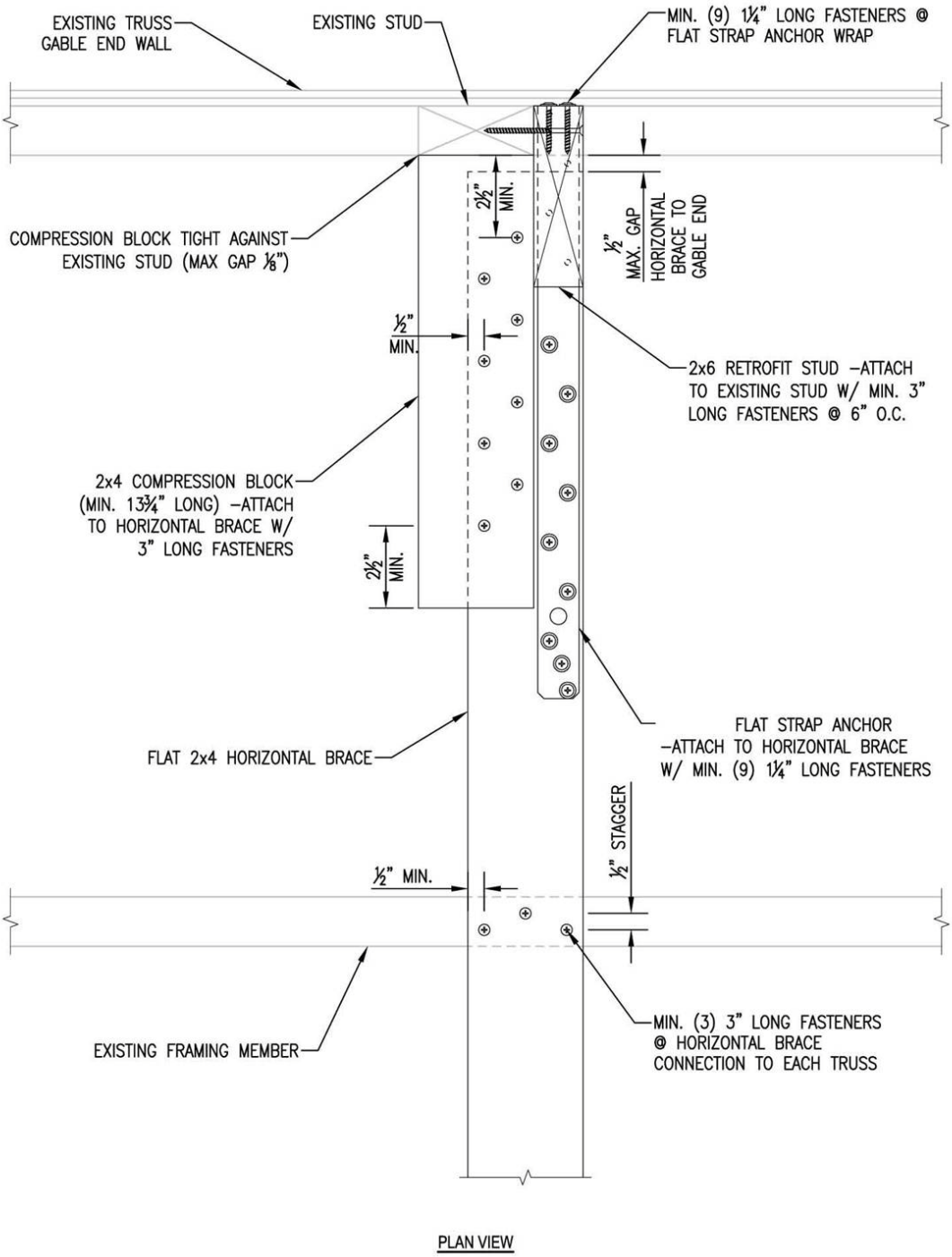


FIGURE A-3 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – 2x6 RETROFIT STUD

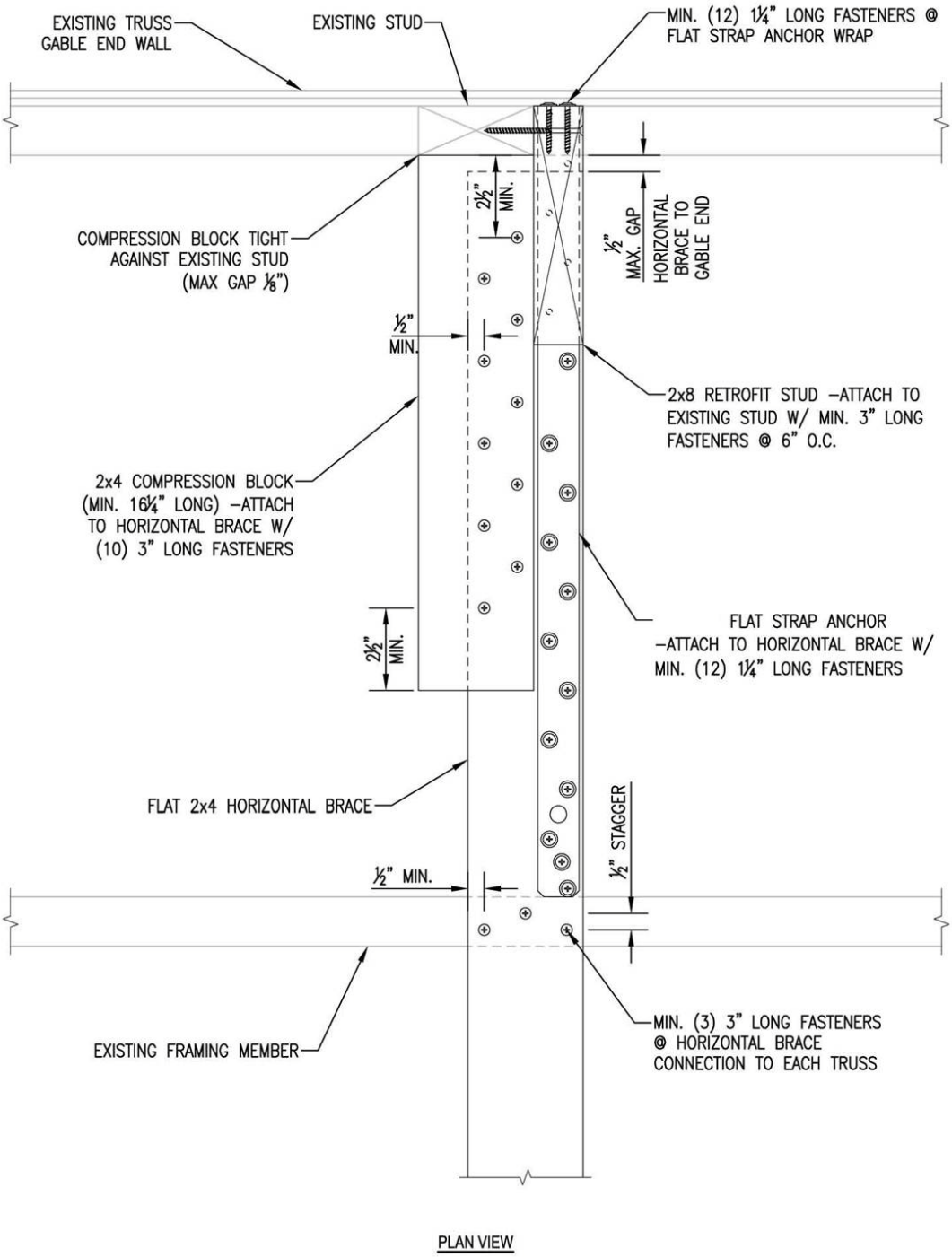


FIGURE A-4 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – 2x8 RETROFIT STUD

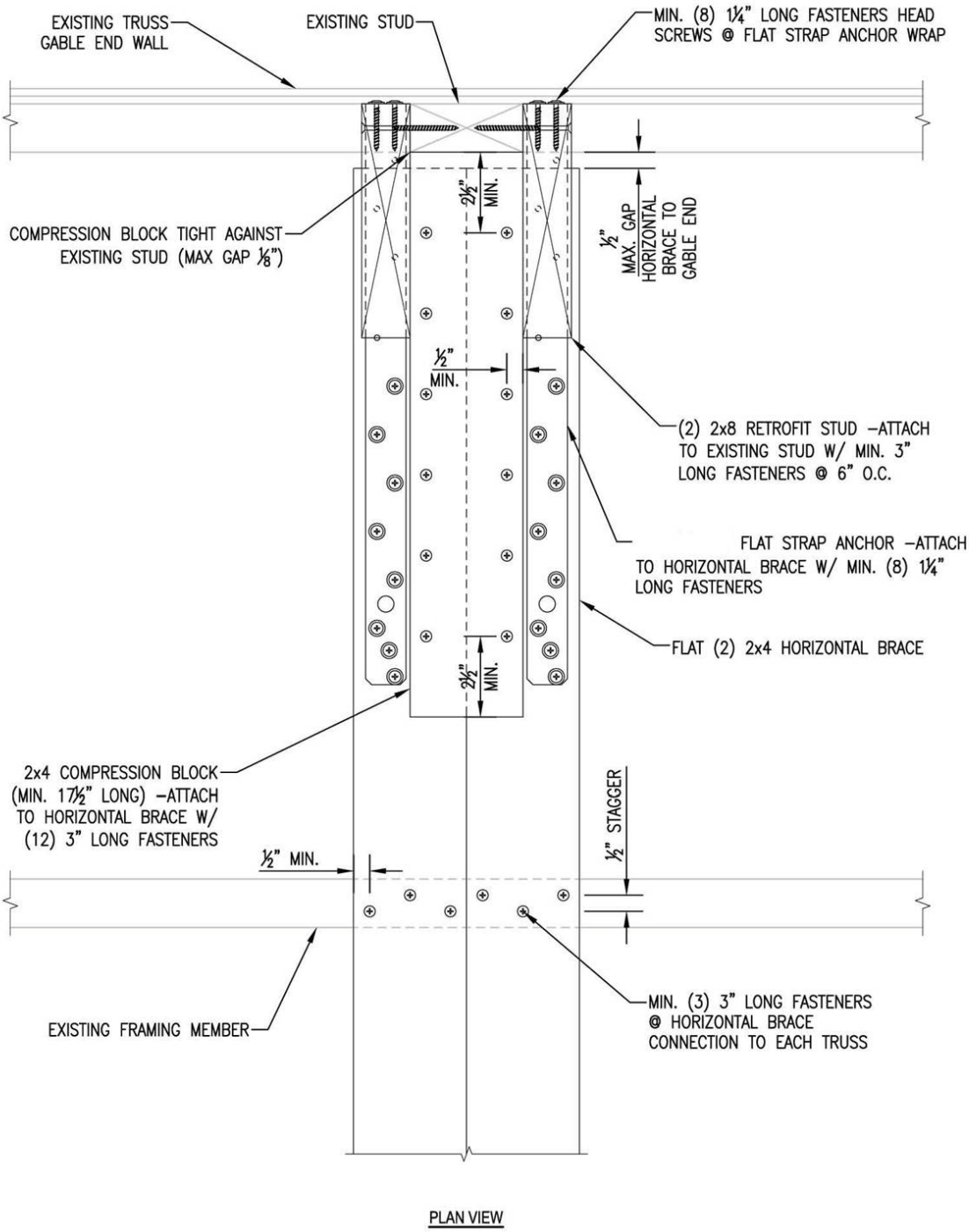


FIGURE A-5 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – (2)2x8 RETROFIT STUD

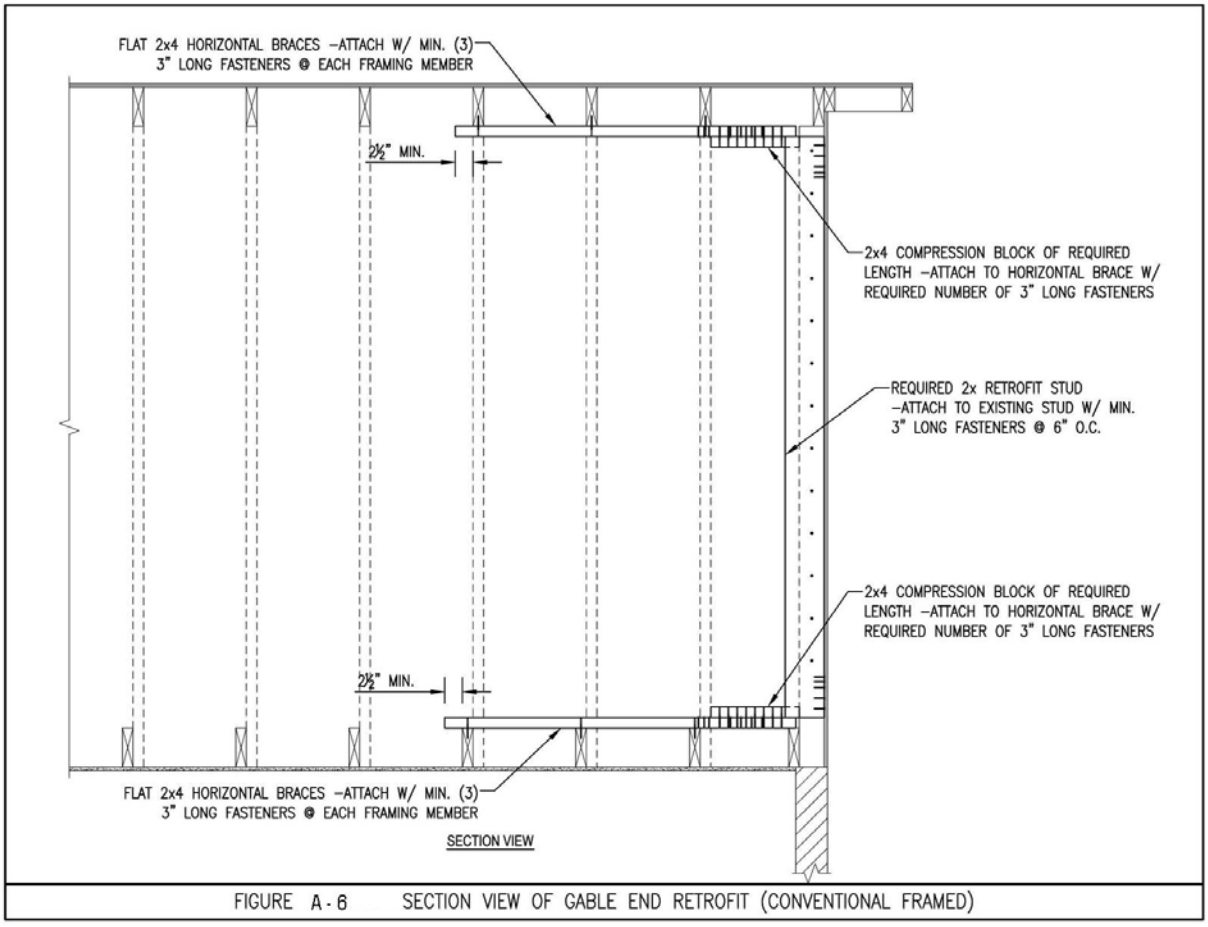


FIGURE A-6 SECTION VIEW OF GABLE END RETROFIT (CONVENTIONAL FRAMED)

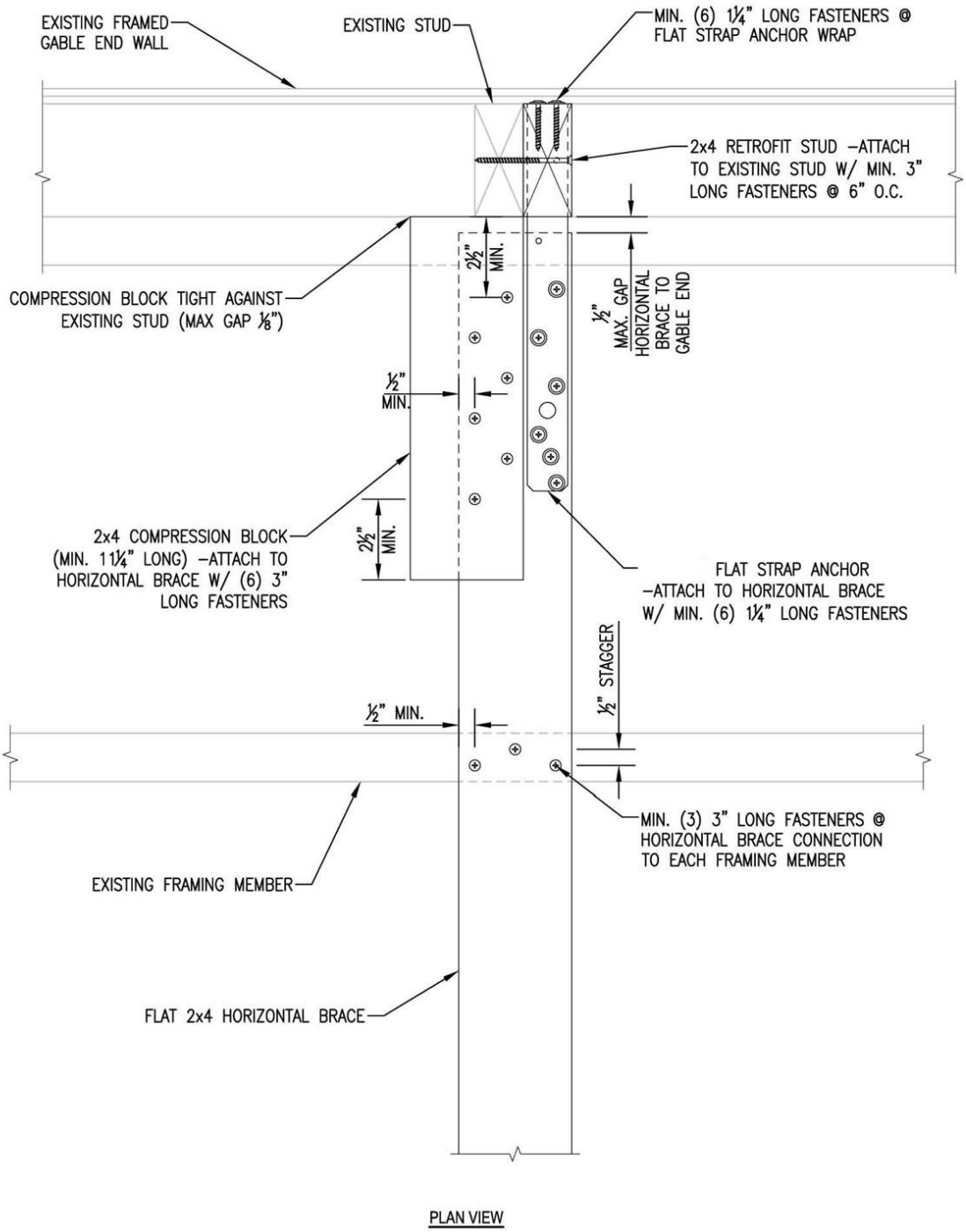


FIGURE A-7 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – 2x4 RETROFIT STUD

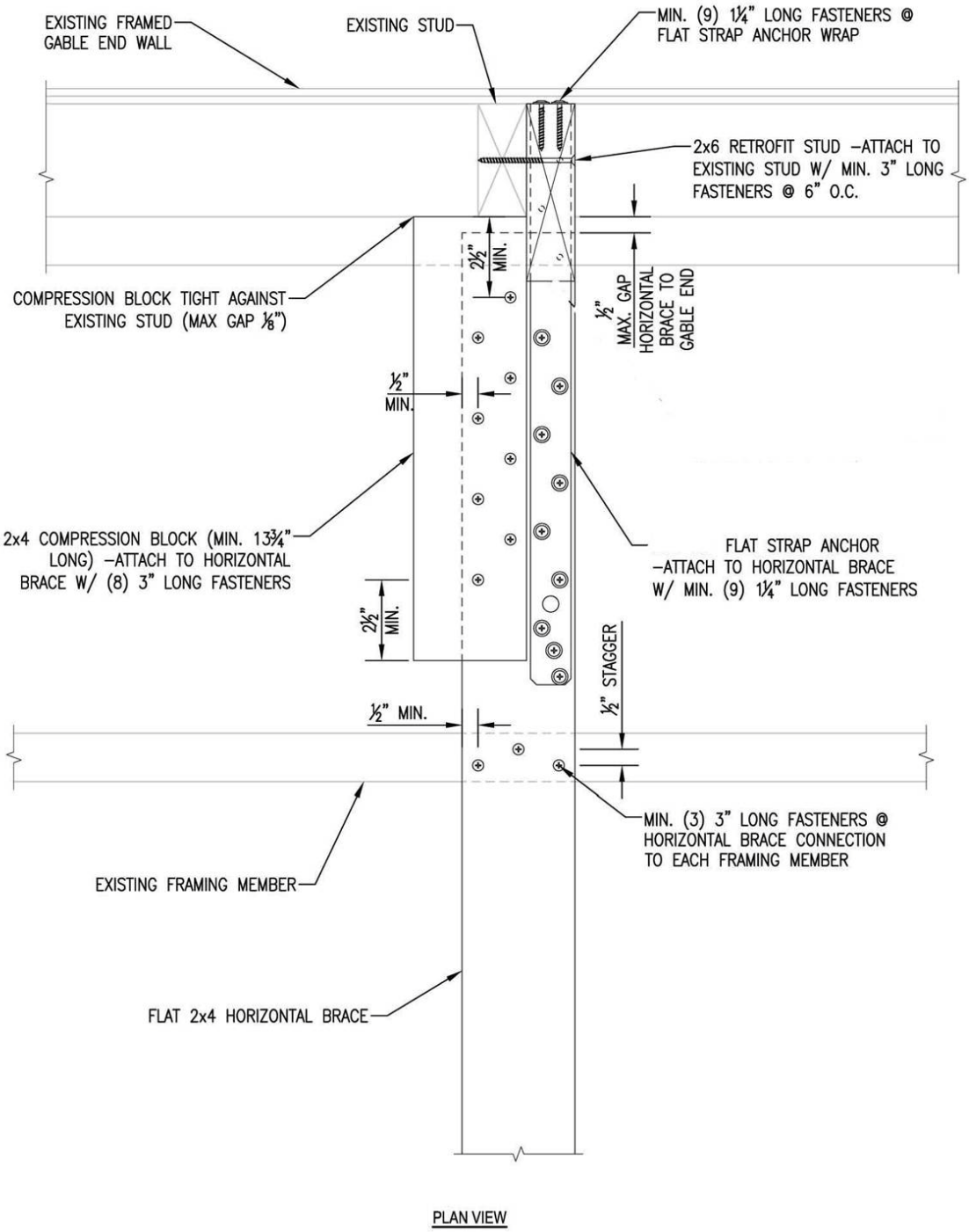


FIGURE A-8 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – 2x6 RETROFIT STUD

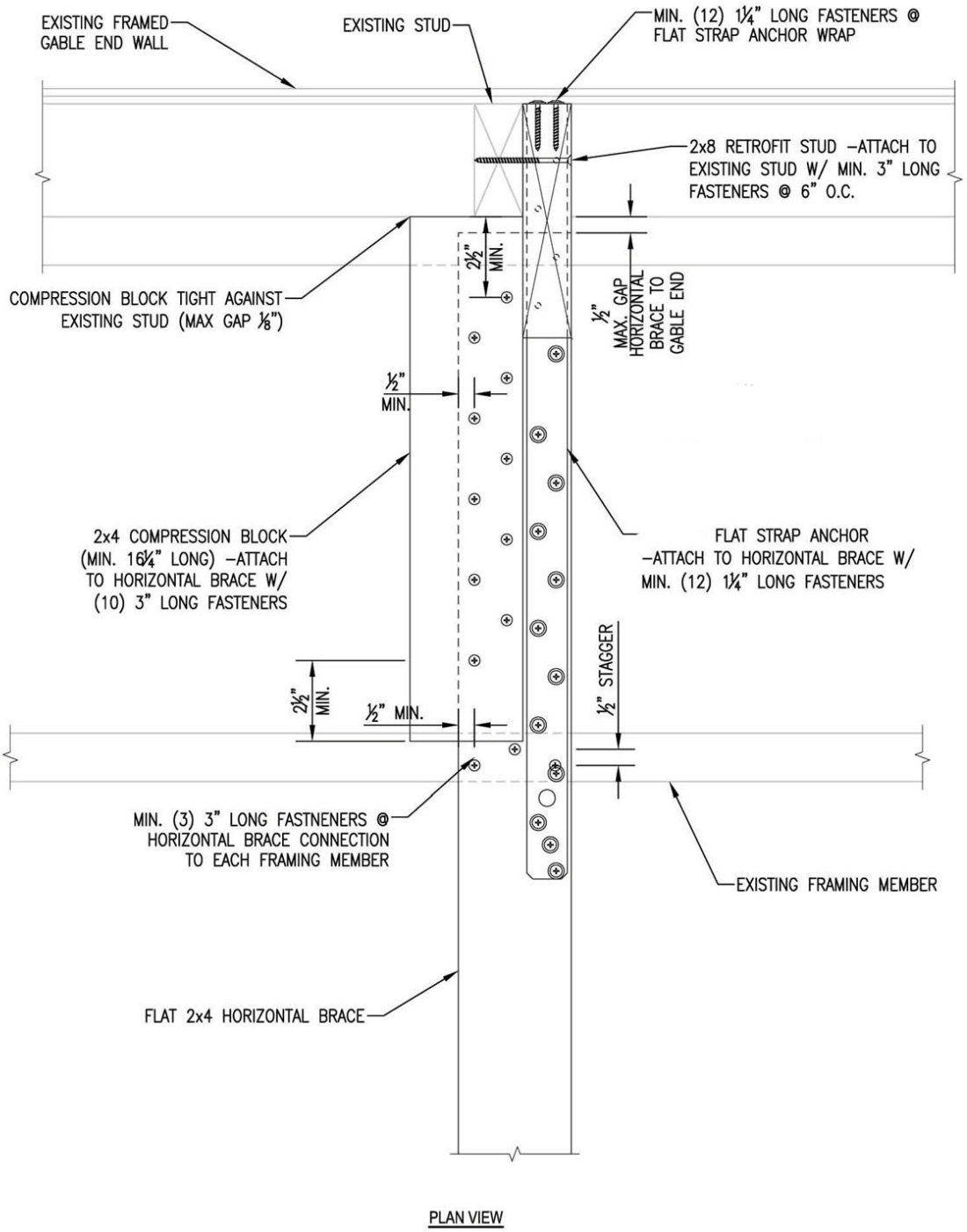


FIGURE A-9 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – 2x8 RETROFIT STUD

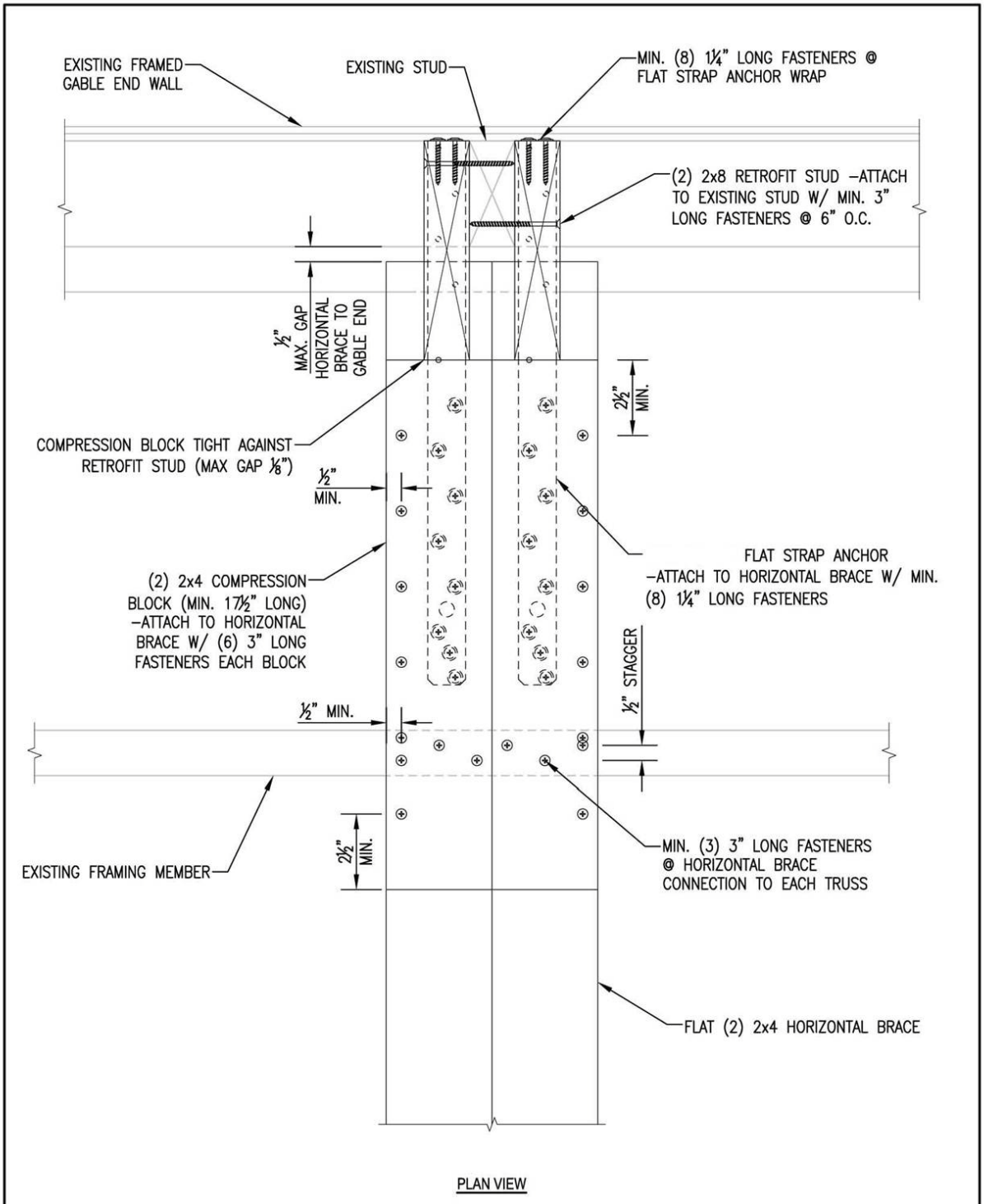
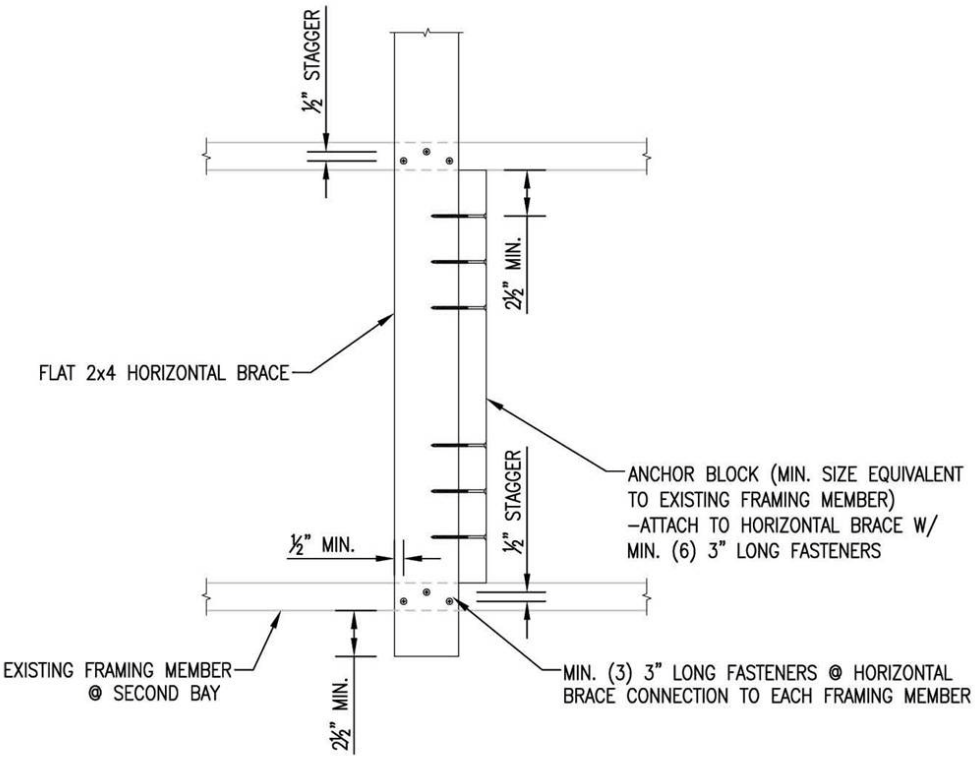


FIGURE A-10 DETAILS OF STRAP & COMPRESSION BLOCK INSTALLATION – (2)2x8 RETROFIT STUD



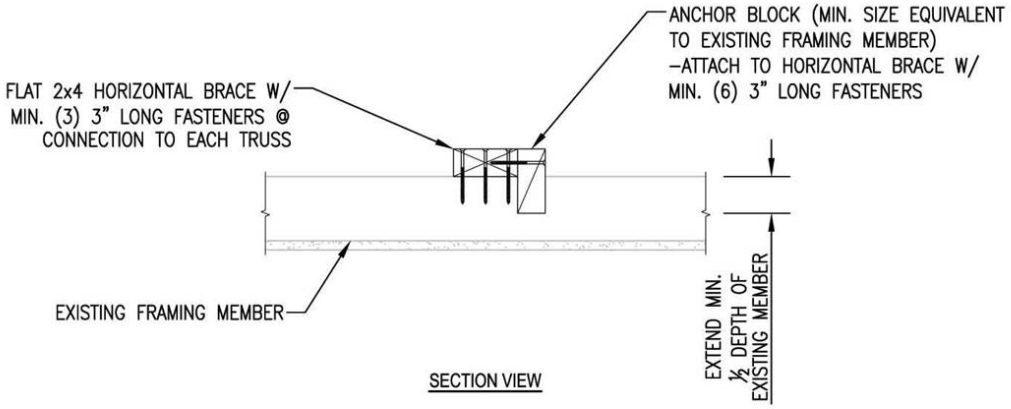
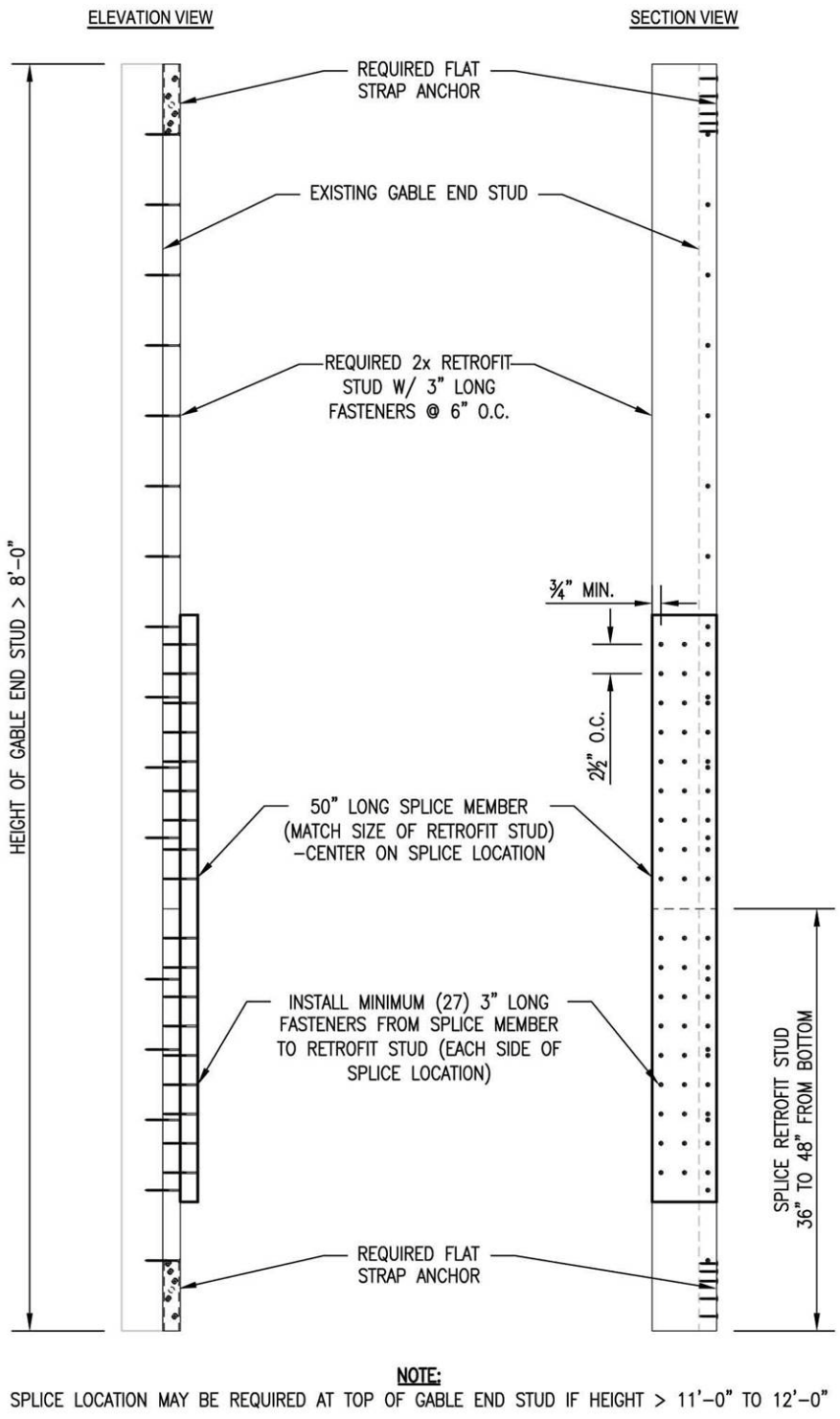


FIGURE A-11 DETAIL OF ANCHOR BLOCK INSTALLATION



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

FIGURE A-12 DETAIL OF RETROFIT STUD SPLICE

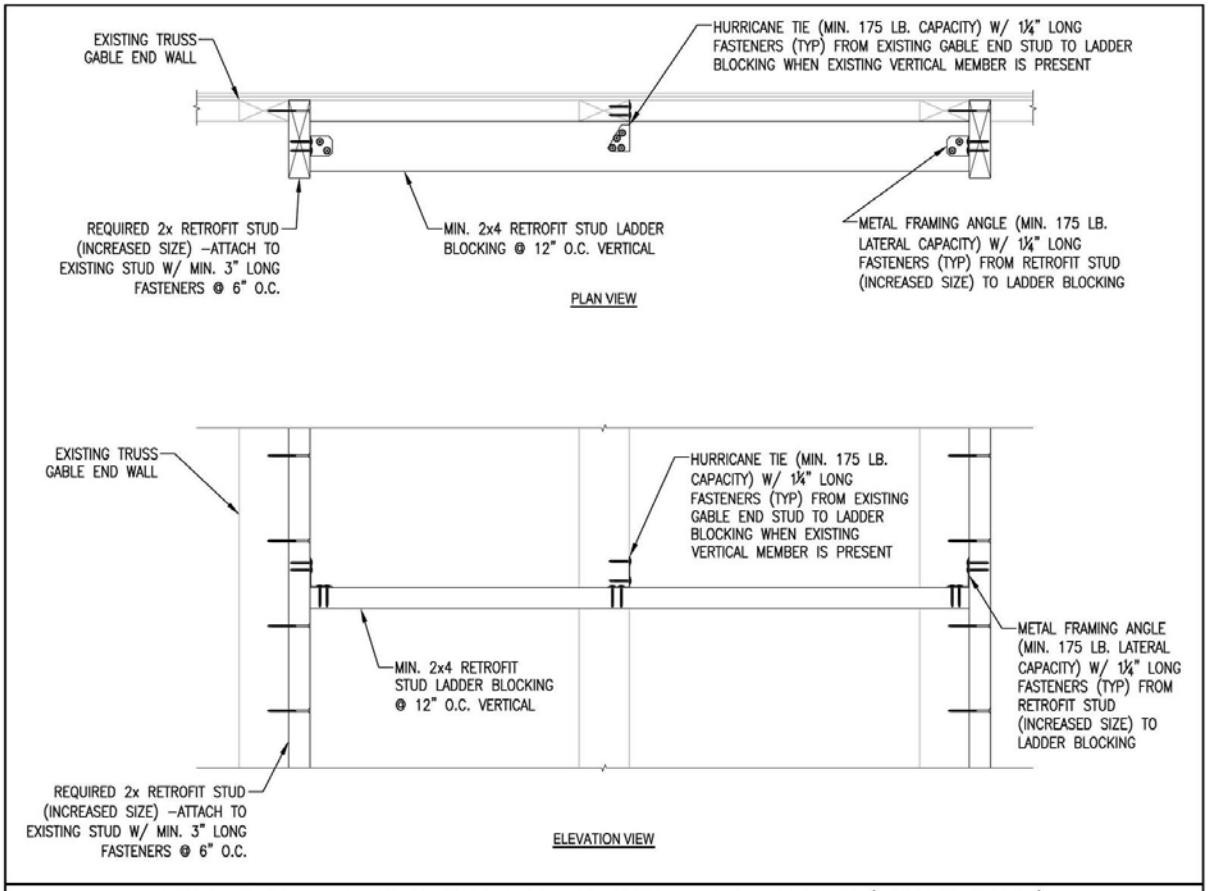


FIGURE A-13 DETAIL OF LADDER BRACING FOR OMITTED RETROFIT STUD (TRUSS GABLE END)

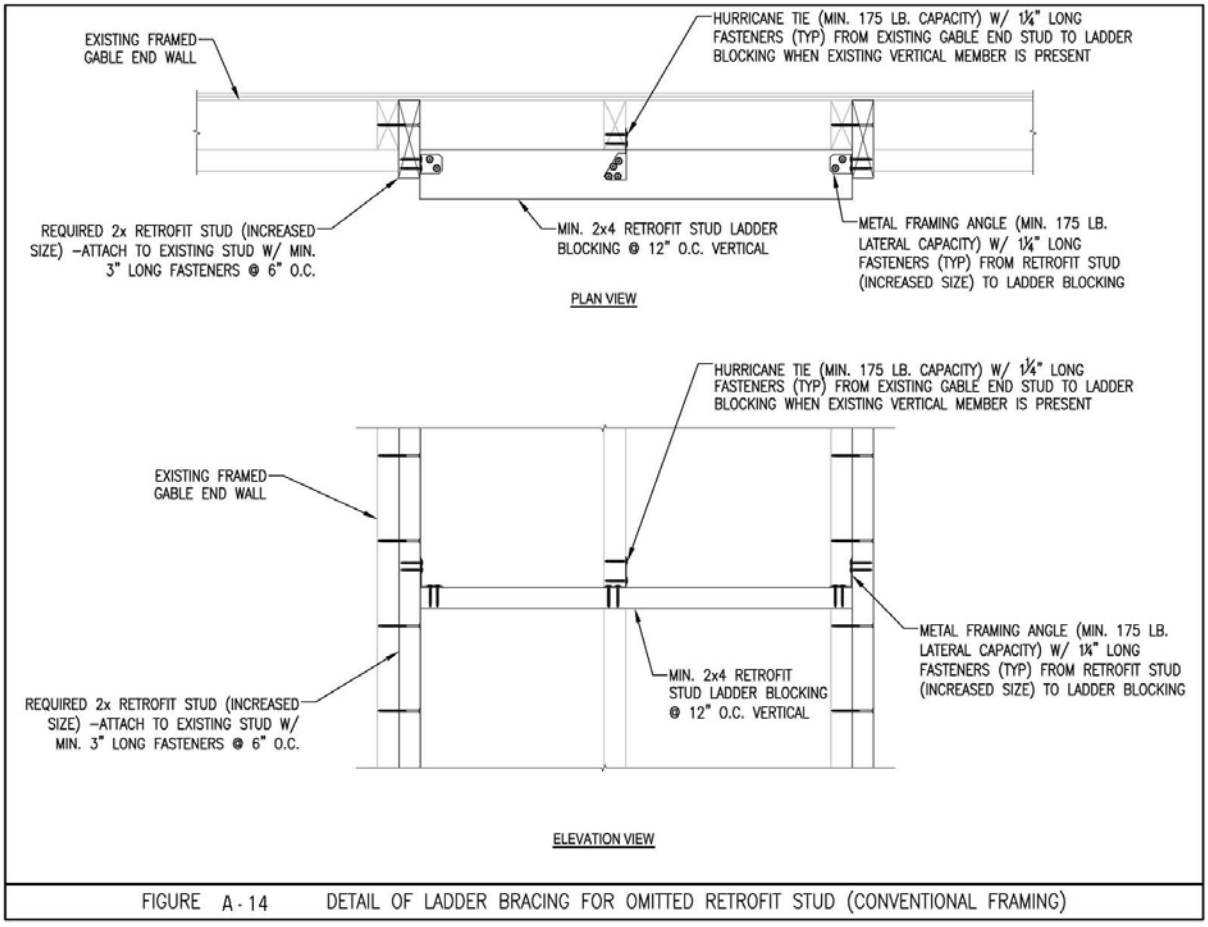


FIGURE A-14 DETAIL OF LADDER BRACING FOR OMITTED RETROFIT STUD (CONVENTIONAL FRAMING)

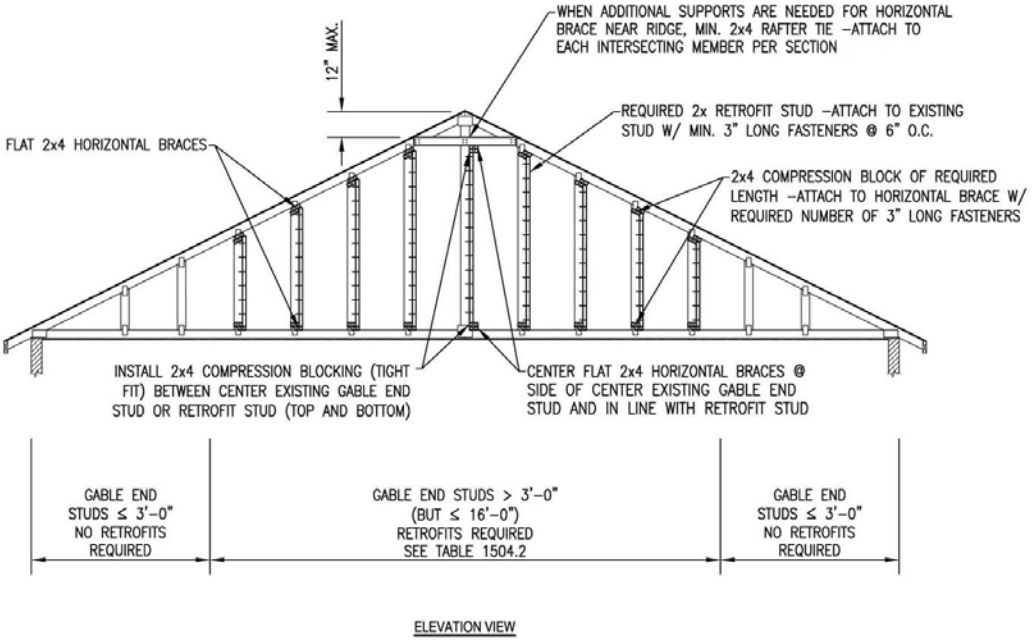


FIGURE A-15 DETAIL OF RETROFIT RIDGE TIE INSTALLATION