

The Designer's Guide to RETROFIT ROOFING SYSTEMS



The Designer's Guide
to
Retrofit Framing Systems
(2ND EDITION)

© McElroy Metal, Inc. 2012

Corporate Office
P.O. Box 1148
Shreveport, Louisiana 71163
(800) 950-6531
Fax: (318) 747-8029
www.mcelroymetal.com

The information contained within this manual is intended to serve as a guide to illustrate certain methods, which may be used by Design Professionals, Contractors and Retrofit System Installers. It is believed to be true and accurate at the time of printing. Certain specifications may be subject to change and specific components may vary slightly in appearance from those pictured. Depending upon specific requirements, adaptation, modification and/or production of custom components may be necessary. If you have any questions relative to your particular application, please contact McElroy Metal Technical Service Department to ensure that you have the most current information available.

Chapter	Page		
1 - Introduction	1-1		
2 - General Information			
Industry History	2-1		
Project Feasibility	2-1		
Other Reasons to Use Retrofit	2-2		
Product Testing Descriptions	2-4		
Industry Terminology and Roles	2-5		
Service and Product Disclaimers	2-8		
Metal Construction Glossary	2-9		
3 - Retrofit Fundamentals			
Design Considerations	3-1		
Installation Precautions	3-2		
Existing Building Inspection	3-3		
Structural Analysis of Existing Roof	3-5		
Material Weights and R-Values	3-7		
Open Web Bar Joist Data	3-7		
Ventilating Retrofit Attics	3-8		
Insulating Retrofit Roofs and Controlling Condensation	3-10		
Conventional Roofing Methods	3-11		
Acceptable Re-roofing Methods	3-14		
Re-roofing Cost Comparisons	3-14		
4 - Retrofit Applications and Systems			
Existing and New Roof Geometry	4-1		
Architectural Applications	4-1		
Functional Applications	4-2		
Problematic Geometry	4-2		
Metal-on-Metal	4-2		
McElroy Retrofit Framing Systems	4-3		
Perimeter Framing	4-3		
Low-Slope Framing	4-4		
Post and Purlin Framing	4-4		
Wide-Span Framing	4-6		
Framing Fit-for-Use Applications	4-7		
5 - Retrofit Framing Design			
Design – Past and Present	5-1		
Understanding Structural Grids	5-1		
Anchorage of the Framing System	5-5		
Commonly Used Anchors	5-6		
Compression Resistance	5-7		
McElroy Standard Framing	5-7		
Purlin Sizing	5-7		
Post Sizing	5-8		
		Base Zee Sizing	5-8
		6 - Roof and Wall Systems	
		Architectural Standing Seam	6-2
		Functional Standing Seam	6-3
		Functional Exposed Fastener	6-4
		Wall/Fascia and Soffit Panels	6-4
		7 - Roof and Wall Accessories	
		Rooftop Ventilation	7-1
		Wall Ventilation	7-2
		Rooftop Penetrations	7-3
		8 - Technical Information	
		Quote Request Requirements	8-1
		Order/Contract Processing	8-2
		Framing System Specifications	8-4
		Insulation Specifications	8-9
		Ventilation Specifications	8-10
		Rooftop Equipment Specifications	8-10
		9 – Integrated Solar Retrofit Roofs	
		General Descriptions	9-1
		Solar Photovoltaics	9-1
		Solar Thermal Air/Water	9-2
		10 - Standard Construction Details	
		Index of Details	10-1
		Eave Conditions	10-2
		Canopy Overhangs	10-20
		Gable Conditions	10-42
		Member Splices	10-51
		Post & Purlin Interior Framing	10-56
		Low-Slope Interior Framing	10-73
		Wide-Span Interior Framing	10-76
		Metal-over-Metal Systems	
		Attachment to Purlins	10-81
		Low Eaves	10-86
		High Eaves	10-92
		Rake Conditions	10-95
		Ridge	10-100
		Hip	10-101
		Valley Gutter	10-102



Since 1963, McElroy Metal has served the construction industry with quality products and exceptional customer service. Our architectural and engineered systems focus is helping design professionals and quality contractors find solutions in metal. McElroy's products canvas the metal construction industry providing quality systems for agriculture, commerce, education and industry. Our retrofit framing systems satisfy a variety of applications for low-slope, high-slope and special construction or problematic geometry issues. These framing systems can offer design professionals, contractors and

building owners with a multitude of options that are economically feasible while still maintaining the quality product integrity that is expected from a manufacturer.

Metal roof systems continue to gain in popularity and are frequently installed to replace traditional and conventional roofing systems. It is more important than ever for building owners/managers, design professionals and contractors to understand how these systems work and what their advantages and benefits are in comparison to other methods of re-roofing.

What's new in this printing of the Designer's Guide? Based on recent reports and studies, metal construction industry has gained approximately 20% in roofing market share since this book's first printing in 2005. In addition, our world today is even more focused on saving energy through upgrades for efficiency as well as employing renewable energy technologies into the building envelope. Because of this, Chapter 3 has been expanded to include detailed information from research that began in 2005 at Oak Ridge National Laboratories on dynamic and convective ventilation being incorporated into re-roofing assemblies. Furthermore, we have included what we call the "Next Generation of Metal Roofing" where fully-integrated solar hot air and water as well as power generation photovoltaic equipment being installed on the metal roof.

Retrofit metal framing systems are now entering their fourth decade of service. They offer design professionals a multitude of options ranging from low-slope functional systems for simply discharging or diverting rainwater from the roof to high-slope architectural applications. For building owners wishing to beautify their existing building, retrofit metal roofing represents an economical and functional solution. Design professionals can employ higher slopes and utilize metal roof panels in an attractive array of colors. For finishing touches, hips, valleys, dormers, and other architectural concepts can be combined with conventional wall improvement systems such as EIFS and other products. By adding insulation and installing properly designed ventilation accessories, the retrofit concept is an excellent remedy for energy-saving deficiencies in older buildings and an important role of the U.S. energy policy. In addition and little known to most, retrofit systems are often employed to correct existing roof geometry that may be problematic insofar as roof drainage



concerns. These systems can be designed to remove unwanted conditions found in many older buildings that have experienced facility additions or are presently undergoing expansion programs causing weathertight concerns. All of these situations are discussed in complete detail in this manual.

While developing the McElroy Retrofit Framing Systems, we first identified what other manufacturers were not doing in the marketplace. For example, with just a handful of them offering fully engineered retrofit systems, most do not make it easy for design professionals and contractors to understand the design dynamics of retrofit itself. If they did, they would provide them the capability of developing a proper layout of the framing for their own projects.

This guide was created with a focus on educating the user in the totality of retrofit systems. It provides everything from basic background knowledge for evaluating alternative conventional re-roofing methods to outlining analysis procedures on the existing building and installation of miscellaneous products that are normally not provided by the systems manufacturer. While this guide has the information needed to create properly documented construction specifications and drawings for bid purposes, it also has sufficient technical data to essentially layout your own system (if legally authorized to do so). Of course, you can contact us to assist in the design and development of your project

McElroy supports this product offering with complete technical expertise including estimating, engineering and technical drawing capabilities as well as field personnel that are specifically trained on retrofitting existing structures. We also offer consultation on projects that are in their early stages by assisting design professionals and contractors in the initial development of a project including preliminary details, budget pricing and other needs.

While many manufacturers offer training programs for installers, McElroy has taken this vital step in quality assurance one step further. All of our training programs feature hands-on activities with each participant leaving the program having actually installed nearly all of the common problematic conditions associated with metal roofing. This superior approach to training has been integrated into the retrofit framing product offer as well. Training is available for installers to not only erect framing components with labor saving methods, but to pass knowledge of why certain techniques and materials are used, as well as understanding the essential relationship between the existing building roof and its new retrofit framing system. McElroy has always believed that to fully understand a product, you must know everything about it including proper application, technical properties and of course, the installation methods to ensure a quality-constructed project.

Although there is a great deal of information offered in this design guide for retrofitting building roofs, additional information is available by contacting the McElroy Technical Services Department at 1-800-950-9082. The contents of this design guide is also available online at www.mcelroymetal.com.

Thank you,

McElroy Metal, Inc.

GENERAL - This chapter provides users with some fundamentals relating to the history of the retrofit industry and information for investigating the overall feasibility of a retrofit project as well as other advantageous reasons for using the retrofit concept. Some of the reasons may include energy efficiency upgrades as well as renewable energy systems that are incorporated into the retrofit system assembly.

Also included in this chapter are general descriptions that outline the various tests used for establishing performance values on metal roof systems. They are followed by established industry definitions pertaining to the roles and responsibilities of the parties involved on a metal roof system project. In addition, McElroy Metal's product and service disclaimers that are specifically related to the engineering of the retrofit framing which it manufactures, are also included. These address the effects on the structural integrity of the existing building roof as a result of adding a retrofit metal roof system and what testing and evaluation should be undertaken to ensure the existing roof is not overloaded. At the end of this section, we have provided a glossary of metal construction terms for your use.



RETROFIT INDUSTRY HISTORY - The retrofit industry has its formal roots going back to late 1970, when a then prominent pre-engineered building manufacturer published the first known technical product manual. This manual illustrated typical light-gauge cold-formed steel components used to make up framing assemblies. All of the components were standard members that the manufacturer used in its metal building product offering. The assemblies were principally designed for low-slope applications with thru-fastened and standing seam metal roof systems. Before this manual, retrofitting an existing building roof was accomplished by using dimensional yard lumber, structural steel sections and some light-gauge members combined to usually make up a jobsite built system. Many of the projects built back then paid little attention to building codes, design load compliance and adherence to good engineering principles. More simply put, the systems installed did not transfer loads in accordance with the original design intent of the existing building structural system. Refer to chapter 5 for a more detailed explanation.



Nowadays, cold-formed framing members in cee, zee, channel and angle shapes are utilized together to create slope-framed systems, also known as slope conversions, to support a new metal roof system. These systems have a multitude of applications as referenced elsewhere in this manual and are effectively designed to satisfy and to comply with the original design intent of the existing building's structural support system. Supported by McElroy's Technical Services and Engineering departments, each McElroy project is engineered specifically to the demands of the existing roof's structural grid and in accordance with sound engineering practices.

PROJECT FEASIBILITY – Buildings with flat roofs are subject to ponding water and therefore are exposed to more than normal moisture gain and possible infiltration. These flat roofs utilize a

design considered to be hydrostatic (watertight) and their inability to simply shed rainwater to the building's perimeter subjects them to a broader range of performance issues. Retrofit and metal roof systems employ another design method known as hydrokinetic (water-shedding). By discharging the rainwater from the building roof, the roof's weathering surface and membrane consequently is subject to less performance issues.

The feasibility of any construction project is subject to the building owner's needs and specifically what has to be achieved or satisfied. Common with most retrofit opportunities, the building owner is currently experiencing roof leaks and in many cases has gone through several attempts to have the leaks eliminated. Many of these building owners have spent enormous amounts of money over the years for constant repair and maintenance and even some have had to go to the extreme of a complete tear-off and replacement of the building's roof weathering surface and membrane, only to experience continual problems with water infiltration.

The building owner that typically becomes interested in retrofit is one that intends to occupy the building for many years to come unless the purpose is for other reasons as noted below. Otherwise, the assurance that a metal roof system provides in long-term performance and weathertightness reliability can be over shadowed by the initial cost of retrofitting. In these cases, the following should be discussed as methods to reduce the cost of the retrofit option and/or to amortize the investment over an extended life cycle of the various re-roofing alternatives.

1. If the intent of retrofitting is strictly to shed water from the building, unlike the existing flat roof, then a minimal slope framing and a functional standing seam metal roof system should be considered. These low profile systems reduce the framing material and installation labor and may prevent re-work or relocation of existing rooftop equipment, which will help keep cost at a minimum.
2. Regardless of the reason for retrofitting, adding economical fiberglass blanket or loose-filled blown-in insulation onto the existing roof can increase the overall energy efficiency of the existing building. This minimal investment will pay back the owner in reduced energy costs for years to come offsetting the cost of the retrofit option. Of course, this is largely dependent on whether or not the building is temperature controlled or what its occupancy or use is.
3. If the building owner is facing a tear-off and replacement to install a new conventional re-roofing system, evaluate the effects on the business's operations and/or production. The cost associated with the loss of production and/or relocation of business operations within the building or at another site should be added to the conventional re-roof option.



OTHER REASONS TO USE THE RETROFIT CONCEPT - Leaky flat roofs and conventional membrane issues are not always the major consideration for retrofitting a building. In many cases, other reasons may abound to create the need where the building owner, with the help of a design professional, will configure the project from the other benefits that retrofit has to offer. These alternatives include any of the following:

1. In the case where a building owner is more

- interested in enhancing the curb appeal and architectural appearance of the building, retrofitting with a high-slope system can bring many other options into the conceptual picture. These systems have the benefit of adding aesthetically pleasing architectural metal roof systems available in a multitude of styles and color options. In addition, design professionals can introduce numerous conventional construction materials such as EIFS for improving building entrances and other edifices. This alternative is especially true when an older building has recently been purchased and the new owner wants to upgrade the building's appearance and increase its monetary value or even marketability.
2. Many design professionals have utilized light-gauge retrofit framing for its economic benefits to construct roof systems over new construction. This is very common when the building is being constructed with structural concrete where the retrofit framing is installed over an "attic" deck/slab. In these cases, the framing system can be designed to assist the installation of electrical/mechanical equipment and ductwork and in some cases provide code approved attic storage.
 3. Many facilities have undergone or are currently undergoing building expansions that create problematic conditions, such as multi-gable or other valley gutter conditions. Retrofit systems offer a sound solution for these detrimental conditions. To better explain this, the following figures are provided. Figure 1 illustrates an extremely common condition found in pre-engineered building facilities and Figure 2 could be applicable to existing conditions or issues caused by a new building being constructed adjacent to an existing building.

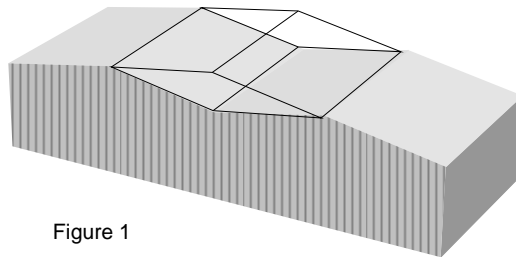


Figure 1

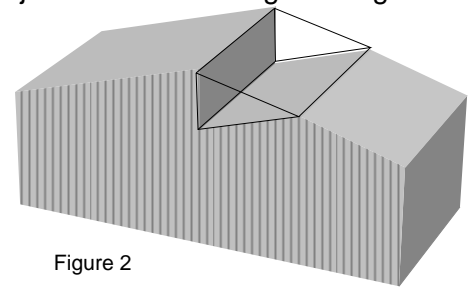


Figure 2

4. With our Nation being focused on the environment and energy conservation today, a building owner now has the ability to respond to these concerns when faced with re-roofing his building. This is especially true if his company has made the commitment to reduce their carbon footprint. LEED, or Leadership in Energy and Environmental Design, is redefining the way we think about the places where we live, work and learn. As an internationally recognized mark of excellence, LEED provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions. Principally created to focus on new construction, the authors of LEED did not forget about our existing buildings which were more than likely were not originally built with an energy efficient focus. The truth of the matter is a retrofit roof framing system over an existing building with a new high-performance metal roof installed can help obtain several points required for the building to become LEED certified. Technologies for obtaining points include adding insulation to bring the building's roof up to Model Energy Code minimum standards and rainwater collection/harvesting for green-area site irrigation as well as renewable energy technologies as mentioned earlier.

PRODUCT TESTING DESCRIPTIONS - The following is provided to assist the design professional and contractor in their understanding of the specific requirements involved in various metal roof system testing procedures. It is also important to note that these tests are for the sole purpose of establishing performance criteria on products and they should not be used for specified independent design load criteria on a metal roof system project.



Underwriters Laboratories (UL-90 Uplift Rating) – This wind uplift resistance test (UL580 test protocol) has become an industry standard for insurance purposes. Test panel specimens are placed onto a 10 feet by 10 feet test chamber and fastened to the tested substrate. The test involves severe load cycling as well as testing for a sustained period of five (5) minutes at a maximum uplift pressure of 105 pounds per square foot (PSF) for a UL-90 Rating. Because specimens are not tested to failure and the testing is not similar to an actual roof assembly, test ratings and assemblies should not be used for design purposes. Other ratings exist such as UL-30 and UL-60.

Factory Mutual (FM Standard 4471-Class 1 Roof Panels)– This is a series of tests that includes combustibility, wind uplift, foot traffic, hail and water leakage resistance. Factory Mutual is a private enterprise, which provides testing and approval of various products that meet established performance criteria as well as the manufacturer's ability to comply with defined quality control procedures. The wind uplift test involves exposure to wind loads in the field (interior) and securement requirements for corner, perimeter and appropriate roof peaks, which are generally higher than the load acting in the field of the roof. Specimens (12 feet x 24 feet) are tested to failure based on established minimum pressures. Ratings are 1-60 thru 1-180, where as the numeric value is equal to the minimum uplift pressure subjected for a duration of one minute. Intermediate values can be obtained in 15 PSF increments.

American Society of Testing Materials (ASTM E1592 Uplift)

– This is the most recognized and industry accepted metal roofing uplift test, which simulates actual field conditions because of the large chamber it uses in the procedure. The test chamber is usually at least five (5) panels wide by a length adequate enough to test multiple purlin spacing (usually 25'). Air pressure is applied to the underside of the metal roof assembly, which is considered to be a "structural" system, meaning the panels span from purlin to purlin without the benefit of a solid metal or wood decking. The air pressure is produced by a high volume industrial fan in approximately six equal intervals until failure. The metal roof assembly must sustain each level of pressure for one-minute. At each interval, deflections are recorded so the test results can be used for design purposes, unlike the UL uplift test results. Since the specimen is tested to failure, this is the standard test required for standing seam roof systems for all U.S. Army Corps of Engineers projects as well as being accepted for a



manufacturer obtaining Florida Product Approval (FBC). It is also required by any building code authority that has adopted the IBC Code as a standard.

American Society of Testing Materials (ASTM E283 Air Infiltration) – This is a static air infiltration test using an airtight test chamber assembly in the form of a large box. The panel test specimens, which constitute one side of the box. Air is forced into or exhausted from the test chamber, producing a pressure differential across the specimen. The amount of air passing through the test panels is measured in cubic feet per minute (CFM).

American Society of Testing Materials (ASTM E331 Water Penetration) – This is a static water penetration test. The test chamber is identical to the Air Infiltration Testing. Differential pressures are applied for fifteen (15) minutes while spraying water uniformly over the exterior surfaces of the panel test specimen. The passing requirement for ASTM E331 is that there be no evidence of any “uncontrollable leakage” during the test.



INDUSTRY TERMINOLOGY AND PARTY ROLES¹ – The metal roofing industry has certain practices and terminology relating to the design, manufacture and installation of its products. The following is provided to clarify the responsibilities of each party involved in a project and what their particular roles should be. Also included are definitions of the documents involved in the construction process and what their significance is to the project.

Manufacturer – The party that designs and fabricates the materials included in the metal roof system in accordance with the order documents. The Manufacturer’s responsibility is as follows:

Party Roles:

1. It is the responsibility of the manufacturer when engineering services are contracted, to design the metal roofing system to meet the design criteria incorporated by the roofing contractor into the order documents.
2. The manufacturer is not responsible for making an independent determination of any local codes or any other requirements not part of the order documents.
3. The manufacturer is responsible for only the structural design of the metal roofing system it supplies to the roofing contractor. The manufacturer or the manufacturer’s engineer is not the design professional or “engineer of record” for the construction project. The manufacturer is not responsible for the design of any components or materials not supplied by it or their interface and connection with the metal roofing system.
4. When specified by the order documents, the manufacturer is responsible for supplying adequate evidence of compliance with the specifications, design criteria, design loads and other specified information necessary for the roofing contractor or design professional to incorporate the metal roofing system into the construction project.

Industry Terminology

¹ Taken in part from the First Edition of the Metal Roofing Systems Design Manual – published by the Metal Building Manufacturers Association (MBMA) – Cleveland, OH

Bid Documents – The documents that define scope and magnitude of work at the planning stage that are prepared by the design professional for the purpose of obtaining project pricing from the contractor. Bid documents include, but are not limited to, the project plans and specifications. In the event of a discrepancy in the bid documents, the design professional's specifications will govern² unless otherwise qualified in the McElroy Metal proposal. In the event of a discrepancy between annotated dimensions and scaled dimensions, the annotated dimensions will govern.

Contract Documents – The documents that define the material and work to be provided by the general contractor (or the roofing contractor, if acting in this capacity) for a construction project. The contract documents consist of the written agreement defining the scope of work, contract price, schedule and other relevant terms of the agreement. Typically, they include the design professional's drawings and specifications.

Construction Project – Includes all material and work necessary for the construction of a finished structure³ for occupancy by the end customer, such as site preparation, foundations, mechanical, electrical work, etc. The metal roof system and the installation of the metal roof system are both elements of the construction project.

Design Professional – An architect, engineer or roof consultant⁴ retained by the end customer, general contractor or roofing contractor to assist in the preparation of design specifications for the construction project including the metal roof system and its installation. Where appropriate, the design professional is to assist in supervising the construction process for compliance with the contract documents. For all construction projects, the responsibilities and rights of the design professional and the end customer are defined in a separate agreement for professional services between the parties.

Design Responsibility – Where the end customer hires a design professional for a construction project, it is the responsibility of the design professional to specify the design criteria for the metal roofing system to be used by the roofing contractor and manufacturer including all applicable design loads. When the end customer does not retain a design professional, it is the responsibility of the end customer to specify the design criteria to be used for the metal roofing system including all applicable design loads. In any event, it is the responsibility of the roofing contractor to interpret all aspects of the end customer's specifications and incorporate the appropriate specifications, design criteria and design loads into the order documents submitted to the manufacturer.

Effect On Existing Buildings – The design professional is responsible to investigate the influence of the metal roofing system on existing buildings or structures. The end customer assures that such buildings and structures are adequate to resist snowdrifts or other conditions as a result of the presence of the retrofit or metal roof system.

End Customer – The party who will be or is the owner of the construction project. The term includes any agent of the end customer including any design professional or general contractor retained by the end customer. In those situations where the roofing contractor also meets the definition of the end

² Except in the case that specifications do not exist and the project plans do not provide adequate information for interpretation, and then McElroy Metal's proposal shall govern.

³ In the case of the retrofitting of an existing building, the finished structure shall include only the metal roofing system and as well, any alterations included in the scope of the McElroy Metal proposal and order documents.

⁴ May include a roof consultant if legally qualified to perform professional design services.

customer, the relationship to the manufacturer remains that of a roofing contractor, not an end customer. For a specific construction project, the end customer may act as the general contractor. If the end customer purchases “materials only” from the roofing contractor, the end customer has the responsibility for the installation of the metal roof system as provided.

The End Customer’s Responsibility is as follows:

General – The end customer is responsible for identifying all applicable building codes, zoning codes or other regulations applicable to the construction project, including the metal roofing system. It is the responsibility of the end customer to prepare complete specifications including the applicable design criteria, codes, standards and regulations, and all the design loads or other requirements, which affect the design or installation of the metal roofing system. The end customer or the design professional should supply the following information to the roofing contractor to ensure a successful project:

- A. The building geometric requirements such as length(s), width(s), height(s), roof shape(s) and slope(s).
- B. The applicable code or standard that describes the application of design load to the metal roofing system.
- C. The applicable design loads including live, snow, wind, seismic, collateral and auxiliary loads required by the manufacturer to enter the order. Design loads must be accurately defined in the order documents.
- D. Building end use (occupancy classification) and topographical information.
- E. Site and construction conditions that affect design criteria such as conditions causing snow drifting, including location of adjacent structures.
- F. Building conditions that could cause an increase in internal pressure, such as open wall conditions or accessories that are not wind rated.
- G. All information necessary to ensure that the metal roofing system can be designed to comply with the specified code or standards and is compatible with other materials used in the construction project.
- H. All serviceability criteria limiting vertical or horizontal deflections.
- I. The owner is responsible for providing clearances and adjustments of material furnished by other trades to accommodate all of the tolerances of the metal roofing system.

General Contractor – The party that has the overall responsibility for providing all materials and work for the construction project (including the metal roof system) as specified by the contract documents.

Installer – The party that installs the metal roof system. The roofing contractor, general contractor, manufacturer, or another party pursuant to an agreement with the roofing contractor, general contractor or end customer may act as the installer.

Order Documents – The documents required by the manufacturer in the course of entering and processing an order by which the roofing contractor orders the metal roof system from the manufacturer. The order documents consist of the purchase order and/or proposal/contract, the manufacturer’s written acceptance, drawings, specifications or other documents required by the manufacturer in the course of entering and processing an order. Unless specifically agreed upon in writing by the manufacturer, specifications and drawings prepared by the roofing contractor, end customer or a design professional are not part of the order documents.

Roofing Contractor – The party that orders and purchases the metal roof system from the manufacturer. The roofing contractor is an independent contractor and is not an agent of the manufacturer. For purposes of this definition, roofing contractor means any buyer of a metal roof system other than the end customer. In those situations where the roofing contractor also meets the definition of the end customer, the relationship to the manufacturer remains that of a roofing contractor, not an end customer. If the roofing contractor acts only as a material supplier, the roofing contractor has no responsibility for installation of the metal roof system. In this event, the roofing contractor is responsible for conveying to the general contractor or end customer the engineering data, plans and other information that is provided by the manufacturer, if applicable.

Supporting Design – The design professional is responsible for the design, materials and workmanship of the supporting structure. Anchorage and load plans prepared by the manufacturer are intended to show location only. It is the responsibility of the design professional to verify that the attachment to the existing substructure can withstand the required design loads. The manufacturer is responsible for providing to the roofing contractor the loads imposed by the metal roofing system on the supporting structure. It is the responsibility of the design professional to ensure that adequate provisions are made for determining if the supporting structure can resist the design loads imposed by the metal roofing system.

MCELROY SERVICE AND PRODUCT DISCLAIMERS - The following are specific to McElroy and its retrofit framing and metal roof systems product offering. These are so noted in this design guide to clarify what McElroy is not responsible for on a retrofit metal roof system order.

1. McElroy shall design the framing and cladding systems based on the dimensions and contract documents supplied by the owner and/or contractor. The retrofit framing and cladding systems as supplied by McElroy Metal will induce point loads on the existing building's structural roof system. Therefore, the existing structure should be investigated and analyzed by a qualified structural engineer before McElroy commences any retrofit system design work. This ensures the newly imposed loads and added weight of the retrofit system will be in compliance with the building's structural integrity and its originally intended use. **MCELROY METAL SHALL NOT BE RESPONSIBLE FOR THE ENGINEERING WORK REQUIRED ON THE EXISTING STRUCTURE IN CONNECTION WITH THE INSTALLATION OF THE FRAMING AND CLADDING SYSTEMS. THE CUSTOMER HEREBY RELEASES MCELROY METAL AND AGREES TO HOLD MCELROY METAL HARMLESS FROM ANY CLAIMS, CAUSES OF ACTION OR LIABILITY FOR DAMAGE TO PROPERTY OR PERSONS ARISING OUT OF OR RELATED TO THE FAILURE OF THE STRUCTURAL INTEGRITY OF THE EXISTING BUILDING, INCLUDING BUT WITHOUT LIMITATION, DAMAGE DUE TO LOAD AND ADDITIONAL WEIGHT OF THE RETROFIT SYSTEM, WIND INDUCED LOADING AND SNOW LOADING.**
2. The addition of a retrofit system will alter the geometry of the original structure. These changes could result in design deficiencies of the existing structure due to the behavior of wind induced loading as well as additional snow loading. This should be considered by the structural engineer engaged by the owner/contractor as mentioned above and prior to commencing any retrofit system design work.
3. Anchors for attaching the new retrofit system to the existing structure are not provided by McElroy Metal unless specified in the contract/purchase documents. However, the maximum uplift and shear loads at the anchorage locations will be included with the McElroy system installation documents for the owner's/contractor use in determining the type and

number of fasteners required to obtain proper anchorage of the retrofit system. It is important to note that a factor of safety and/or any wind load reduction will not be included in the uplift forces provided by McElroy and therefore it is the owner's/contractor responsibility to apply proper factors as permitted or required by any specification or code authorities.

4. It is the customer's responsibility to inform McElroy Metal of any adjacent structures, which are located within the immediate area of the proposed retrofit area. This information is needed by McElroy Metal in the design phase in order to determine potential wind force and snow accumulation conditions, which may be created by such adjacent buildings.

Metal Construction Glossary



The following glossary represents common terminology associated with the metal construction industry, which includes pre-engineered buildings, metal components, metal roof and wall systems and retrofit framing systems.

— A —

ACCESSORY

An extra building product that supplements a basic solid sheeted roof or wall such as louver, ventilation device, curb or roof jack.

ADAPTOR TRIM

Trim designed to close off and trim the junction of a wall panel with masonry.

AGGREGATE

(1) Crushed stone, crushed slag or water worn gravel used for surfacing a built-up roof or (2) any granular mineral material.

AISC

American Institute of Steel Construction

AISI

American Iron and Steel Institute

ANCHOR

A fastener such as screw, bolt, drive pin or expansion sleeve used to secure a structural member to a support system.

ANCHOR BOLTS

Bolts used to anchor structural members to a foundation or other support system. Usually refers to the bolts at the bottom of columns.

ANODIC

In regard to metal and galvanic response, when two metals are connected in an electrolyte, they will form a galvanic cell, with the higher metal in the galvanic series being the anode. The anodic metal, being more "active" oxidizes first, thus protecting the cathodic metal from corrosion.

APPROVAL DRAWINGS

Approval drawings may include framing drawings, elevations and sections through the building as furnished by the manufacturer for approval from the buyer. Approval by the buyer or the authorized approving authority affirms that the manufacturer

has correctly interpreted the overall contract requirements for the system and its accessories, specifically for the products being provided by the manufacturer.

ARCHITECTURAL PANEL

Intricately formed panel with special attention given to its appearance having a primary purpose for the aesthetic enhancement of a building or structure.

ASSEMBLY

In relation to metal systems, a group of mutually dependent and compatible components or sub-assemblies of components.

ASPHALT FELT

An asphalt-saturated and/or an asphalt-coated felt.

ASTM

American Society for Testing and Materials

ATTIC

In relation to retrofitting a building, the area between the existing roof and the new metal roof system.

AUXILIARY LOADS

All specified dynamic live loads other than the basic design loads that the building must safely withstand such as cranes, material handling systems, machinery, elevators, vehicles, and impact loads.

AXIAL FORCE

A force tending to elongate or shorten a structural member.

— B —

BALLAST

Material used in conventional roofing to hold down the roof membrane with its weight. Gravel and lightweight aggregate are common ballast types used with built-up and rubber membranes.

BAR JOIST

(Open web joist) Normally used as beams or horizontal structural members suitable for the support of floors or roof decks, with top and bottom chords of tees, pairs of angles, or round bars and round bar web members.

BARREL VAULT

A semi-circular shaped roof.

BASE ANGLE

An angle secured to the perimeter at the existing roof edges to support wall panels.

BASE FLASHING

The lower flashing component of a two-piece metal flashing detail. Two-piece flashing details are often used either for expedience or to allow differential thermal movement between building elements or accessories. The lower component is the "base" flashing and the upper component is the "counter-flashing".

BASE MEMBER

A structural member that attaches to the existing building roof support structure and accepts the vertical retrofit framing members. May be in the shape of a channel, angle, plate, zee or cee.

BASE PLATE

A steel plate of particular dimensions, normally square, used beneath a base member to distribute the imposed positive loads. Also known as a spreader plate.

BASE TRIM

A formed trim designed to close off the opening at the base of the wall and to flash to other construction components.

BATTEN

Raised rib, in a metal roof, or a separate part or formed portion in a metal roofing panel.

BAY

The space between frame centerlines or primary supporting members, normally in the lengthwise direction of the building or roof.

BEARING PLATE

(See Base Plate)

BILL OF MATERIALS

A list that enumerates, by part number or description, each piece of material or assembly being shipped to a jobsite. Also referred to as a tally, shipper or shipping list.

BIRD SCREEN

Wire mesh used to prevent birds, rodents or other pests from entering the roof cavity area through ventilation devices such as louvers.

BLANKET INSULATION

Fiberglass insulation in roll form, often installed between the metal roof panels and the supporting purlins or directly over the existing roof in retrofit projects.

BLIND RIVET

A small headed pin with expandable shank for joining light gauge metal. Typically used to attach flashing components.

BLOCKING

Term used to describe various materials of varying thickness to support a framing member between it and the existing roof decking.

BOOT

A rooftop device used to flash and seal around circular penetrations caused by sanitary vents, flues and other mechanical or electrical construction. Commonly referred to as a roof jack or dektite.

BOXSILL

The trim at the outermost portion of a soffit and the a vertical wall or other surface.

BRACING

Members used to resist lateral wind forces imposed on the framing system. May be angle or cee shaped members, cable or flat strapping.

BRAKE FORMED

Metal sheet or strip that has been cold-formed into a desired cross section by press brake equipment. Lengths vary but are generally limited to 20'.

BRIDGING

Members used to brace two or more other members such as purlins, girts, etc. May be angle shaped or of steel threaded rod.

BUILDING CODE

Adopted regulations established by a recognized agency or authority describing design loads, procedures and construction details for structures usually applying to a designated political jurisdiction (city, county, state, etc.)

BUILT-UP MEMBER

Structural framing member comprised of two or more steel plates cut to specific dimensions and then joined by hand welding or by continuous process

BUILT-UP ROOFING/BUR

A roof covering made up of alternating layers of tar or asphaltic materials and layers (plies) of organic and synthetic fabric.

BUTTON PUNCH

A process of indenting two or more thicknesses of metal that are pressed against each other to prevent slippage between the metal.

BUTYL TAPE

A common abbreviation for polyisobutylene-isoprene polymer sealant tape used between metal roof panels and flashing joints.

— C —

CAMBER

A predetermined curvature designed into a structural member to offset the anticipated deflection when loads are applied.

CANT

A diagonal strip normally found at the junction of a wall and roof. Used in conventional roofing to allow proper flashing methods.

CANOPY

Any overhanging or projected roof structure with the extreme end usually unsupported.

CANTILEVER

A projecting beam that is supported and restrained at one end only.

CAPILLARY ACTION

An action which causes movement of liquids when in contact with two adjacent surfaces such as panel sidelap.

CATHODIC

With regard to metal and galvanic response, cathodic metals are lower (and more noble) in the galvanic series. (See Anodic)

CAULK

A waterproofing compound or material used to seal joints, seams or voids to make weathertight.

“C” OR CEE

A member cold-formed from steel sheet in the shape of a cee with returning stiffening lips.

CHANNEL

A member cold-formed from steel sheet or hot rolled steel in the shape of a cee without return lips.

CLADDING

Exterior metal coverings, including roof and wall panels and any related flashings.

CLEAT

A sheet metal strip used in concealed fashion to secure panels or flashing that permits thermal movement.

CLIP

A piece of hardware used to fasten two or more members together.

CLOSURE

A seal that is formed to match the configuration of panels or trim used at certain locations to seal off voids.

CLOSURE STRIP

A resilient strip formed to the contour of ribbed panels and used to close openings created by ribbed panels joining other components.

COIL COATING

The application of a finish to a coil of metal sheet using a continuous mechanical coating process.

COLD-FORMED

The process of forming sheet steel into desired shapes through a series of rollers in a rolling mill or by bending at ambient temperature. Common shapes are angles, channels, "C" sections, and "Z" sections.

COLLATERAL LOAD

All specified additional positive acting (dead) loads other than the metal roof framing and cladding (i.e. sprinklers, mechanical and electrical systems, ceilings, etc.).

COLUMN BRACE

A member such as a girt, an angle flange brace or both. Used for lateral bracing of a column.

COMPOSITION

Refers to the existing roof and all of the materials, which make up the system. This would include the substrate, insulation, membrane and ballast

COMPRESSION TEST

Refers to a series of tests at various locations on the existing roof where the membrane and insulation is evaluated for ultimate compression strength and resistance. Normally, a core is cut from the roof and then installed in a testing device. Other methods can be used in the case of retrofitting an existing building as referenced in this manual. The results are recorded and referred to in pounds per square inch.

CONCEALED CLIP

A hold down clip used with a wall or roof panel system to connect the panel to the supporting structure with the fasteners not exposed to the exterior surface

CONDENSATION

The conversion of water vapor or other gas to liquid as the temperature drops (See Dew Point).

CONDUCTOR HEAD

A transition component between a through-wall scupper and downspout used to collect and direct rainwater.

CONTINUOUS PURLIN

Purlin that overlaps at main primary framing assemblies and is based on the use of continuity in design.

CONTINUOUS VENT

A roof ventilator that is normally located at the ridgeline of a building and is made possible by connecting multiple vents or assemblies.

COPING

Term used to describe flashing at the top of a parapet wall. May be of various materials different than the wall material.

CORNER CAP

Pre-manufactured custom trim piece used to trim the corner of roof from the rake trim to the gutter or eave trim.

CORNICE

A decorative finish or flashing that accents the top of a wall, or the juncture of a roof and wall.

CORRUGATED PANEL

A metal or fiberglass panel having alternating sinewave shaped ridges and valleys in parallel.

CRICKET

A relatively small, elevated area of a roof constructed to divert water around a chimney, curb or other projection.

CURB

A raised member used to support roof penetrations such as skylights, hatches, air-handling equipment, etc.

— D —

DEAD LOAD

Non-moving rooftop or suspended loads, such as mechanical equipment or ductwork, fire sprinkler systems, air-conditioning units, and the roof decking itself.

DECK

A structural element, which is fastened to the roof framing system, typically of corrugated metal sheets or plywood. It acts as the substrate for non-structural roof panels.

DEFLECTION

The displacement of a structural member relative to its supports due to applied loads. Can be horizontal or vertical.

DESIGN LOADS

The loads expressly specified in the contract documents, which the metal roofing system is designed to safely resist.

DESIGN PROFESSIONAL

The architect or engineer responsible for the design of a construction project. May be a roof consultant if legally qualified.

DEW POINT

The temperature at which water vapor starts to condense in cooling air at the existing atmospheric pressure and vapor content.

DIAPHRAGM ACTION

The resistance to racking generally offered by the covering system, fasteners, and secondary framing except in most types of standing seam roof systems.

DOWNSPOUT

Rectangular and/or round tube used to channel water from the gutter to a pre-selected location.

DRAFT CURTAIN

A vertical wall assembly used in the roof cavity/attic area to prevent fire and smoke from spreading. Normally constructed of non-combustible materials.

DRIFT LOAD

The positive acting load that is created due to accumulation and drifting of snowfall. Typically located at valleys, roof-to-wall conditions and other areas that allow snow to accumulate above its initial snowfall.

DRIP EDGE

A metal flashing, with an outward projecting lower edge, intended to control the direction of dripping water and to protect underlying building components.

DUTCH GABLE

An architectural appearance where all eaves of the building are at one constant elevation and the sloping roof terminates at the hips to create a small gable condition. This appearance is commonly used for ventilation of the roof cavity.

— E —

EAVE

The line along the sidewall plane formed by the intersection of the roof and wall panels.

EAVE ANGLE

An angular formed member having two legs, which is attached to an eave purlin and receives the roof and wall panels.

EAVE FASCIA

Trim formed that may match the rake fascia that can be used to trim the eave of the roof.

EAVE GUTTER

Pre-formed trim, which receives rainwater and is formed with a face configuration that matches the rake fascia.

EAVE HEIGHT

The vertical dimension from the finished ground level floor elevation to the intersection of the new roof and wall.

EAVE MEMBER

A steel assembly made of one or more members to receive the roof panel. May be designed for fixed (no vertical movement) or floating conditions.

EAVE PLATE

A one-piece structural member attached to the existing roof edge to receive the roof panels.

EAVE PURLIN

A zee shaped member located at the roof eave to receive the Eave Angle.

EAVE TRIM

Trim designed to close off the top of wall panels or building materials such as existing walls and gravel-stop fascia trim in retrofitted roofs.

EDGE STRIP/ZONE

The surface area of a building at the edges of the roof and at the wall intersections, where the wind loads on components and cladding are greater than those at other areas of the building.

EDGE STRIPPING

Application of felt strips cut to narrower widths than the normal felt roll width to cover a joint between flashing and built-up roofing.

EFFECTIVE WIND AREA

The area used to determine the wind coefficient. The effective wind area may be greater than or equal to the tributary area.

ENDLAP

A term that refers to the lapping of two components at their extreme ends such as roofs or wall panels, roof purlins and wall girt, etc.

END ZONE

The surface area of a building along the roof at the endwall and at the corners of the walls.

ENGINEER OF RECORD

The engineer who is responsible for the overall design of the building project. The manufacturer's engineer is not to be considered the project's "Engineer of Record".

ENVELOPE

Term used to describe the entire roof system once completed inclusive of roof and wall panels with trim.

EPDM

Ethylene Propylene Diene Monomer. A synthetic thermoset rubber, which is popular for membrane roofing and flashings, and as a gasketing material for the head of weather sealing screw fasteners or devices.

ERECTION

The on-site assembling of the pre-fabricated components to form a complete structure.

EXPANSION CLEAT

A cleat designed to handle thermal movement of the metal roof panels.

EXPANSION JOINT

A break or space in construction to allow for thermal expansion and contraction of the materials used in the structure. May be transverse or longitudinal.

EXPOSURE

The terrain surrounding a building categorized by the amount of obstruction to wind or snow loading.

— F —

FABRICATION

The manufacturing process performed in a plant to convert raw materials into finished roof system components. The main operations are cold forming, cutting, cleaning and painting.

FASCIA

A decorative trim or panel projecting from the face of a vertical wall.

FELT

A flexible sheet manufactured by the interlocking of fibers through a combination of mechanical work, moisture and heat. Roofing felts may be manufactured principally from wood pulp and vegetable fibers (organic felts), asbestos fibers (asbestos felts), glass fibers (fiberglass felts or plysheet), or polyester fibers.

FIELD

1. The jobsite building site, installation workers or general market area. 2. The uninterrupted principle area of a roof, exclusive of edges, accessory and other flashing areas.

FISHMOUTH

(1) A half-cylindrical or half-conical opening formed by an edge wrinkle; (2) in shingles, a half-conical opening formed at a cut edge.

FIXED CLIP

A standing seam roof system hold down clip, which does not allow the roof panel to move independently of the roof substructure.

FIXED EAVE

1. Conditions where the eave member(s) create a fixed vertical dimension and do not allow vertical latitude. 2. A condition where the roof panels are fixed at the eave in order to promote thermal movement upward.

FLANGE

The projecting edges or legs of a structural member.

FLANGE BRACE

Diagonal angle brace from a wall girt or a roof purlin to the primary frame assembly.

FLASHING

A sheet metal closure which functions primarily to provide weathertightness in a structure and secondarily to enhance appearance.

FLASHING COLLAR

A counterflashing used to cover and/or seal the top of a pipe flashing or other small base flashing at penetrations through the roof.

FLOATING CLIP

(See Sliding Clip.)

FLOATING EAVE

1. A condition where the eave members create a variable dimension to satisfy irregularities at the existing roof edge. 2. A condition where the roof panels are allowed to float as a result of thermal expansion and contraction movement. This condition must fix the roof panel at an upper point.

FOUNDATION

As it relates to retrofit, the roof supports which exist at the time of the new framing system erection.

FRAME

A main primary framing assembly, which receives secondary members such as purlins. May be designed as a continuous section, trussed assembly or other variation.

— G —

G-90

A typical coating weight for galvanized metal sheets. Equates to 0.90 ounces of zinc per square foot, measured on both front and back surfaces. Other coating weights are G-30 and G-60.

GABLE

A triangular portion of the transverse end of a roof directly under the sloping roof and above the eave line.

GABLE SHEETS

Those wall panels installed at the gable.

GAUGE

Thickness of steel or distance between holes. Also written as gage.

GALVALUME®

A proprietary trade name for a coating, used over sheet steel that is composed of an aluminum-zinc alloy for corrosion resistance. The alloys that make up the coating are aluminum (55%) and zinc (45%). Also referred to in the marketplace as Zinc-Aluminum, Zinalume and Aluminum-Zinc.

GALVANIC ACTION

An electrochemical reaction between dissimilar metals in the presence of an electrolyte.

GALVAN

Steel coated with 95% zinc and 5% aluminum.

GALVANIZED

Steel coated with 100% zinc for corrosion resistance.

GIRDER

A main/primary horizontal or near horizontal structural member that supports vertical loads.

GIRT

A secondary horizontal structural member attached to the vertical planes to receive the wall panels. May be hat, zee or other shapes.

GRADE

The term used when referring to the ground elevation around a building.

GRAVEL STOP

A trim piece for the purpose of retaining the roof aggregate or ballast on the roof.

GRID

The term referred to in the layout of the retrofit framing in relation to the existing building's structural support system.

GROOVES

(See Pencil Ribs.)

GROUND SNOW LOAD

The probable weight of snow on the ground for specified recurrence interval exclusive of drifts or sliding snow. Defined by building codes or local code bodies.

GROUT

A mixture of various compounds used to fill cracks and cavities. Often used under base plates or leveling plates to obtain uniform bearing surfaces.

GUSSET PLATE

A steel plate used to distribute loads.

GUTTER

A channel member installed at the eave of the roof for the purpose of carrying water from the roof to the drains or downspouts.

GUTTER END CLOSURE

Metal insert provided with sealant and fasteners to close the end of the eave gutter.

— H —

HARDWARE

Miscellaneous roofing parts used to install the roof panels and flashing such as clips, fasteners, joggles, cleats, etc.

HAT SECTION

A framing member used for various purposes that is hat shaped and press-broke or roll-formed. Typically made of 22, 20, 18 or 16-gauge material.

HEADER

A horizontal framing member over an opening used to support the vertical and horizontal loads.

HEADER FLASH OR TRIM

Trim piece used to hide the header framing.

HEM

The edge created by folding metal back onto itself. Can be open as in an open-hem or completely compressed as in a closed-hem.

HIP ROOF

A roof that rises by inclined planes from all sides of the building at each outside corner.

HOT ROLLED SHAPES

Steel sections (angles, channels, I-Beams, etc.), which are formed by rolling mills while the steel is in a semi-molten state.

HYDROKINETIC

Metal panel systems that are designed to “shed water” are referred to as hydrokinetic. Hydrokinetic roof details are typically devoid of sealant and rely on water to freely shed over joints. These details are not be used on roof slopes less than 3:12.

HYDROSTATIC

Roof membrane systems including metal roofing that are designed to withstand being submersed in water for periods of time are called hydrostatic systems. Hydrostatic roof details rely on sealant to keep water from infiltrating the joints and seams. These details can be used at almost any roof slope at a minimum of ¼ inch per 12 inches (1/4:12).

— I —

ICE DAM

A buildup of ice that forms a dam on the roof covering, usually along the eave of the building.

INSET GIRT

Girts that are installed with their outside face flush with their support structural member.

INSIDE CORNER TRIM

Trim designed to flash the inside corners of walls.

INSULATION

Any material used in building construction to reduce heat transfer.

INTERMEDIATE COLUMN

Also known as soldier column, a structural member located between two other main structural members normally used to support a roof structural member.

INTERNAL PRESSURE

Pressure inside a building or roof cavity caused by wind entering the building or from air-producing equipment.

— J —

JAMB

Vertical members that frame openings in walls.

JAMB TRIM

A trim used to conceal the opening's jamb sub-framing.

JOIST

Secondary structural member acting as a beam and supported by primary structural members or walls. Can be made of open or solid-web steel, wood, concrete and other various structural materials.

— K —

KNEE (OR HAUNCH)

The connecting area of a column and a rafter or structural frame assembly.

KNEE CAP

A metal cover trim that fits over a panel rib or seam area after it has been cut and bent at a fascia break detail. Found at knuckle eaves or roof-to-wall turn down transition and commonly referred to as rib cover.

KNUCKLE EAVE

An architectural appearance where the sloped roof transitions to a vertical plane at the eave line without the use of trim or other horizontal flashing. Rib covers are used to cover the rib transition openings.

— L —

LAP JOINT

A joint where one roof panel or flashing segment overlaps another.

LEAN-TO

A structure, such as a shed, having only one slope or pitch and depending upon another structure for partial support.

LEED

"Leadership in Energy and Environmental Design" consists of a suite of rating systems for the design, construction and operation of high performance green buildings, homes and neighborhoods.

LINER PANEL

Sheeting or covering on inside of building.

LIVE LOAD

Loads on floors and roofs that are produced 1. During maintenance by workers, equipment, and materials. 2. During the life of the structure by

movable objects but not including wind, snow, seismic or dead loads.

LONGITUDINAL

A term, which refers to the direction that is perpendicular to the slope of the roof panels.

LOUVER

An opening provided with fixed or movable, slanted fins to allow flow of air.

— M —

MAIN OR PRIMARY FRAMING

Structural assemblies spaced some distance apart to support secondary framing members such as joists, purlins and girts.

MANSARD

A steep sloped (almost vertical) real or mock roof element on the perimeter of a building. Originated by the French architect, François Mansart.

MANUFACTURER'S ENGINEER

An engineer employed by a manufacturer who is responsible and in charge of the structural design of a metal roofing system, which is fabricated by the manufacturer. The manufacturer's engineer is not considered to be the Engineer of Record.

MASTIC

Caulking or sealant furnished in rolls, normally used for sealing roof panel laps with other roof panels or flashing.

MATERIAL SAFETY DATA SHEETS (MSDS)

A written description of the chemical composition of a product and other information such as safe handling and emergency procedures.

MEAN ROOF HEIGHT

The average height of a roof measured at the mid-point between a roof's lowest and highest elevations above grade.

MODEL CODES

Codes established to provide uniformity in regulations pertaining to building construction. Examples: International Building Code (IBC) published by the International Code Council, Uniform Building Code (UBC) published by the International Council of Building Officials, National Building Code (BOCA) by the Building Officials and Code Administrators International (BOCA)

and Standard Building Code (SBC) by Southern Building Code Council.

MODEL ENERGY CODE

In 1989, the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) adopted a standard practice code to influence compliance with minimum levels of energy efficiency in non-residential buildings. Titled ASHRAE 90.1, has been adopted by most States and Federal Agencies and sets forth design requirements for the efficient use of energy in new buildings intended for human occupancy except single and multi-family residential buildings of three or fewer stories above grade.

MODULE STRIP

A tool utilized to maintain the roof panel module (rib spacing) during installation.

MONOSLOPE

A roof area that slopes only one direction from one side of the building to the other side.

— N —

NON-STRUCTURAL PANEL

Panels that are not designed to carry positive snow or live loads and are not normally capable of spanning between structural supports without benefit of solid substrate materials such as wood, metal or concrete decks.

NOTCH

1. Factory prepared condition on roof panels to allow the pan of the panel to bend under and form a finished edge. 2. Miter cut at top of ribbed wall sheets to allow them to mate with a ribbed roof sheet.

— O —

OIL CANNING

An inherent characteristic of metal panels manufactured with broad non-interrupted flat areas caused by the expansion and contraction of the metal during outside temperature changes. All panels manufactured from light gauge metal may exhibit oil canning in the broad flat portion or pan, of the panel. It is not considered to be a defect nor does it affect the structural integrity of the metal panels. Oil canning is not cause for rejection.

ORDER DOCUMENTS

The documents normally required by the manufacturer in the ordinary course of entering and processing an order. These can include specifications, drawings, sketches, estimates, contracts and purchase orders.

OSB

Oriented Strand Board (OSB) is composed of rectangular-shaped wood strands that are cross-oriented, compressed, and glued together with waterproof adhesives. OSB is often used in both residential and non-residential construction, such as floors, walls and roof sheathing. *Note:* Particle Board is not considered OSB, and should not be used in roofing applications.

OUTSET GIRT

Secondary framing member that pass by the outside faces of the wall framing.

— P —

PAN

The lower most part of a roof panel, which is between the ribs, which is typically the bearing surface area.

PANEL CREEP

The tendency of the transverse dimension of a roof panel to gain in modularity due to spring-out or storage-distortion.

PANEL RIB CAP

Ridge cap sheet die-formed from a short piece of ribbed panel.

PARALLEL

The term used to describe the framing system application where the new roof slope is parallel to the span of the existing secondary structural roof supports (joist, purlins, etc).

PARAPET

The portion of the wall that extends above the roof.

PEAK

The upper-most point of a gabled roof.

PEAK CAP/BOX

Pre-fabricated trim piece that conceals the rake trim fascia connection at the peak of the gable.

PENCIL RIBS

A groove or grooves roll formed longitudinally into a panel profile to either minimize oil canning or to introduce a pattern in the profile to meet aesthetic or specified requirements.

PERFORATED

In relation to metal construction, refers to panels or sheet metal strips that have been mechanically and uniformly punched with holes in various manners to provide air circulation.

PERPENDICULAR

The term used to describe the framing system application where the new roof slope is perpendicular to the span of the existing secondary structural roof supports (joist, purlins, etc).

PHASE CHANGE MATERIAL (PCM)

A phase-change material (PCM) is a substance with a high heat of fusion which, melting and solidifying at a certain temperature, is capable of storing and releasing large amounts of energy. Heat is absorbed or released when the material changes from solid to liquid and vice versa; thus, PCMs are classified as latent heat storage (LHS) units. This material has made its way into the construction industry and is currently being integrated with metal roof assemblies.

PITCH

(See Roof Pitch or Slope.)

PITCHBREAK

Flashing used at the high-end juncture of the roof panels and a vertical surface.

PITTSBURGH LOCK SEAM

A method of interlocking two pieces of metal. Contrary to popular belief that a Pittsburgh seam folds the metal 360°, only one piece is 360° while the other is 180°.

PONDING

(1) The gathering of water at low or irregular areas on a flat roof. (2) Progressive accumulation of water from deflection due to rain loads.

POP RIVET

A small headed pin with expandable shank for joining light gauge metal. Typically used to attach flashing, gutter, etc.

PRIMARY FRAMING

The structural framing which consist of major load carrying members of a structure, such as beams, girders, columns, etc., which support secondary framing members

PRIMER PAINT

This is the initial coat of paint applied in the plant to the structural framing.

PULLOUT

The term used to describe the ultimate strength of a fastener or anchor when subjected to pulling forces.

PULLOVER

The term used to describe the ultimate strength of a fastener when subjected to pulling forces from a prying action

PURLIN

A secondary structural member located in the roof that directly supports the roof sheeting and is in turn supported by the primary structural framing.

— R —

RAGGLE

A groove or slot often cut in a masonry wall or other vertical surface adjoining a roof, for inserting an inset-flashing component such as a reglet.

RAKE

The roofline along the roof panel located at the roof's edge at a gable wall.

RAKE FASCIA

A flashing designed to close the opening between the roof and endwall panels.

RAKE TRIM

(See Rake Fascia)

REGLET

A sheet metal trim piece that acts as a receiver for the attachment of counterflashing, when mounted to a wall constructed of conventional materials.

RETROFIT

A term used to describe the reconstruction and improvement of a building. In relation to this design guide it represents the improvement of an existing building roof by the addition of sloping built-up light-gauge framework supporting a new metal roof system.

RIB

The longitudinal raised profile of a panel that provides much of the panel's bending strength.

RIBBED PANEL

A panel that has ribs running its length with sloping sides forming a trapezoidal shaped void at end and the panel juncture with other panels at its sides.

RIDGE CAP

A transition of the roofing materials along the ridge of a roof. Also called ridge roll or ridge flashing.

RIDGE PURLIN

First purlin downhill from the peak or ridge.

RIDGE/RIDGELINE

The peak of the building or the uppermost portion of a gabled roof.

RIGID INSULATION

A rigid foam board that resists deformation and maintains shape when a force or load is applied due to compressive strength.

ROLL FORMED

Specific width metal sheet coil or strip that has been cold-formed into a desired cross section by being inserted and driven through a rolling mill, which has a series of roller dies that progressively form the panel's final cross-section as the material passes through each die.

ROOF EXTENSION

Cantilevered continuation of roof at the gabled end of the roof.

ROOFOVER

Term used to describe the retrofitting of an existing slope roof with or without sub-framing members.

ROOF OVERHANG

A roof extension beyond the endwall or sidewall of a building.

ROOF PITCH OR SLOPE

The tangent of the angle that a roof surface makes with the horizontal, usually expressed in units of vertical rise to 12 units of horizontal run (e.g., 3:12 = 3" rise per every 12 inches horizontal).

ROOF SEAMER

A machine that crimps or folds adjacent edges of standing seam metal roof panels together, to form a weathertight seam.

ROPE SEAL

Refer to Butyl Tape.

— S —

SANDWICH PANEL

Term used to describe a roof or wall panel assembly made of normally an outer and inner sheet with an insulated center core. Also known as Insulated Panel.

SCUPPER

An opening in a gutter or parapet wall to discharge rainwater.

SEALANT

Any material that is used to close up cracks or joints to protect against water and air infiltration.

SEAMING MACHINE

A machine that crimps or folds adjacent edges of standing seam metal roof panels together to form a weathertight seam. Typically, the completed seam is folded to 90° or 180°.

SECONDARY FRAMING

The framing which consist of minor load carrying members of a structure, such as joist, purlins, girts, struts, etc., which are supported by primary framing members

SELF-DRILLING SCREW

A fastener that combines the functions of drilling and tapping its own hole. Used for attachment of framing members as well as panels to framing or other panels and flashing.

SELF-TAPPING SCREW

A fastener, which taps its own threads in a predrilled hole.

SHIM

An object of minimal thickness, of various materials, used to level or square framing. Usually not provided by McElroy.

SIDELAP OR SIDE JOINT

The side junction of two panels which upon installation forms a weathertight seal.

SILL

The bottom horizontal portion of an opening such as a window or door.

SINGLE SLOPE (aka "SHED" ROOF)

(See Monoslope)

SKYLIGHT

A roof accessory to admit light, normally mounted on a curbed framed opening or custom fitted and manufactured to a metal panel.

SLIDING CLIP

A standing seam roof system hold down clip, which allows the roof panel to move independently of the roof substructure.

SMACNA

Sheet Metal and Air Conditioning Contractors National Association

SNAP-ON CAP

A cap that snaps over the vertical legs of some single standing or batten seam metal roof systems.

SNOW LOAD

A positive acting load imposed on the roofs of buildings or other structures due to snowfall.

SOFFIT

The underside covering of an overhang.

SOFFIT TRIM

Trim used at the junction of the soffit and wall or other vertical surface.

SOFFIT VENT

A pre-manufactured or custom-built air inlet located in the soffit of a roof assembly.

SPAN

The distance between supports of any two framing members.

SPECIFICATIONS

A written document that outlines the expectations of the building project's owner and/or design professional insofar as specific information pertaining to the performance and provision of products, components, materials, labor and other work to be performed during the construction of a building or structure.

SPLICE

Connections at two like parts in a structural member or a trim component.

SPREADER PLATE (aka "BEARING PLATE")

See "Base Plate".

SSR

Refers to Standing Seam Roof, which normally relates to trapezoidal profile roofing.

SSMRS

Refers to Standing Seam Metal Roof System

SSSMRS

Refers to Structural Standing Seam Metal Roof System

STANDING SEAM

Side joints of roof panels that are arranged in a vertical position above the drainage plane of the panels or flashings.

STANDING SEAM ROOF SYSTEM

A metal roof system comprised of standing seam panels, which are generally secured to the roof substructure by means of concealed hold down clips; together with related flashings and other weatherproofing materials and accessories.

STIFFENER LIP

A short extension of material that is at an angle to the flange of cold-formed structural members, which adds strength to the member.

STITCH SCREW

A fastener used to connect panels at their sidelap.

STRAPPING

Material used to satisfy bracing design requirements. Normally, specific width steel of 26, 24 or 22 gauge thickness.

STRIATIONS (SHADOWLINE)

Lines that are parallel to the panel ribs, which have a low silhouette pattern that is formed into the panel profile having a light-diffusing quality, which assists in masking over oil canning in the broad flat pan of the panel. From a distance, the difference between striated and flat panels is not readily detectable.

STRUCTURAL PANEL

A panel that is capable of spanning between structural supports otherwise known as open

framing. The panel can resist snow, dead, live, concentrated and wind loads without the benefit of any underlying solid substrate material.

STRUCTURAL STEEL MEMBER

Load carrying members, may be hot rolled sections, cold-formed shapes or built-up shapes.

STRUT

A brace fitted into a framework to resist forces in the direction of its length.

SUB-PURLIN

A structural member that is installed directly above and parallel to underlying secondary structural members, which provide support to roof sheathing or cladding such as metal roofing

SUBSTRATE

As it relates to retrofit, a term used to describe the existing roof composition. This would include the decking and insulation. As it relates to metal roofing, it represents the material immediately beneath the new metal roof panel that is being attached too.

SWEDGE

A factory forming process that reshapes the end of the uphill (upper) roof panel to fit into the downhill (lower) roof panel when panel end lap conditions are required.

— T —

THERMAL BLOCK

Extruded (polystyrene) spacer block installed between the purlin and the metal roof panel to compensate for insulation value loss due to insulation compression over the purlin.

THERMAL MOVEMENT

The expansion and contraction that occurs in materials due to temperature changes.

THERMAL RESISTANCE (R-Value)

Under steady conditions, the mean temperature difference between two defined surfaces of material or construction that induces unit heat flow through unit area. Thermal resistance and thermal conductance are reciprocals.

THERMAL TRANSMITTANCE (U-Factor)

The time rate of heat flow per unit area under steady conditions from the fluid on the warm side of a barrier to the fluid on the cold side, per unit

temperature difference between the two fluids. First evaluating the R-Value and then computing its reciprocal equate it.

THRU-FASTENED ROOF SYSTEM

A roof system is where the roof panels are attached directly to the roof substructure with fasteners, which penetrate through the panel itself and into the substructure and the fastener heads are exposed.

TRANSVERSE

A term to describe the direction of a roof or building system. Most commonly relates to the direction parallel to the roof slope or eave to eave.

TRAPEZOIDAL

A term used to describe some roof panel profiles where the ribs have a semi-trapezoidal shape.

TRIBUTARY AREA

A term that describes the amount of load being subjected to a structural member or assembly. For example: a purlin's tributary area is the distance which it is spanning from end to end and one half the distance from itself to adjacent purlins on each side of itself.

TRIM

The light-gauge sheet metal used in the finishing of a building or roof system, especially around openings and at intersections of surfaces. Often referred to as flashing.

TRUSS

A structural assembly made up of three or more members, with each member designed to carry a tension or compression force. The entire assembly in turn acts as a beam.

— U —

UNDERLAYMENT

A secondary waterproofing sheet material installed between the substrate and the roof panels, usually used in hydrokinetic roof construction. Some types may be self-adhering.

UNSUPPORTED

The condition that exists when a structural member such as a column does not have any lateral support. A column is unsupported when there are no braces attached to its compression flanges.

UPLIFT

Negative pressure represented in pounds per square foot (PSF) caused by wind passing over a roof creating suction that in fact, tries to lift the roof panels upward from their substructure and attachments.

USGBC

The U.S. Green Building Council is a non-profit trade organization that promotes sustainability in how buildings are designed, built, and operated. It is best known for the development of the Leadership in Energy and Environmental Design (LEED) green building rating systems and Greenbuild, a green building conference and expo that promotes the green building industry, including environmentally responsible materials, sustainable architecture techniques and public policy.

— V —

VALLEY

An architectural detail created where two roof panels intersect at the downhill slope, usually having ridgelines at right angles to each other located at the upper most end of the valley.

VALLEY GUTTER

A sheet metal flashing created to collect rainwater from both of its sides as a result of two roofs sloping towards each other. Found in multi-gabled buildings having parallel ridgelines.

VAPOR BARRIER

Material used to retard the flow of vapor or moisture to prevent condensation from forming on a surface.

VENT

An opening designed to exhaust air, heat, water vapor or other gas from a building or a building component to the atmosphere.

VERTICAL GIRT

Girt attached to masonry wall vertically to receive horizontal girts.

— W —

WAINSCOT OR WAINSCOTE

Exterior wall sheeting that begins at the base level (floor, etc.) and terminates before reaching the top of the wall where it joins with a different material.

WAINSCOT TRIM

Trim piece located at the top of wainscot sheeting, which flashes over the sheeting and under the upper sheeting or material.

WALL COVERING

The exterior wall cladding consisting of panels and their attachments, trim fascia and weathertight sealant.

WATERPROOF MEMBRANE

A self-adhered underlayment that offers leak protection in trouble prone roof detail areas and performs as a vapor barrier. An example is Vycor® Ice & Water Shield® manufactured by W.R. Grace & Co. which adheres to the roof deck, at laps, and seals around deck fasteners.

WEB

That portion of a structural member between its flanges.

WIND LOAD

The load caused by wind from any horizontal direction.

WIND UPLIFT

The differential negative pressure caused by the deflection of wind at roof edges, roof peaks or obstructions, causing a drop in air pressure immediately above the roof surface. Wind uplift may also occur because of the introduction of wind pressure underneath the membrane and roof edges, where it can cause the membrane to balloon and pull away from the deck.

— Y —

YIELD STRESS

The stress value at which the strain ceases to be directly proportional to the stress.

— Z —

“Z” OR ZEE

A member cold-formed from steel sheet in the shape of a zee.

GENERAL – This chapter provides the user with reference information needed to properly begin the evaluation process of the existing roof system as well as other pertinent topics that are related to retrofitting buildings. Included are initial design considerations and installation precautions as well as an outline for what is needed during a jobsite roof inspection. This is followed by information pertaining to the analysis of the existing roof support system for structural integrity and also includes tables of common building material weights and thermal resistance values. In addition, we have provided the correct methods for increasing thermal performance with insulation, controlling condensation and ventilating the new attic space created by the retrofit system. At the end of the section, you will find detailed descriptions on conventional re-roof methods along with an application table and a cost comparison on these methods versus retrofit metal roof systems.



DESIGN CONSIDERATIONS – The following is provided for design professionals and contractors for their consideration during the development of a project feasibility and budget, working towards the contract documents. Understand that these are common to retrofit system construction and that each project will vary insofar as specific requirements. Therefore, use them as each becomes applicable to your project.

1. All retrofit framing systems utilize the existing roof structure to transfer loads to the existing bracing system. Because of this, the existing building must provide a serviceable diaphragm for bracing requirements.
2. Removal of loose gravel or ballast, if applicable, on the existing building roof should be considered to reduce dead weight and to compensate for the weight of the newly added retrofit framing and metal roofing. When removing, investigate environmental regulations and restrictions that may affect the disposal thereof. In addition, if the existing roof is a ballasted type, determine if removal prior to the new retrofit system being completed will create potential problems caused by shrinkage in the existing roof membrane.
3. The space between the existing and new roofs, if applicable, should be ventilated to assist in condensation control and dissipation of trapped moisture in the existing roof membrane. Refer to Page 3-9 for more information on ventilation and condensation.
4. A retrofit project is considered by many building code officials to be classified as renovation. Because of this, it is recommended that an investigation be performed for compliance to any adopted Model Energy Codes (ASHRAE 90.1) or newer, life safety or fire prevention requirements (NFPA-101, etc.) and the local governing building code (IBC, etc.).
5. The retrofit system will be anchored to the existing roof's structural system. Anchors should be designed using resultant values obtained from actual rooftop conducted pullout tests with applied safety factors. Also while performing these tests, the compression resistance of the existing membrane and insulation should be recorded or core tested to evaluate the positive load affect at points of anchorage attachment. For more information, refer to Chapter 5 under Anchorage of Framing Systems.



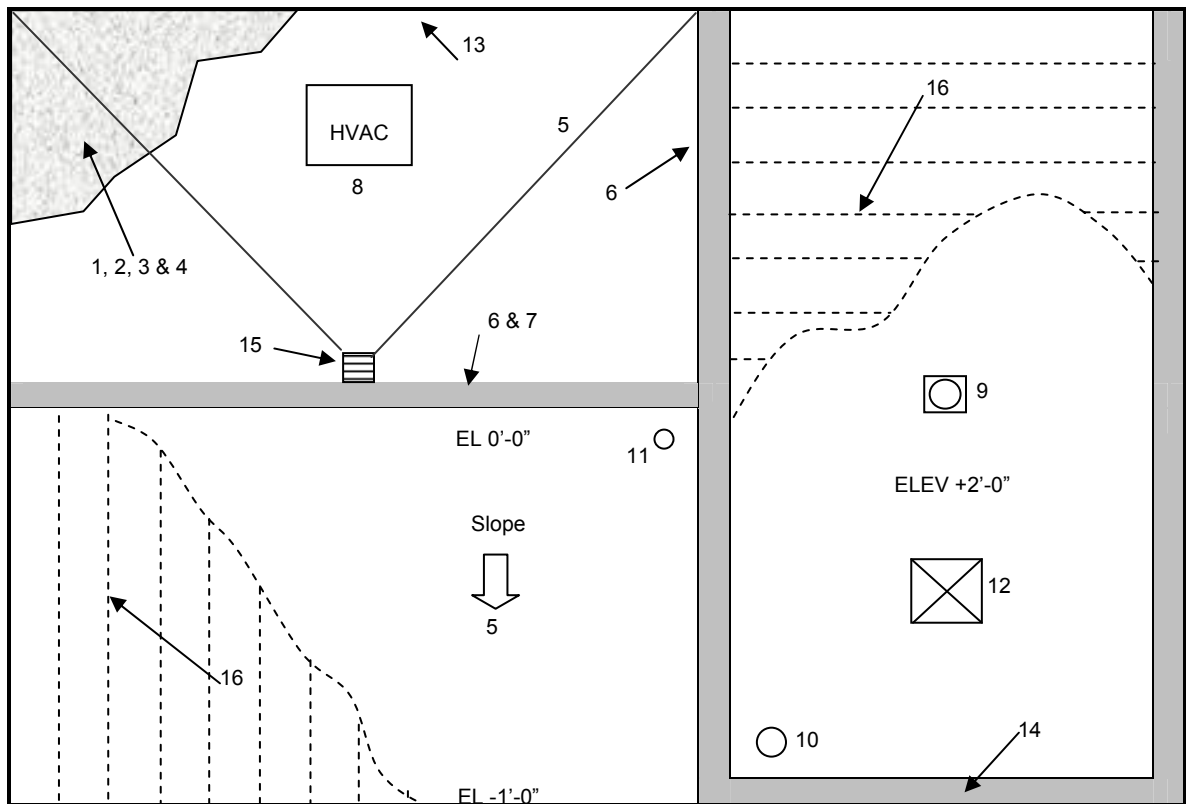
INSTALLATION PRECAUTIONS – The following is provided for the retrofit contractor as recommended procedures and precautions to be considered during the installation of the retrofit framing system.

1. The existing roof assembly, including the deck, insulation and membrane, must be checked for trapped moisture. If moisture is present, the existing roof should be removed entirely or at the affected areas. All anchors that penetrate existing roof assemblies may be subjected to premature corrosion and therefore, at minimum, should have a corrosion resistant coating.
2. When a retrofit system is anchored to the existing building, a compatible sealant should be installed at any and all penetrations through the existing roof assembly. This will help prevent rainwater or other moisture infiltration, which may occur during the erection and installation of the retrofit system, from passing into the building interior space.
3. When continuous base members are included in the McElroy erection drawings, the contractor should install a shim beneath each anchor location. These will aide in preventing water damming between the continuous members in the event the project is subjected to rainfall prior to being fully enclosed with the metal roof system. The composition (metal, wood, etc.) of the shim is determined by the contractor, but should be of a non-deteriorating and high compressive strength material. Thickness should be sufficient to allow the base member to span over the existing roof where normally $\frac{3}{8}$ " to $\frac{3}{4}$ " will satisfy the condition.
4. In order to satisfy anchorage requirements and to basically ensure that the retrofit framing and metal roof system stays on the existing roof, the design professional or contractor will need to conduct pullout testing. These tests are conducted by simply selecting appropriate anchors that are designed for securement into the existing roof's structural system type (steel, wood or concrete) and physically pulling them from the existing member until they fail and come out. This is done using a calibrated pulling device. Refer to Chapter 5 for more information.
5. At each retrofit framing system base member attachment location, the contractor needs to evaluate the compression resistance of the existing roof's substrate and membrane. It is common that the new imposed design load from the retrofit framing and metal roof system will exceed the compressive strength of the existing roof assembly. Refer to Chapter 5 for more information.
6. Prior to installing anchors, the installer should investigate the "under structure" beneath the existing roof decking to explore the presence of electrical, mechanical and plumbing system



components. This knowledge is imperative in preventing anchors from accidentally coming in contact with these components and causing harm to the building or the installer's personnel.

EXISTING BUILDING INSPECTION – All existing buildings, subject to being retrofitted, should be inspected prior to evaluating proposed systems and finalizing the new roof geometry. Existing conditions, rooftop obstructions and other construction may very well have an impact on design considerations insofar as appearance such as eave elevations, low or high pitches and hip or gabled ends. In the roof plan illustration shown below, the user will find numeric notations that refer to specific items to be explored and considered in the early stages of design. These notations are described respectively below the illustration.

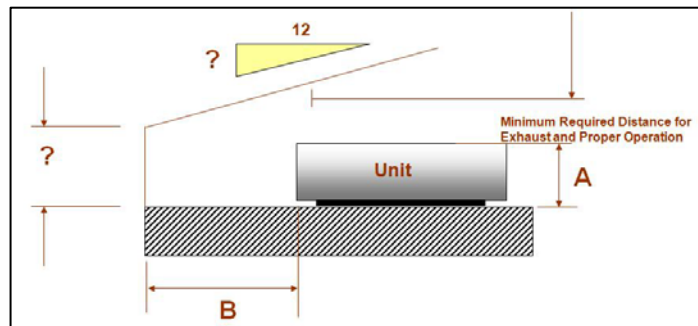


1. Inspect the existing roof membrane and insulation assembly to determine if any areas have become waterlogged or deteriorated. These areas are of concern because of compression resistance and their ability to accept loads from the new retrofit system. Refer to item no. 5 on page 2 of this section for further information.
2. Identify existing membrane type and determine what compatible sealants are required at framing system anchorage penetrations.
3. For existing BUR roofs with aggregate (gravel), determine if this material should be removed and disposed of. Note however, the removing of this material may expose the existing membrane to damage during retrofit system construction. Also note the aggregate's current adhesion level and evaluate costs associated with removal (spudding, slitting, stripping and

disposal) if you need to reduce the dead weight and compensate for the weight of the new materials to be installed with the retrofit system.

4. For single-ply roofs with ballast, consider the effects to the membrane when the ballast is removed. In many cases, excessive shrinkage has occurred, resulting in damage to perimeter conditions and flashing. This too applies to compensating for the weight of the new materials to be installed.
5. Evaluate inconsistencies and slope in the existing roof plane. These can sometimes control the geometry of the new roof, especially framing assemblies at eave lines.
6. Identify roof steps and internal parapets. These may create requirements for thermal expansion assemblies in the new “retrofit” framing and roofing systems.
7. Make note of firewalls located within the limits of the building perimeter. Firewalls can create requirements of extending the walls through the new roof and other costly considerations.

8. Locate existing rooftop mechanical equipment and their proximity to the existing roof edges. These will sometimes control the geometry of the new roof as well as determine the new eave height and its elevation above the existing roof. In addition, it will be necessary to evaluate whether to raise the equipment to the new roof plane or to construct the new roof over the units. Note that in some cases, mechanical wells can be designed into the new roof geometry to allow for the equipment to be located in a common area or louvered dormers can be added to the new roof, directly over the existing units, allowing adequate operating air-space around them and to provide ventilation if required. Regardless, it is recommended that a mechanical engineer or contractor be consulted to assist in this evaluation.

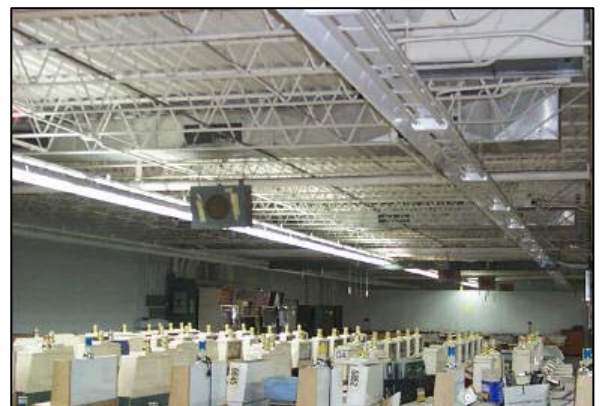


9. Locate existing exhaust and fresh air intake fan hoods and other smaller equipment that will remain operational and determine those that must be extended to the new roof plane. Also, consider any air movement devices that can be coupled together to minimize new roof penetrations and further evaluate routing them to a vertical wall surface, if available, to eliminate roof penetrations completely.
10. Identify existing furnace flues and evaluate extending them through the new roof. Examine for temperature requirements to select appropriate new roof jacks/boots or curbs.
11. Inspect existing sanitary vents and determine if they can be combined into a manifold to minimize penetrations through the new roof. Also evaluate if they can be routed to penetrate through an available vertical wall surface, if applicable.
12. Evaluate existing skylights and determine if they will be removed or reused. When reusing them, determine feasibility of constructing wells from the new roof to the existing opening that allows for light to be transmitted.

13. Inspect the condition of existing roof edges, fascias and gravel stops. Their condition could control new flashing conditions insofar as extending new flashing to hide old and unsightly materials. Record dimensions so new flashing can be fabricated to hide them and provide to McElroy upon requesting a proposal. It will also be important to note if there is any slope along the existing roof edge, that will require a floating eave assembly (refer to page 4-3).
14. Examine existing parapet wall construction and determine if they are structural or non-load bearing. With non-load bearing parapets, the perimeter retrofit framing will require cantilever members to ensure the design loads are transferred to the existing framing system and not on to the parapet. With structural parapets, evaluate parapet caps to determine if they are capable of receiving retrofit framing anchoring devices and loading. Record their dimensions so new flashing can be fabricated to hide them and provide the dimensions to McElroy upon requesting an estimate and proposal.
15. Locate existing roof drains and evaluate their use and what safety measures should be utilized during the construction of the new “retrofit” roofing system to ensure rainwater drainage is not obstructed and permitted to discharge properly without incident.
16. Identify the existing structural roof framing from beneath the roof. As you will see in chapters 4 and 5, these elements control virtually everything in the design of the new retrofit framing system. Record and photograph the type of secondary spanning members (bar joist, wood joist, etc), their span direction, and exact spacing will be required by McElroy to commence engineering and design work.

In summary, on the roof inspection, take photographs and record perimeter dimensions, roof height changes and any other information pertinent to the project. Provide McElroy with as much information as possible. This will only ensure that the proposal you receive will include all of the materials needed to satisfy your contractual obligations. Please take note of any qualifications on the McElroy proposal for items that are being excluded as well as any assumptions that may have been made during the project’s estimating, which will require further investigation or confirmation.

STRUCTURAL ANALYSIS OF EXISTING ROOF SYSTEMS – Understanding the marriage between the existing roof’s structural system and the new retrofit framing system requires fundamental understanding of how these structural grids work in harmony in order to not overload the existing roof. This will also help you understand that the existing roof system must be structurally adequate in order to receive the newly imposed loads created by the new retrofit system.



Due to probable building code design load changes since the building was first constructed and the changes in the new roof geometry, the secondary or primary assemblies may very well be subjected to excessive loading. These geometry changes include additional snow loads created by drifting loads at valleys and other conditions. All of these changes and adding the weight of the new retrofit system is the very reason why existing roof systems and their structural components must be analyzed to confirm their capability to support the total of the new and existing loads.

Virtually all roofs utilize a structural grid, whether constructed of steel, wood or concrete. This grid combines primary and secondary load-bearing assemblies that receive positive acting (downward) loads and ultimately transfers them to the building foundation through load-bearing walls and/or structural columns. For example: A pre-engineered metal building has rigid frames (primary) that are normally spaced from 20 to 30 feet on center, making up is referred to as a “bay”. The rigid frames receive the design roof loads (snow, dead and collateral) from the roof panel and purlins (secondary). From these, the loads are transferred to the columns into the building foundation. Chapter 5 discusses this in much more detail.

The primary assembly can be load-bearing walls including those at the exterior perimeter of the building, steel/wood girders and trusses, or steel/concrete and wood beams. The secondary assemblies can be open web steel bar joists, steel or wood purlins and concrete beams including tees used in precast roof systems. Most secondary assemblies distribute uniform loads to their outer ends where its total tributary load is distributed ($\frac{1}{2}$ of the total load¹ at each end) to the primary assembly.

To begin the analysis, it is first necessary to determine the required design live, wind and snow loads. Essentially, the design live loads specified in building codes going back to the early-1900's have not changed to those of today. Therefore, use the design live load as specified in the current governing building code. Wind and Snow loads on the other hand have changed and since the retrofit system will be designed in accordance with the current building code, use the loading as specified by the code. For dead loads, the weight of the existing roof assembly must be determined along with the estimated weight of the new retrofit system, which can be provided by McElroy.

In order to determine the specific dead load of the existing roof, it will be necessary for the engineer to have information available on the existing components of the roof system. More importantly, this information should be concurrent with the time frame that the building was constructed. To do this, it will be necessary to specifically identify what the existing roof's structural components are physically, and then obtain their respective load-carrying capacities. The tables on the following pages provide information that can be used to calculate the weight of the existing roof assembly including ceilings, if applicable and to identify members. To obtain their load carrying capabilities, you can refer to the referenced manuals as footnoted.

Common Construction Material Weights and R-Values – Below is for determining the total weight of the existing roof assembly including dead load for various interior building finishes (ceiling, insulation, etc.). In addition, R-values are provided to calculate the overall thermal resistance of the existing building's roof assembly. At the bottom of the page, we have provided a table for which you can calculate both of these for any project that you are working on.

¹ Total Load is the combination of Live plus loads produced by construction materials (dead load) and snow.

**Approximate Weights of
Common Construction Materials**

Material	Lbs/SF
Ceilings:	
Acoustic Tile	1.2 – 1.57
Suspended	1.40
Lath & Plaster (1")	10.50
Roofing	
EPDM Adhered	0.28
EPDM Ballasted	12.0
Modified Bitumen	0.25
PVC Foam (1")	0.02
3-Ply Felt	3.00
3-Ply Felt with Gravel	5.50
5-Ply Felt	3.50
5-Ply Felt with Gravel	6.00
Decking	
¾" Wood	3.00
2" Gypsum Plank	12.00
20 Gauge Metal	1.50
22 Gauge Metal	1.25
LW Concrete (per 1")	3.0 – 9.0
Insulation	
Loose Fill	0.50
Poured in Place	2.00
Rigid (1")	0.75
Fiberglass Batt	0.10 – 0.40
Foam Board (1")	0.16
Tectum (1")	1.75

**Approximate Thermal Values of
Common Construction Materials**

Material	R-Value
Ceilings (no insulation)	
Acoustic Tile	2.38
Suspended	2.28
Lath & Plaster (1")	.94
Roofing	
EPDM Adhered	0.24
EPDM Ballasted	0.37
Modified Bitumen	0.75
PVC Foam (1")	3.85
3-Ply Felt	0.24
3-Ply Felt with Gravel	0.33
5-Ply Felt	0.40
5-Ply Felt with Gravel	0.55
Decking	
¾" Wood	0.44
2" Gypsum Plank	1.80
20 Gauge Metal	0.0001
22 Gauge Metal	0.0001
LW Concrete (per 1")	0.3 – 0.9
Insulation	
Loose Fill	2.2 – 3.5
Poured in Place	6.25
Rigid (1")	2.78
Fiberglass Batt	4.00
Tectum (1")	5.56
Foam Board	6.00

Calculate Your Existing Building Roof's Dead Load and R-Value

Roof Assembly Weight	
Material	Lbs/SF
Roofing	
Roof Deck	
Roof Insulation	
Secondary Structural System ¹	
Ceiling	
Ceiling Insulation	
Mechanical/Electrical – 5 Lbs/SF	
Fire Sprinkler – Allow 5 Lbs/SF	
Total Dead Load =	

Building Thermal Value	
Material	Lbs/SF
Roofing	
Roof Deck	
Roof Insulation	
Ceiling	
Ceiling Insulation	
Total R-Value =	

1 – Secondary structural system weight is not included in this manual, but can be obtained by referring to other specific industry manuals. For open web bar joist, refer to footnote 1 on the next page.

Open Web Steel Bar Joists - The following tables are provided as reference on open-web steel bar joist, the most common structural roof support system found on retrofit projects. The data can be used for identifying existing joists and matching to their proper designation. Once identified, refer to the Steel Joist Institute (SJI) load tables (see footnote 1) to evaluate their current loading capacity as well as future loads to be imposed by a retrofit system. Calculating the weight per square foot in the table shown on the previous page and multiplying by the joist's spacing will obtain the current load in Lbs/Lineal foot. Joist tables provide allowable total safe load in Lbs/LF based on

a specified span. Therefore, you will need to know the span of the joist you are evaluating. It is important to note that in many cases, existing buildings may have had interior building finishes added that were not originally appropriated for in the design of the existing roof. These finishes could include the addition of ceilings, mechanical/electrical and/or fire sprinkler systems as well as any other materials suspended from the existing roof or its support structure.

Open Web Steel Bar Joist Dimensional Data¹

Series	Manufacture Date	Std End Depth	Available Depths	Web Type
SJ, S J, H or K	1930 – 1952	2½"	8" – 16" (2" increments)	Round Bar
	1952 – 1972		8" – 24" (2" increments)	
	1972 - 1988		8" – 30" (2" increments)	
L, LA, LJ or LH	1953 - 1988	5"	18", 20", 24", 28", 32", 36", 40", 44" and 48"	Angle
Deep Span ² DLJ or DLH	1970 - 1988	Chords 10 – 17 = 5"	52" – 72" (4" increments)	Angle
		Chords 18 – 20 = 7½"		

Refer to footnote below for the most current data.

Open Web Steel Bar Joist Chord Sizes¹ – Series SJ, S, J and H

Chord ID	Possible Angle Sizes (inches)	Chord Hole Gauge ³ (inches) (c/c of chords)
1	¾ x ¾ x ⅛ or 1 x 1 x ⅛	1⅛ - 1⅜
2	1 x 1 x ⅛	1½
3	1¼" x 1¼" x ⅛	1⅞
4	1½" x 1½" x ⅛	2⅛
5	1½ x 1½ x ⅜ ₃₂ or 1¾ x 1¾ x ⅛	2¼ - 2½
6	1½ x 1½ x ⅜ ₁₆	2¼
7	1¾ x 1¾ x ⅜ ₁₆	2⅝
8	2 x 2 x ⅜ ₁₆ or 2 x 1 ½ x ⅜ ₁₆	2⅞
9	2 x 2 x ⅜ ₁₆	3
10	2 x 1½ x ¼ or 2½ x 2 x ⅜ ₁₆	3 – 3½
11	2 x 2 x ¼	Varies due to Web Dimension

¹ Data collected from the SJI's 60-YEAR MANUAL 1928-1988 © 1992, a compilation of specifications and load tables. This manual was updated in 2007 and is now named "80 YEARS OF OPEN WEB STEEL JOIST CONSTRUCTION", which is available by contacting the SJI at 843-626-1995 or their website at www.steeljoist.org.

² Deep Span joist are typically used as primary girders and do not necessarily become a concern with retrofit. However, there are buildings that used these joist supported by joist girders. In those cases, refer to the SJI manual for chord dimensions

³ Gauge is the distance between the centers of the two bar joist chords.

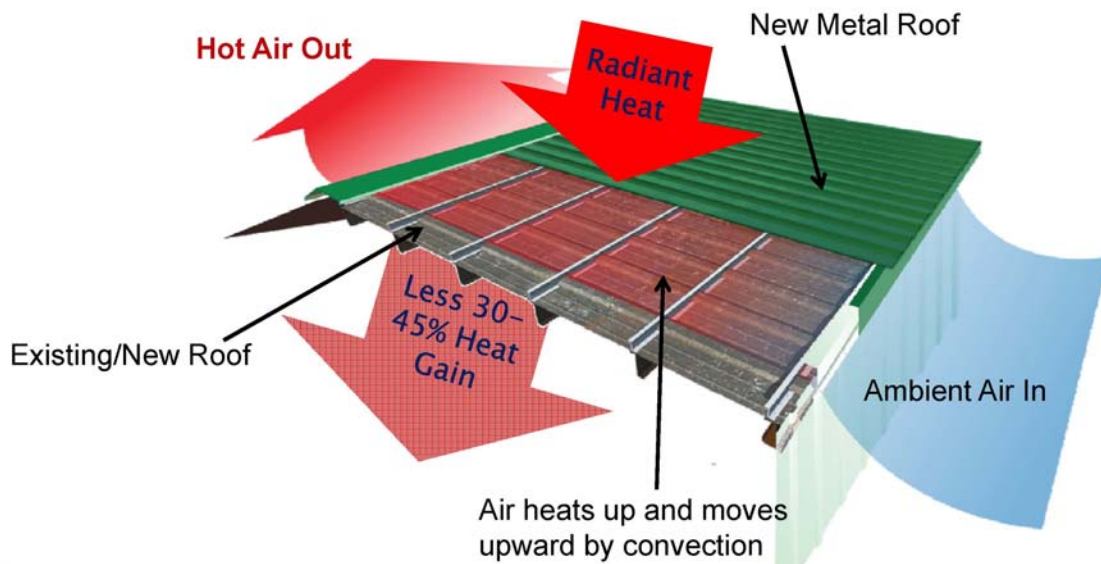


VENTILATING THE RETROFIT ATTIC - One of the most overlooked elements in the design of retrofit systems is ventilation. This stands true whether the assembly is being constructed over an existing flat roof creating a new attic space or over a sloped roof where a shallow cavity is being created.

A properly engineered ventilation system using a gravity exhaust vent at the high points of the roof (Ridge, High Sidewall, Pitchbreak or Roof-to-Wall) in conjunction with an eave intake air vent strip will provide fresh air movement through the roofing

system removing hot, stale air. Summer radiant heat is released naturally, extending both the life and performance of the roof system. During winter, proper ventilation can assist in the control of condensation and other moisture problems such as rust and insulation deterioration. Typically, it is recommended that the new attic space created between the old and new roofs be ventilated at a minimum ratio based on industry standards of 1:300 (one square foot of free intake and exhaust air movement to 300 square feet of attic space). Another standard is based on exchanging the air in the space from 3 to 4 per hour with fresh ambient air. This value is subject to local codes and regulations and should be investigated to determine what controls the design of the ventilation system.

Research conducted in recent years at Oak Ridge National Laboratories (ORNL) near Knoxville, TN has validated the importance of ventilating metal-over-sloped roof retrofit cavities with a new metal roof installed. Named by ORNL, Above Sheathing Ventilation (ASV) can produce major energy efficiency and cost savings to the building owner. How do ASV systems work? Per the below illustration, fresh ambient air is introduced to the cavity between the old and new roofs through ventilation at the low-eave of the building. When the sun heats the new metal roof, the cavity air becomes less dense. Because of this, the air becomes more buoyant and therefore begins to move upward at the immediate underside of the new metal roof. The air is then exhausted at the high point of the roof (ridge, etc.) through convection. The end result is the system creates an insulating barrier of air between the two roofs.



Many ventilation products are available that accommodate these applications and the system has the natural ability to dissipate moisture caused by condensation as well as aiding in the elimination of mold growth.

The ASV system testing has indicated that the system reduces the heat radiation through the roof assembly a minimum of 30% and as much as 45%, if the new roof is installed with a “Cool-Rated” coating. Depending on the profile of the existing roof, most cavities are no more than two-inches deep. To increase the thermal resistance even more, rigid or fiberglass insulation can be added to the cavity, but it is important to note that a minimum of 1” must be provided above the insulation to allow for adequate airflow. In some cases, a simple radiant barrier can be installed atop the existing

roof to increase the assembly's energy efficiency. Effectively, an ASV system reduces heat gain in the summer and reduces heat loss in the winter.

McElroy has included in its retrofit systems product offering, many ventilating products as listed below. For more information on these products, refer to Chapter 7 for descriptions and Chapter 8 for technical specifications.

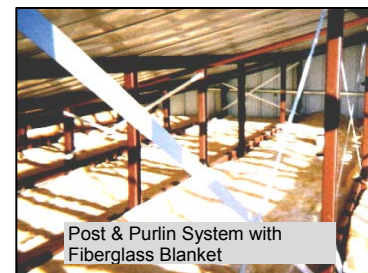
1. Perforated Marquee II and Matrix soffit panels installed either continuous or intermittently providing up to 14.4 free square inches of ventilation area per square foot of panel area. Refer to Chapter 6 for more information
2. A low profile PreVent[®] eave strip approximately 11 square inches Net Vent Free Area (NVFA) per linear foot. This product is concealed beneath the roof's high point or ridge flashing and the eave device is available in powder coated color-matching colors. Refer to panel construction details for further information. There are other low eave ventilation products that provide adequate air-flow.
3. Low-profile Ridgeline[®] intermittent or continuous ridge ventilators having approximately 18 square inches of NVFA per lineal foot at a base rating of 450 CFM. The primary benefit of this vent is it has an optional damper to assist with solar heat recovery systems as explained in Chapter 9.
4. Perforated zee closures located at ridge and hips providing approximately 19 free square inches per lineal foot.
5. Round ventilators in 12"-24" diameter, providing varying ranges of CFM values.
6. Conventional intermittent or continuous 9" throat ridge ventilators providing approximately 2700 CFM for industrial applications.
7. Fixed or adjustable vertical louvers that vary in sizes including round, half-round or quarter-round, which are self-framing and self-flashing. Ridge or hillside mounted cupolas in three standard sizes of 2', 3' and 4' square.

INSULATING RETROFIT ROOFS AND CONTROLLING CONDENSATION

- Due to energy-saving deficiencies common to older buildings, many industry authorities recommend insulating the space between the old and new roofs. In doing this, the placement location of the insulation has for many years been a debated topic. It has caused confusion for design professionals, contractors, and owners. The following is offered by several insulation industry authorities in order to resolve any questions on the proper location and placement of insulation.



1. If your desire is to increase the thermal efficiency of the existing building, then the insulation should be placed directly on the existing roof. Thickness of insulation is subject to your requirements and desire to upgrade as well as what thermal value the existing building has, but typically, designers will specify the addition of 6" minimum fiberglass insulation providing an additional R-19. A laminated vapor barrier in this case is not recommended since the existing roof effectively



acts as a barrier and if a laminate was used, it would restrict moisture dissipation in the existing roof substrate. If the project were to be designed in accordance with ASHRAE 90.1 at a minimum, an R-30 may be required. Therefore, after calculating the existing roof's thermal resistance value as provided in the table on page 3-7 of this section, you can then determine the additional insulation that will be required. Overall thickness, of course, is restricted to the retrofit cavity depth, which can be increased to accommodate.

2. Condensation occurs when moisture-laden air comes in contact with a surface temperature equal to or below the dewpoint of the surrounding air. This phenomenon creates problems that are not unique with metal roofing construction, but can actually be found in nearly all types of construction as well. Many design professionals and contractors will recommend installing minimal thickness fiberglass insulation laminated to an appropriate and economical vapor barrier directly beneath the new metal roof. While this will provide excellent condensation control over and above ventilating the cavity, it will not effectively increase the thermal resistance of the overall assembly.



CONVENTIONAL RE-ROOFING METHODS – The following addresses the various roofing membranes that were commonly used in roofing applications from 10 to 40 years ago. Many of these are still used today because of continued improvement and technology. In this section however, we elected to provide the descriptions from publications dating back to the early-1980's because it is very likely that these are roofs that are likely candidates for being retrofitted. The descriptions explain the roof membrane materials and physical properties, but also describe their pitfalls and

limitations. At the end of this section, you will find an application table for various re-roofing systems that illustrates acceptable industry practices for roofing over the conventional membranes. Another table is provided that compares average life expectancies, associated maintenance costs and total cost to the owner with those of low-slope and high-slope retrofit applications. You will see that because of metal roofing's long-term performance and low maintenance cost, it is without a doubt the best investment.

Built-Up Roofing (BUR) – The flat and low-slope roofs used on commercial and industrial buildings for many decades have been protected with a built-up roofing membrane. The name is arrived from the method of construction used to create the waterproofing cover: Layers or plies of felts made of paper, asbestos, polyester or glass fibers. These are embedded in alternate layers of hot-applied or cold-applied waterproofing asphalt or coal-tar based bitumens. The surface layer is also embedded in a flood coat of asphalt or coal-tar pitch and is generally topped with aggregate granules or small pebbles. The BUR has to be protected from ultraviolet exposure with this granule surfacing to ensure long-term performance. The following explains the basic components of a BUR membrane, bitumen and felts as well as installation characteristics.

Bitumen – The bitumen in a built-up roof has a two-fold function: to act as a waterproofing layer and to act as an adhesive. The bitumen has various types that have specific applications:

- Dead-level asphalt is suitable for roofs having slopes up to 1:12.

- Flat asphalt is suitable for slopes typically up to 3:12, but some manufacturers limited to ½:12.
- Steep asphalt is required for slopes up to 6:12. This asphalt was regarded as an adhesive. It was not considered to be a waterproofing material because of its poor weathering qualities.
- Special steep asphalt was recommended for slopes greater than 6:12. For asphalt, its weather resistance was the poorest performance.
- Coal-tar pitch was used on roofs that were nearly level. It was considered superior to dead-level asphalt on roofs that experienced ponding, but it had several drawbacks. Its weatherability was very poor and had to be protected from ultra-violet exposure with aggregate gravel. It is important to note that it was incompatible with asphalt and therefore proposed problems at flashing locations.

Felts – the layers of felt provide strength and dimensional stability to the bitumen. This is due to the fact that bitumens tend to stiffen at low temperatures and become brittle with age. The felts also make it possible to accommodate thermal movement by helping to avoid the splitting of the membrane. The following explains the various felts used:

- Organic felts almost always split along the felt lines unless their directions were reversed during installation. Coated felts exhibited no substantial difference in service from ordinary paper felts.
- Asbestos felts provided the advantage of greater moisture resistance, but their poor tensional values made them less strong than paper or glass-fiber felts. These felts were used in 3-ply roofs because of their low cost. However, the sacrifice in strength resulted in a greater tendency for splits. .
- Glass- fiber felts enjoyed the lead in the BUR roofing market because of their weathering characteristics. There were four types produced - steam blown mat, wet process mat, continuous-strand mat and polyester mat. Each type had its own inherent advantages and disadvantages:
 - Steam blown mats had moderate cross-sectional tensile strength and were not suitable for colder climates.
 - Wet process mat, the most widely used, had very good flexibility allowing it to conform to configurations that others could not. However, this mat had poor tear strength and fair durability.
 - Continuous-strand mat had a uniform high tensile strength and could be used in all climates. Its disadvantage was higher cost and limited uniformity compared to steam blown and wet process mats.
- Polyester mat has excellent elongation characteristics and flexural strength. However, they could not withstand the high temperatures of mopping asphalt and therefore was mated with cold asphalt or emulsion.

Installation characteristics – Asphalt must be applied at the appropriate temperature to deliver its waterproofing characteristics. The correct temperature ranges were from 375° F to 425° F. If overheated for any extended period, its physical properties are modified and the integrity is undermined. For coal-tar, the appropriate temperature is just as important but was often neglected by installers. If overheated, coal-tar becomes thinned and its performance qualities are greatly reduced.

Modified Bitumen Systems – These roof systems included a broad class of materials and blends. The modifiers and additives enhanced the material properties of roofing grade asphalt and

improved the performance. This membrane is a composite sheet of two or more materials and additives, which closely resemble BUR except that the individual plies are factory laminated and the membrane is applied in one layer. These composite sheets can either be self-adhering or heat applied.

- Self-adhering - These sheets have a base layer of bitumen that is modified with a plasticizer and a top layer of polyethylene film, which acts as a protective barrier and a base for a liquid protective applied coating or gravel adhesive with mineral granules.
- Heat-applied – These composite sheets contain a reinforcing layer at mid-depth. This reinforcement may be plastic sheeting, polyethylene film, heavy polyester mat, glass-fiber felt or fabric, or a combination thereof. The asphalt may be modified with rubberizers or special plasticizers. Surfacing may be a thin embossed metal, a mineral aggregate or a special protective coating.

Installation characteristics – Self-adhering sheets have a protective release paper on the bottom side that is removed immediately before installation to the substrate. The asphalt and added tack oils create an almost instantaneous bonding. Because of this, sheets must be carefully aligned. Seams are bonded with mechanical pressure applied with a roller. Heat torching joins reinforced modified bitumen sheets, which is subject to the installer's skills to control the flame and avoid burning through the membrane.

Single-Ply Membranes – During the energy crises beginning in the early 1970's, single-ply membranes like rubber and thermoplastics became very popular. Known as elastomeric systems, there are basically two types; thermosetting and thermoplastic. Thermosetting materials solidify when first heated under pressure and cannot be re-melted or re-molded without destroying their original composition. Thermoplastic types are readily softened when heated and hardened when cooled, returning to their original characteristics. The membranes typically had good weathering qualities and some had good resistance to chemical and corrosive environments. The following describes the various attachment methods and the different membranes that have been available at some point in over the last 30 years:

Installation methods:

- Fully adhered – This method glues (adheres) the membrane to an insulation board such as polyisocyanurate, which is attached to the supported deck.
- Partially adhered – Where the membrane is partially bonded with adhesive and in some cases with mechanical fasteners. This method glues the membrane in strips to allow for a specified percentage of non-bonded area.
- Mechanically attached – This method attaches the membrane to the deck through the insulation board, with battens hot welded at the seams.
- Ballasted – This method attaches the membrane at its perimeters with a layer of heavy rock spread over the entire roof surface to hold it down to the insulation and deck. A polyester protection matt is installed over the membrane to protect it from the rocks themselves. The weight of this system can be as much as 12 PSF.

Membranes types:

- Neoprene – This was the first commercially produced synthetic rubber. Sheets were available in weathering (black) and non-weathering (light colors) grades. The latter had to be protected from ultraviolet exposure, usually with a coating.

- Polyisobutylene (PIB) – A synthetic rubber sheet classified as an uncured elastomer, composed of isoprene, high molecular isobutylene and aging protectors. This membrane had good ultraviolet and weathering resistance.
- Ethylene propylene diamine (EPDM) – A thermoset synthetic elastomer membrane that is glued or fastened to the deck.
- Chlorinated polyethylene (CSP and CSPE) - Rubber like materials of high molecular weight, low-density polyethylene that are mechanically fastened to the deck. Seams are heat welded. CSP is typically white or gray and CSPE was available in several colors and usually had an asbestos backing. These membranes offered good acid resistance, but would swell if exposed to chlorinated and aromatic solvents.
- Polyvinyl chloride (PVC) - A thermoplastic synthetic polymer composed from vinylchloride that comes in reinforced and non-reinforced versions. Through aging and solar exposure, this membrane can become brittle caused by the loss of plasticizer. They can be protected from ultraviolet degradation with ballast or by adding inhibitors in its composition.
- Ethylene copolymer bitumen (ECB) – A thermoplastic material mixed with anthracite microdust.

Spray-on Coatings – This roofing system comprises polyurethane foam and various protective coatings. Because of the polyurethane’s high thermal conductivity and resistance values, they offered unique advantages to older energy deficient buildings. The polyurethane foam is a result of a reaction of two major components: isocyanate and polyol. These two elements, with additives and catalyst, undergo an exothermic reaction when mixed and then sprayed onto the subject roof area, causing the material to expand within seconds to 30 times its original volume. A coating to make it watertight and to prevent degradation from ultraviolet exposure must be applied to protect the foam. Various coatings have been used over the last 30 years such as urethane elastomer, elastic acrylics and silicones. Others have been butyl rubber, chlorosulfonated polyethylene, neoprene, polyvinyl chloride and vinyl. Some of the coatings are breathable and allow passage of water vapor while others retard it. The performance of this roofing system is highly dependent on weather conditions and the quality control of the equipment being used for installation of the foam and especially controlling the thickness of the protective coating.

Acceptable Re-roofing Methods - Since there are numerous roof types that have been used on buildings for decades, the following table is provided to determine what new re-roofing systems and methods are acceptable insofar as their application over the various systems.

Existing	New Re-Roofing Protective Membrane				
	BUR	Mod-Bit	Single Ply	Spray-on	Metal Retrofit
BUR	1	2	2	4	Acceptable
Mod-Bit	2	3	2	4	Acceptable
Single Ply	4	3	3	4	Acceptable
Spray-on	4	3	3	4	Acceptable-5

- 1 - Acceptable per roofing industry standards and practices
- 2 - Industry recommends a minimum ¼:12 slope
- 3 – Acceptable with complete tear-off of existing system to deck and replacing with all new materials
- 4 – Acceptable with tear-off to existing insulation at minimum and replacing with new membrane
- 5 - Recommended to remove foam and coating, dependent on thickness of foam at framing attachment location.

Re-Roofing System Cost Comparisons - This table is provided to assist the user and building owner in evaluating and selecting a re-roofing system. Even though the initial cost of a conventional re-roofing system can be much less than a retrofit system, the metal roof will always be the best investment when compared to its counterparts. Because of continuous maintenance expense and lesser life spans on conventional roof replacement systems, installing a retrofit system

can represent a payback in 3.74 to 4.5 years using the savings over the long-term. As with any roof system and dependent on a roof's exposure to the elements and environment, conventional membranes will require replacement once they reach their average life expectancy. It is important to note that this table uses 25-years as a basis even though metal roofing has proven its superiority for 40 and more years.

New Roof Replacement Membrane	Initial Cost ¹	Maintenance Cost \$ over 25 Years	Replacement \$ ²	\$ Total Cost ³ over 25 Years	Retrofit System Payback ⁵ in Years
		\$/SF/YR	Average Life Span Years	Retrofit Cost compared to Membrane ⁴	
4-ply BUR with Gravel	\$61,401	\$61,981 \$0.17	\$101,486 17.2	\$217,575 <\$193,976>	3.04
60 mil fully adhered unreinforced EPDM	\$48,331	\$72,919 \$0.20	\$95,384 23.0	\$209,342 <\$172,672>	5.31
60 mil mechanically attached TPO	\$46,768	\$94,794 \$0.23	\$84,468 20.0	\$218,738 <\$180,506>	5.30
SBS base and cap Modified Bitumen	\$63,418	\$61,981 \$0.17	\$117,975 21	\$236,082 <\$214,499>	2.52
Retrofit System⁶	\$85,000	\$7,292 \$0.02	Not required 41.6 plus	\$92,792 N/A	N/A

Sources: RCI Interface/EUAC LCCA Analysis 2007, Ducker Worldwide Survey 2007 and RetroSpec, LLC Life Cycle Costing studies.

1 – Costs are based on a 10,000 square foot building without rooftop penetrations located in the central United States installed during the year of 2012.

2 –Replacement costs includes the removal and disposal of existing roof membrane and insulation with new 2" polyiso insulation installed based on a 3% inflation per year. Roof edges are considered standard gravel guard fascia (no parapets).

3 – Total cost calculation includes the initial installation cost and maintenance cost with a replacement of the system at the year-end (rounded up) of the system's average life span. Maintenance and replacement costs include a 3% per year inflation rate.

4 – Comparative cost between the membrane roof replacement and the retrofit system includes the cost of the roof replacement at the end of the average life span plus the difference in maintenance cost over the 25-year term less the initial retrofit system cost difference.

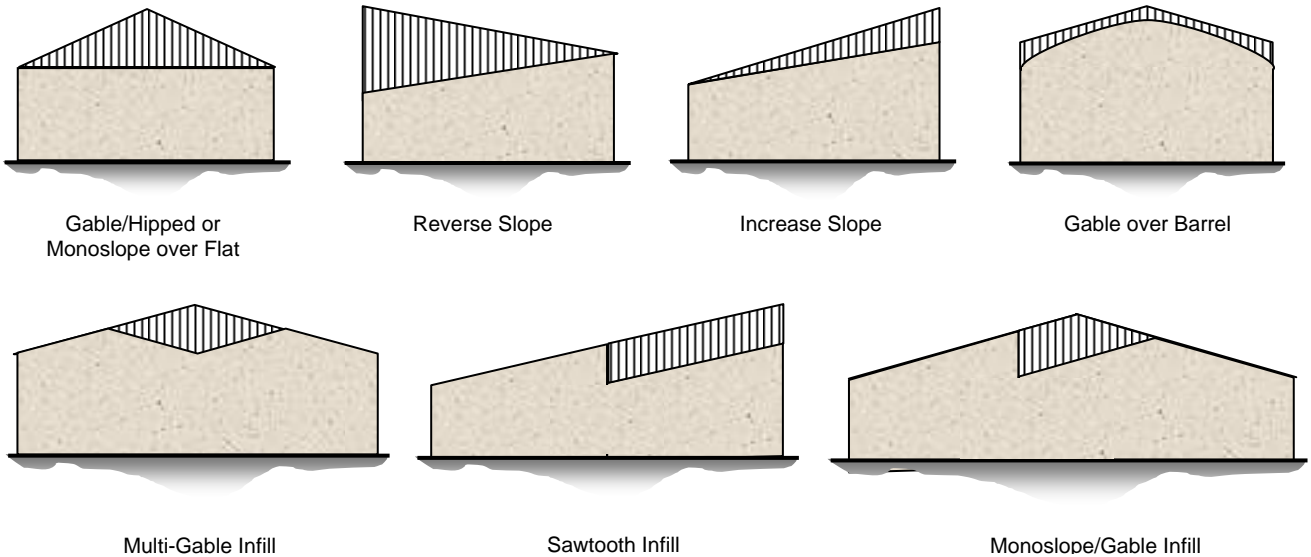
5 – Payback years is calculated using the initial cost difference between the two roofs, divided by the savings over the 25-year term. It does not include any savings due to reduction in energy consumption from the addition of insulation as part of the retrofit system, which can reduce the payback years even more

6 – Retrofit system includes unpainted trapezoidal SSR type roof system with maximum framing member height of 48", insulated at existing roof elevation with 6" of fiberglass blanket.

GENERAL - This chapter will discuss the multitude of applications that McElroy's retrofit framing systems can employ for satisfying a project's needs. These include both architectural and functional applications as well as those created because of existing or newly presented problematic geometry conditions. In addition, this chapter presents illustrations which represent the differing geometry of existing roofs and the applications that are afforded by the retrofit concept. This is followed by detailed descriptions with illustrations of each of McElroy's retrofit framing systems as well as a fit-for-use table explaining their compatibility with the various construction materials used in existing buildings. This chapter will help you understand the relationship between the existing roof support system and the new retrofit framing. Having this knowledge is imperative to successfully designing a framing system, which is discussed in detail in Chapter 5.



EXISTING AND NEW ROOF GEOMETRY – The following figures are provided to illustrate what types of existing roof geometry are candidates for retrofit systems. Dependent on the existing roof's structural system type, each of these can be satisfied by using one or more of McElroy's framing systems as we will explain later.



ARCHITECTURAL APPLICATIONS – As discussed previously in the General Information chapter, there are many reasons to employ retrofit framing on new and existing building roofs. For those building owners and design professionals wishing to improve the curb appeal of the building, an architectural application would be the most likely choice. Simply put, these applications typically utilize steeper slopes greater than 3:12. They also employ vertical seam roofing profiles such as McElroy's Maxima and Medallion-Lok systems with a Kynar® color finish. Other treatments may include the addition of eave canopies with our Marquee II type soffit (perforated for ventilation purposes), hips in lieu of gables or even dutch gables and dormers with painted fixed louvers. Sculptured or boxed style trims are also common. In many cases, other materials and features can be used in the aesthetic design concept such as EIFS, cultured stone or numerous other options.



Courtesy of Roof Hugger®, Inc.

FUNCTIONAL APPLICATIONS – These applications are commonly used where the building owner is focused on eliminating roof leaks. The issue is not to improve the appearance of the building and in many cases, hiding the new retrofit roof system can be a concern. When being constructed over existing flat or nearly flat roofs, slopes are typically from ¼:12 to a maximum 3:12 using trapezoidal rib standing seam roof systems such as McElroy’s MasterLok-90 and Mirage. If economy is a primary factor, McElroy’s exposed fastened R-Panel and Multi-Rib can be installed. However, because these panels are exposed fastened and have trapezoidal shaped ribs, it is recommended that the new roof geometry utilize gable ends and avoid hips and valleys.

Problematic Geometry - As part of functional applications and maybe what is little known to most, is how retrofit can satisfy problematic geometry issues. In the figures shown on the previous page, you will see that the three “Infill” applications represent very common conditions, which exist in many industrial and manufacturing facilities throughout the nation. You should note that the “Monoslope/Gable” infill could be applicable to a building expansion where the monoslope building on the left is new construction. As you can see, the undesirable condition between the monoslope and gabled buildings is satisfied with the retrofit infill. In addition, the two buildings now have a symmetrical ridgeline.

Metal-on-Metal – For existing metal roofs, special low-profile sub-purlins make it possible to install a new metal roof without removing the old roof. The need for this application can be for any number of reasons including rusted roof panels, leaks caused by excessive thermal expansion and contraction or due to corrosive atmospheric conditions in and around the building. Prior to the introduction of aluminum-zinc alloy coatings (Galvalume™, etc.) in the early 1980’s, metal building manufacturers utilized galvanized metal for their roof panel systems. If the roof panels were painted, the older silicone based coating systems lacked long-term performance in fade, chalk and weatherability. One of the most prevalent problems with older metal buildings is their exposed fastened roof system’s inability to satisfy thermal movement as evident with elongated screw holes (see photo above right) and cracked ridge caps (not pictured).



Courtesy of RetroSpec. LLC Consultants



Courtesy of Roof Hugger®, Inc.

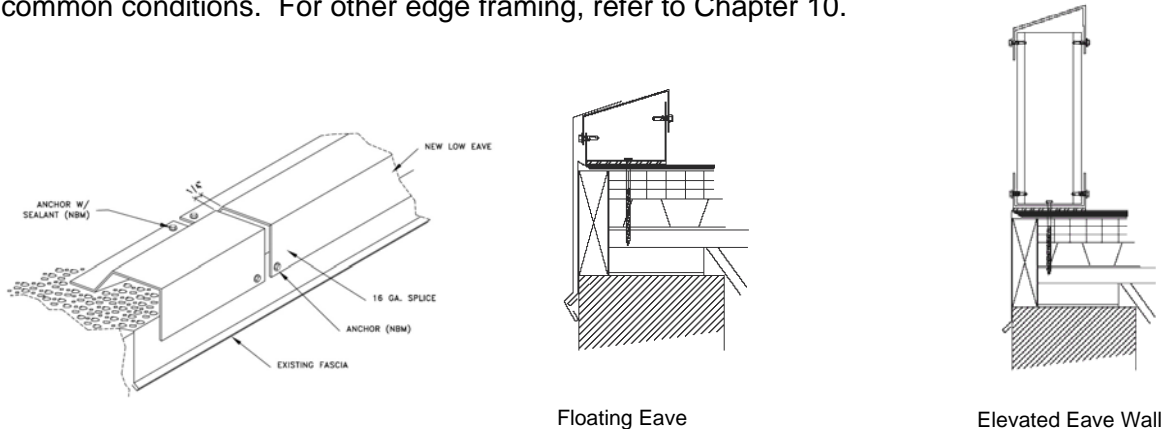
McElroy’s engineering expertise, we have the ability to employ the very well known nested sub-purlin system, RoofHugger™, into the design of a re-roof framing system over existing metal buildings. The need may be to meet engineering and specification requirements or to upgrade the building to current Building Code compliance with wind loads that are greater than those which were used in the original design.

MCELROY RETROFIT FRAMING SYSTEMS –

Because of the numerous existing roof support systems and multiple applications as explained previously, McElroy has developed various framing systems, each having the ability to comply with load-bearing requirements of the existing roof support system. They can be combined with each other to accommodate multiple systems present in the existing building. In addition, McElroy has developed standard details and framing assemblies (see Chapter 9) to address a multitude of perimeter construction methods, including inconsistent elevation at roof edges, gravel stops and load bearing/non-load bearing parapets. Most of these systems incorporate installer-friendly attributes to assist labor savings and speed of installation.



Perimeter Framing – Regardless of the framing system type(s) used to convert the existing roof to a sloped plane, McElroy has developed roof perimeter framing methods to satisfy variable existing conditions including inconsistent elevation at roof edges, gravel stops and load bearing/non-load bearing parapets. Also included, as detailed in Chapter 10 standard assembly details are gable walls, gable purlin extensions and low eave canopies/overhangs. Each of these accommodates the parameters that are presented at any one of many existing roof edges. Below, are the most common conditions. For other edge framing, refer to Chapter 10.

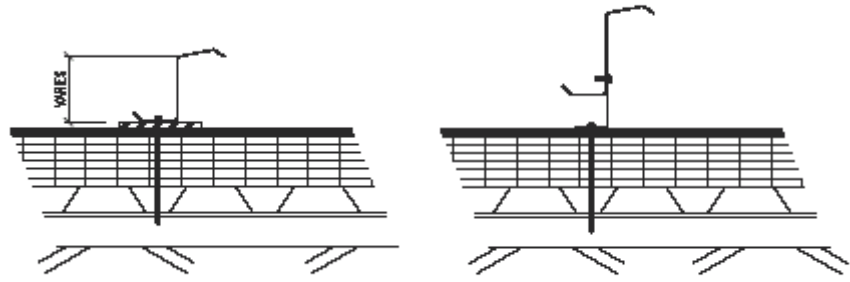


Before we describe the different McElroy framing systems, it is important to understand two basic terms that pertain to the dynamics of retrofit framing in the relationship of the new roof's slope direction to that of the span direction of the existing roof joists.

Parallel Framing – defined as the existing joist spans are parallel with the new roof slope; therefore often allowing the new framing to only require a point loaded type base member (Base Shoe).

Perpendicular Framing – defined as the existing joists are perpendicular with the new roof slope; therefore often requiring the new framing to require a load-distributing type base member that runs across the existing joists (Continuous Base Zee).

Low-slope System – The most economical framing method, but most limited as well, this system utilizes varying height zee-shaped members that are press-broke or roll formed from 16-gauge steel with web depths of 3-1/2" to 12". The maximum web depth is what limits the use of this system. The 12" depth limits its use to narrower buildings.



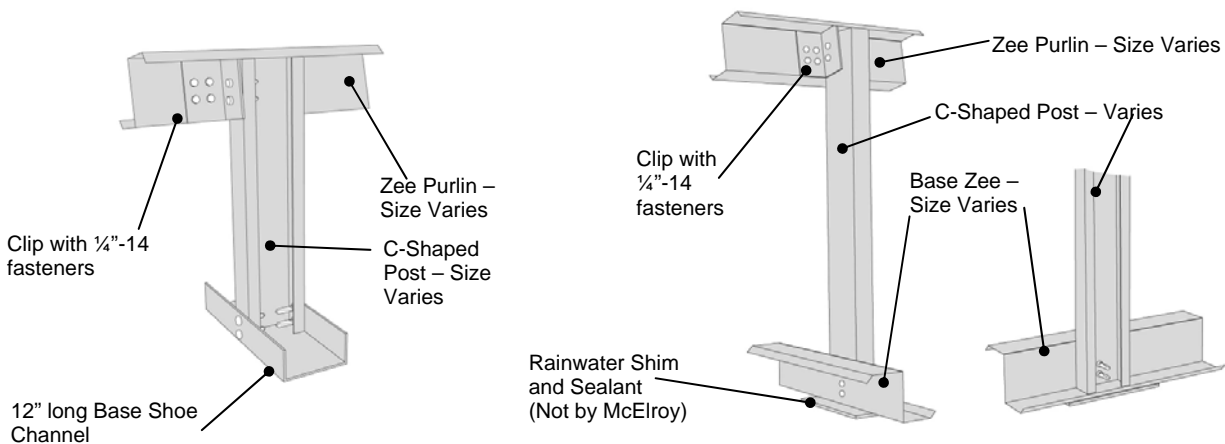
Variable Height Zee

Zee with Stand-off Clip

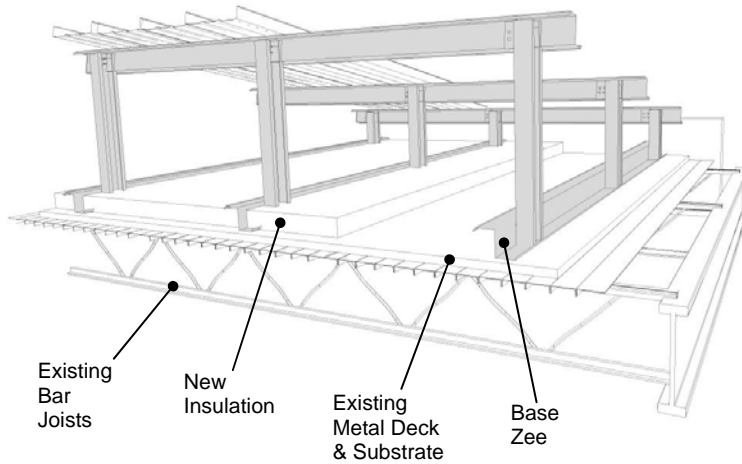
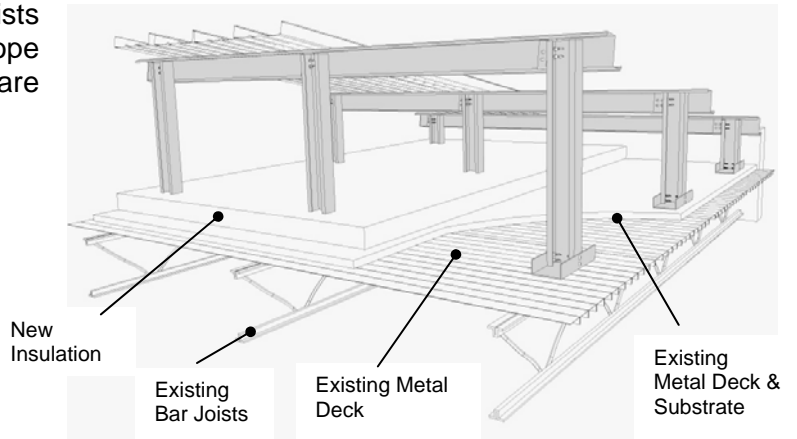
For example, if a new roof slope is 1/4:12, then the ultimate building width would be limited to 48'-0". Although limited in use, this system is regularly used in conjunction with the McElroy Post and Purlin framing system. The zee-shaped members can be used on concrete roof systems and wood or steel joist systems where the joists are spanning eave to eave, otherwise known as parallel framing.

Post and Purlin Systems – The most commonly used system because of its adaptability to steel, wood and concrete roof systems. This system uses cee-shaped posts that support zee-shaped purlins. Because of member dimensions and connection requirements, the minimum height of this framing is approximately 8 inches, where its limitation on ridge height (above the existing roof) has been designed to 25 feet and more with horizontal struts that brace the system. Its base member type is dictated by the span direction of the existing roof joists as explained above in the Parallel and Perpendicular term definitions. The illustrations on the following pages show the framing differences with steel, wood and concrete systems. Note the significance in the location of the new cee-shaped posts in their relation with the existing roof joists.

Post & Purlin Base Member Types: The first two illustrations shown below depict the various base members employed in post and purlin framing. Each has specific applications that relate to the existing roof's secondary support system span direction as explained above for parallel and perpendicular framing. In most cases, the post web is attached to the base zee's web making web-to-web connection. It is also important to note that the continuous base zee is generally used for all existing roofs constructed with dimensional lumber.

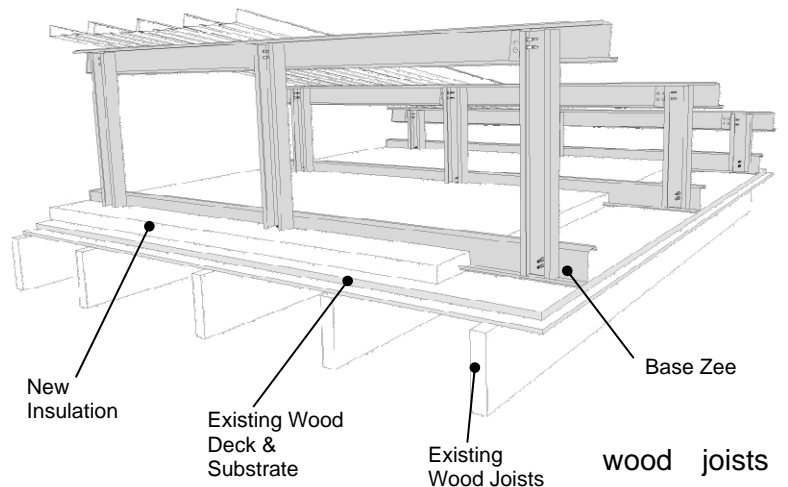


Post and Purlin system over steel bar joists spanning parallel to the new roof slope uses base shoes and posts that are centered over the existing bar joists.

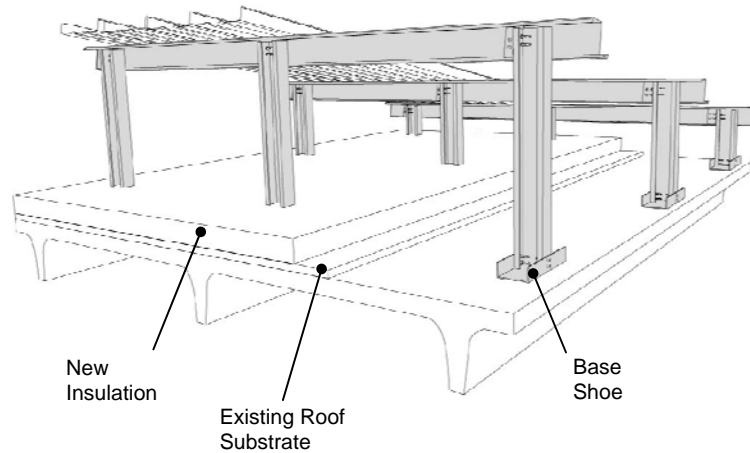


Post and Purlin system over steel bar joists spanning perpendicular to the new roof slope uses a continuous base zee member running across the joists. The posts are spaced based on the purlin's span capacity, which is designed by McElroy as well as considering the maximum load limits being imposed onto the existing roof and its joists.

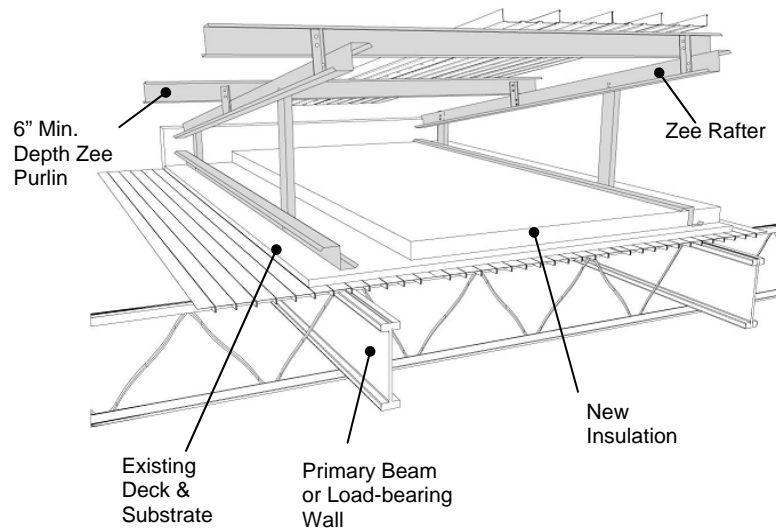
Post and Purlin system over wood framed roofs use a continuous base zee member due to the joists typically being spaced from 16 to 24 inches on center. In both parallel and perpendicular cases, the base zee direction runs across the wood joists. Posts are normally not spaced more than 2 times the wood joist spacing, or $16'' \times 2 = 32''$. Wood framed roof support systems present special considerations to retrofit. These can include anchorage where it is proper to anchor the base zee at each and every wood joist it crosses.



Post and Purlin system over structural concrete (Tee) roof system uses base shoes and posts that are installed centered over the existing tee beams since this application is considered as a parallel condition.



Wide-Span Systems – A unique system that has specific applications where as the existing roof’s primary support systems are parallel to the new roof slope. The existing roof joists, if applicable, are perpendicular and the new framing system is designed to install directly over load-bearing walls or other components that support the joists. Because of this, the system utilizes a “bay system” with 6” minimum zee purlins up to 10”, making spans up to 30’-0” possible. A frame assembly made up of a zee-shaped base member and rafter connected together with a cee-shaped post, providing support for the purlins. The frames are located directly over the primary support components of the existing roof and the webs are spaced the same as the roof’s secondary joists. With this system, the anchorage connections to the existing roof system are usually the controlling factor in whether this type of framing can be used.



The frames are located directly over the primary support components of the existing roof and the webs are spaced the same as the roof’s secondary joists. With this system, the anchorage connections to the existing roof system are usually the controlling factor in whether this type of framing can be used.

Framing System Fit-For-Use Applications - To ensure proper design loading is distributed into the existing roof system, the following Table is provided to assist in selecting the proper McElroy framing system that is best suited for installation over the various existing roof systems. It also identifies the type of base member that should be used.

(Framing System Fit-for-Use Application Table Follows on Next Page)

Framing System Fit-for-Use Application Table

Existing Roof Construction Type	Existing Joist ¹	Base Type ²	Retrofit System Type			
			Low-Slope	Post & Purlin	Wide-Span	Metal-on-Metal
Dimensional lumber joists with wood deck	Parallel	Zee	•	•		
	Perpendicular	Zee			•	
Heavy timber trusses with wood or steel purlins and wood deck	Parallel	Zee	•	•		
	Perpendicular	Zee			•	
Glue-laminated beams with structural wood deck	Parallel	Shoe ³		•		
	Perpendicular	Zee			•	
Bar joists with insulated metal deck assembly	Parallel	Shoe	•	•		
	Perpendicular	Zee			•	
Bar joists with metal deck and lightweight concrete	Parallel	Shoe	•	•		
	Perpendicular	Zee			•	
Bar joists with tectum decking	Parallel	Shoe	•	•		
	Perpendicular	Zee			•	
Bar joists with standing seam metal roofing	Parallel	Zee	•	•		
	Perpendicular	Zee			•	•
Sloped roof with steel trusses, structural purlins and insulated metal deck assembly	Parallel	Shoe	•	•		
	Perpendicular	Zee			•	
Steel barreled trusses with structural purlins	Perpendicular	Shoe			•	
Pre-engineered building purlins over rigid frames	Parallel	Zee		•		
	Perpendicular	Zee	•		•	•
Concrete post & beam with structural concrete deck	Parallel	Shoe	•	•	•	
	Perpendicular	Zee		•	•	
Concrete structural tees and insulated deck	Parallel	Shoe	•	•		
	Perpendicular	Zee		•	•	
Intermittent concrete structural tees with tectum	Parallel	Zee	•	•		
	Perpendicular	Zee		•	•	

¹ Represents span direction of existing joists or other secondary type members with the slope direction of the new metal roof.

² Base member for Post & Purlin and Wide-Span framing systems. Does not apply to Low-Slope or Metal-on-Metal.

³ Base shoe to be located directly over the existing panel points of the truss with cee posts supporting transverse rafter.

GENERAL – This chapter will discuss roof design in general and the procedures for proper layout of framing system components including base members, posts and purlins. The user should understand that retrofit framing is an engineered system; therefore, it will require the assistance of a professional engineer that is familiar with structural design and cold-form framing. The information contained in this chapter is intended to assist the engineer in specifying proper components based on the existing building systems and conditions. We will also address the method of determining the quantity of anchors as well as provide common pullout values for fasteners used in retrofit.



DESIGN CRITERIA - PAST AND PRESENT – As briefly explained in Chapter 3, the design of any roof system takes into account gravity loads and wind loading as well as static loads that include the weight of the roof assembly as well as building service equipment (HVAC, Electrical, Fire Sprinkler, etc.) that is suspended and supported by the roof. In a retrofit application, it is important to understand that the existing roof was engineered based on the building's occupancy at the time it was initially constructed, including installed service equipment. Since these buildings were built in the past, other considerations have to be explored. The engineer of record on a retrofit project must determine what the governing building code was at the time the building was constructed and what gravity and wind loading requirements existed. Furthermore and even more important, what equipment or construction components have been added since the building was built. These would include the effects of a change in occupancy that resulted in the addition of a fire sprinkler system, a suspended ceiling, lighting and ductwork to name a few. These additional loads reduce the roof's load carrying capability.

For example; a warehouse built in 1975 was re-purposed in 1995 to an office building and now is receiving a new Metal-over-Flat roof retrofit, creating a new sloped roof. The original design loading was a 20 PSF Live Load with a 10 PSF Snow Load, or a total 30 PSF gravity load. When the building occupancy was changed to offices, the weight of the ceiling, sprinkler and other components created an additional 10 PSF of suspended loads. The result, the building roof then would have been overstressed unless remedial work had been performed on its structural supports. Now, we are attempting to add an additional 3 to 5 PSF in weight from the retrofit framing and metal roof assembly, possibly making the roof even more overstressed. In addition to the existing loads, the new retrofit roof may very well create some other concerns in the form of snow drift loading. When a flat roof is retrofitted, going from flat to a sloped roof, the basic geometry of the roof is also changed. Valleys, parapets and other conditions associated with sloped roofs can very well create snow drifting that must be considered in not only the analysis of the existing roof, but in the design of the new retrofit framing system.

These are a few of the compelling reasons why a professional engineer should be consulted on a retrofit project. The process in determining the affects will demand a thorough examination of the building and its roof system as well as the structural analysis described in Chapter 3.

UNDERSTANDING STRUCTURAL GRIDS – As explained in Chapter 3, every building roof has more than likely been built using a structural grid concept regardless whether they are constructed with steel, wood or concrete systems. As a reminder, this structural grid uses secondary and primary components that support the overall roof. The secondary supports (joist, trusses, beams, etc) receive tributary live, dead and snow loads. These loads are then transferred to primary supports. The primary supports (exterior and interior load-bearing walls, girders, beams supported

by interior columns, etc.) then transfer the collected loads from the secondary supports into the building foundation. Because of the manner that these two systems work together, the newly imposed loads from a retrofit framing system must mirror the existing roof's structural grid. McElroy's retrofit framing systems have been developed to satisfy the various conditions that this structural grid proposes. This is why the terms "Parallel" and "Perpendicular" have been employed into the retrofit concept. As we explained in Chapter 4, these two terms dictate the type and direction of the base member and in some cases will control purlin spacing.

Figure 1 illustrates an existing flat roof building, built with bar joists that transfer load into column supported primary steel beams. In this case, since the bar joists are parallel to the new roof slope, continuous base zee members are not required. McElroy's standard base shoe would be used to receive the new purlin supporting posts, which would be located directly over and attached to the existing joists. The new purlins are spaced transversely from eave to ridge based on the new metal roof system's design capacities for snow and wind loadings.

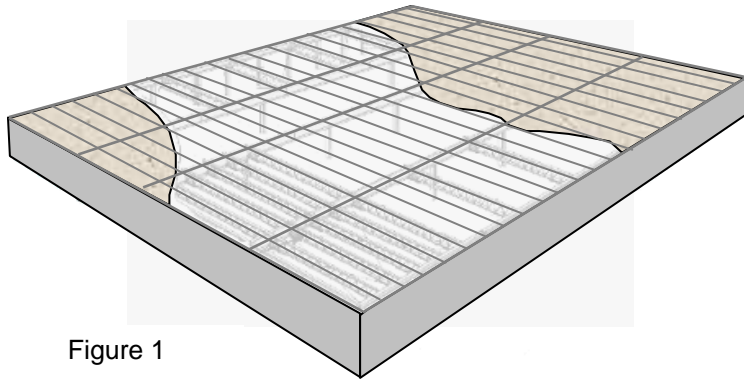


Figure 1

Figure 2 illustrates the same roof as figure 1 with the new retrofit framing system partially installed for clarity purposes. The posts (represented by the vertical lines) are shown located directly over the existing bar joists.

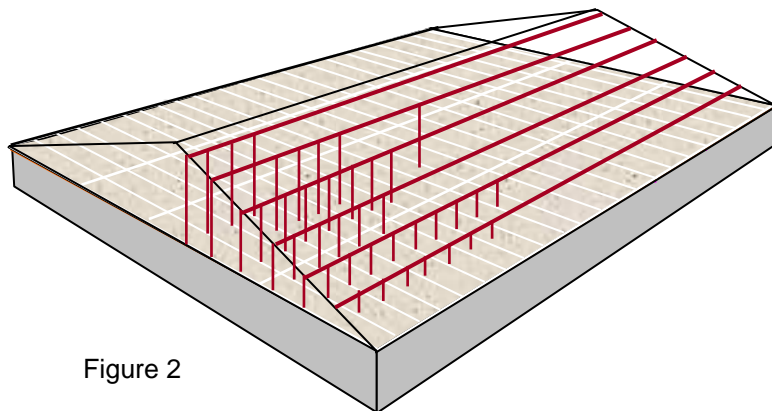


Figure 2

Figure 3 illustrates a different building that will utilize or employ both types of base members. Base shoes are required in the parallel areas and continuous base zee members at the perpendicular areas (shaded). This is a result of the building having hipped ends, where the purlins in the hip and valley areas begin to run the same direction as the existing bar joists. Notice that the base zeers extend past the hip and valley lines to the next bar joist. Doing this permits a post to be located near the hip or valley centerline (refer to figure 5 for more detail).

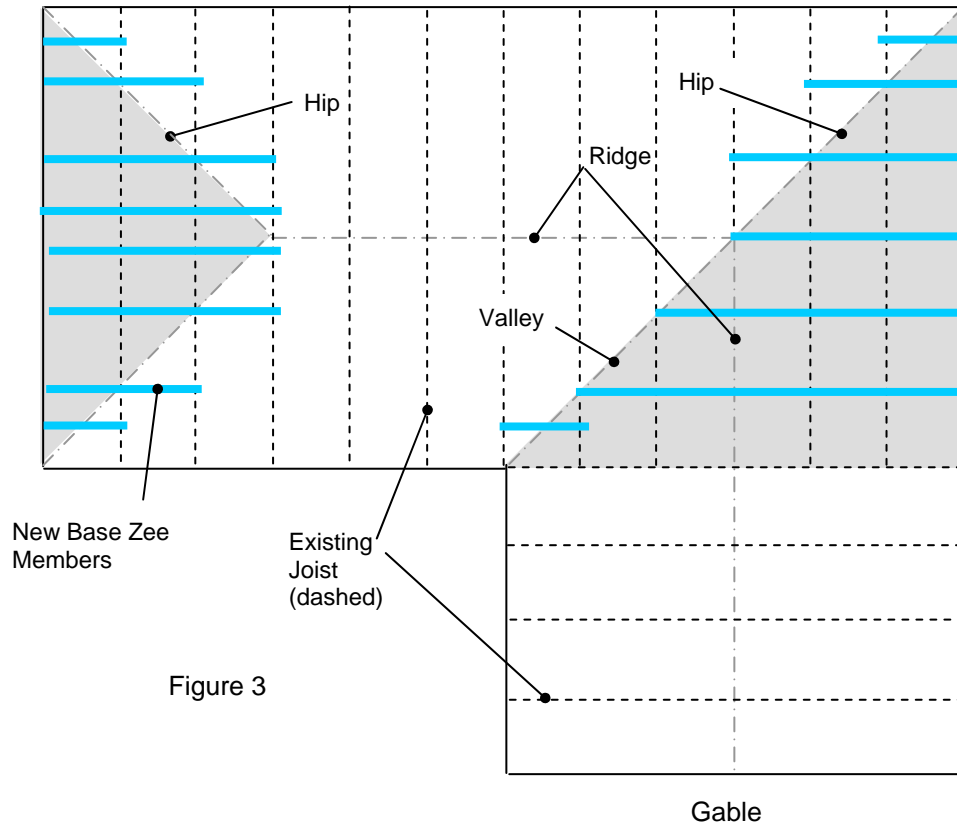


Figure 3

Figure 4 on the next page includes the new purlins and some posts for illustrative purposes. Note the base shoe and posts that are located in the parallel areas and that the posts are attached to a continuous base zee member at the perpendicular hip/valley areas. Refer to figure 5 for more detailed framing at the hip corner as shown within a box below.

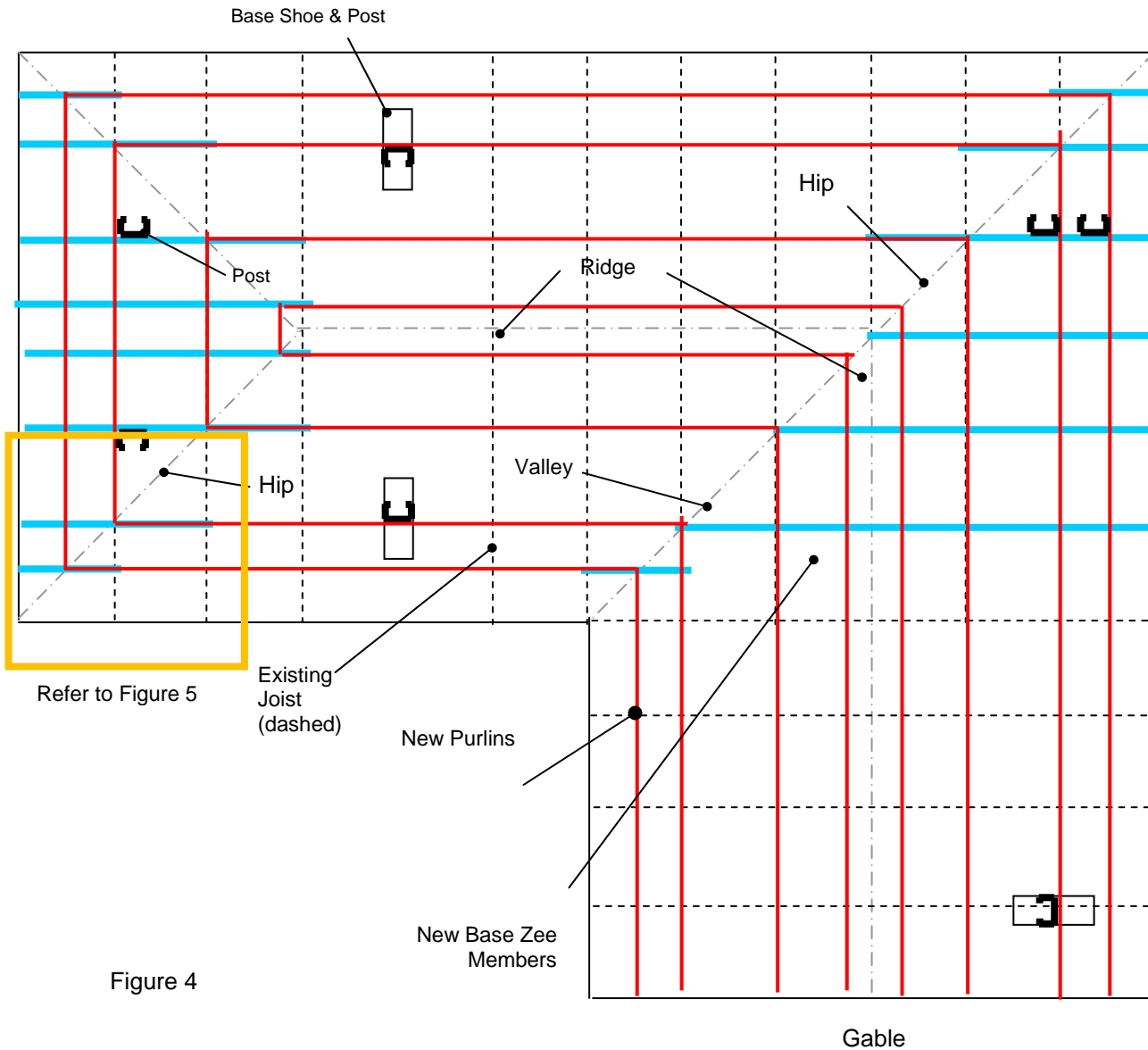
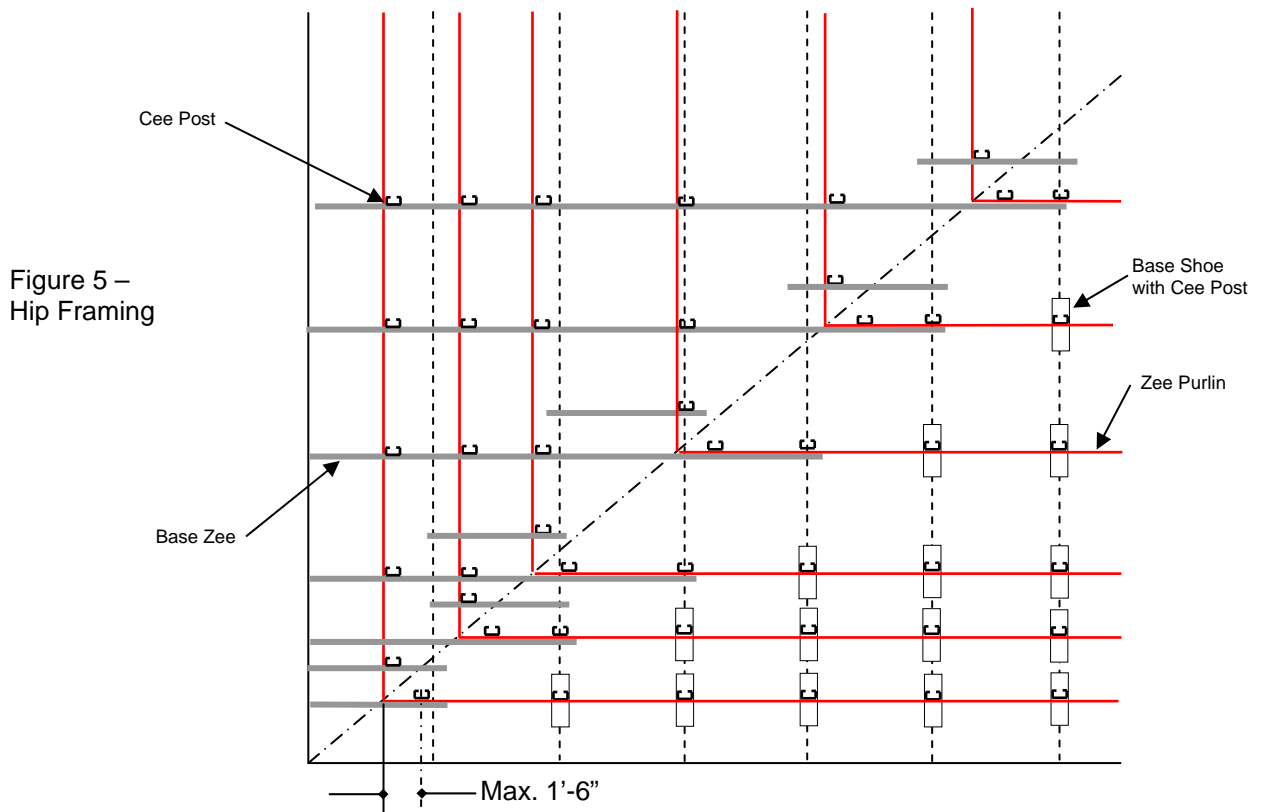


Figure 4

Figure 5 on the next page illustrates the required base zee members, base shoes, and posts to frame a hip (similar at valleys). Note the short base members that span only one existing bar joist spacing. These are needed to install an additional post to support the hip purlins, where the maximum span from the hip centerline to its nearest post is 1'-6". Also note the spacing of the purlins in the hip area do not coincide with the existing bar joists, which is the purpose of the base zee member.



ANCHORAGE OF RETROFIT FRAMING SYSTEM – As mentioned in Chapter 3, pullout tests must be performed at the jobsite on the existing roof. These tests are simply conducted by first selecting appropriate anchors, which are compatible to the existing building's type of structural components. Multiple tests should be performed at different areas of the overall roof. This is done to collect enough pullout values for establishing an average to be used in calculations. After installing a test anchor, the pullout tester (see photo at right) simply pulls the anchor until it fails (strips out of its hole). At the point of failure, a value is recorded from the tester's calibrated gauge. This is the actual jobsite pullout value.



Once all of the tests are conducted, a calculation can be performed to determine the quantity of anchors to be used at each attachment location. For use in an example, let's say that from this testing, it is found that the average value of a 1/4"-14 x #3 point self-drilling screw penetrating a 1/8"

thick steel bar joist chord resulted in 2100 pounds of pullout resistance. To determine the quantity of fasteners at each base shoe or zee member, this value is divided by the maximum negative uplift load as provided by McElroy. Before doing this, it is important to note that the pullout resistance should be multiplied by a safety factor, which is typically specified by a design professional. If a safety factor has not been specified, the contractor should consult with a design professional. McElroy does not specify this factor. Also, let's say that McElroy determines the maximum negative uplift load (upward) is 1100 pounds and a safety factor of 2.5 is specified. Then, the example calculation is $1100 \times 2.5 = 2750$ pounds. This is the total pullout value that must be satisfied by the anchorage method. Hence, $2750 \div 2100$ pullout resistance = 1.31 or a minimum of two fasteners required. Note that it is recommended that a minimum of two fasteners be installed at any location where the framing base member is subject to twist or pivoting at its attachment to the existing structure. This, however, is not necessarily true with continuous base zee members. The following table provides pullout values of common anchors used for the various types of roof construction.

Anchors Commonly used in Retrofit Applications

Existing	Manufacturer Designation	Diameter - Threads per inch	Available Lengths	Pullout Value ¹ (LBs)
Attachment to Wood				
2" x Pine ²	Concealor® Pancake Head Screw	#14-13	1½" to 9"	991
2" x Fir ²	Triangle Fastener Corp Tapper Type A	¼"	up to 6"	991
	Common Lag Screw	5/16"	up to 6"	172-1169
		¾"	up to 12"	186-1330
		½"	up to 24"	191-1609
Attachment to Concrete				
Concrete ³	Sentry Plus Five® Roofing Screw	#14-13	1¼" to 12"	740
		#15-13	1¼" to 24"	1002
	Zamac Drive Pin	3/16"	7/8"	500
		¼"	¾" to 2"	580-1150
	Spike® Nail-in	¼" (1¼" Embed)	2" to 14"	820-5460
	Tapcon® Threaded Screw	¼" (1¼" Embed)	1¼" to 6"	1050
		¼" (1½" Embed)		1380
¼" (1¾" Embed)		2020		
Attachment to Steel				
14 Gauge	Concealor® Pancake Head Screw	#1/4-14 DP3	1¾" to 6"	1077
12 Gauge				2170
1/8"				2030
¼"				4493
3/16"	Blazer® Drill Screw Hex Washer Head	¼-14 DP3	¾" to 8"	3863
¼"				4493
3/8"		¼-20 DP5	3" to 8"	4283
½"				4680

1 – Average ultimate value in pounds with no safety factors applied. Where a range is provided, the ultimate pullout value is totally dependent on the actual condition of the material being attached to.

2 – Fastener with full penetration (greater than 1") into wood member. Consult with Fastener manufacturer or distributor for minimum requirements.

3 – Concrete based on 3,000-PSI minimum with manufacturer specified embedment. Tapcon anchors based on 3,145-PSI concrete.

4 – Values are as provided by Triangle Fastener Corporation (TFC) manufacturer's literature and testing. Visit www.trianglefastener.com for more information or call 800-486-1832 for assistance with determining what anchors and the quantity required. In addition, TFC provides assistance with jobsite pull-out testing and evaluation. **PLEASE NOTE: McElroy Metal does not supply anchors/fasteners for anchoring the McElroy retrofit framing system to the existing building.**

SATISFYING COMPRESSION RESISTANCE - As mentioned in Chapter 3, satisfying compression resistance of the existing roof's substrate and membrane is another calculation that needs to be performed. If the compression resistance is not satisfactory for accepting the newly imposed loads, the contractor will need to utilize a load-distributing component between the base shoe or zee member and the existing roof at each deficient anchor location. This component can be of any high compressive strength material and its size is calculated by dividing the maximum positive load (provided by McElroy) by the compression resistance value obtained from field-testing. This value can be determined during the pullout testing described above or by actually extracting actual core specimens of the existing roof substrate and membrane and then having them tested by a laboratory.



MCELROY STANDARD FRAMING COMPONENTS – The following information and table are provided, in general, to illustrate the sizes of purlins, posts and base zee members used in McElroy's retrofit framing systems. Each retrofit project is unique in its required engineering and is comprised of various members as illustrated in this manual. For purlins and posts, it is possible depending on the project design requirements that more than one size for each component could be selected. If the contractor chooses not to use McElroy's Technical Services and Engineering departments to engineer the retrofit system, then the design should be performed by a professional engineer that is licensed to perform design services. McElroy's Technical Services and Engineering departments are equipped to fully engineer any retrofit system and to produce erection drawings and other installation documents as required. Our expertise can assist in value-engineering a system that is economical and erector-friendly. Therefore, please contact your Sales Representative if you do not have these qualified services available to you.

Purlin Sizing - The tables below and on the next page provide the common zee-shaped purlin sizes used with the McElroy retrofit framing systems and their maximum span capacities members manufactured by McElroy.

Table 1 - Purlin Sizes for McElroy Retrofit Framing Systems

System Type	Purlin Sizes and Gauge Commonly Used
Post and Purlin	3.5 x 1.5 Z-16 GA, 4 x 2.5 Z-16 GA and 4 x 2.5 Z-14 GA
Wide-Span	6 x 2.5 Z-16 GA, 6 x 2.5 Z-14 GA, 6 x 2.5 Z-12 GA, 7 x 2.5 Z-16 GA, 7 x 2.5 Z-14 GA, 8 x 2.5 Z-16 GA and 8 x 2.5 Z-14 GA

It is important to note that purlins are normally spaced from eave to ridge based on the span capacity of the selected metal roof system. All of McElroy standing seam metal roof systems are tested for wind uplift in accordance to ASTM E-1592 (Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference), which determines the ultimate negative pressure that the metal roof system will withstand. These tested values are used in the design of all McElroy metal roof systems for new and retrofit construction projects. The standard in the industry is to install structural standing seam metal roof systems (SSSMRS) over support framing (purlins or joists) having a maximum span of 5'-0" without the benefit of solid roof decking (metal or wood). Refer to Chapter 6 for more information on McElroy's metal roof systems.

Post Sizing – Normally, McElroy utilizes a 4" x 2" nominal cee-shaped member for its posts used in the Post and Purlin and Wide-Span retrofit framing systems. The typical thickness of this member is 16-gauge and its sizing is subject to height and the directly imposed load which it will receive. McElroy employs horizontal struts, which allow the member's height limitation to extend to approximately 20'-0" above the existing roof. In cases greater than this and if the design wind or snow loading is excessive, cee post members up to 8" deep have been used.

Base Zee Sizing – When not permitted to use a standard base shoe channel (parallel conditions), a continuous base member will be required as illustrated in Chapter 4. This member is normally a 3½" x 1½" or 4" x 2½" nominal zee-shaped component with a thickness of 16-gauge. Since we have recommended to always use a rainwater shim beneath continuous base members, the base zee is allowed to span from one existing joist to another. Thus, shims permit the base zee to act as a spanning member in lieu of continuous bearing on the existing roof, which could very well impose unnecessary load into the existing roof deck. In addition, shimmed base zeers permit rainwater to flow to the existing drainage during installation to prevent damming, which could overload the existing roof as well. Again, a qualified structural engineer should review these types of details to ensure they are not overloading the existing roof deck.

DESIGN SUMMARY – It is evident by the procedures and post-construction changes to a building roof, as provided in this chapter, that a professional engineer should be employed to conduct analysis of the existing roof and its structural load capacities. Furthermore, you have the assurance that McElroy will engineer the new retrofit framing and metal roof assembly to comply with the specified building code and criteria. These two engineering disciplines are necessary for a retrofit project to be safe shelter for the building owner and to be completed successfully and without incident of failure.



GENERAL – This chapter is intended to describe the proper fit-for-use application of McElroy’s metal roof, wall and soffit panel systems. For purposes of retrofit, McElroy offers these systems in two categories: Architectural and Functional as described in chapter 4. Both of these categories are

considered to be “structural” type systems. The reason for this, is the panels must attach to “open framing” without the benefit of a solid backing or substrate such as metal or wood. For roof systems, the panels attach directly to the retrofit purlins and for wall and soffit panels, they attach to various types of horizontal sub-framing known as girts.

McElroy’s architectural roof systems offer vertical leg interlocking side joints providing coverage¹ from 12” to 24”. The side joint heights range from 1½” to 3” and are joined by machine seaming (90 and 180 degrees as well as “T” shaped) or by snapping together. Because of the open framing concept with retrofit, architectural profiles must be of the structural standing seam metal roof, “SSSMR”, type. These are not to be confused with other systems in the industry termed as architectural standing seam metal roofing, “ASSMR”, which require solid substrates for support. The National Roofing Contractors Association (NRCA) and the Construction Specifications Institute (CSI) as well as most of the building code governing authorities have adopted these two acronyms for use in specifications and construction documents.

Functional roof systems are normally more economical than architectural, but they are also more limited in their application with various metal roofing conditions such as hips and valleys. These systems are provided in both exposed-fastener² and “standing” seam profiles with interlocking side joints. McElroy’s exposed-fastened systems have overlapping side joints providing 36” coverage with intermittent ribs formed into the panel spaced from 9” to 12” on center. Its sidejoint is secured with exposed fasteners and sealed with rolled butyl mastic. The standing seam profiles, also termed as a SSSMR, form a trapezoidal rib at the side joint once installed, providing coverage from 16” to 24”.

McElroy Metal is equipped to satisfy even the most difficult and complex retrofit projects, including projects that require exceptionally long panel runs (eave to ridge) and curved applications. Jobsite roll-formed roof systems are available using the Maxima and ABC 238T standing seam systems. In addition, both are also capable of being curved to a radius. One-of-a-kind jobsite roll-forming capability is afforded by Archzilla® and Highroller® mobile manufacturing equipment. Panel lengths can be rolled onsite up to 300 feet in length. Contact McElroy for more information.



¹ Coverage is the dimension measured between side joints.

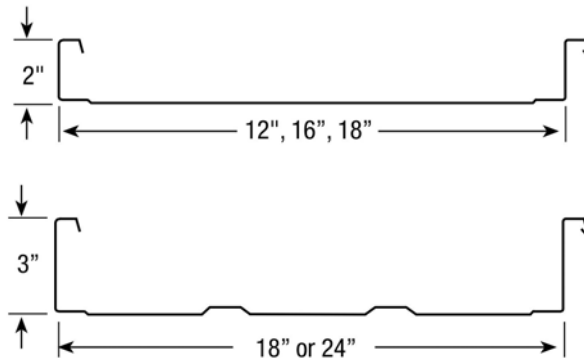
² Exposed-fastener is also referred to as “Thru-fastened”.

The selection between architectural or functional depends on the scope and the intended application of the project as described in chapter 4. On the following page, we have provided the various roof systems as manufactured by McElroy that are applicable to retrofit. In addition, wall and soffit panel systems are provided. These fit-for-use descriptions and tables will assist you in identifying the proper system that can be employed in a project for ensuring correct application with long-term performance results.

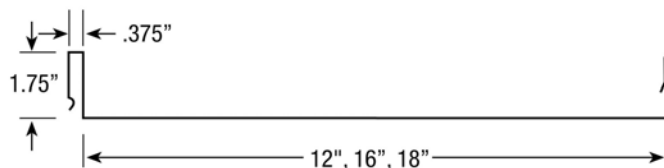
Architectural Roof Panel Systems – McElroy’s architectural roof systems provide a multitude of options with performance testing as shown below.

Profile	Seam Height/Type	Coverage Width	Available Material	Testing
Maxima (Jobsite Roll-formed available)	2" and 3" Triple-Lok 90° Mechanical Seam	(2" Seam) 12", 16" and 18" (3" Seam) 18" and 24"	22 and 24 GA Galvalume and .032 Aluminum	Class A Fire UL580 Class 90 uplift FM4471 (I-90 rated uplift – 24 GA) ASTM E-1592 uplift Florida Product Approval
Medallion-Lok	1 3/4" Snap Together	12", 16" and 18"	22 and 24 GA Galvalume and .032 Aluminum	Class A Fire UL580 Class 90 uplift ASTM E-1592 uplift Florida Product Approval
ABC 238T (Jobsite Roll-formed available)	2 3/8" T-Rib Mechanical Seam	16", 18" and 24"	22 and 24 GA Galvalume and .032 Aluminum	Class A Fire UL580 Class 90 uplift ASTM E-1592 uplift FM Class up to I-195 (22 GA) Florida Product Approval

MAXIMA Machine-Seamed Standing Seam Systems

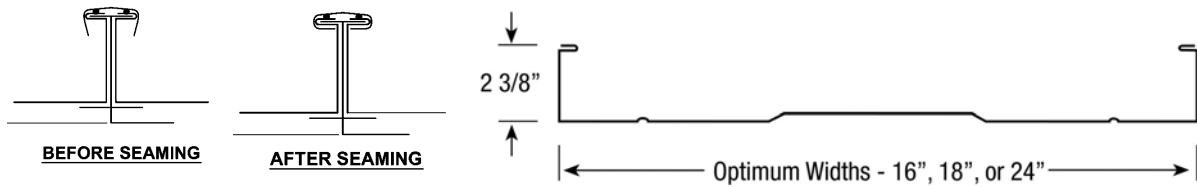


Medallion-Lok Snap-Together Standing Seam System



(Illustrations continued on next page)

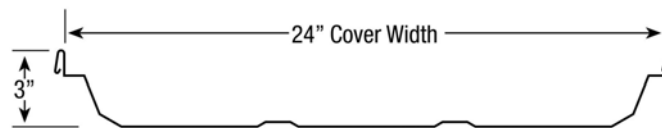
ABC 238T Machine-Seamed Standing Seam System



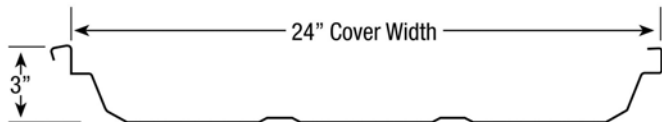
Functional Standing Seam Roof Panel Systems – McElroy’s functional standing seam roof systems provide a multitude of options with performance testing as shown below.

Profile	Seam Height/Type	Coverage Width	Available Gauges	Testing
MasterLok-90	3" Snap Together	24"	22 and 24 GA Galvalume	Class A Fire UL580 Class 90 uplift ASTM E-1592 uplift Florida Product Approval
MasterLok-FS	3" Machine Seamed	24"	22 and 24 GA Galvalume	Class A Fire UL580 Class 90 uplift ASTM E-1592 uplift FM Class 1-90 Florida Product Approval
Mirage	1 5/8" Snap Together	16"	24 GA Galvalume	Class A Fire UL580 Class 90 uplift ASTM E-1592 uplift Florida Product Approval

MasterLok-90 Snap-Together Standing Seam System

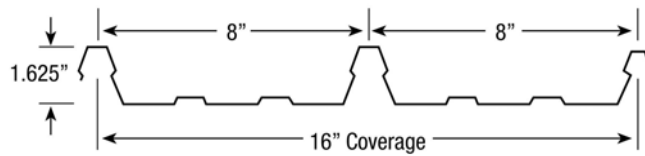


MasterLok-FS Machine-Seamed Standing Seam System



(Illustrations continued on next page)

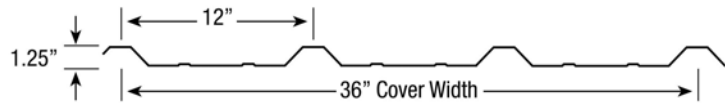
Mirage Snap-Together Standing Seam System



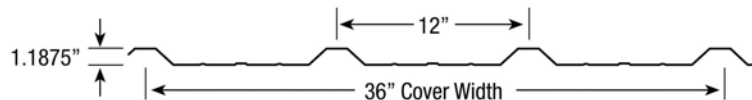
Functional Exposed-Fastener Roof Panel Systems – McElroy’s functional exposed-fastener roof systems provide the basics for economical roof systems.

Profile	Seam Height/Type	Coverage Width	Available Gauges	Testing
R-Panel	1 1/4" Lapped	36"	26 and 24 GA Galvalume	UL580 Class 90 uplift Florida Product Approval
Multi-Rib	1 3/16" Lapped	36"	26 and 24 GA Galvalume	UL580 Class 90 uplift Florida Product Approval

R-Panel Exposed-Fastener Panel



Multi-Rib Exposed-Fastener Panel

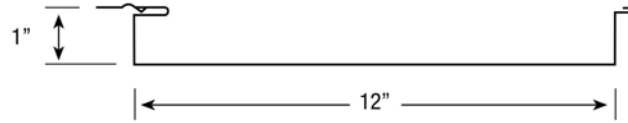


Wall/Fascia and Soffit Panel Systems – McElroy’s concealed-fastener wall systems provide aesthetically pleasing results.

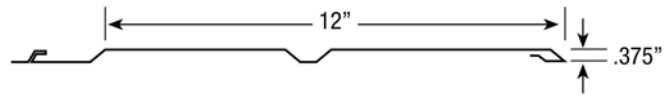
Profile (Application)	Height	Coverage Width	Available Gauges	Comments/Options
Marquee-Lok (Wall and Soffit)	1" (nominal)	12"	24 GA Galvalume and .032 Aluminum	Concealed-fastener / Non vented (smooth) and vented
Matrix (Soffit Only)	3/8"	12"	29 and 24 GA Galvalume and .024 Aluminum	Concealed-fastener / Non Vented (Smooth) and Vented

(Illustrations on next page)

Marquee-Lok Wall/Fascia and Soffit Panel



Matrix Soffit Panel

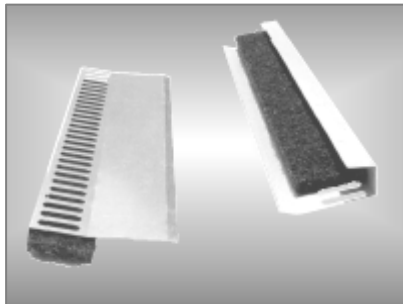


Note that McElroy Metal has several other functional exposed fastener panel profiles that can be used for vertical and horizontal applications. Refer to our other literature and/or our website www.mcelroymetal.com that describes these systems.

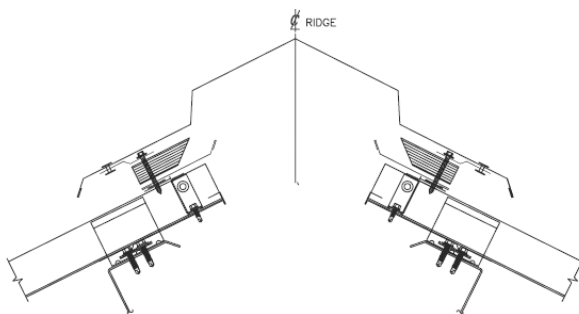
GENERAL – The following accessories are available from McElroy retrofit related applications providing alternatives in ventilation and for accommodating the extension of existing rooftop equipment. Contact McElroy if additional information is needed.

ROOFTOP VENTILATION

Eave PreVent™ Vent Strip – manufactured of 16-GA Galvalume™ with ½” x 2” die-punched slots spaced at 29/32” centers with continuous Cobra® Vent insert for prevention of insect and wind-driven entry. Provides 13.0 NVFA¹. Available in bare finish or powder coated to match adjacent trim. Refer to eave details in chapter 9 for applications.

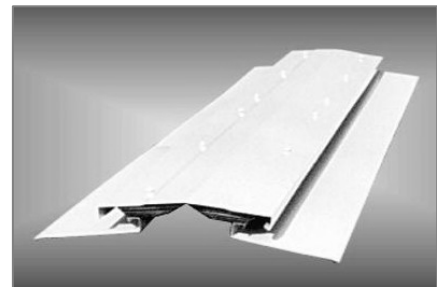


Ridge/High-Side² Vent Strips – these assemblies are custom created for each of the McElroy architectural standing seam roof systems. Includes Cor-A-Vent® insert with 9.0 NVFA per strip.

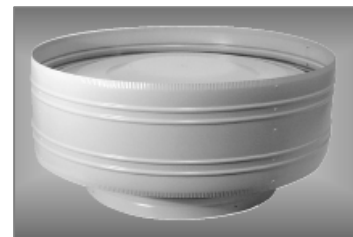


¹ NVFA = Net Vent Free Area per lineal foot of vent.
² High-Side represents venting at high eaves and roof-to-wall conditions.

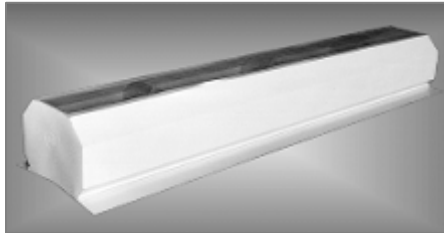
Dampered Ridgeline Vent - Low Profile Floating Ridge Vents ...featuring Cor-A-Vent® ventilation core is designed specifically for architectural standing-seam retrofit applications where maximum ventilation is required in an attractive, very low-profile unit that provides 18.0 NVFA. This unit has a damper that can be manually opened and closed from the roof top on Metal-over-Metal retrofit applications to allow for the change in seasons when wanting to utilize the cavity between the old and new roofs for solar heat recovery as described in Chapter 9.



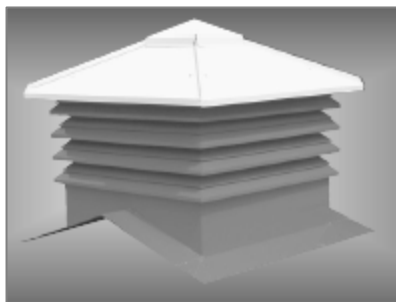
Round Ventilators – manufactured of 26-GA inner/outer bands with rain shield, pre-formed baffles, integral base flat skirt and galvanized 4 x 4 mesh hardware cloth. Available in 12”, 20” and 24” throats with operable dampers and factory painted to match roof panels mounted to customer furnished roof panel.



Ridge Ventilators – manufactured of 26-GA exterior combined with 24, 20 and 18-GA die-formed internal baffle and rain shield with integral dampers and galvanized 4 x 4 mesh hardware cloth. Available in 9” and 12” x 10’-0” long throats with operable dampers activated by hand or electric winch operator(s) and factory painted to match roof panels. Die-formed skirts available for function exposed-fastener roof panels.



Vented Ridge and Hillside Cupolas – manufactured of .050 aluminum tops and .080 aluminum bases with mitered and welded blades at 45° angle. Mounted on 16-GA curb and includes 18/16 insect screen. Available in 36” and 48” square with factory installed 1½” thick-3lb density foil-faced fiberglass insulation. Factory painted to match roof panels.



WALL VENTILATION

Louvers – fixed and operable³ 45° blades. Electrostatically coated with 2-mil oven-baked polyester finish. Includes removable 18/16 aluminum mesh screen at interior side. They are self-mulling, self-flashing and self-framing providing a minimum 55% free area airflow. Available in multiple sizes with mullions to assist installation and operation and can be hinged to permit access to underside of roof/attic space. Operable blades are provided with hand crank.

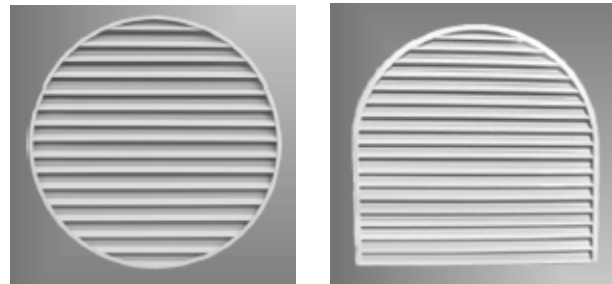
Square or Rectangular

18-Ga Galvanized and 20-GA Blades



Dormer Applications

.080 Aluminum with .080 extruded Blades



Gable Applications

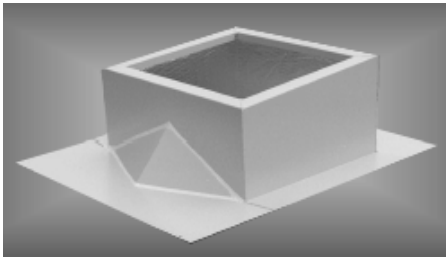
.080 Aluminum with .080 extruded Blades



³ Only square and rectangular louvers are available operable.

ROOFTOP PENETRATIONS

Roof Curbs – manufactured of .080-3003H14 aluminum or heavier to support the load of the equipment with fully mitered and heli-arc welded corners, 8” minimum height above finished roof, integral base plates and water diverter cricket. Available in two-piece construction for Retrofit Applications and factory painted to match roof panels.



Roof Hatches/Scuttles – Constructed same as roof curbs with gas-charge openers and pad-lockable from inside or out.



Roof Jacks/Boots – manufactured of non-cracking ozone/ultra-violet resistant gray EPDM or Silicone with flexible corrosion resistant aluminum base that conforms to most panel profiles.

- EPDM sizes from ¼” to 24” diameter
- EPDM has service temperature range of minus 30° F to +250° F
- Silicone sizes from ¼” to 18” diameter
- Silicone has service temperature range of minus 40° f to +350° F



Retrofit Jack/Boots - manufactured of EPDM with compression fit zipper that forms around existing round penetrations.

- Sizes from ¾” to 10” Diameter
- Service Temperature Range of minus 30° F To +250° F





GENERAL – McElroy prides itself on having one of the most responsive and qualified Project Services groups in the metal components industry. With metal framing components and roofing systems being employed in new, renovation and retrofit construction, it is imperative that manufacturer's have the ability to produce fully-engineered systems. Moreover, it is important that design professionals have these services available to assist in the development of a project.

McElroy consistently provides professional engineering and quality installation documents specific to the systems we manufacture. In addition, professional consultation is provided on job specific issues or simply for responsibly selecting the proper fit-for-use framing or metal roof system

on a project. Having this available, ensures design professionals that the project will employ the correct system for the application as required by the project's scope and the building owner will obtain the system that will provide the expected long-term performance.

As part of Engineering Services, system testing is of the utmost importance. At McElroy, testing is an on-going process with some tests being conducted in our laboratory located at our home office/plant in Bossier City, Louisiana while others are conducted in well qualified and certified labs across the country specializing in metal roof systems. All tests are performed under the direct supervision of a professional engineer including those for wind uplift (ASTM E-1592 and UL) as described in Chapter 2.

In support of our customers and their personnel, which physically install our systems, McElroy conducts regularly scheduled training programs for the installation of our functional and architectural metal roof systems as well as the retrofit framing systems specified in this design guide. This training is made up of approximately 25% classroom for the basics and fundamentals and then 75% "Hands-On" installation using life-size assemblies. Each attendee is graded and tested under a pass/fail curriculum, which provides the design professional and owner with true factory-trained assurance in the Installer.

ESTIMATING & QUOTE REQUEST REQUIREMENTS – All McElroy retrofit framing and metal roof systems are estimated by the McElroy Technical Services department in Bossier City, Louisiana. This ensures the project is designed and estimated in accordance with the project's specifications and bid documents as well for compliance with other requirements set forth by the existing building's roof and structural support system. Each project is first reviewed by a Project Manager that specializes in retrofit applications to determine that a adequate amount of information is available to release to McElroy's design and estimating teams. If not, the estimate request could be stalled waiting for additional information. Therefore, if your project is for bid on a specific date, then make all attempts to provide the following information:

- A. Bid documents including drawings and specifications if applicable. Also include "As-built" drawings if available.
- B. Since we are working on existing buildings, the physical street address is essential. This will permit McElroy's design team to view the building roof in Google Earth® or other software. This helps McElroy in identifying surrounding structures missed that may affect the retrofit system design as well as rooftop units and other obstacles that may be miss in your description of the project.
- C. A roof plan or sketch prepared with physical roof dimensions that have been confirmed at the jobsite. These dimensions should include perimeter measurements, parapet heights, elevation changes/transitions in roof elevation, existing slope if any, existing rooftop drainage and penetrations.
- D. Identify the type of existing roof supports/joists (steel, wood or concrete, etc.) and their respective spacing and span orientation (east-west or north-south). In order to obtain this information, it will require a survey of the supports from the underside of the roof. This process can sometimes be very difficult because of ceilings or other construction that may prevent you from physically seeing the structural components. However, please understand that this information is absolutely necessary to

generate an accurate design and estimate. Without it, it is only a guess of what the actual project will require from a materials standpoint.

- E. The roof(s) height above grade as well as the occupancy type (office, church, etc.) and the a general description of the neighboring structures. This provides the exposure of the roof from a wind affect.
- F. Results of onsite rooftop inspections of the existing roof conducted with locations of rooftop equipment that will remain on the existing roof or those being relocated to the new roof elevation. This should include any special conditions (pathways) to provide access to packaged air-handling units that will be roofed over for repair and maintenance or removal and replacement in the future. In addition, locate new mechanical wells if equipment is to be relocated to one central area. In these cases, new ductwork sizing may be required so the retrofit framing can be designed to not obstruct the new work. Refer to Chapter 3 for more information.
- G. Last but definitely not least, submitting photographs from ground level and from the rooftop are essential. These photos can tell “the rest of the story” about the existing roof and are helpful in identifying conditions or obstacles that need to be accommodated in the estimate.

To accurately prepare a quote and to determine if the project can in fact be estimated, the McElroy Project Services team evaluates all of the information once received. In cases where not all of the information is provided, it is possible sometimes for McElroy to “Qualify” the quote by making educated assumptions. However, it is important to understand that if this option is exercised, the quoted dollars are not guaranteed and the quote is subject to be estimated once a project is contracted and order processing begins. Furthermore, if the proper information is not known at the time the order is placed with McElroy, the processing of the order and installation documents (engineering and drawings, etc.) will be delayed waiting for the information to be sent to McElroy. For this reason, it is critical that you provide as much of the information described above as physically possible and the information contained in the Tech Services Estimate & Services Request form.

SPECIAL NOTE: McElroy Metal’s retrofit framing systems include base members, purlins, bracing, self-drilling attachment fasteners, columns/posts, eave members, and additional sub-structural members required for the complete installation of the retrofit system as per the design by McElroy Metal and as qualified in the estimate. They do not include anchors or fasteners for attaching the retrofit framing system to the existing building and/or its roof structural supports. It is important to understand that some framing members will require field-cutting from standard factory lengths as qualified in the McElroy Metal estimate, unless specifically otherwise requested by the customer. These members may include continuous base zees, intermittent base shoes, vertical columns/posts and others as deemed project specific and appropriate by McElroy Metal.

ORDER AND CONTRACT PROCESSING - During the estimate process, McElroy’s Project Services team has determined the project requirements from the information provided to them. In order to provide a detailed estimate of materials to be provided by McElroy, this work has included preliminary engineering of all components in the retrofit framing and new metal roof system.

Once the customer is ready to submit an order, he/she will execute the proposal/contract and submit to their McElroy salesperson. Upon receipt at McElroy’s Bossier City, LA offices, a member of the McElroy Project Management team is assigned to the job and will be responsible for managing it throughout the engineering and drafting processes, and then on to pre-shipment and post-shipment coordination. However, before the order can be released for processing to McElroy’s engineering and drafting teams, the Project Manager must obtain from the customer, the most current issue of construction documents if applicable, existing roof system information and other items as described above in the estimate process. This is the final step in securing information that will provide a successful project and shipment of materials arriving at the jobsite.

Since retrofit projects are largely dependent on the existing roof construction, all retrofit orders are first entered “For Approval”. This means the job will be engineered and preliminary drawings will be created that will be sent to the customer for their approval prior to final material take-off and manufacture. The “For

Approval” stage requires the customer to verify all dimensions shown on the McElroy installation drawings to ensure the job requirements have been interpreted correctly. In most cases, there will be other items shown on McElroy’s drawings asking for verification or for the customer to provide further explanation or documentation. Please note that approval of these documents by the project’s Engineer of Record or Architect does not constitute approval by the McElroy customer. This is necessary because most design professionals will not answer McElroy’s requests for verification and explanation. It is also important to understand, “For Approval” drawings should not be used for obtaining building permits. If a set of drawings is required for a building permit, with design calculations when necessary, McElroy can provide similar documents issued and marked for “Permit Drawings”. These documents are intended for the customer to submit for his/her building permit office approval and are not to be considered a release for construction. If permit drawings are required, additional fees may apply. Upon the receipt of the “For Approval” drawings by McElroy’s Project Manager, they are inspected to confirm all verifications and information requests have been answered. If not, the order will be delayed until the information is received.

In summary, retrofit projects are typically very complex due to the new retrofit assembly where as the framing must be designed and detailed based on the existing roof system, in order to construct the new roof as requested in the bid documents. Because of this, their order processing is of the utmost importance for you to have a pleasant experience that is not delayed or troubled with field discovered conflicts once you have started erecting the framing system. Proper due diligence up front will always prove worthy of the time and trouble it takes.

SPECIFICATIONS – On the following pages, we have provided a guide specification to establish a quality level and performance standard for a project consisting of a new metal roof system supported by a new fully engineered light-gauge retrofit framing system. This specification is for the framing system only. Refer to other McElroy specifications for metal roof, wall and soffit systems. In addition, if the Specifier wishes to include insulation, ventilation and rooftop equipment work that are commonly considered to be an integral part of a retrofit project, we have provided the additional sections at the end of the specifications.

This specification section would typically be included as part of CSI formatted specification Section 05165 – Metals. This section could be incorporated into the Metal Roof Panel Section 07411 at the Specifier’s discretion. In addition, the Specifier may amend this specification as they see necessary to accommodate specific project requirements. If assistance is required, contact your McElroy Metal Architectural Sales Manager.

Note to Specification Writer/Specifier: The Notation **[Specifier Note:]** means that the text following requires examination to determine if the information is applicable to the project and/or may request that you select optional criteria as provided, if required to customize this specification to the project’s locale or parameters.

SECTION 05165 - SPECIFICATIONS FOR RETROFIT ROOF FRAMING SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

1. General

1. The retrofit framing system shall provide support for a new metal roof panel system over the existing building roof and shall accommodate the irregularities of the existing roof to form a structural framework for supporting the new metal roof panels at the specified slope. Furnish all labor, material, tools, equipment and services for the retrofit framing system as indicated, in accord with the provisions of the contract documents. The metal roof panel system manufacturer will provide all components required for a complete single-supplier system including base members, clips, purlins, purlin supports, bracing and structural member-to-member fasteners as well as panels, panel clips, trim/flashing, fascias, ridge, closures, sealants, fillers and any other required items as specified in related sections.

B. Related work specified elsewhere:

2. Section 07411 – Metal Roof Panels
3. Section 07620 – Sheet Metal Flashing and Trim

1.02 QUALITY ASSURANCE **[Specifier Note: Delete references to sections not used and add any references that are specific to the project]**

A. Applicable Standards: All following referenced publications shall be the most current edition in effect on the date of solicitation.

1. American Institute of Steel Construction (AISC)
 - a. AISC - Specification for Structural Steel for Buildings
2. American Iron and Steel Institute (AISI)
 - a. AISI CF00-01 – A Design Guide for Standing Seam Roof Panels
 - b. AISI CF97-01 – A Guide for Designing with Standing Seam Roof Panels.
 - c. AISI “Cold Form Steel Design Manual”
3. American Society of Civil Engineers (ASCE)
 - a. ASCE-7 - Minimum Design Loads for Buildings and other Structures
4. American Society for Testing and Materials (ASTM) (As Applicable)
 - a. ASTM A 36/A 36M - Structural Steel
 - b. ASTM A 307 - Steel Bolts and Studs
 - c. ASTM A 446 - Steel Sheet, Zinc Coated (Galvanized) By The Hot-Dip Process
 - d. ASTM A 525/A 525M - Steel Sheet, Zinc-Coated by the Hot-Dip Method
 - e. ASTM A 529/A 529M – Structural Steel with 42 KSI Minimum Yield Point
 - f. ASTM A 1101 – Steel Sheet and Strip, Carbon, Hot-Rolled
 - g. ASTM A 653/A 653M – Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy - Coated (Galvannealed) By Hot-Dip Method
 - h. ASTM E 1514 –Structural Standing Seam Steel Roof Panel Systems.
 - i. ASTM E 1592 - Structural Performance Test for Metal Panel and Siding Systems by Uniform Static Air Pressure Difference
 - j. ASTM A792 – Specification for Galvalume Coated Steel
5. Metal Building Manufacturers Association
 - a. MBMA – Metal Building Systems Design Practices Manual
6. Factory Mutual
 - a. FM-4471 – Wind Uplift Test for Metal Roof Panel Systems
7. American Welding Society
 - a. AWS D1.1 Structural Welding Code – Steel
 - b. AWS D1.3 Structural Welding Code – Steel Sheet

8. Steel Structures Painting Council
 - a. SSPC- SP10 - Steel Structures Painting Manual
 9. Underwriters Laboratories, Inc. (UL)
 - a. UL 580 - Tests for Uplift Resistance of Roof Assemblies
 10. American Society Of Heating, Refrigerating And Air-Conditioning Engineers (ASHRAE)
 - a. ANSI/ASHRAE Standard 90.1, Energy Standard for Buildings
- B. Manufacturers Qualifications
1. Manufacturer of the retrofit framing system shall be experienced in fabricating complete single-supplier metal roof systems of similar size and scope to this project for a minimum of five (5) years.
- C. Installing Contractor Qualifications
1. Installer shall be experienced in installation of structural light-gage retrofit framing and metal roof panel systems for a minimum of two (2) years and shall meet the following minimum criteria.
 - a. Shall be a factory-authorized installer of the manufacturer trained in the installation of the metal roofing system specified.
 - b. Maintain \$1,000,000 minimum general liability insurance coverage.
 - c. Maintain statutory limits of worker's compensation coverage as mandated by law.
 - d. Will provide a full-time project foreman/superintendent at the jobsite that has been trained by the metal retrofit roofing system manufacturer for the supervision of the installation.
- D. Installation Quality Control
1. The contractor shall conduct inspections of the retrofit framing system prior to metal roof panel installation to ensure straightness and proper alignment to minimize oil-canning and to confirm the system components have been installed in accordance with the installation documents.
- 1.03 EXISTING ROOF SYSTEM AND TESTING
- A. The existing roof assembly consists of a **[Specifier Note: Briefly describe the construction of the existing roof support system, substrate and membrane assembly. If these vary, you may wish to disregard this section or expand the description. Example: structural open-web steel bar joist system with 22 gauge metal decking, 2" of rigid insulation and built-up roof membrane]**.
 - B. Where conditions permit and are required, the contractor shall obtain field measurements and forward them to the retrofit system manufacturer for coordination and integration into the installation documents and submittals. This shall be done prior to commencing any engineering and design work and before fabrication of any materials.
 - C. The contractor shall have conducted field pullout testing for evaluation and selection of framing system anchors to attach the new retrofit framing base members to the existing roof support system. The testing will be conducted at multiple locations of the existing roof area using a calibrated pullout tester. Pullout values shall be recorded at each location for each specific anchor used. All anchors shall penetrate and attach to existing structural support members. The contractor shall have the attachment connection designed to satisfy wind uplift values, as provided by the retrofit system manufacturer, multiplied by a safety factor of 2.5. This analysis shall be submitted for review and approval.
 - D. The contractor shall conduct field compressive strength testing performed for evaluation of the existing roof substrate and membrane assembly. These values, recorded in pounds per square inch (PSI), will be analyzed to determine if each retrofit framing system base member's bearing surface area is adequate in size, to distribute the imposing positive loads as to not exceed the compressive strength of the existing roof substrate and membrane assembly. If the values exceed the compressive strength, then an additional bearing component of sufficient size will be added between the base member and the existing roof.

1.04 DESIGN REQUIREMENTS

A. General

- a. Design for approval and installation in accordance with the included drawings and these specifications, a complete retrofit framing and metal roof panel system as a structural package, engineered and factory fabricated by one manufacturer in accordance with AISI, MBMA and ASCE references.
 - b. Any additions/revisions to framing members as a result of field conditions and/or demands, shall be the contractor's responsibility, and shall be submitted for review and approval by the manufacturer.
- B. Building Code
- a. The retrofit metal roof system manufacturer shall engineer the entire system to meet the **[Specifier Note: choose one: International Building Code (IBC), Southern Building Code (SBC), Uniform Building Code (UBC) or Building Officials and Code Administrators International Code (BOCA)]** or **[if the project is located within a State that has its own adopted building code such as Florida, North Carolina and others, then write the appropriate code name here]** code and per the current edition of ASCE-7 as applicable.
- C. Wind Load Design
- a. The assembly shall withstand a wind load miles per hour (MPH) velocity as required by the code. The metal roof panel assembly, which includes portions of the retrofit framing system, must be tested in accordance with the UL-580 test procedure and the ASTM E 1592 Structural Performance Test for Metal Roof and Siding Systems by Uniform Static Air Pressure. The metal roof panel system shall be classified as a UL-90 rated assembly.
- D. Live and Snow Load Design
- a. Horizontal Assemblies shall withstand minimum live and snow loads as required by the code plus the weight of the retrofit framing and metal roof panel assembly.
 - b. The retrofit framing system shall transfer loads from the new roof system to the existing roof structure in such a manner as to not overload the existing roof's structural support members as well as the substrate and membrane assembly - refer to 1.03.C.
 - c. Horizontal deflection shall be L/180 of span after installation of equipment and vertical deflection in framing members shall not exceed H/60th of their length.

1.05 SUBMITTALS

- A. The following shall be submitted by the retrofit framing system manufacturer for approval in a timely manner after award of contract.
- a. Detail drawings shall consist of catalog cuts, design and installation drawings and other data necessary to clearly describe design, materials, gages, sizes, layouts, construction details, fasteners and erection. Detail drawings shall be accompanied by engineering design calculations for the structural properties of the retrofit framing components and metal roof panel system, which shall bear the seal and signature of a Professional Engineer registered to practice in the State of **[Specifier Note: insert name of the State, which the project is located]**.
 - b. Manufacturer's product literature for retrofit framing system components including purlins and supports, clips, bracing and connection fasteners.
 - c. A minimum of six (6) project references of similar use and size listing the Architect, owner, location, scope and name of project as provided by the manufacturer.
 - d. Obtain approval of all submittals prior to fabrication and installation.

1.06 DELIVERY AND STORAGE

- A. Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry.

PART 2 – PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. The retrofit framing and metal roof panel system as specified in section elsewhere in this specification shall be as manufactured by the following or a prior approved equal with all roof panel, framing components and accessories from a single source manufacturer

McElroy Metal Inc. - Corporate Office - 1500 Hamilton Road - Bossier City, LA 71111
(800) 562-3576

- B. Supply all products specified in this section from the same manufacturer as for Sections 07411 and 07620

2.02 FRAMING SYSTEM COMPONENTS

- A. The retrofit framing manufacturer shall engineer the framing system to comply with the "Design Intent" of the existing roof's supporting structure to ensure that all new load-bearing or load-transferring members are anchored to and located directly over existing secondary or primary load bearing support members. The retrofit framing system shall consist of any of the following components based on the Manufacturer's design and in accordance with the specifications herewith.
- a. Base clips for purlin supporting member attachment shall be a minimum 4"x4"x3½"x14-gage steel angle having 14.0 square inches of bearing surface area.
 - b. Base channel members shall be a minimum 4-3/16"x2"x16-gage x 12" long having 50.25 square inches of bearing surface area.
 - c. Continuous base members shall be a minimum of 16-gage formed steel channel, cee or zee shape.
 - d. Purlin supports (vertical members) shall be a minimum 4"x2"x18-gage formed steel channel or cee shape.
 - e. Purlins shall be a minimum 3½"x1½"x16-gage formed steel zee shape.
 - f. Purlin clips shall be a minimum 16-gauge formed steel angle shape.
 - g. Perimeter elevated wall framing members shall be a minimum of 16-gage formed steel, channel, and cee or custom shapes to satisfy conditions.
 - h. Transverse and longitudinal angle bracing shall be a minimum of 18-gage formed steel with a minimum 4" pre-formed girth.
 - i. Purlin stabilization shall be a minimum 0.023" thick x 2" wide x 50 KSI steel strapping.
 - j. Hat channels used for bracing, girts, struts or other members shall be a minimum of 22-gage steel with galvanized, G-90 coating, in accordance with ASTM A 525.

2.03 MATERIALS

- A. Steel sheet for roll-formed or press-broke members of the gage indicated herein, conforming to ASTM A 1011 and minimum yield strength 55,000 PSI.
- B. Structural shapes if required for special conditions shall conform to ASTM A 36 and minimum yield strength of 36,000 PSI.
- C. Cold form steel framing system members of the minimum gages indicated herein shall have a protective shop primer coating conforming to FS TT-P-646 with base steel prepared in accordance with SSPC-SP10.
- D. Supply all hardware items required for installation of retrofit framing system in accordance with manufacturer's installation instructions and other indicated items.

2.04 MISCELLANEOUS PRODUCTS

- A. Fasteners And Anchors
 - a. Anchors used for the attachment of the new retrofit framing system to the existing roof structural support system shall be of the type and size that is appropriate for secure attachment to satisfy the required wind uplift pressure values at each location, as specified by the retrofit system manufacturer. All anchors shall attach directly into existing structural members. A minimum of two (2) anchors shall be used for base clips and channels.
 - b. Fasteners used for the retrofit framing system shall be a minimum ¼" diameter with 14 threads per inch having a stress relief head and a corrosion resistant coating.
- B. Anchor Penetration Sealant

- a. Temporary construction sealant shall be used at each anchor penetration at attachment locations of the new retrofit framing system to the existing roof structural support system. The Installer shall select the appropriate sealant type that is compatible with the existing roof membrane, which will provide a leak-free condition throughout the erection of the framing and the completion of the metal roof panel system installation. The installing contractor is responsible for any and all leaks including damage to the building contents.

[Specifier Note: If desired, you may include in this section additional specifications for insulation, ventilation and rooftop equipment that relate to the retrofit roof system. Typically, these are an integral part of a complete retrofit project. Refer to attachments that were included with this specification]

PART 3 – EXECUTION

3.01 DEMOLITION OF EXISTING ROOF MATERIALS

- A. **[Specifier Note:** Choose if you desire to have the existing roof aggregate or ballast removed (if applicable as well)] The installer shall remove the existing loose and semi-loose aggregate from the built-up roofing membrane. Removal shall be accomplished by carefully spudding the existing aggregate so as to minimize damage to the roofing membrane. The removal shall be thorough and shall render a smooth substrate suitable for that attachment of base framing members to the exposed roofing membrane. The installer shall exercise care and shall prevent aggregate from entering roof drains and clogging the existing roof's drainage system. All aggregate surfacing shall be removed and disposed of properly and in accordance with local ordinances and regulations.

3.02 FRAMING SYSTEM INSTALLATION

- A. General
 1. Installation shall be as specified and in accordance with the retrofit systems manufacturer's approved installation documents and erection drawings.
 2. Install the retrofit framing system with consistent purlins erected without waves, warpage, buckles, fastening stresses or other distortion. Every care should be taken in the installation of the retrofit framing to minimize oil canning in the metal roof panel system.
 3. Field cutting of framing members shall be done in a safe manner preventing damage to the existing roof or adjacent materials. The retrofit framing contractor shall use good construction practices to minimize scrap and to utilize the material as provided by the retrofit system manufacturer.
 4. Dissimilar materials that are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds.
- B. Erection Tolerances (Over length of member)
 1. Variation from plumb: 1/8 inch, maximum
 2. Variation from level: 1/8 inch, maximum
 3. Variation from true plane: 1/8 inch, maximum
 4. Variation from true position: 1/4 inch, maximum
 5. Variation of member from plane: 1/8 inch, maximum

3.03 EXTENSION OF EXISTING COMPONENTS

[Specifier Note: the following addresses rehabilitation work that may be required on existing components and rooftop equipment. Use these as appropriate to the project to satisfy the conditions of the project and application of the new retrofit roof system]

- A. Extension Of Electrical Service: When power vents are removed and reinstalled on curbs on the new metal roof panel system, the contractor shall extend the electrical service as required to render the power vent operational. Extensions shall be made with like gage and type wire. If the original service is run in conduit, conduit shall be installed on the extension. Junction boxes shall be provided at splices in wire or conduits. Junction boxes and conduit shall be secured to the steel framing structure. All work shall be accomplished to comply with the local electrical code.

- B. Extension Of Existing Plumbing Vents: During the installation of the specified metal roof panel system, the extension and flashing of existing plumbing vents will be required. The contractor shall extend existing plumbing vents through the metal roof panels, as required and provide flexible vent pipe flashings at the roof panel penetration. Plumbing vent extensions shall be made with material of like composition of the plumbing vent being extended, and shall be securely braced within the attic space to ensure continued service of the vent. As often as possible, when extending plumbing vents, the contractor shall ensure that the roof penetration is located between the side seams of the metal roof panels such that the malleable ring on the flexible vent pipe flashing will lay flat against the roof panel around it's entire circumference. The contractor shall install elbow fittings to horizontally displace the pipe if necessary. The metal roof panel system manufacturer must approve plumbing vents that do not fall between side seams.
- C. Extension Of Existing Hot Flue Stacks: During the installation of the specified metal roof panel system, the extension and flashing of existing hot flue stacks will be required. The contractor shall extend existing hot flue stacks through the metal roof panels, as required and provide flashings at the roof panel's penetration. Flashings shall be flexible vent stack type or rooftop equipment curb type depending on the size of the existing stack. Hot flue stack extensions shall be of double wall construction made with material of like composition of the hot flue stack being extended, and shall be securely braced within the attic space to ensure continued service of the vent. Hot flue stacks shall be extended to be 3 feet higher than the elevation of any roof within a 10-foot radius of the hot flue stack penetration.
- D. Extension Of Existing Ductwork: When existing gravity vents, power vents, gooseneck fresh air make-up, and other vents are installed on curbs on the new metal roof panel system, the extension of vent ductwork will be required. The contractor shall extend existing ductwork through the metal roof panel system, as required to ensure the continued service of the vent. Ductwork shall be securely attached to new rooftop equipment curb and joints shall be sealed tight to provide a leak-proof assembly. Ductwork extensions shall be made with material of like composition and gage of the ductwork being extended.

3.04 REINSTALLATION OF EXISTING COMPONENTS

- A. Reinstallation Of Existing Vents: During the installation of the specified metal roof panel system, the removal and reinstallation of existing power vents, gravity vents, and gooseneck vents shall be required. The contractor shall remove and reinstall vents indicated to extend through the metal roof panel system. The contractor shall have the responsibility to remove such vents without damage, and reinstall the vents on new rooftop equipment curbs. Vents shall be securely fastened to the equipment curb to prevent displacement and to provide a weathertight installation. In the case of power vents, the electrical service shall be extended to ensure continued service of the vent.

3.05 CLEAN UP

- A. The Contractor shall protect installed products from damage by subsequent construction activities until final acceptance. The contractor shall collect and dispose of all framing system cuttings and debris including unused anchors, framing fasteners, sealant and associated material from the jobsite.

DISCLAIMER: McElroy Metal makes no warranty, express or implied, as to the merchantability or fitness for any particular purpose of any product by an optional manufacturer. If you choose to use a product not manufactured by the specified manufacturer, as defined herein, you take the product as is and at your own risk.

To ensure you have the most current information available, please contact McElroy Metal or visit our website at <http://www.mcelroymetal.com> to download the most current specifications.

The following can be added to PART 2 – PRODUCTS of the Retrofit Roof Systems Specification to include insulation and/or ventilation to the overall system.

2.05 INSULATION

- A. **[Specifier Note: Include this if you desire condensation control assistance. It is highly recommended that this insulation method be used if the attic space created by the retrofit framing system is not going to be ventilated]** Insulation shall be 2" vinyl backed type condensation control blanket of sufficient thickness to provide a minimum "R" value of 6 when tested in accordance with ASTM C 177. Insulation shall have a vinyl backing providing permeability of 0.02 perms or less when tested in accordance with ASTM E 96. Vinyl backing shall have a flame spread rating of less than 25 when tested in accordance with ASTM C 84. Insulation shall conform to ASTM C 665, Type II, Class A or Type III, Class A.
- B. **[Specifier Note: Choose one of the following if you desire to improve the thermal efficiency of the building itself]**
1. Un-faced fiberglass insulation shall be installed directly over existing roof. Thickness shall be ___" providing a minimum "R" value of ___ when tested in accordance with ASTM C 177 or

2.06 VENTILATION

- A. **[Specifier Note: Include this if you desire to provide ventilation to the cavity/attic space between the existing and new roofs.]** The contractor shall design and install ventilation components, accessories and/or assemblies that provide a minimum of 3-airchanges per hour for the cavity space between the existing and new roofs. Airflow calculations with appropriate literature shall be submitted for review and approval.

The following can be added to PART 2 – PRODUCTS of the Retrofit Roof Systems Specification to include rooftop equipment related to the extension of existing rooftop equipment

2.07 ROOFTOP EQUIPMENT

- A. Curbs shall be those manufactured by LM Curb, Inc. of Longview, TX or equal. Metal roof system manufacturer shall provide all curbs and scuttles to ensure compatibility with the specified roof panel system.
- B. Rooftop equipment curbs shall be prefabricated of minimum 0.080 aluminum and shall have fully mitered and welded corners, integral base plates and **[Specifier Note: choose water diverter or welded-n cricket]**. All welds shall be prime painted after fabrication. Internally reinforce curbs with steel angle on any side exceeding 3'-0". Factory install 1½" fiberglass insulation with 3# density. Minimum height above finished roof to be 8".
- C. Roof scuttle shall be 2'-6" X 3'-0", with Ladder-Up access as manufactured by Metallic Products Corporation of Houston, TX or approved equal.
- D. Curbs and scuttles shall be painted or powder coated to match the adjacent roof panel.
- E. Roofing System Installer shall install in accordance with the manufacturer's instructions.
- F. Flexible pipe flashing shall be the metal roof system manufacturer's standard product of a configuration to seal around circular pipe penetrations and prevent intrusion of water through the metal roofing membrane. Flexible pipe flashing shall consist of a flexible ring of EPDM or other suitable material bonded to a malleable steel draw-ring which when fastened to the roofing membrane will weatherproof the penetration.

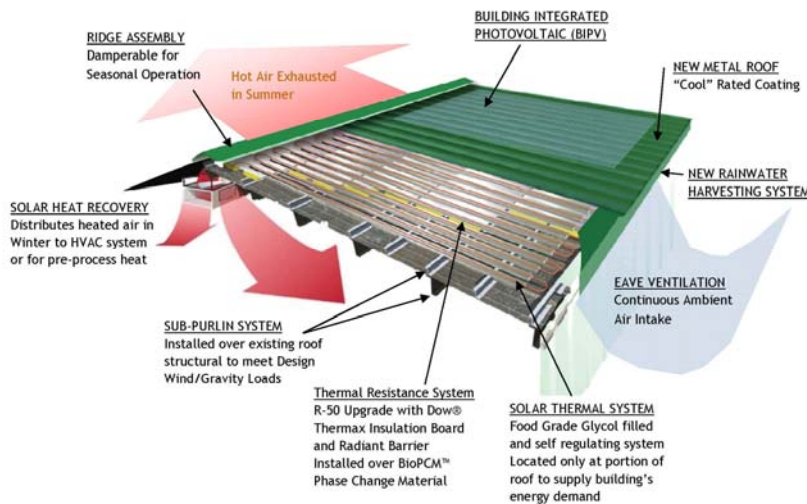
GENERAL – Buildings of the future will be routinely clad with renewable energy systems that play an active role in building energy management. Today's progressive designers of both new and replacement applications can easily implement building envelope systems that can heat and cool both air and water and produce electricity in one common integrated area of a roof, especially a metal roof.

The world is abuzz with the potential of solar power to measurably impact the level of fossil fuel and reduce the rate of climate change. Known as photovoltaic (PV) systems, these systems convert sunlight into electricity and though expensive when compared to today's conventional power generating systems, manufacturers are driving the production costs down as they bring new renewable energy products, known as building integrated photovoltaic's (BIPV) to the building envelope marketplace.



Thin-Film Laminated Amorphous Silicon

There are two primary types of PV renewable electricity systems: Crystalline (mono and poly) and Amorphous. The crystalline systems consist of an array of silicon wafers sandwiched between two layers of glass. These panels can be heavy and must be attached to a metal roof using metal brackets or bracing. The amorphous silicon PV systems are flexible and light weight. A thin film of amorphous PV can be produced as a laminate to be adhered to the flat pan of a metal standing seam roof. In that case, the PV system is actually integrated into the building design and is almost unnoticeable on the roof. Metal roofing provides the best platform for building integrated photovoltaic (BIPV) systems. The synergy between the flexible PV and metal roofing products is causing an increasing use of the systems.



The shy cousin of PV power is solar thermal energy. Solar thermal systems produce heated air or water from the sun's energy for use in domestic, space or process heating applications. Suitable for both new and retrofit installations and highly cost effective today, these systems lack the sizzle (and the rebates) of PV systems that produce electrical power and reinforce the national electrical grid. However, architects adopting building integrated solar thermal (BIST) systems have a vast array of building cladding

materials, finishes and colors on their design pallet and when a building's cladding material becomes the solar absorber, owners are delighted by the additional financial incentives available under the Federal Investment Tax Credit program. McElroy Metal is very much involved in this market providing multiple solutions in renewable solar systems. When coupled with metal roof and wall cladding, some systems approach the ultimate in sustainable design; by increasing the R-value, they reduce building heating and cooling loads and can operate counter cyclically to take

advantage of seasonal cooling or night sky radiational cooling to chill building systems or processes at night. Above sheathing ventilation as described in Chapter 4 can be used to cost effectively increase a buildings' energy efficiency by seasonally cooling the building envelope and during the heating season directing warm air into the building for space heating.

Solar thermal and PV systems can be synergistically engineered into one integrated PV-thermal envelope assembly. Called BIPV-T, these systems are capable of producing 2-4 times the energy available from a pure PV system. The solar thermal system cools the PV system increasing the PV systems efficiency, while cooling the building envelope and putting otherwise wasted heat to work in the building. The BIPV-T systems are available today in either dark blue or black, but keep your eye out for more color options in the future. The entire BIPV-T system is eligible for the Federal ITC and related state and local rebates and incentives.

Building on a deep knowledge base acquired over many years of research and development with federal funding and industry sponsorship, Oak Ridge National Labs (ORNL) is working on the next generation of sustainable energy envelop systems. ORNL is working with industry partners and trade associations such as the Metal Construction Association (MCA), Cool Roof Rating Council (CRRC) and others to develop, test and commercialize the next generation of metal roofing and curtain wall products.

Emerging technologies such as innovative product components called Phase Change Materials (PCM's) are now being specified in mainstream products such as drywall. ORNL is working on the integration of PCM's into optimized metal roof and wall systems, increasing their ability to store thermal energy and transfer it to the building when needed in conjunction with cool roofing, PV and ASV applications. PV paints for roll to roll/continuous coating and PV inks and related printing processes are on the horizon.

It is important to understand that all of these systems are applicable for not only new construction, but even more so for existing buildings. According to the DOE's Energy Information Administration, there are approximately 5,060,000 commercial and industrial buildings in the United States, representing some 82.2 billion square feet. These buildings consume 74.7% of our building energy demand or 29,189 Trillion BTU's per year. Needless to say, the opportunity to reduce our building energy consumption in this nation is with upgrading existing buildings. Simply speaking Retrofit Roofing represents the unique ability to improve a building's aesthetics, functionality and performance by employing an engineered light gauge sub-framing system over the existing roof and then finishing it with a new metal roof. Why is a metal roof such a big part of the overall renewable envelope picture? The answer is easy; metal roofing has a service life of nearly double of its nearest membrane roof system competitor, it provides the designer the ability to employ cosmetic upgrades improving the building's value and it is the ideal surface and assembly to install renewable solar energy applications. Compared to conventional roof replacement membranes for flat and sloped roofs, metal has the only service life that exceeds the expected life expectancy of BIPV between 25 to 30 years based on the manufacturers in this field. So, a better explanation of why incorporate metal retrofit into your renewable solar plans is with conventional membranes, you would have to remove the BIPV assembly upon the end of service life, replace the roof and then re-install the BIPV. This redundant process can be extremely costly to the building owner. These available and proven technologies are the "Future of Metal Roofing".

The standard retrofit assembly details on the following pages are provided to describe the McElroy Framing systems and their components in an installed assembly. In addition, they illustrate the various conditions that exist in conventional flat roof building construction and how these conditions are satisfied when adding a retrofit framing system.

During the development of these standards, we first identified that a complete framing system essentially consist of two elements. These are perimeter framing and interior framing. The perimeter of the existing building, or roof edge, presents different challenges to the design professional than that of the framing that is being installed inward from the roof edge. Because of this, the first set of details illustrates low and high eaves as well as canopies and gable endwall conditions. These are followed by interior framing details that are separated for each of McElroy's retrofit framing systems.

For the Metal-over-Metal retrofit sub-framing systems, the details provided are those of McElroy's strategic partner Roof Hugger, Inc. This system coupled with McElroy's metal roof and wall provides you with a completely engineered metal roof replacement package that does not require removal of the existing metal roof. Sub-purlin profiles can be manufactured to match virtually any metal roof system out there from thru-fastened panels to standing seam profiles. For more information on this factory-notched sub-framing system, you may visit www.roofhugger.com

Perimeter Framing

Eave Conditions

Low Eaves – Fixed	10-2
Low Eaves – Floating	10-6
Low Eave Walls	10-8
High Eaves – Low Slope	10-14
High Eave Walls	10-16

Canopy Overhangs

Low Eave Canopy at Fixed Eave Plate	10-20
Low Eave Canopy at Floating Eave Assembly	10-25
Low Eave Canopy with Drop-down Fascia	10-27
Low Eave Canopy at Elevated Wall	10-32

Gables	10-35
---------------	-------

Framing Member Splices	10-44
-------------------------------	-------

Interior Framing Systems

Post & Purlin System

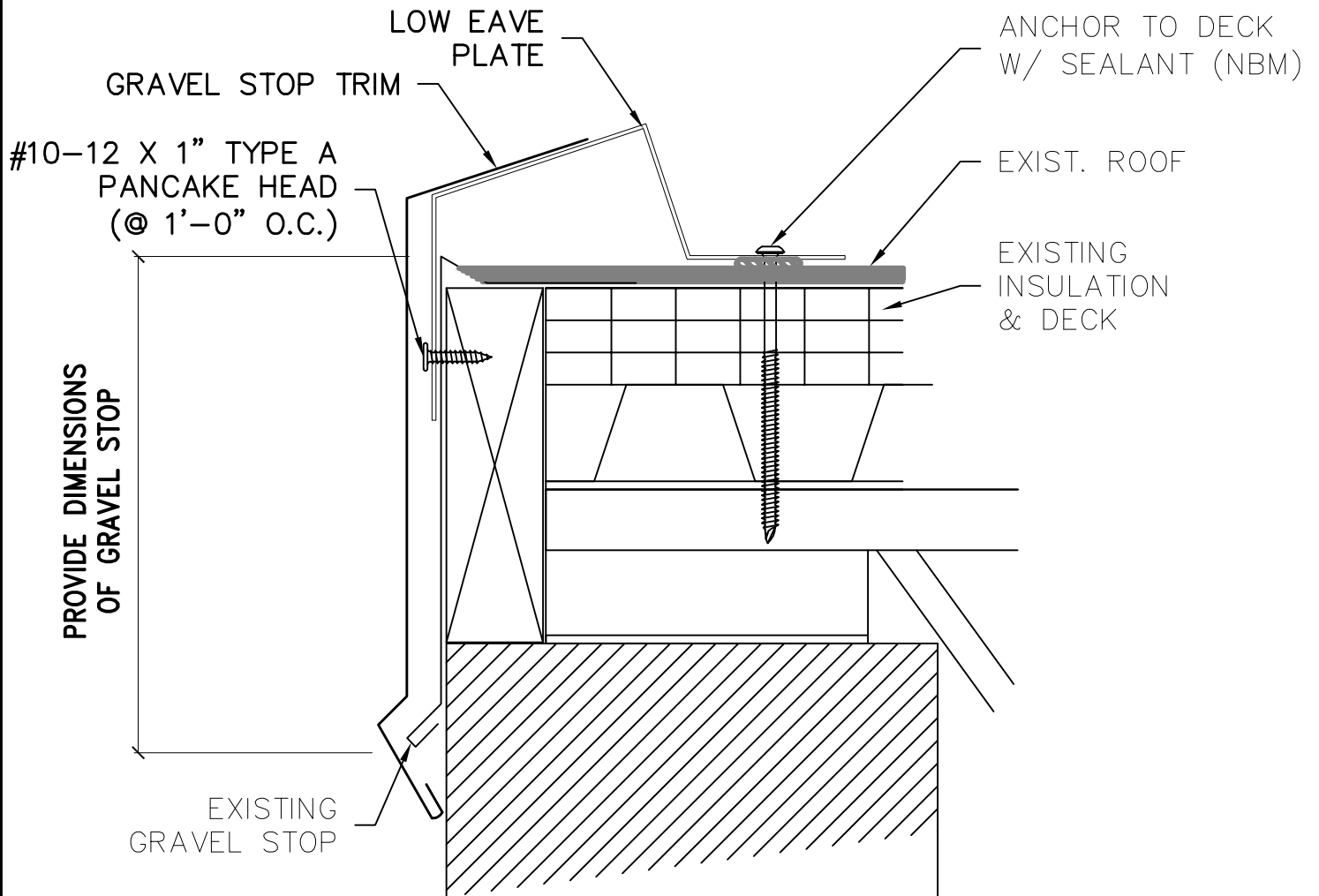
Basic Framing	10-47
Bracing	10-50
Member Laps	10-55
Roof Opening Framing	10-58
HVAC Frame-over	10-59
Hip Framing	10-60
Valley Framing	10-61
Roof/Wall Transitions	10-62

Low-Slope System	10-64
-------------------------	-------

Wide-Span System	10-67
-------------------------	-------

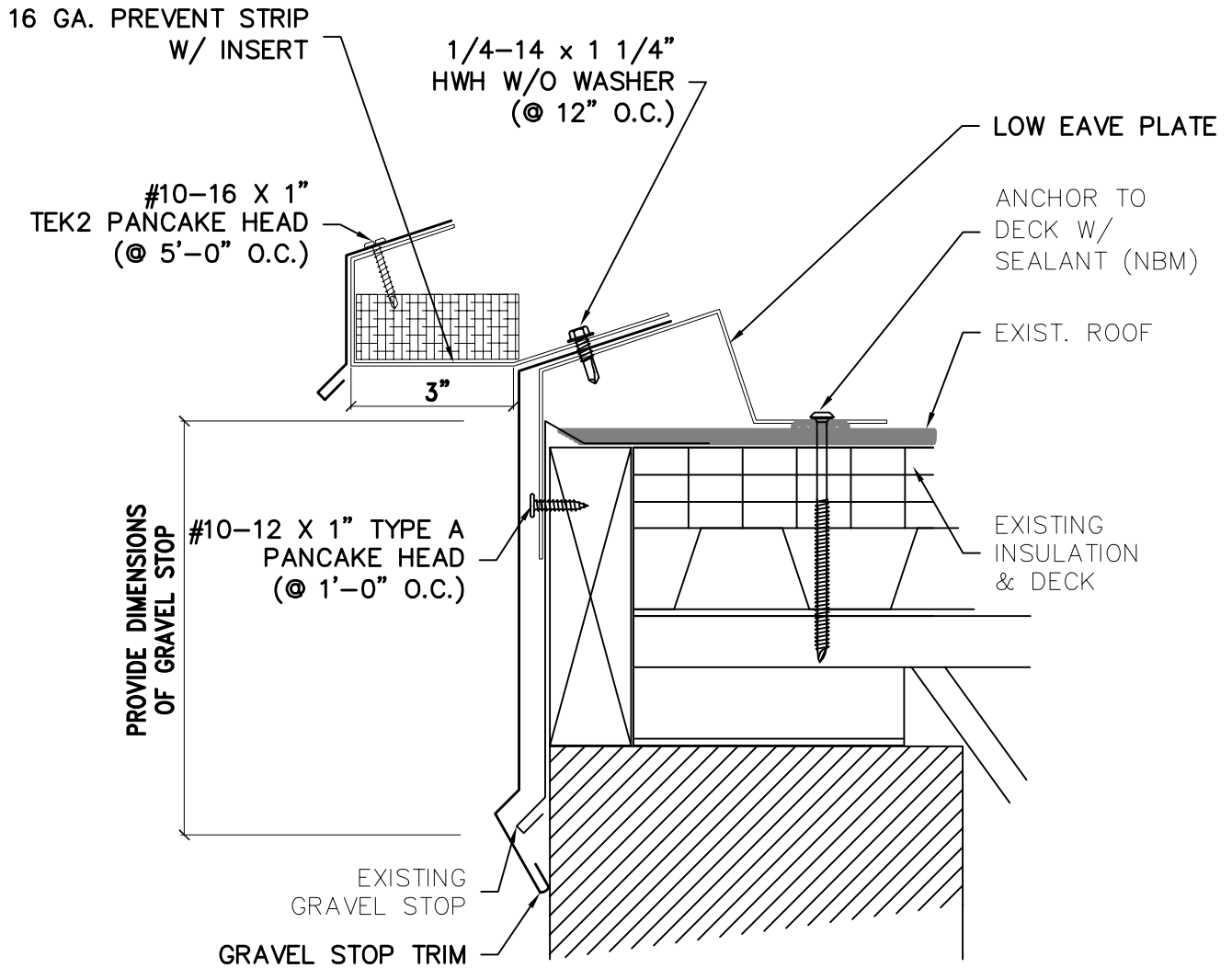
Metal-over-Metal System

Attachment to Purlins	10-72
Low Eaves	10-77
High Eaves	10-83
Rake Conditions	10-86
Ridge	10-91
Hip	10-92
Valley Gutter	10-93



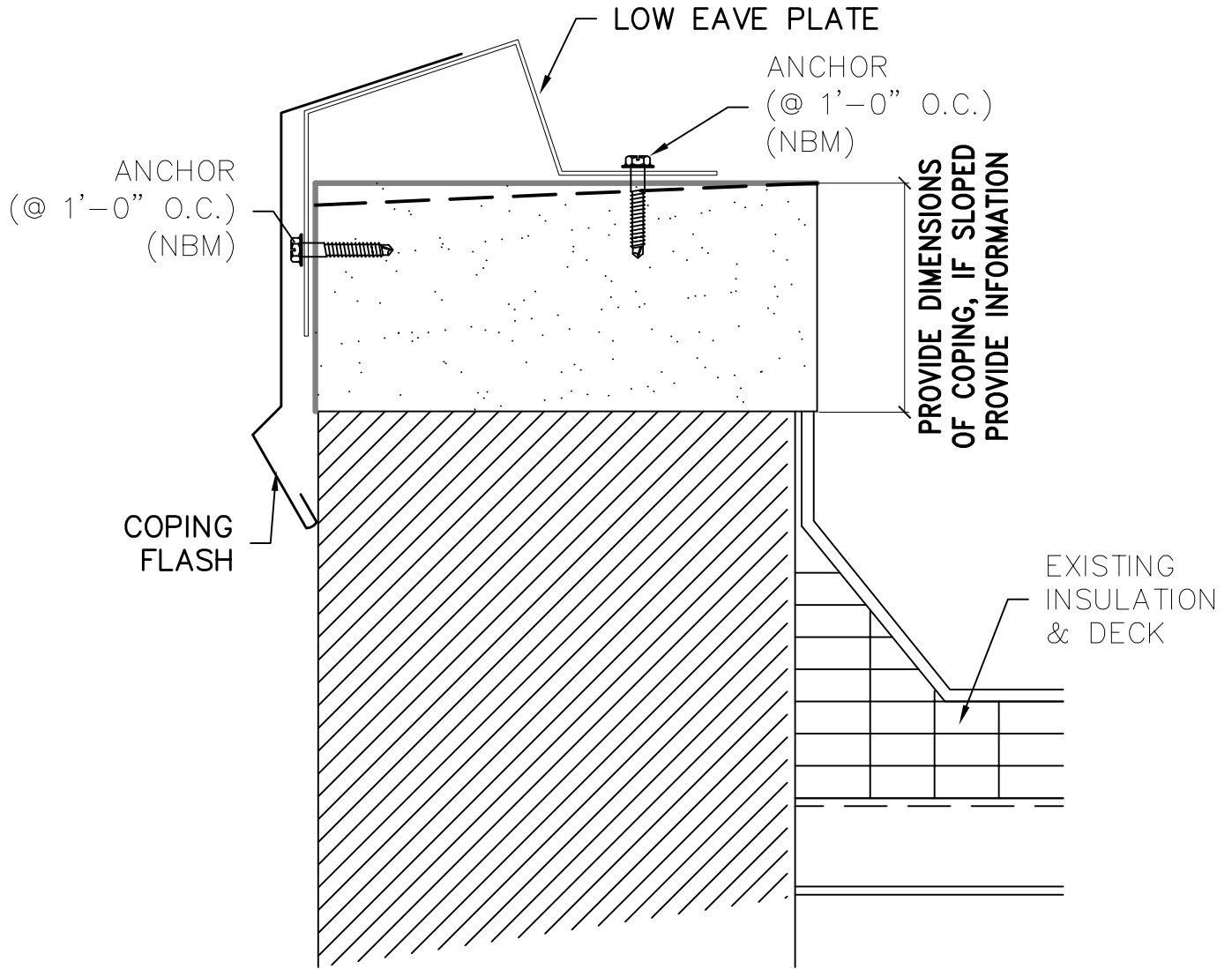
LOW EAVE
© GRAVEL STOP





LOW EAVE W/ PREVENT
@ GRAVEL STOP





LOW EAVE

@ LOAD-BEARING PARAPET



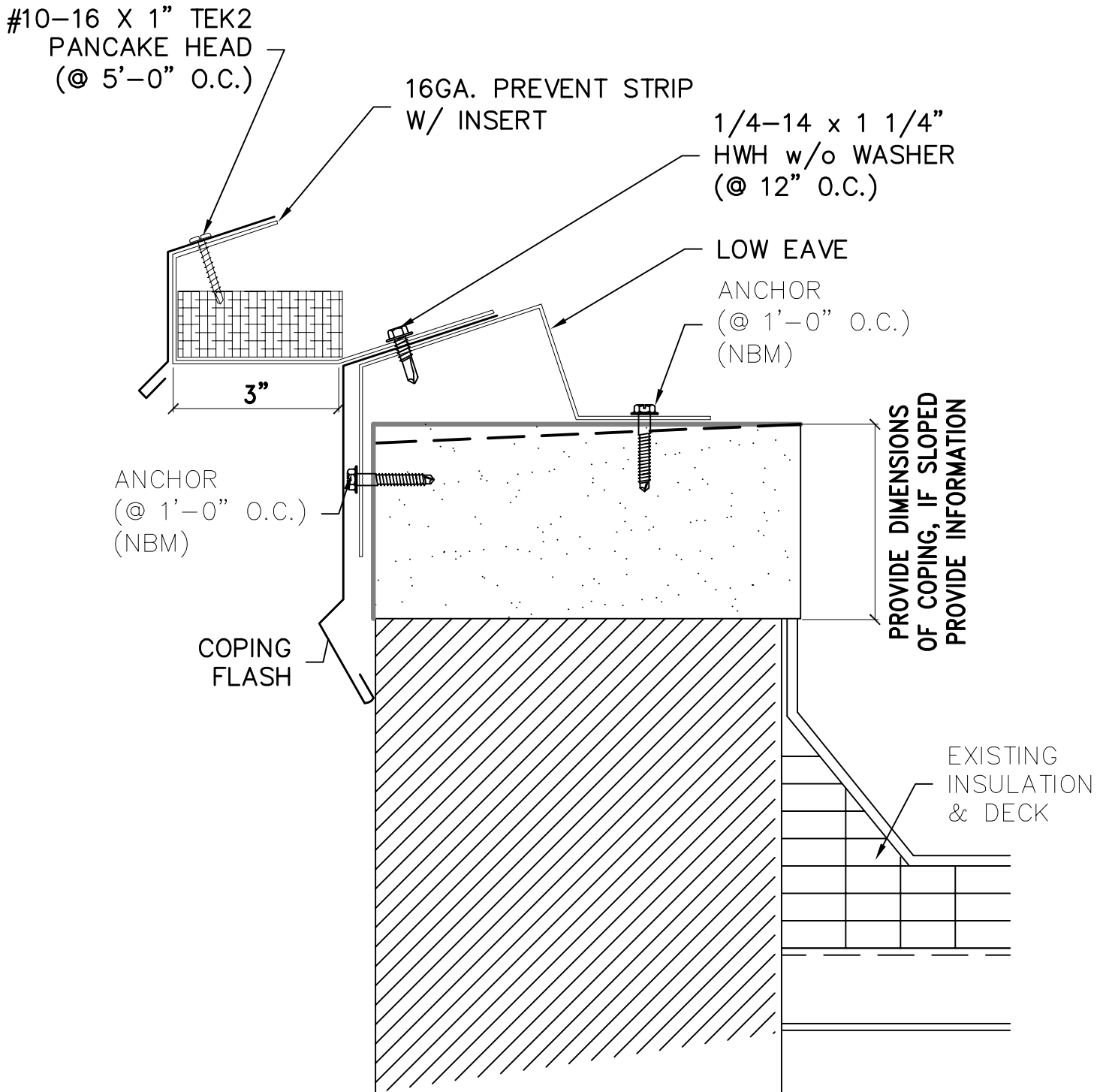
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Eave Conditions

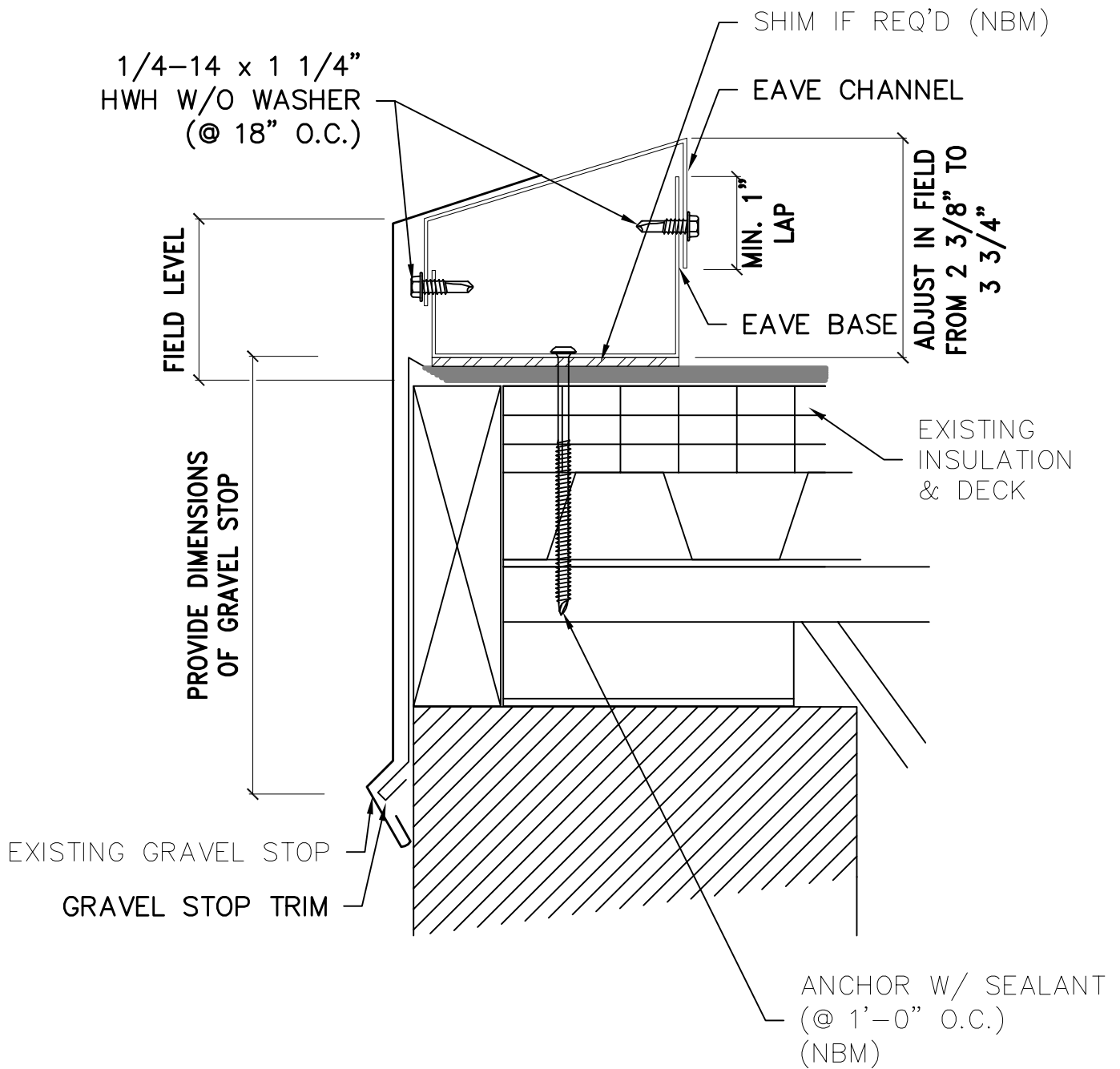
Page

10-4



LOW EAVE W/ PREVENT
© LOAD-BEARING PARAPET





FLOATING LOW EAVE

@ GRAVEL STOP



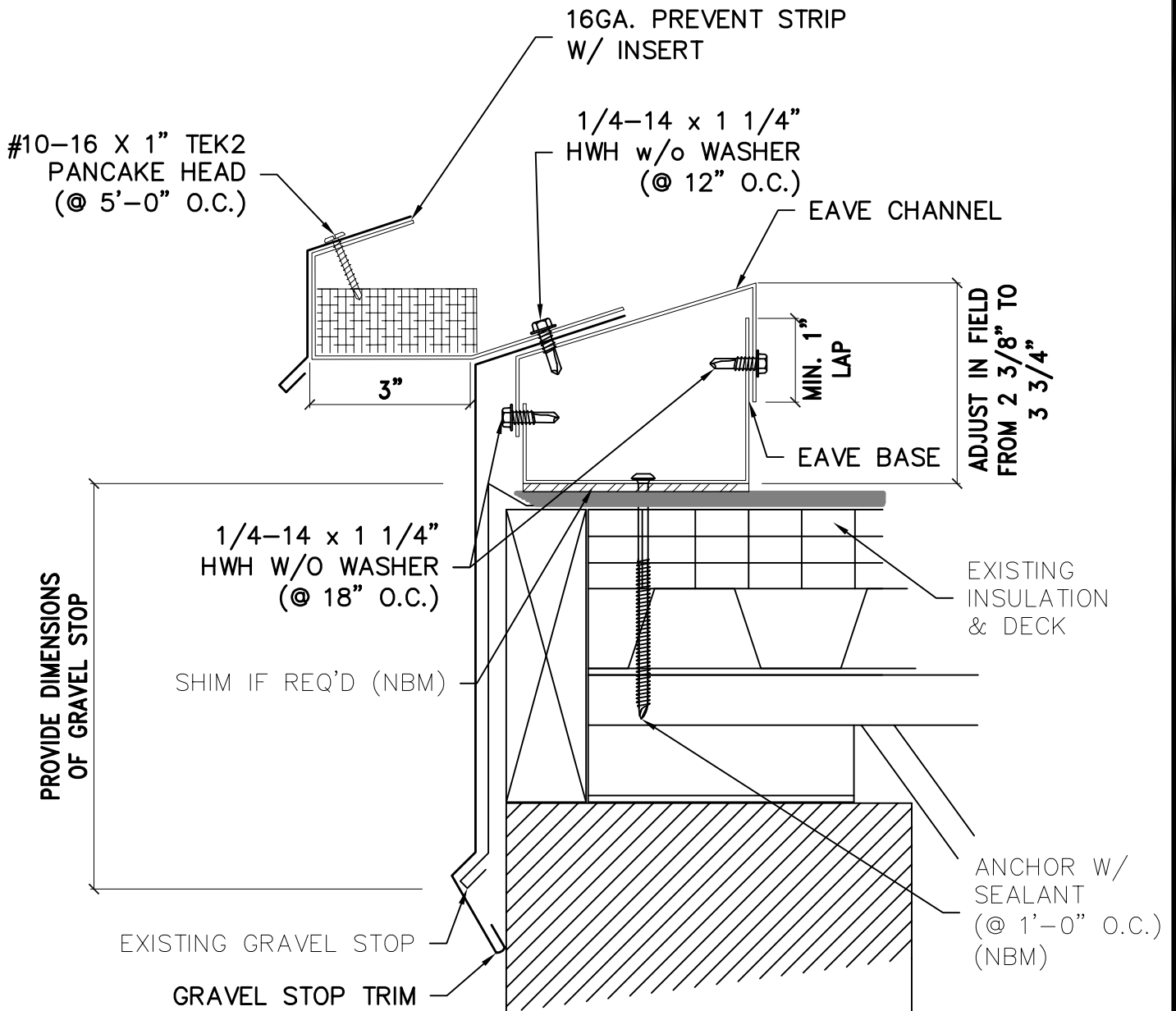
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Eave Conditions

Page

10-6



FLOATING LOW EAVE W/ PREVENT

© LOAD-BEARING PARAPET



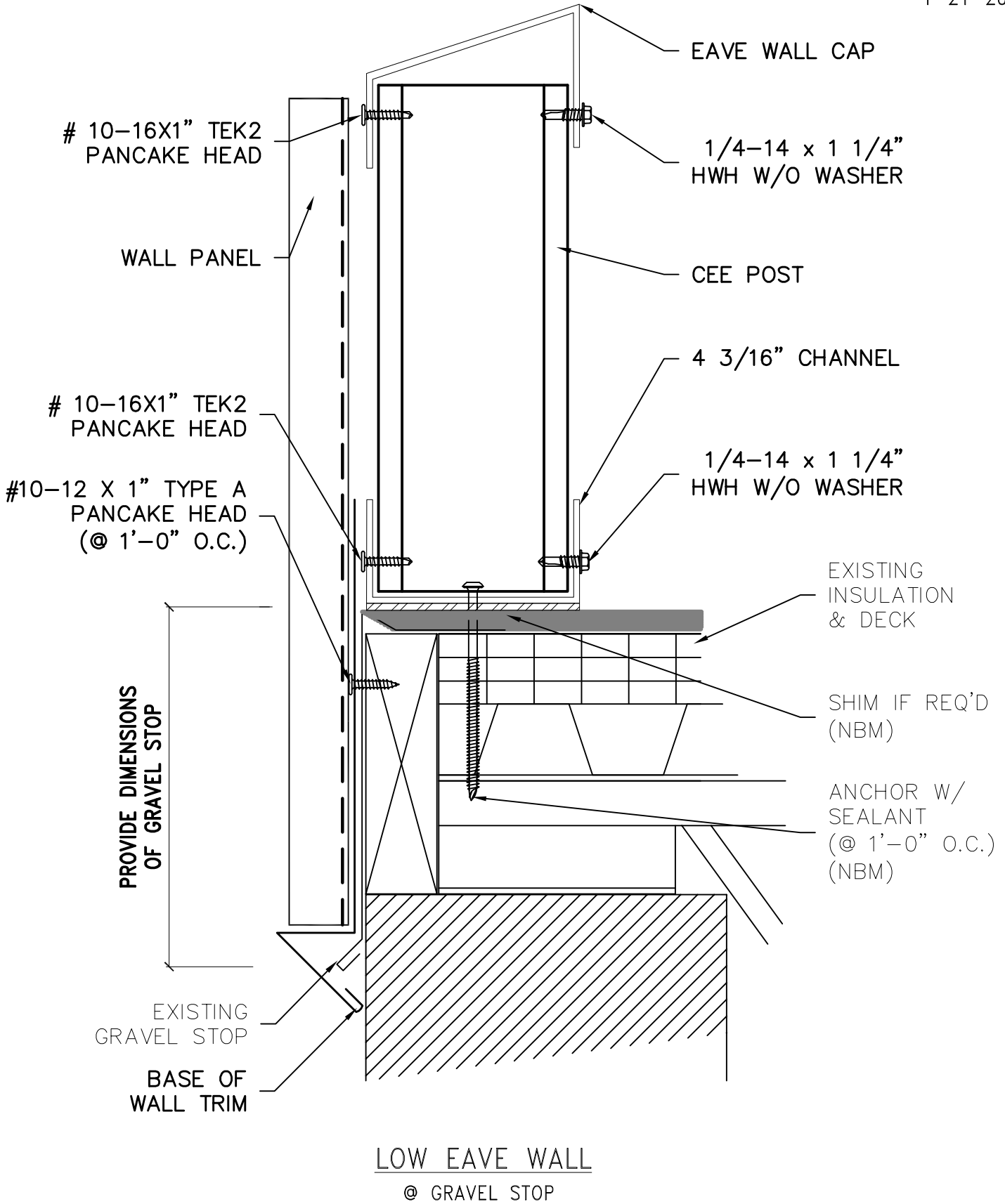
McElroy Metal, Inc.
Retrofit Framing Systems

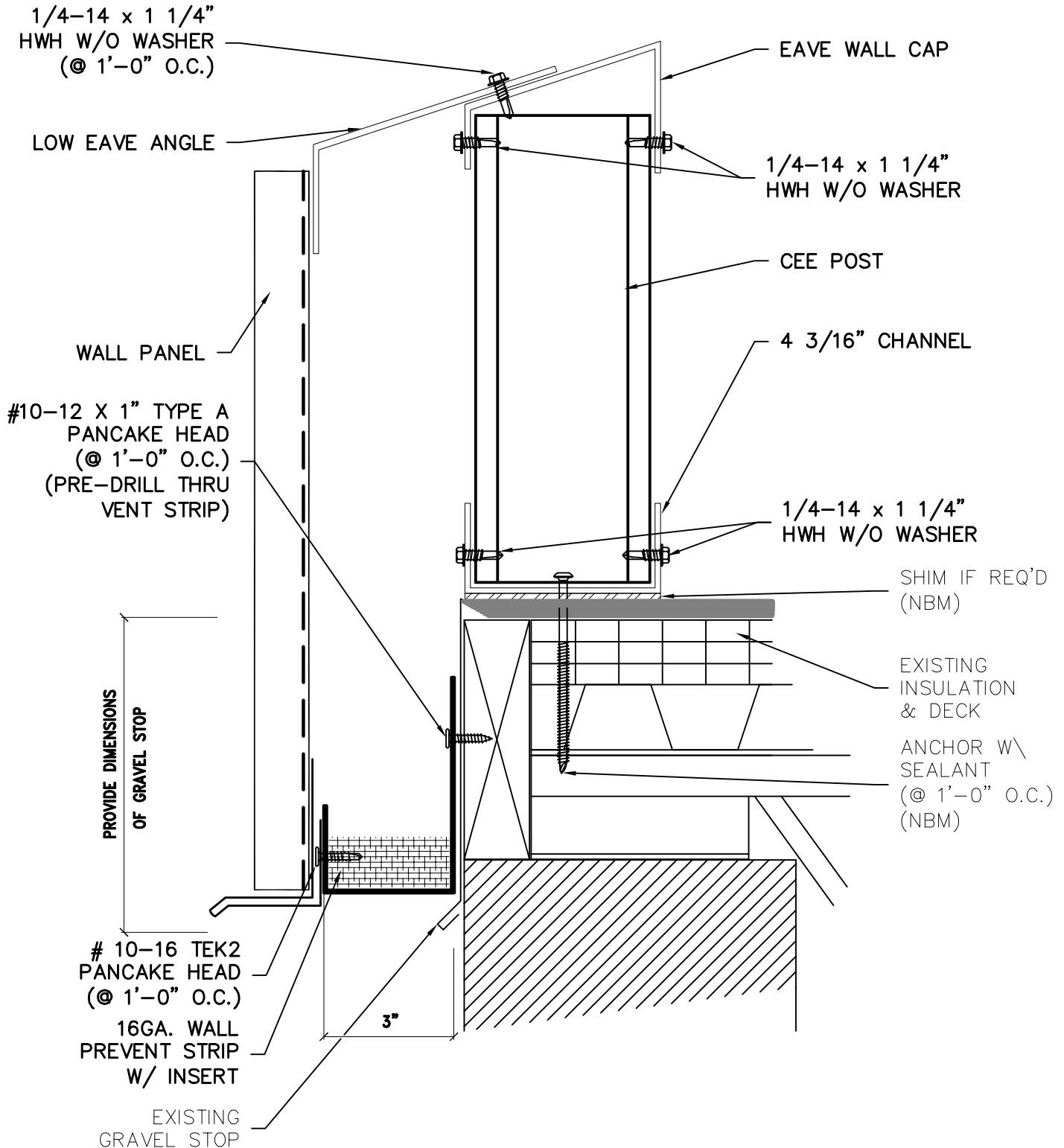
Perimeter Framing

Eave Conditions

Page

10-7





LOW EAVE WALL W/ PREVENT

@ GRAVEL STOP



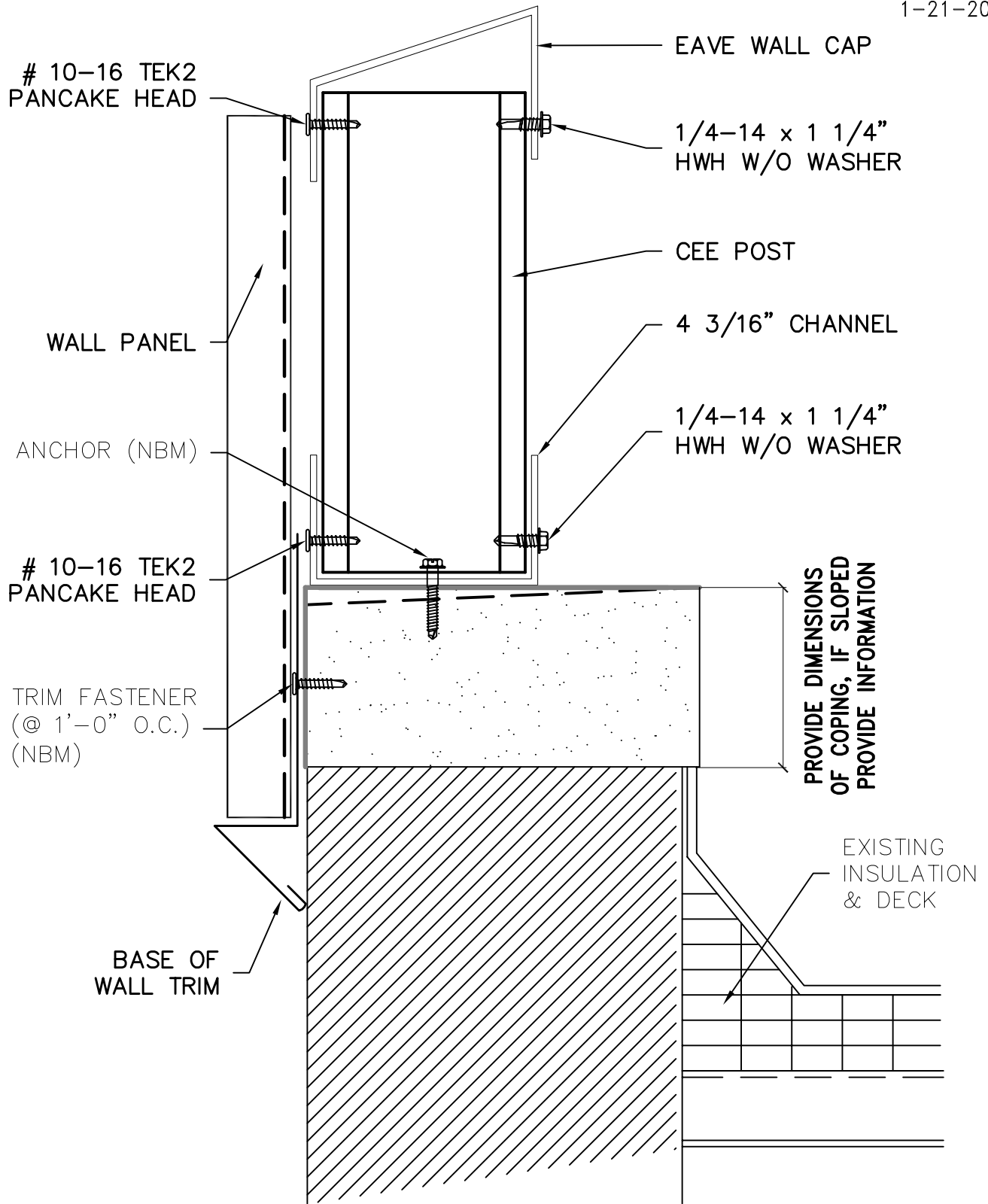
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Eave Conditions

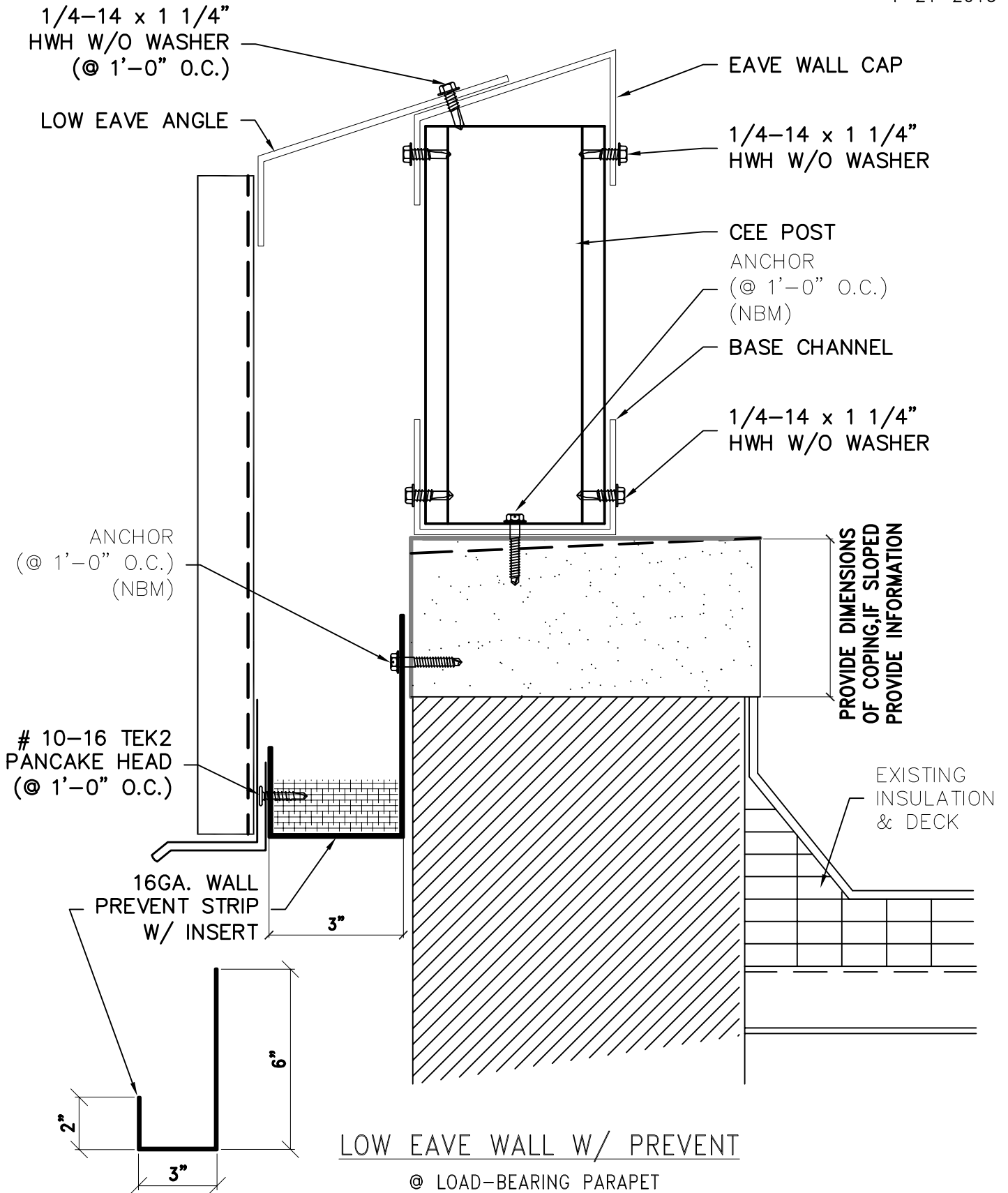
Page

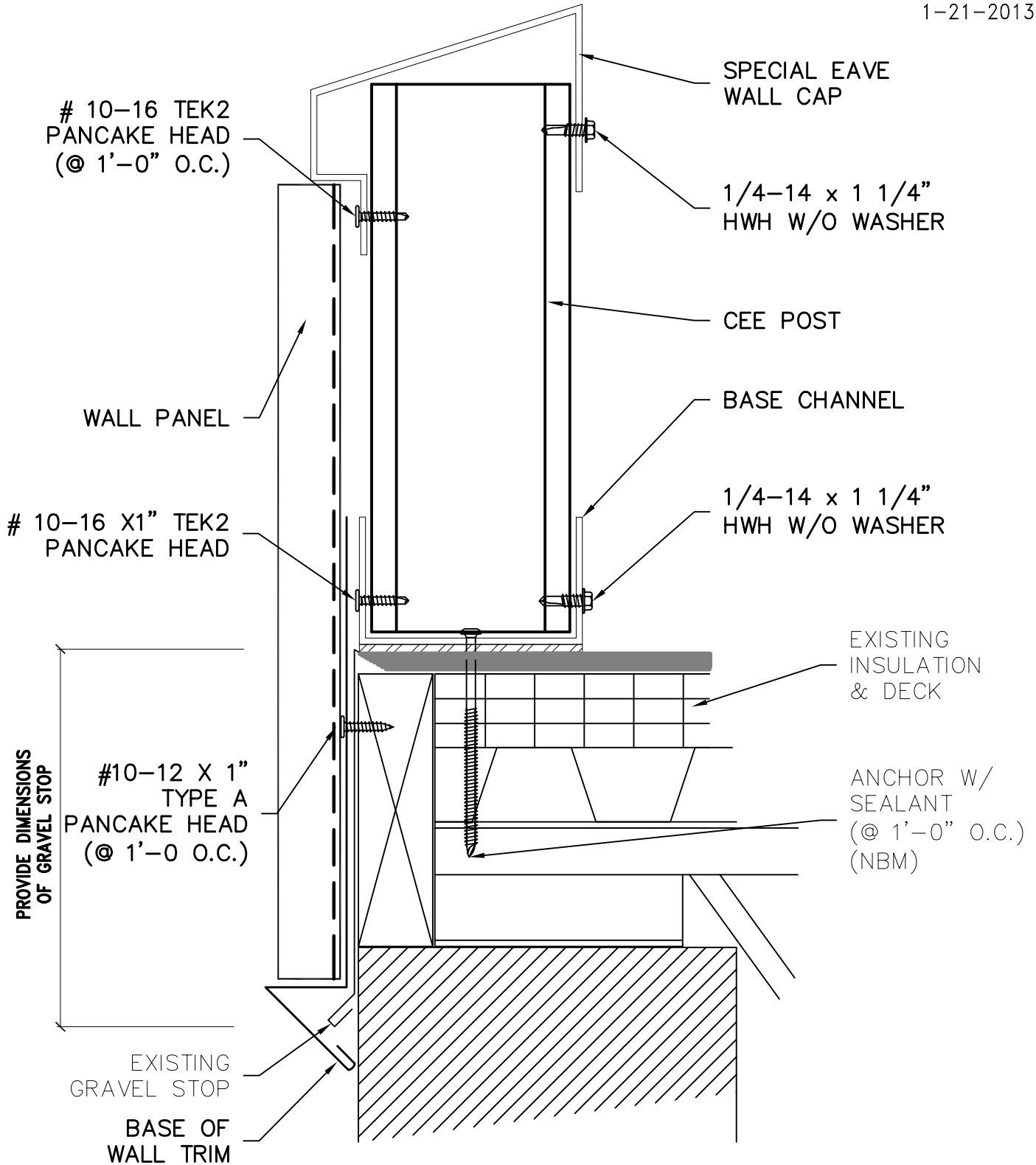
10-9



LOW EAVE WALL
© LOAD-BEARING PARAPET







SPECIAL LOW EAVE WALL CAP

@ GRAVEL STOP

(FOR MAXIMA & MEDALLION-LOK ROOFS)



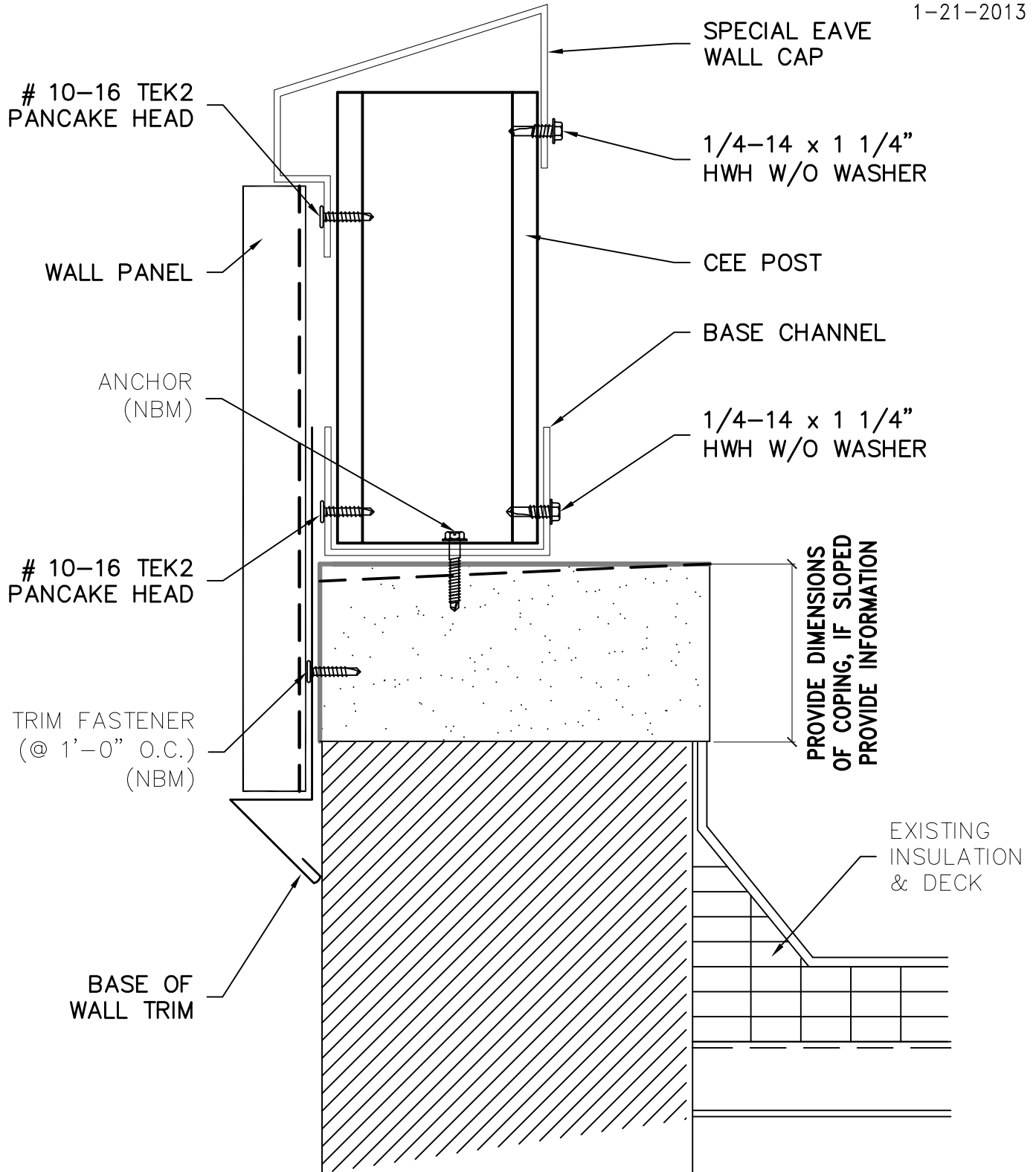
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Eave Conditions

Page

10-12



SPECIAL LOW EAVE WALL CAP

© LOAD-BEARING PARAPET
(FOR MAXIMA & MEDALLION-LOK ROOFS)



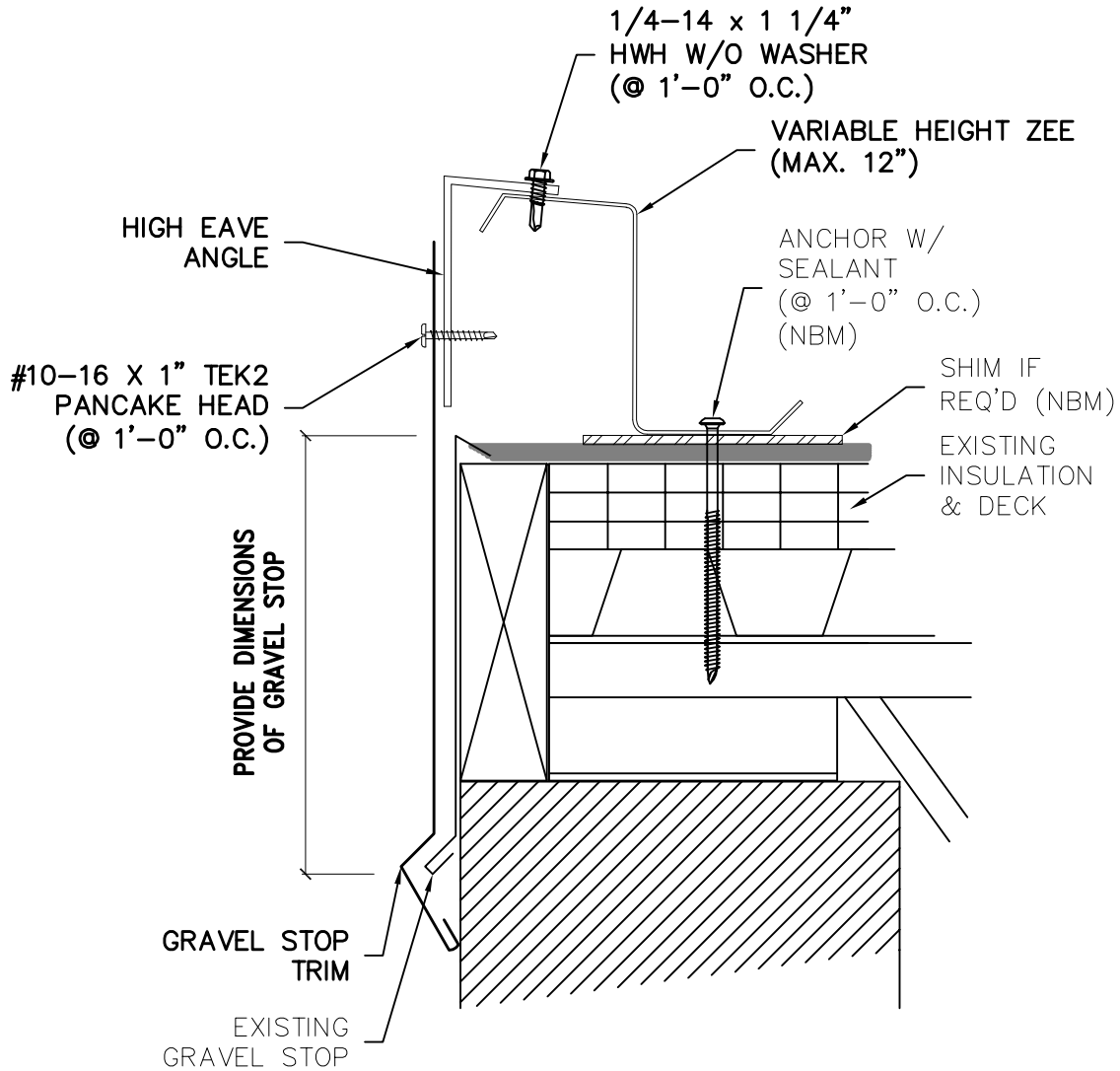
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Eave Conditions

Page

10-13



LOW SLOPE HIGH EAVE WALL

@ GRAVEL STOP



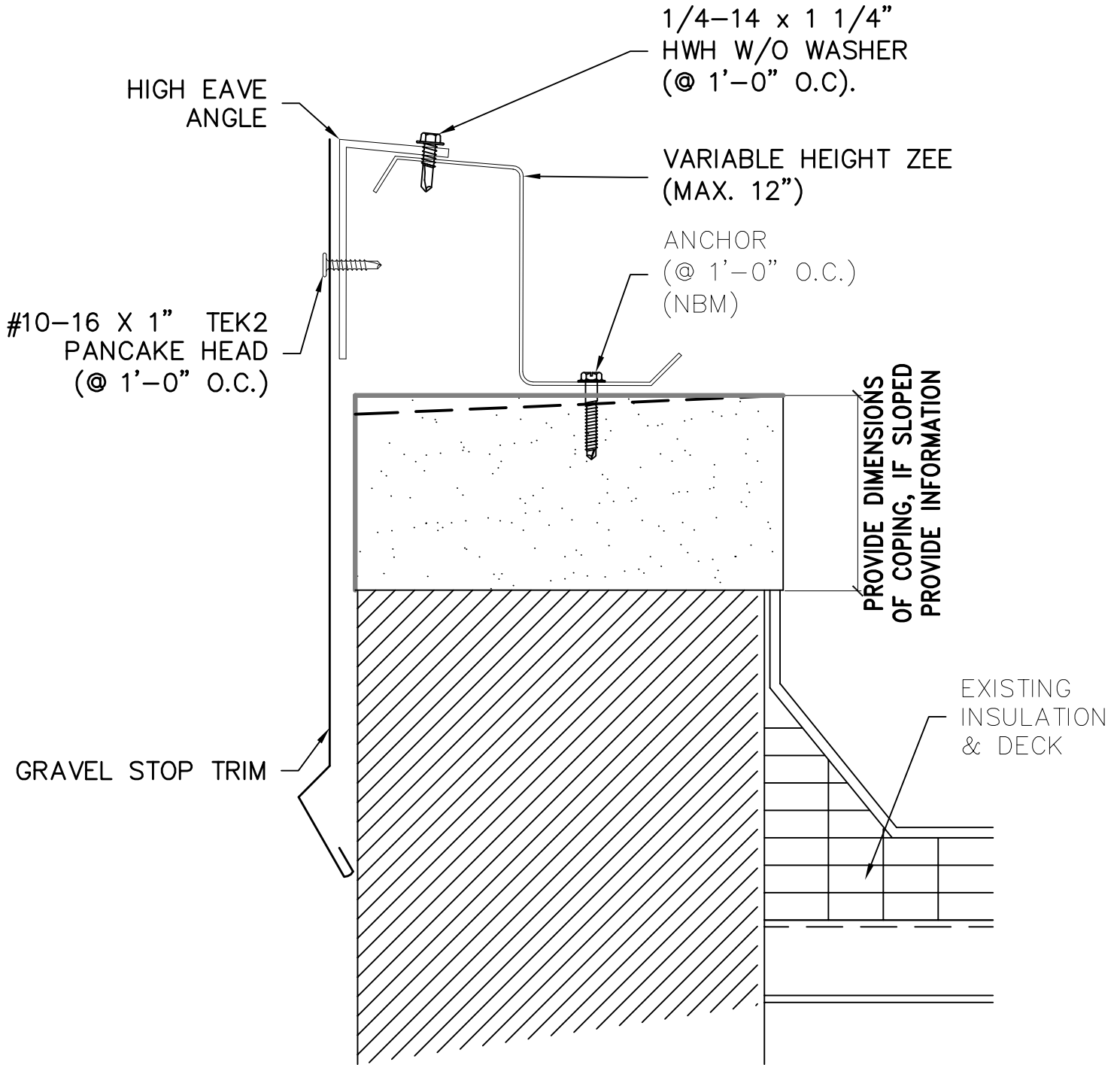
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Eave Conditions

Page

10-14



LOW SLOPE HIGH EAVE WALL

© LOAD-BEARING PARAPET



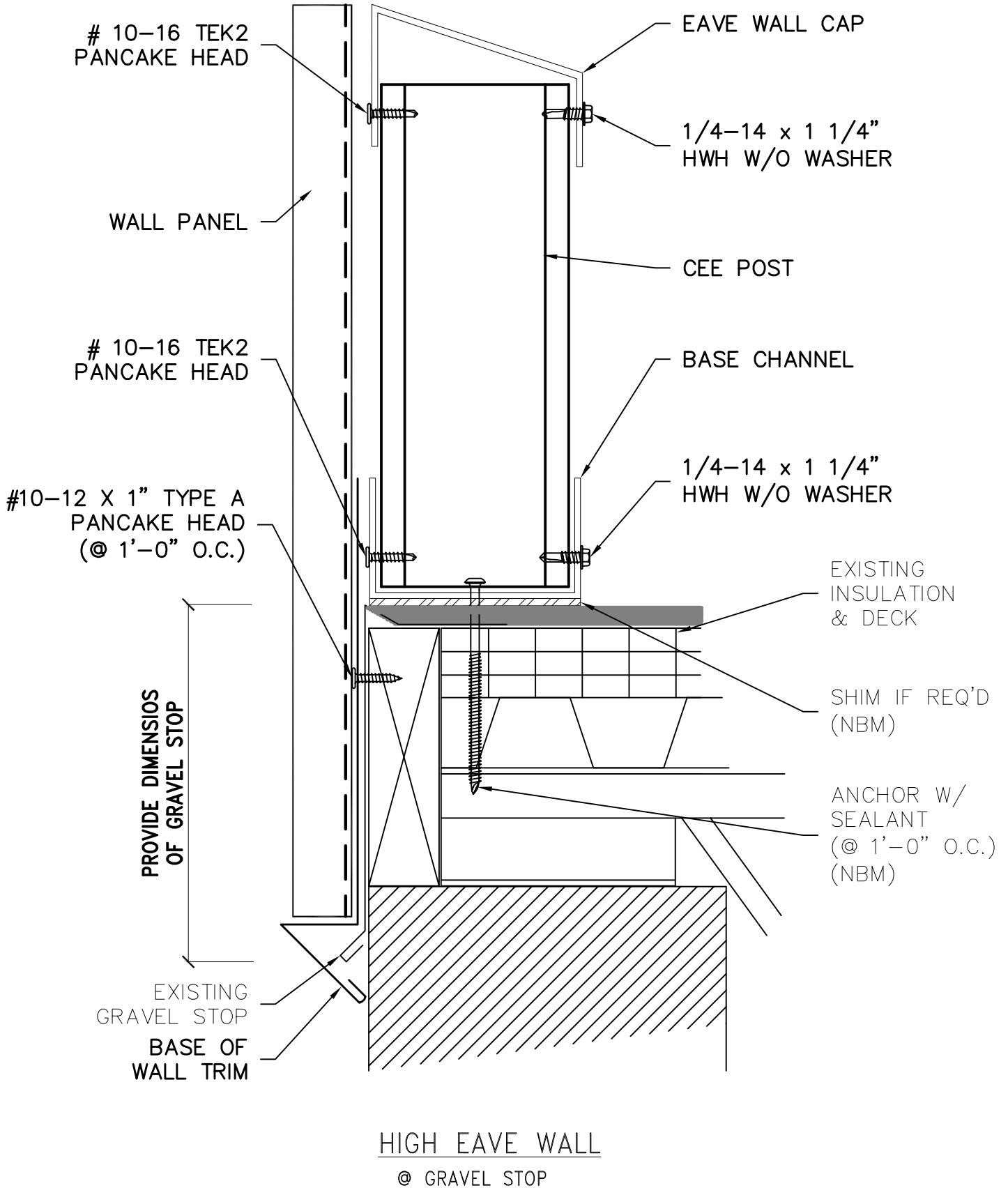
McElroy Metal, Inc.
Retrofit Framing Systems

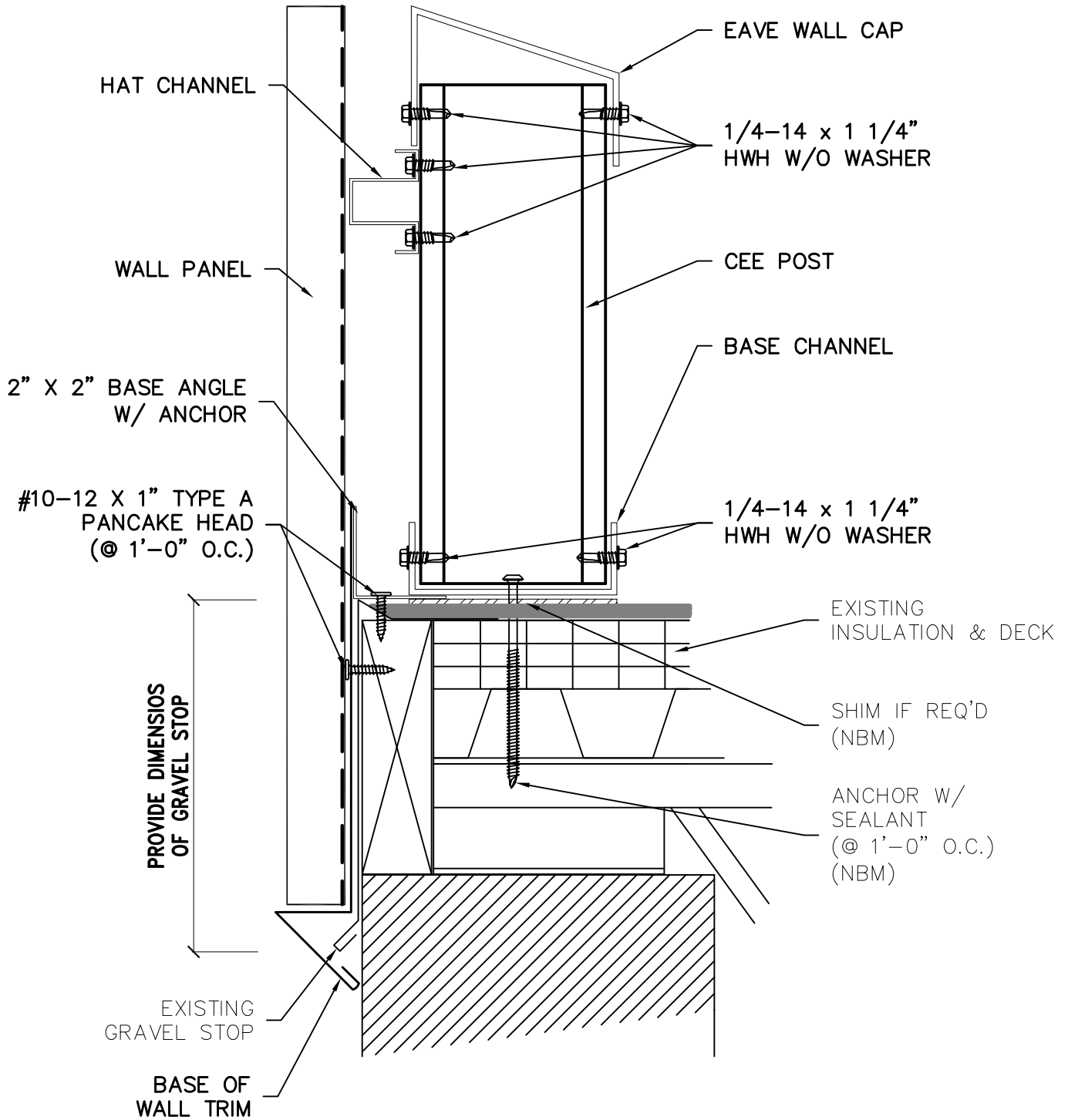
Perimeter Framing

Eave Conditions

Page

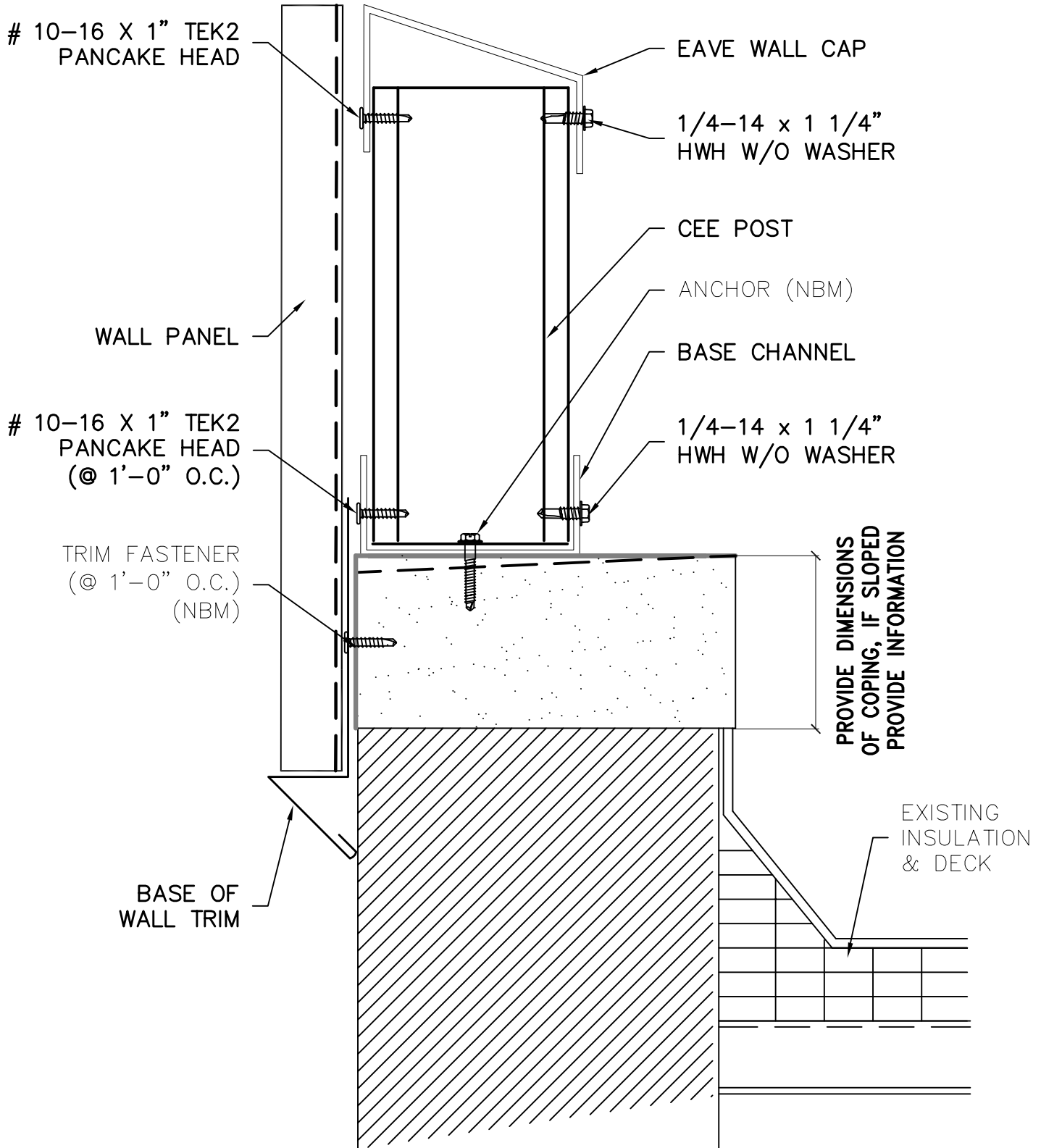
10-15





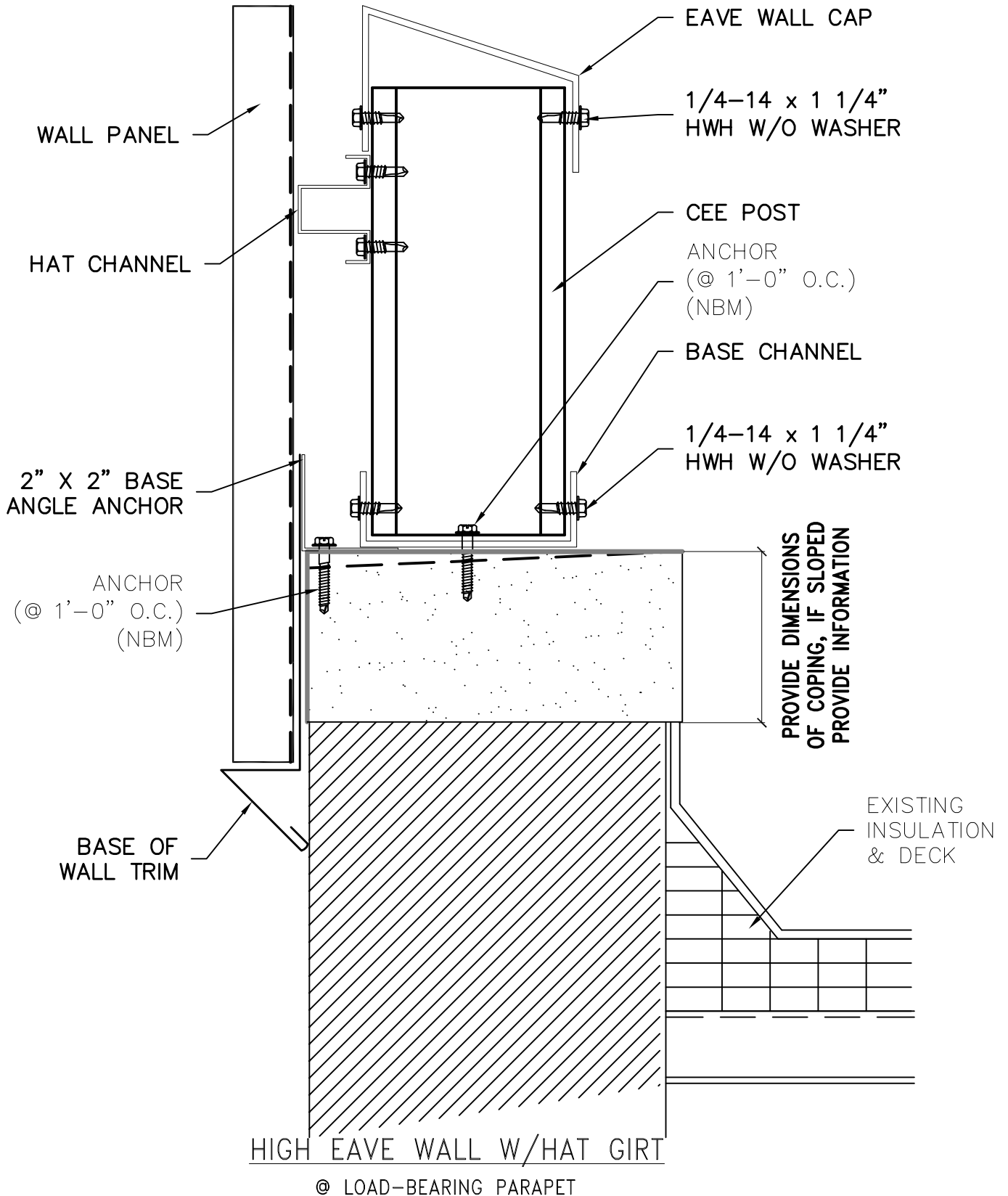
HIGH EAVE WALL W/ HAT GIRT
@ GRAVEL STOP

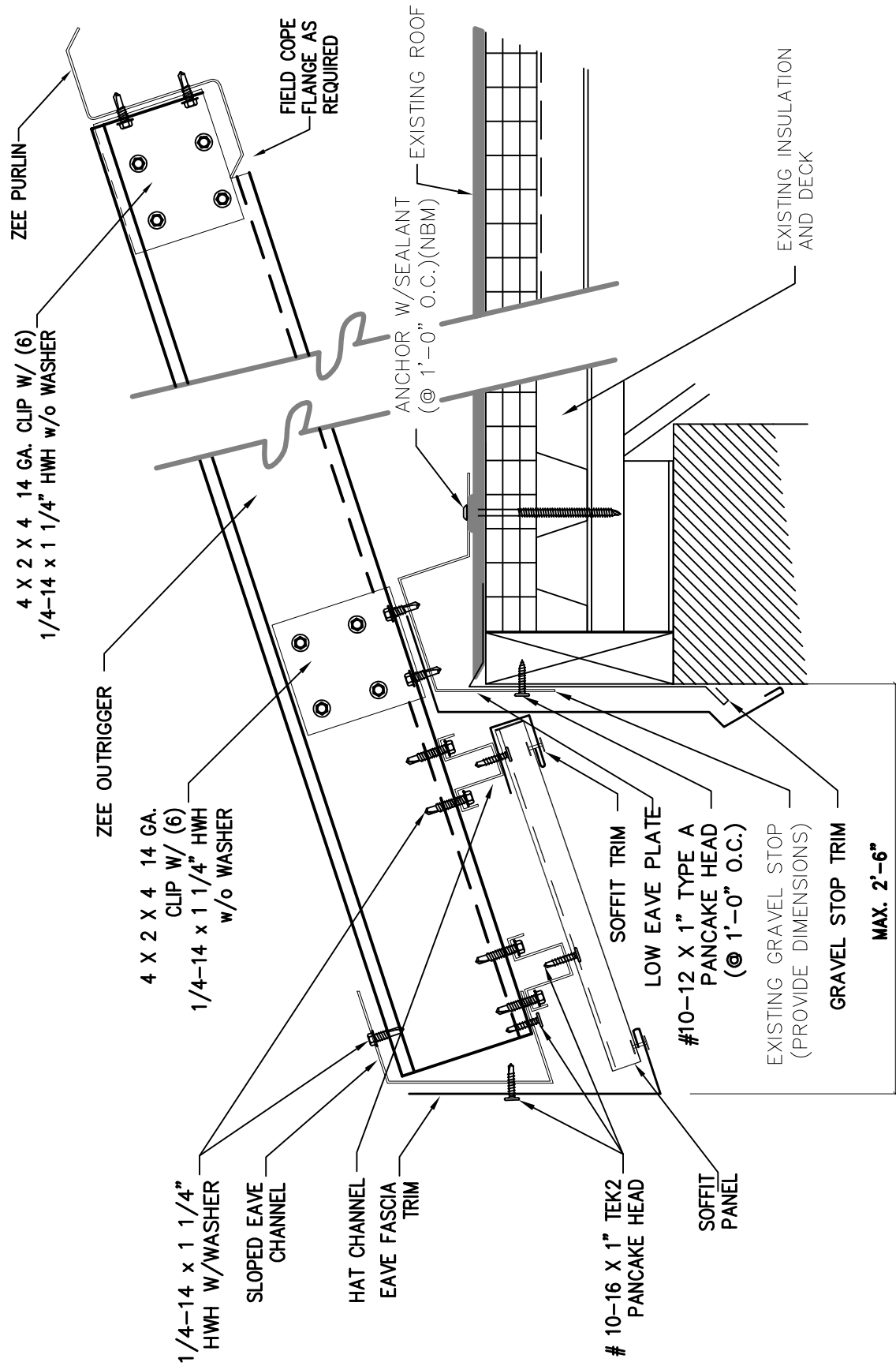




HIGH EAVE WALL
© LOAD-BEARING PARAPET



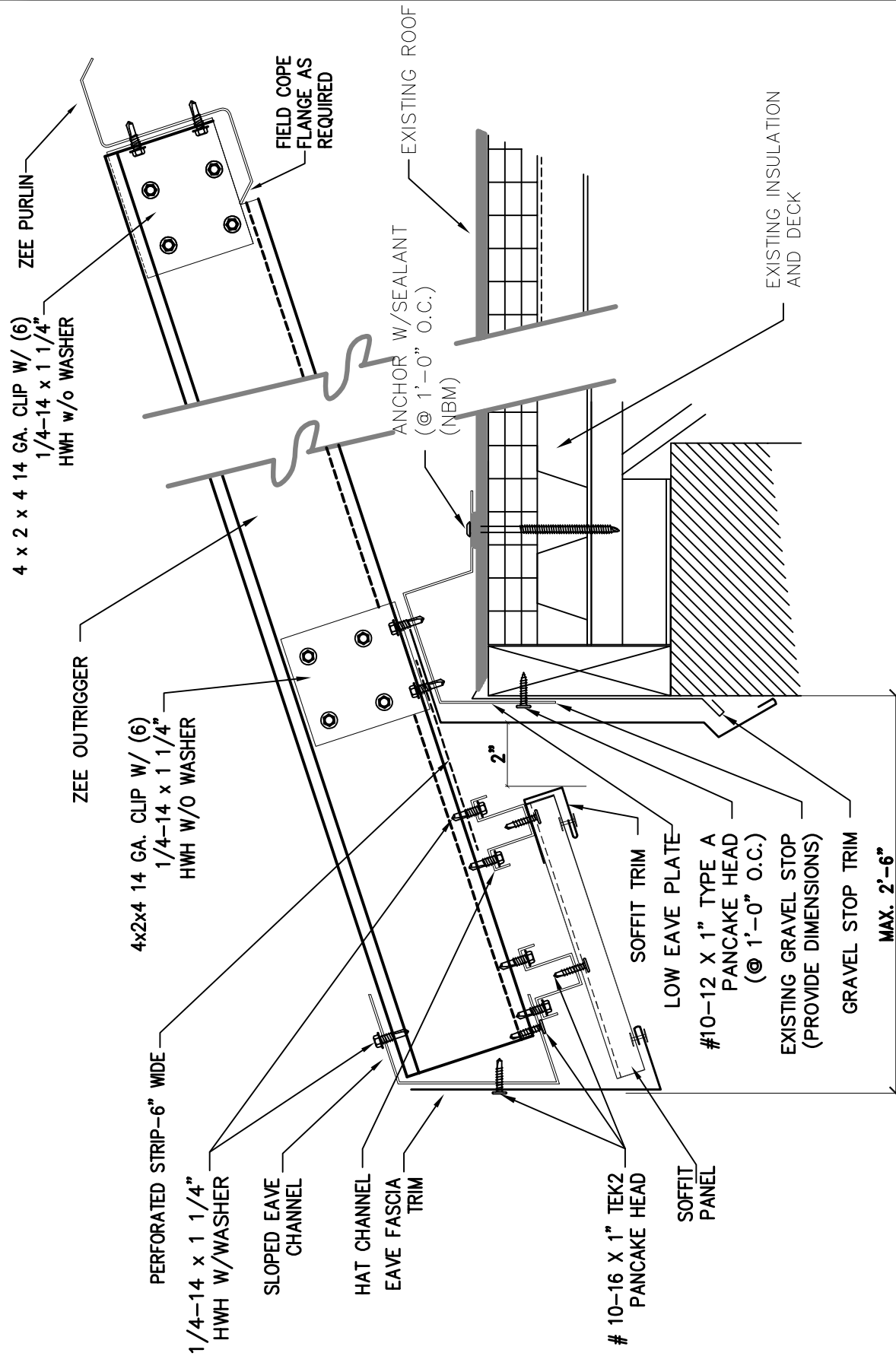




LOW EAVE CANOPY

© GRAVEL STOP

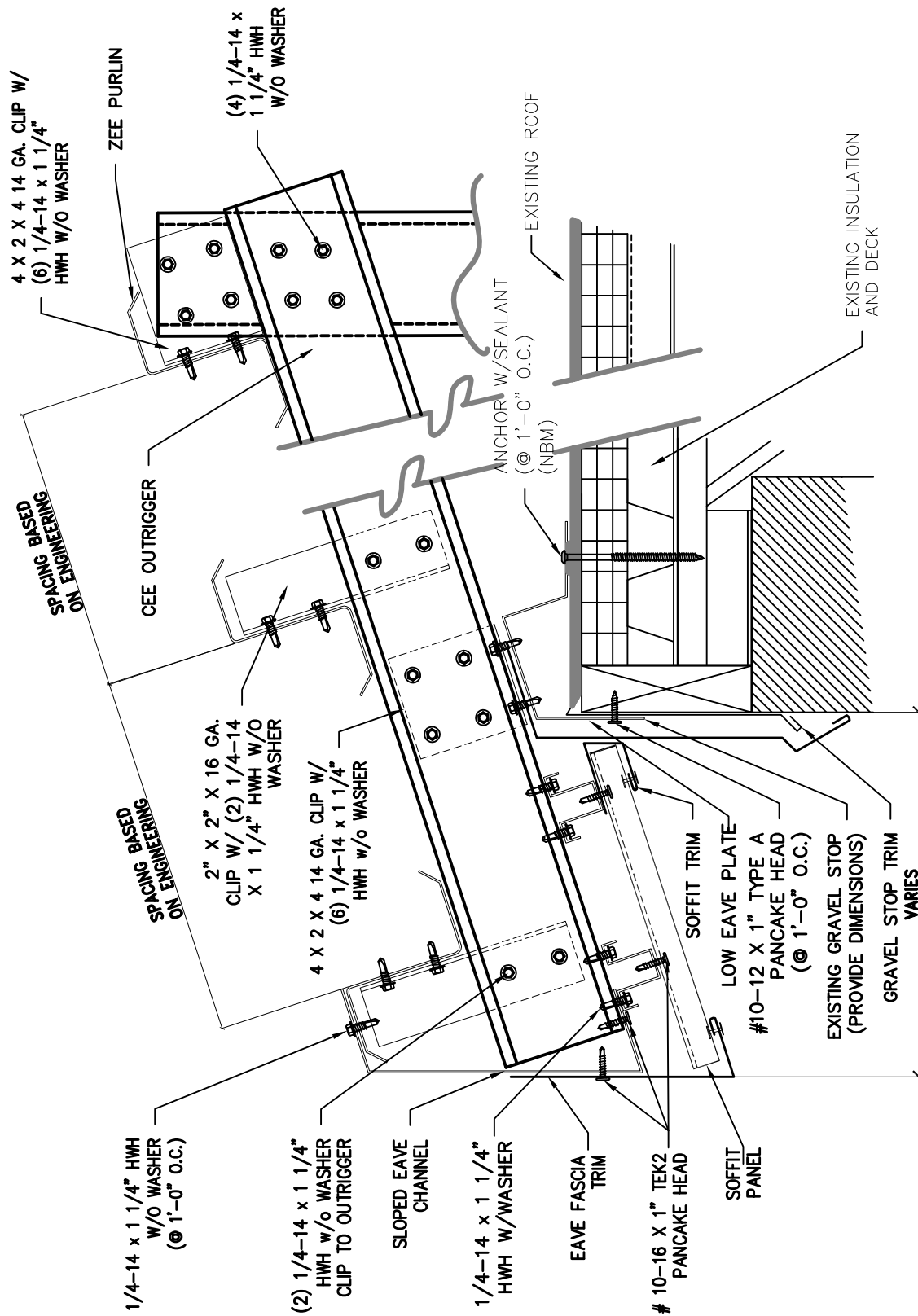




LOW EAVE CANOPY W/ VENT STRIP

© GRAVEL STOP

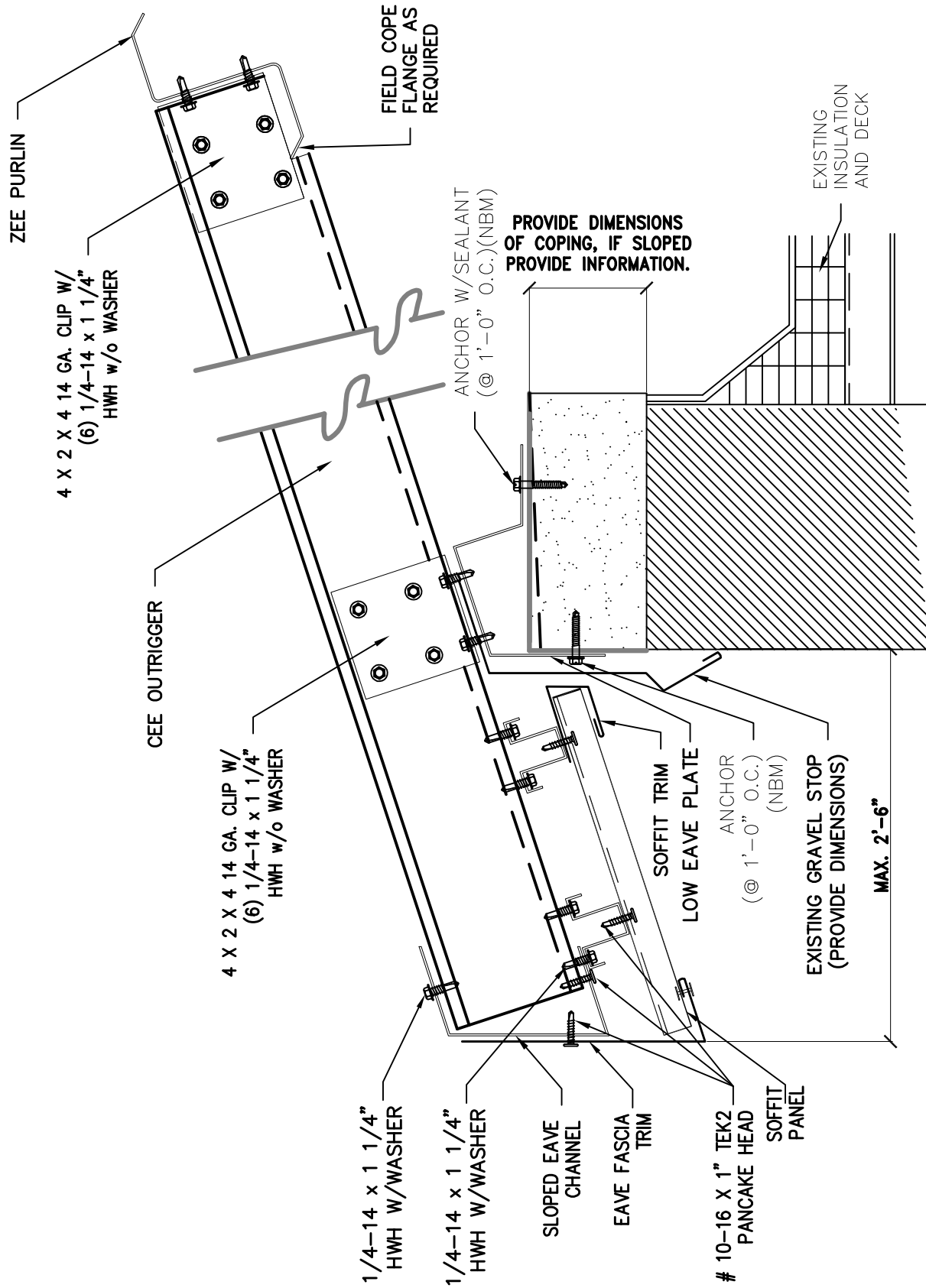




LOW EAVE CANOPY

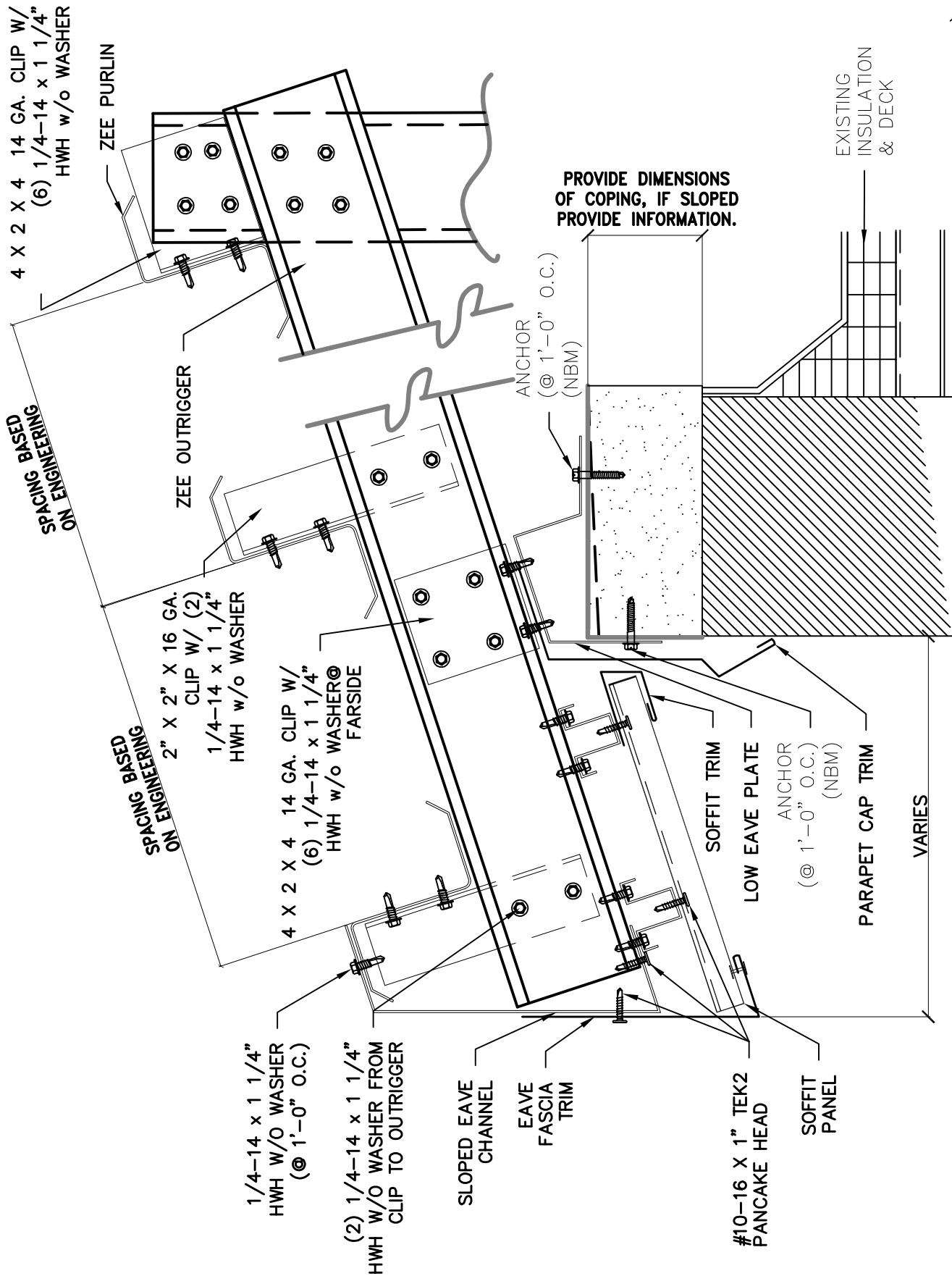
© GRAVEL STOP





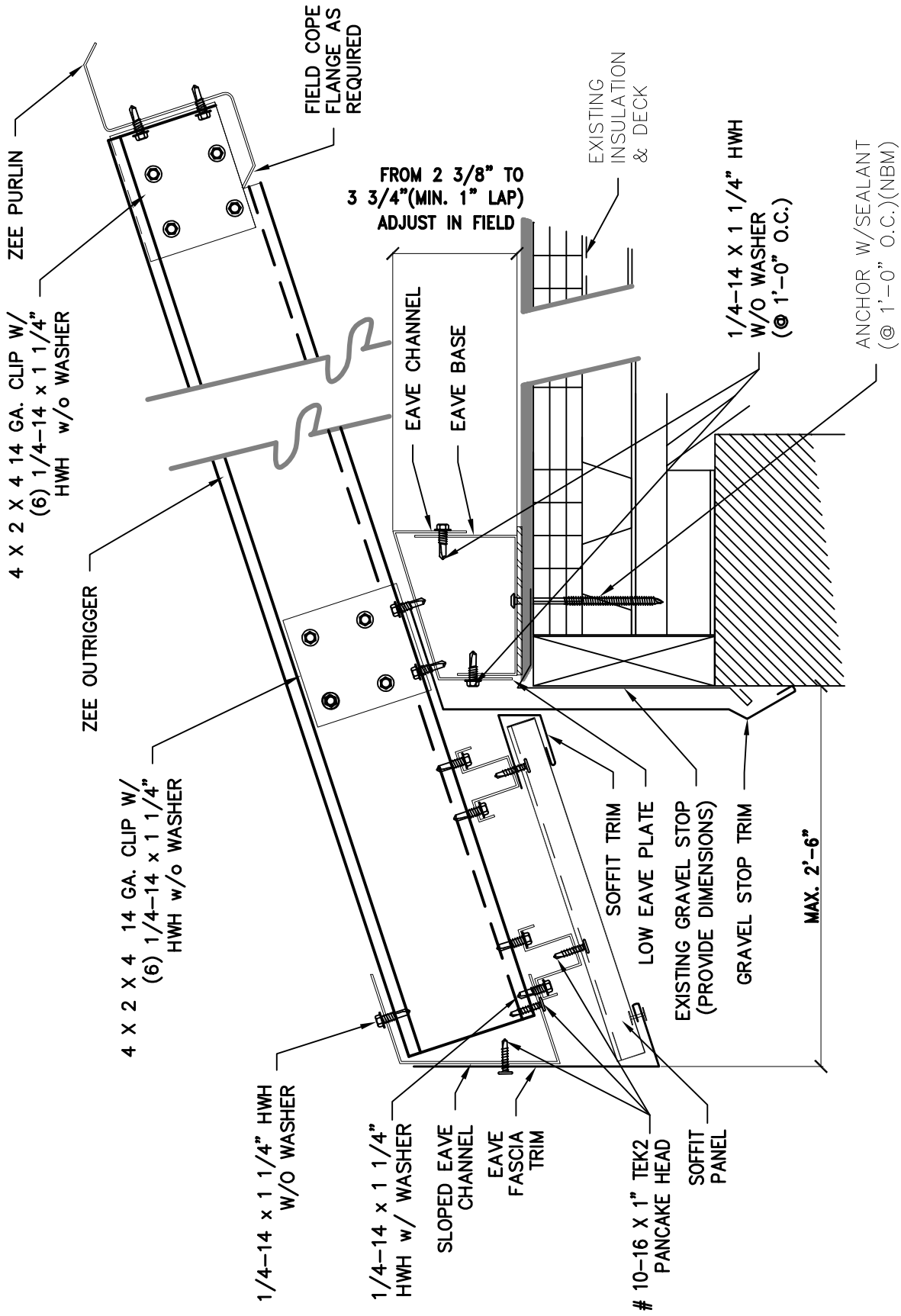
LOW EAVE CANOPY
 © LOAD-BEARING PARAPET





LOW EAVE CANOPY
© LOAD-BEARING PARAPET





LOW EAVE CANOPY FLOATING

@ GRAVEL STOP



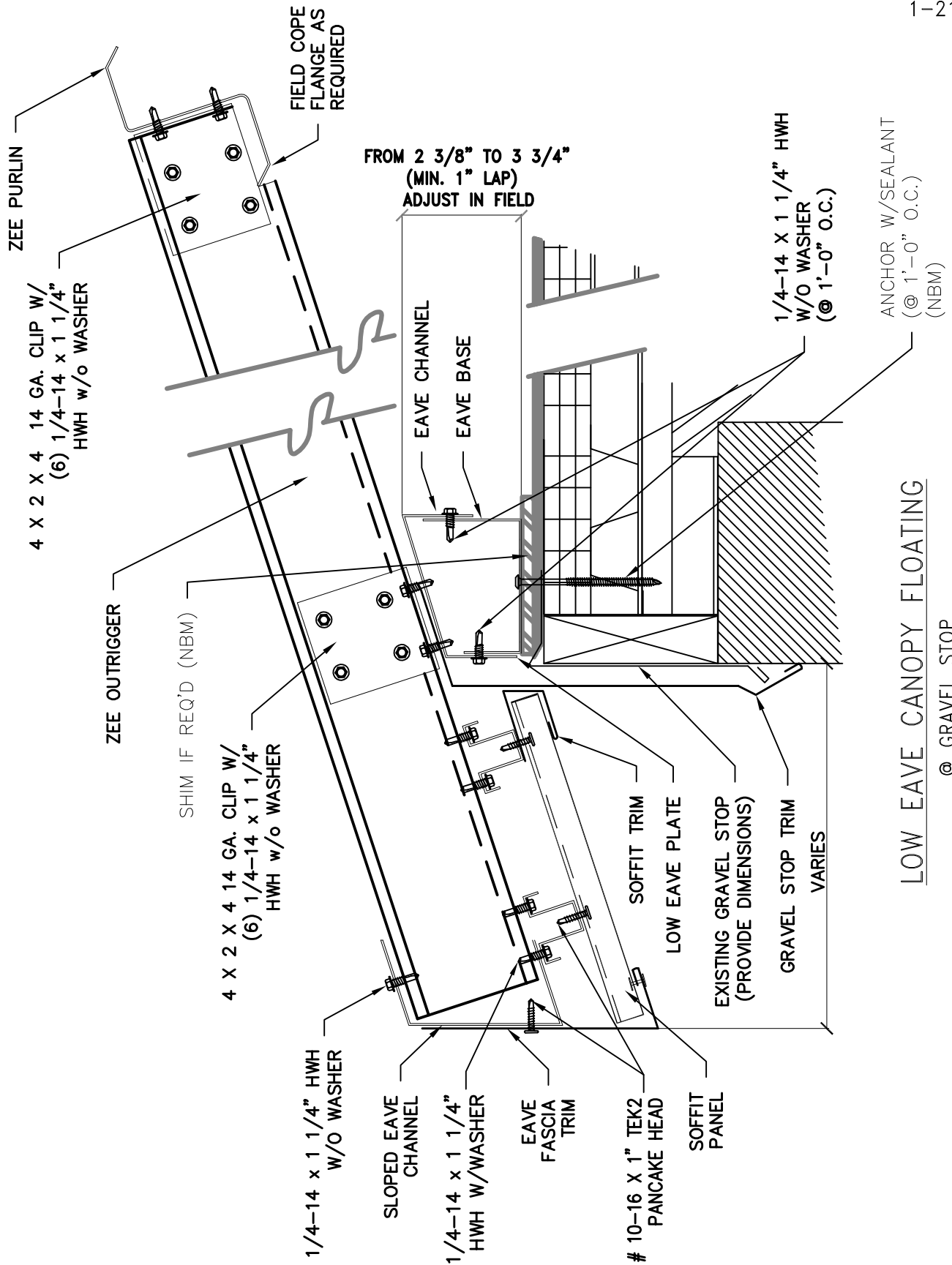
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Canopy Conditions

Page

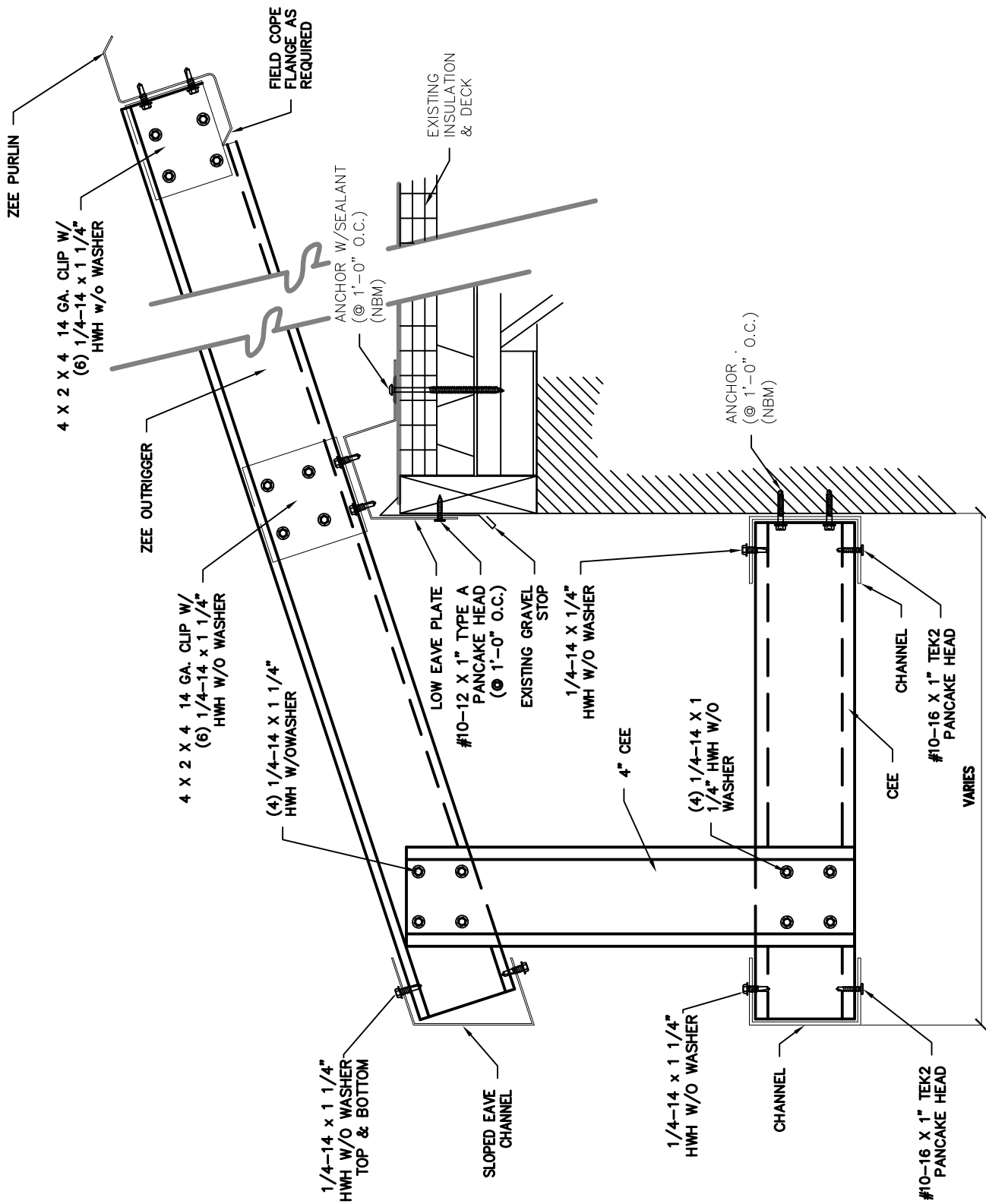
10-25



LOW EAVE CANOPY FLOATING

@ GRAVEL STOP

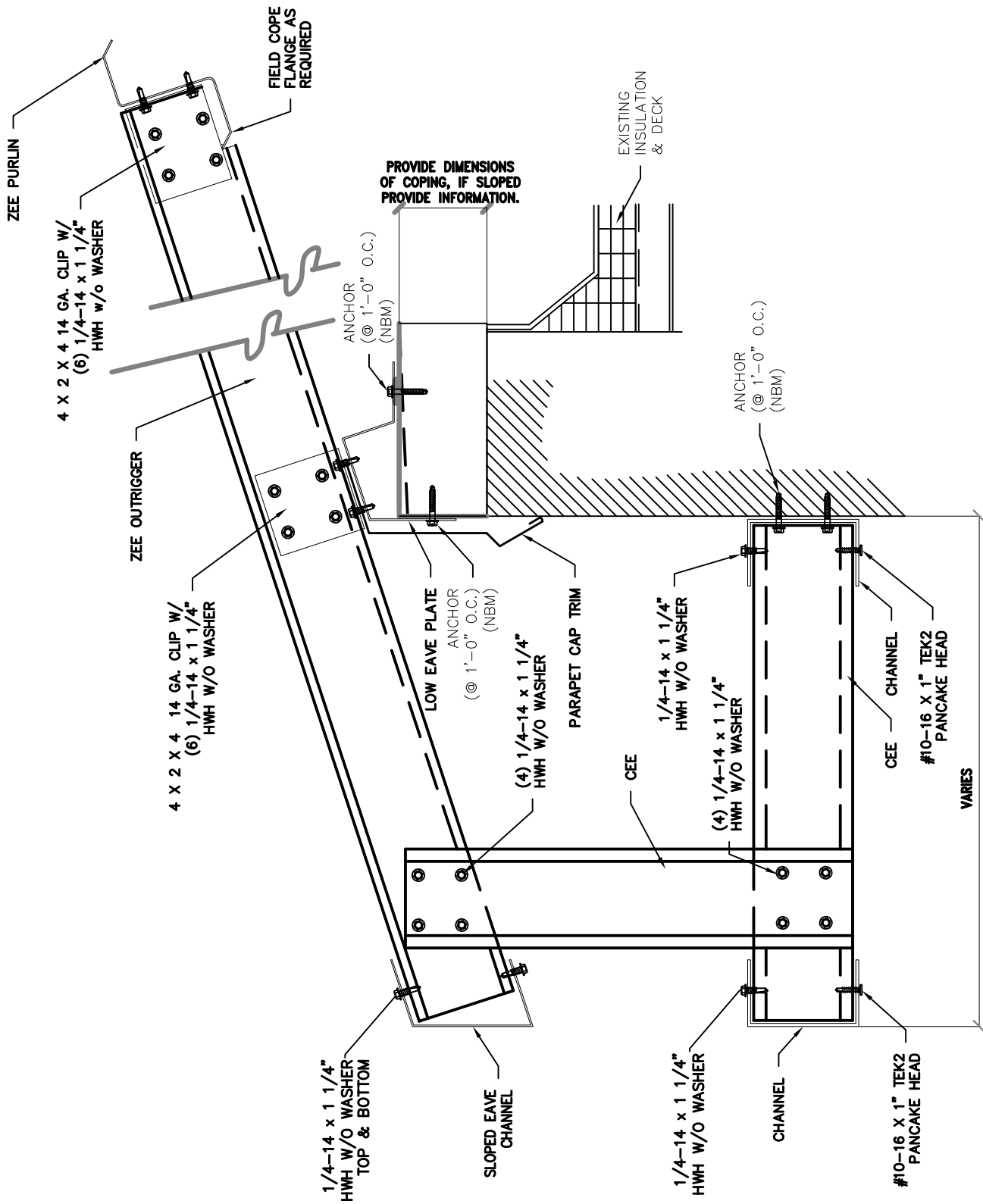




CANOPY FASCIA W/ LOW EAVE

© GRAVEL STOP

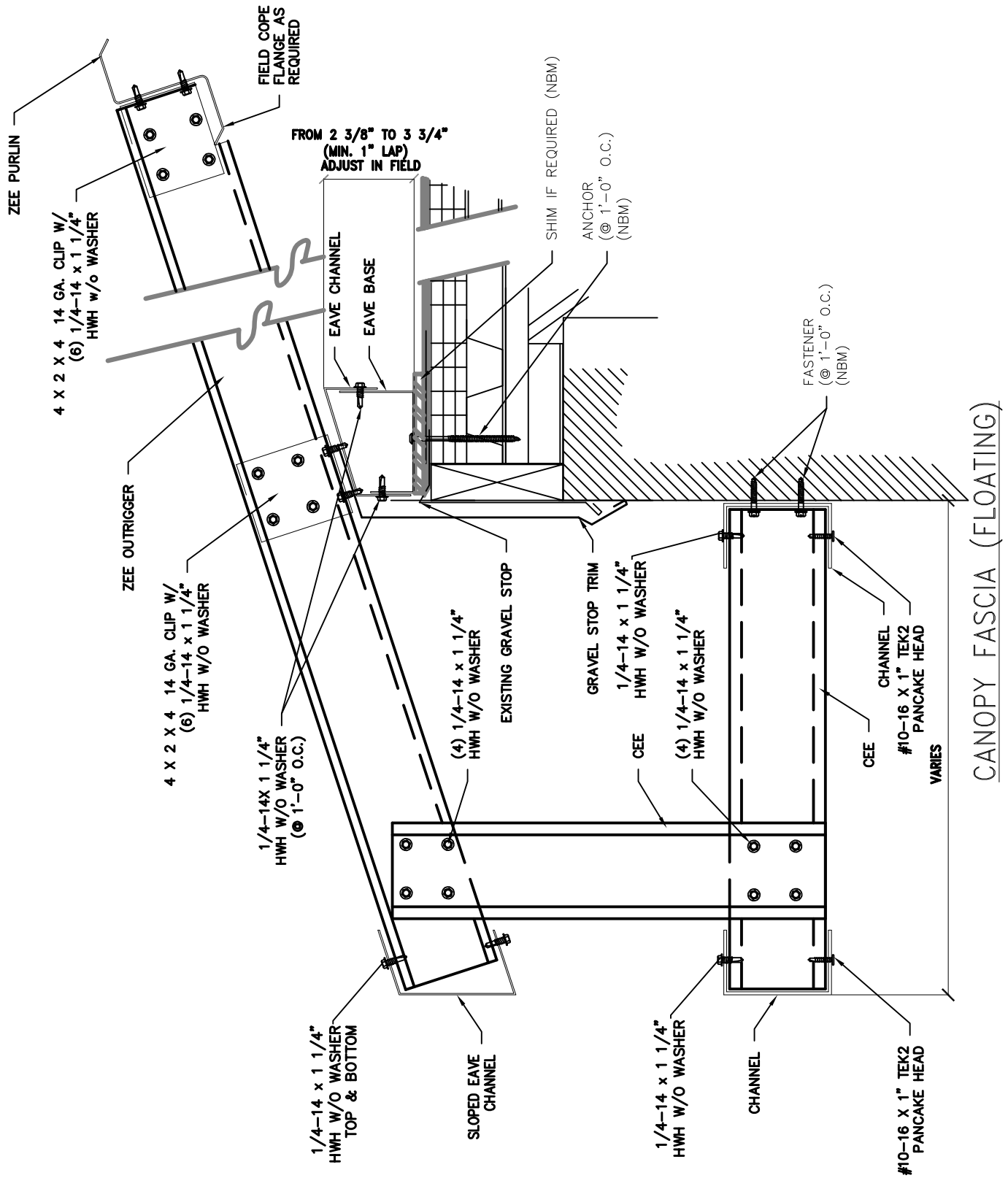


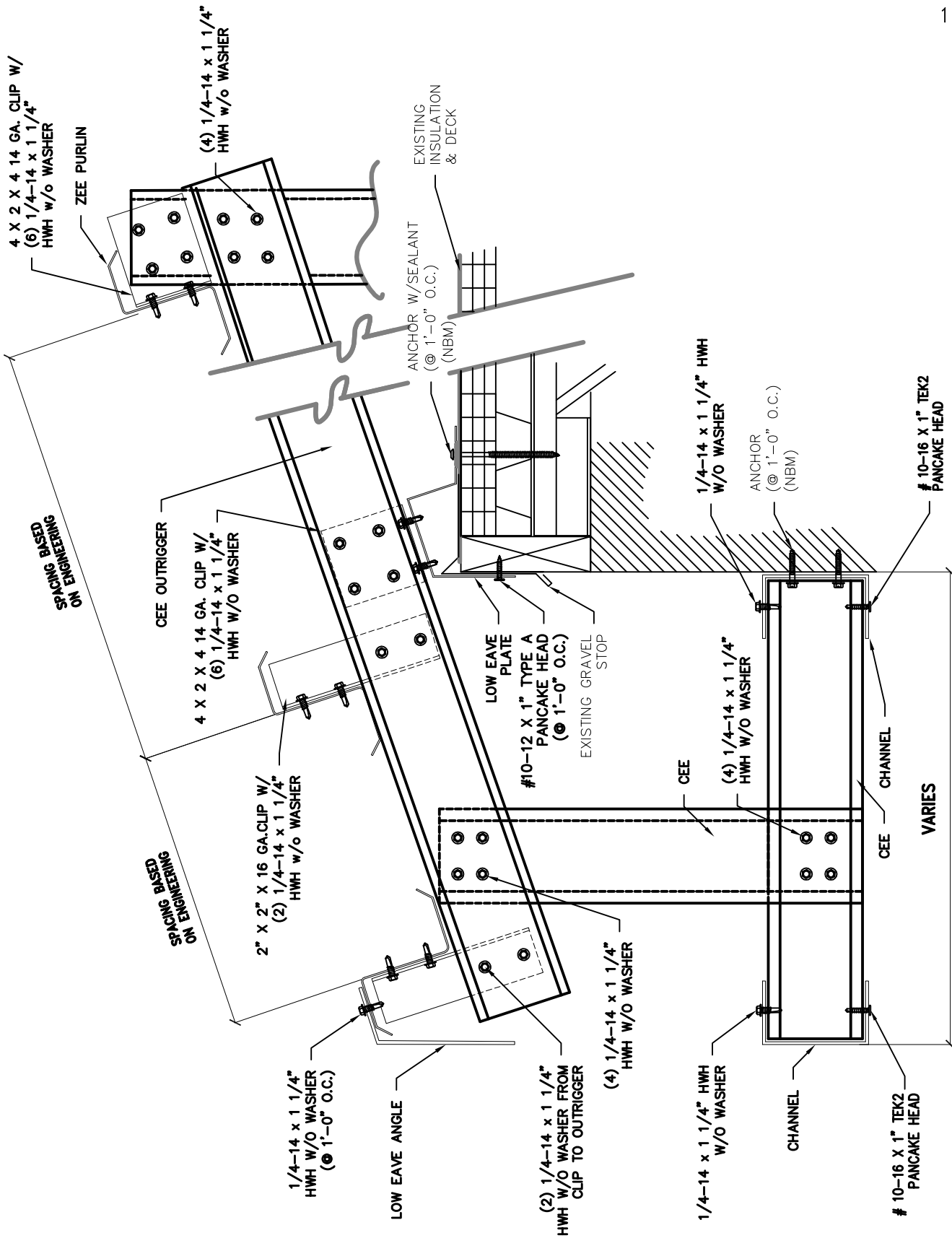


CANOPY FASCIA W/ LOW EAVE

© LOAD-BEARING PARAPET







LOW EAVE CANOPY WALL W/ FASCIA

© GRAVEL STOP



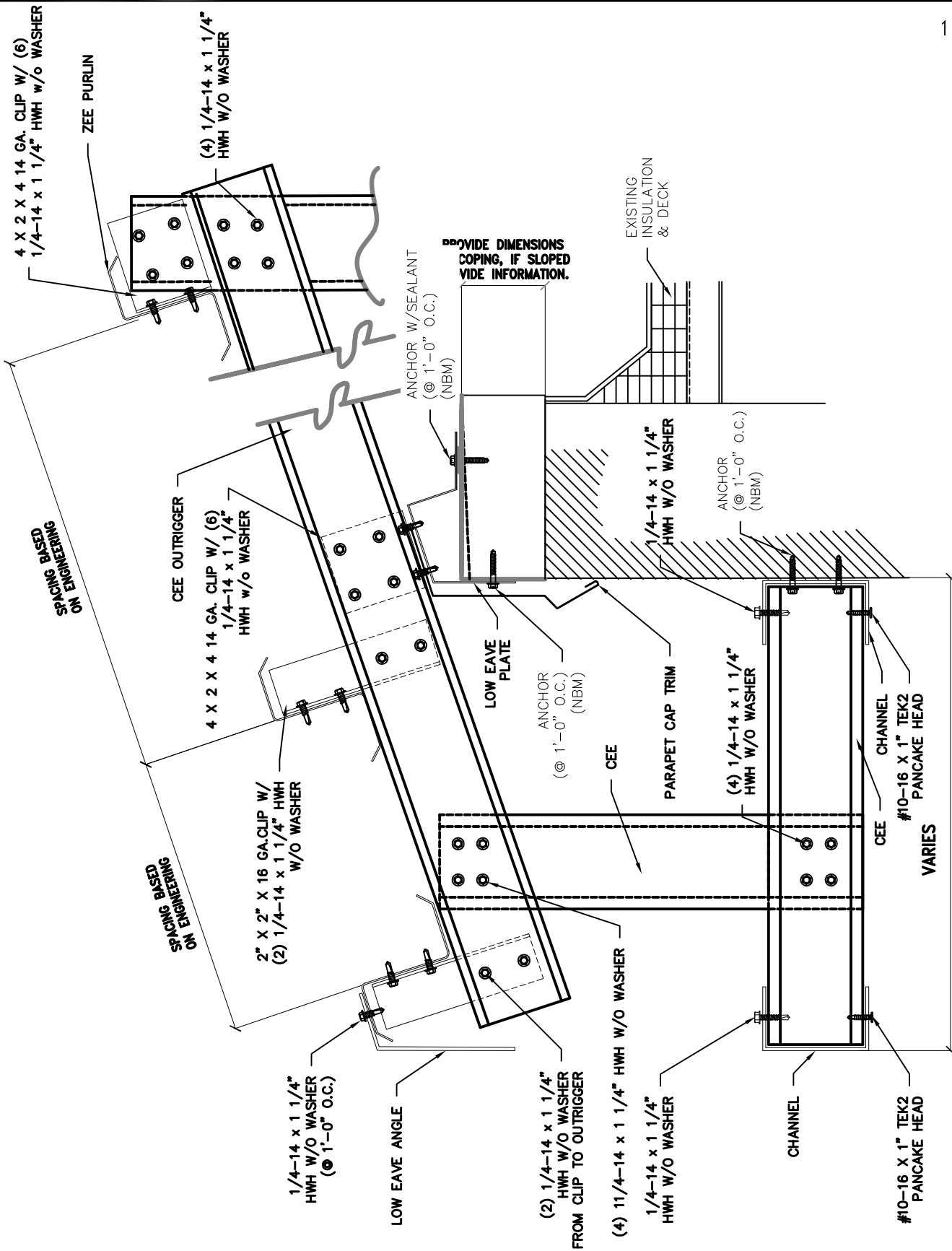
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Canopy Conditions

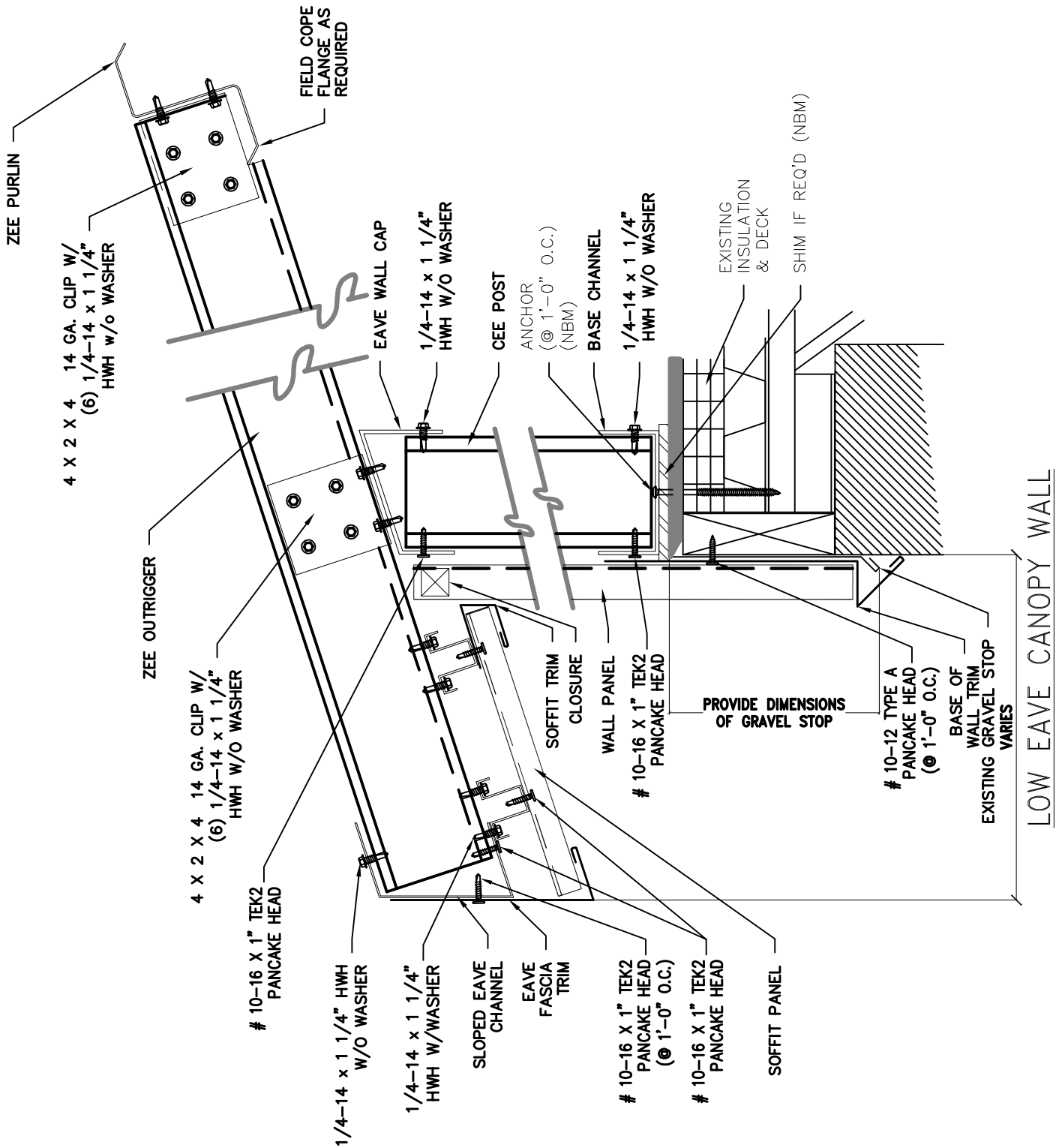
Page

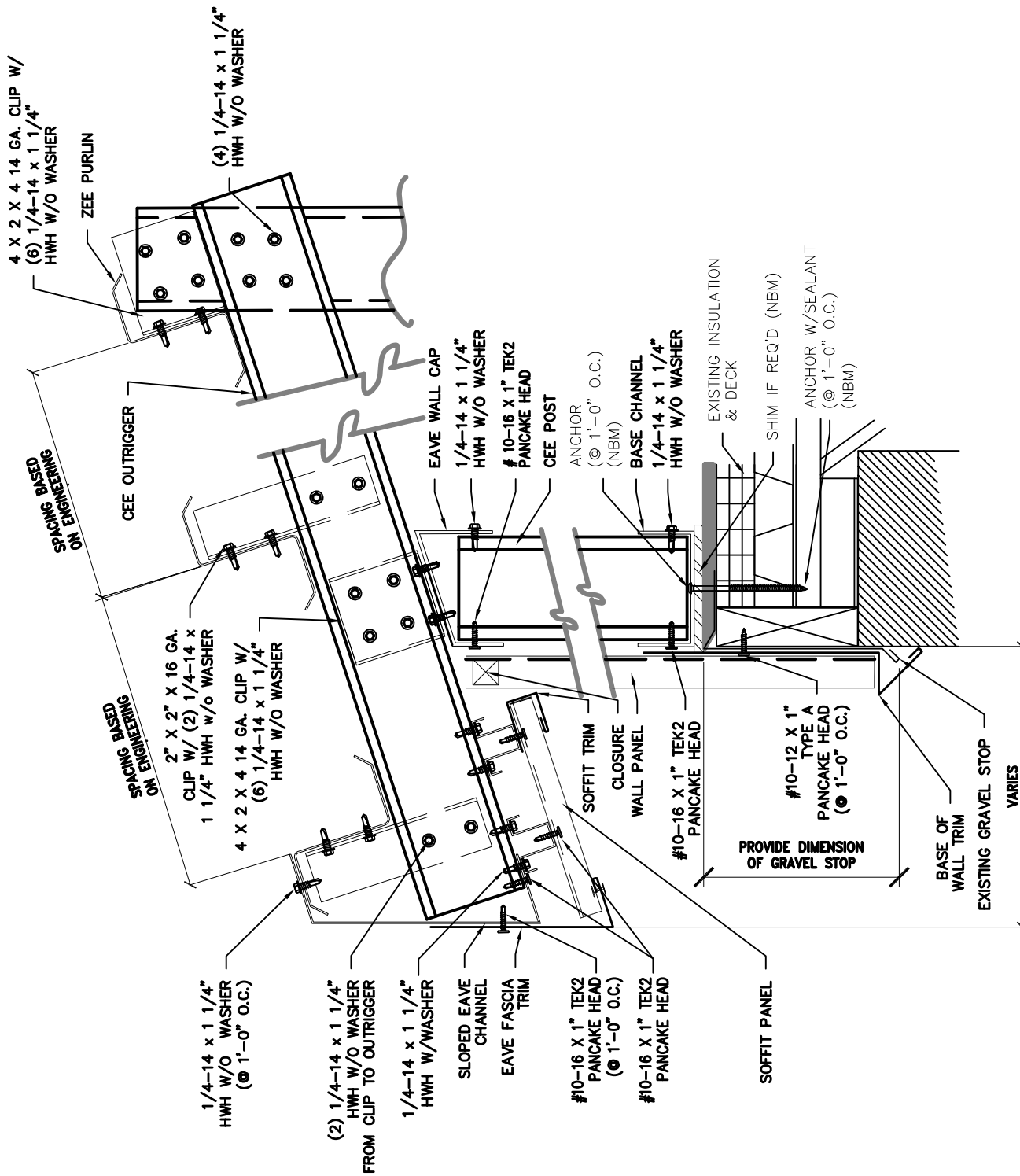
10-30



LOW EAVE CANOPY WALL W/ FASCIA
 © LOAD-BEARING PARAPET



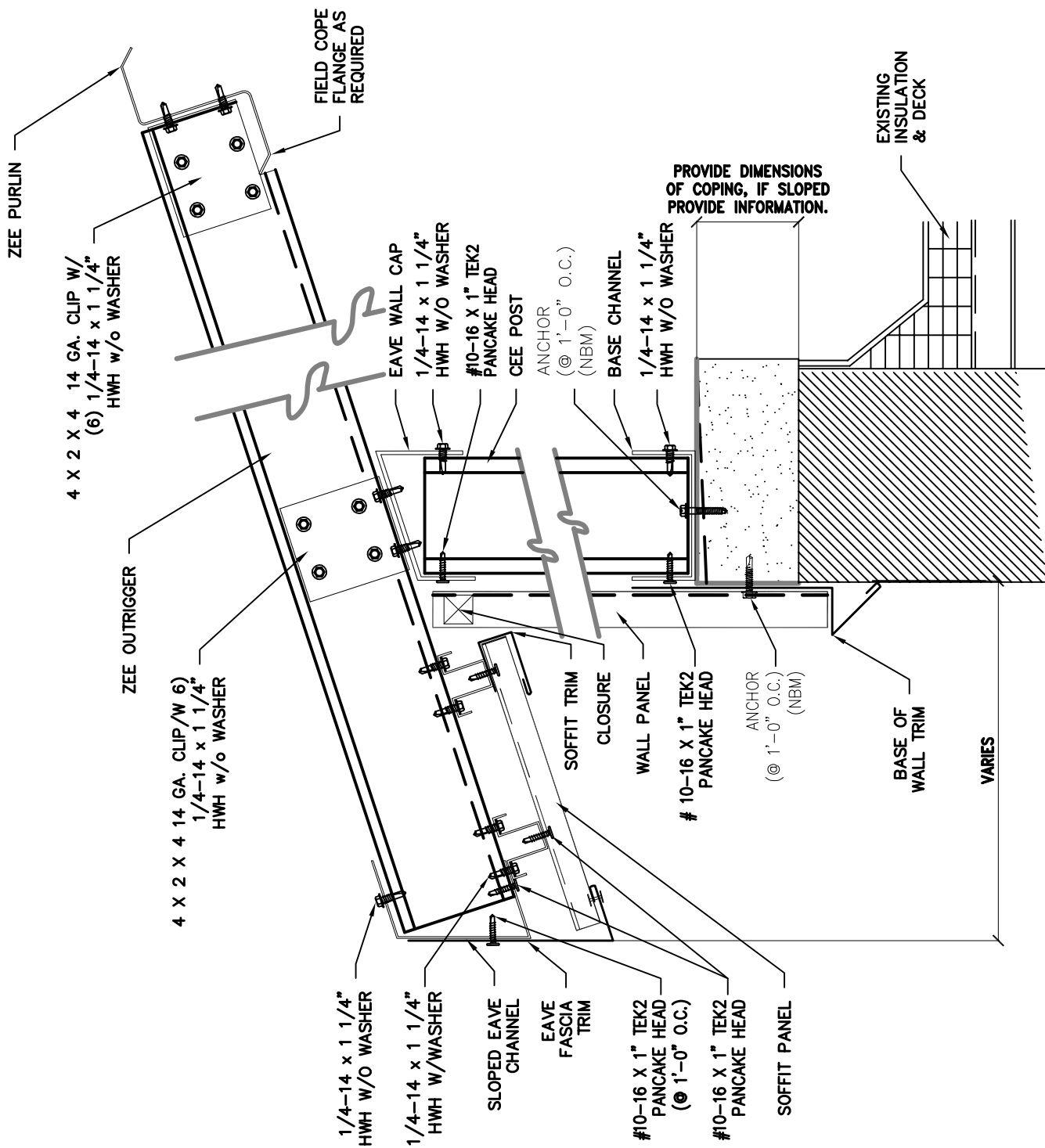




LOW EAVE CANOPY WALL

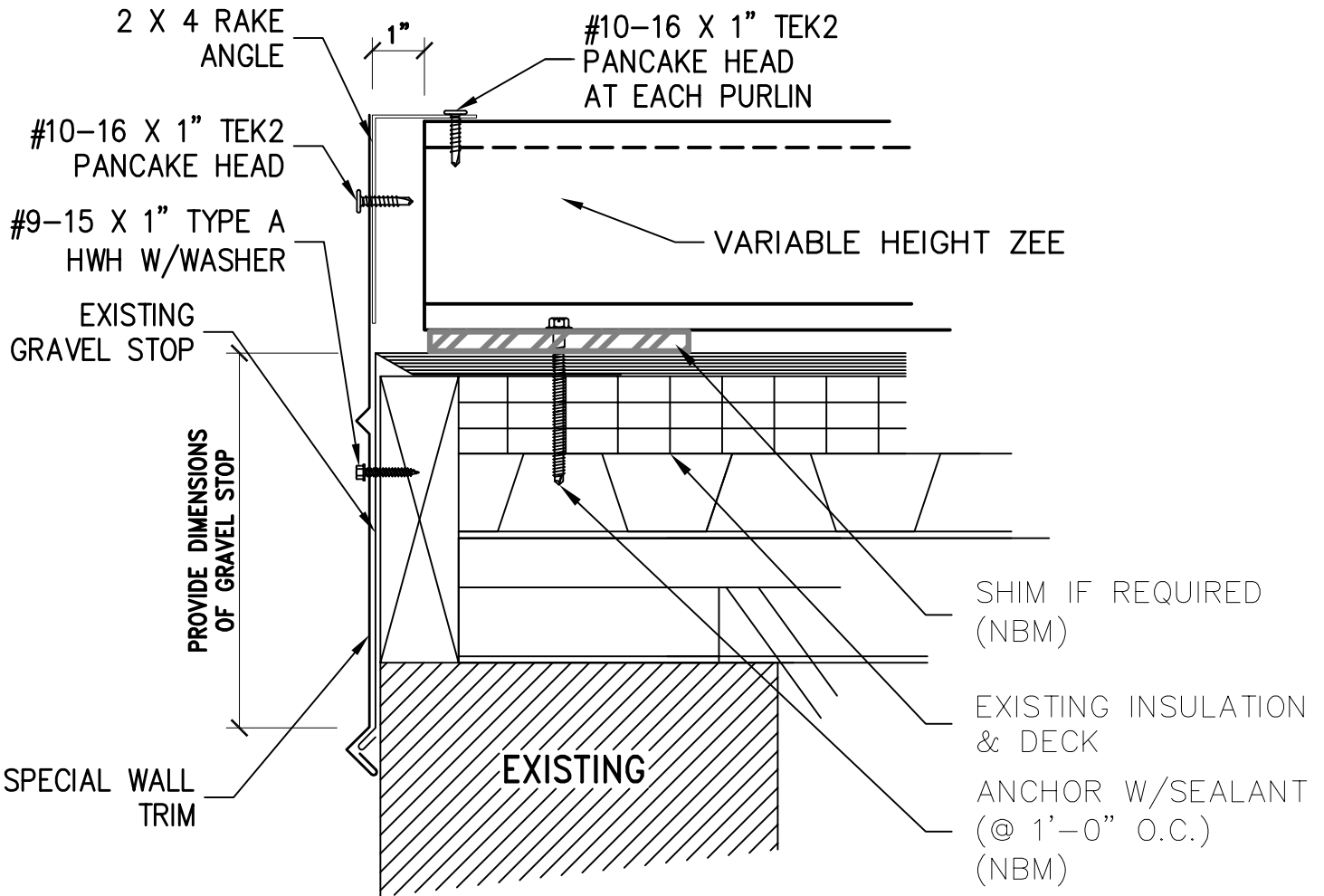
© GRAVEL STOP





LOW EAVE CANOPY WALL
 © LOAD-BEARING PARAPET

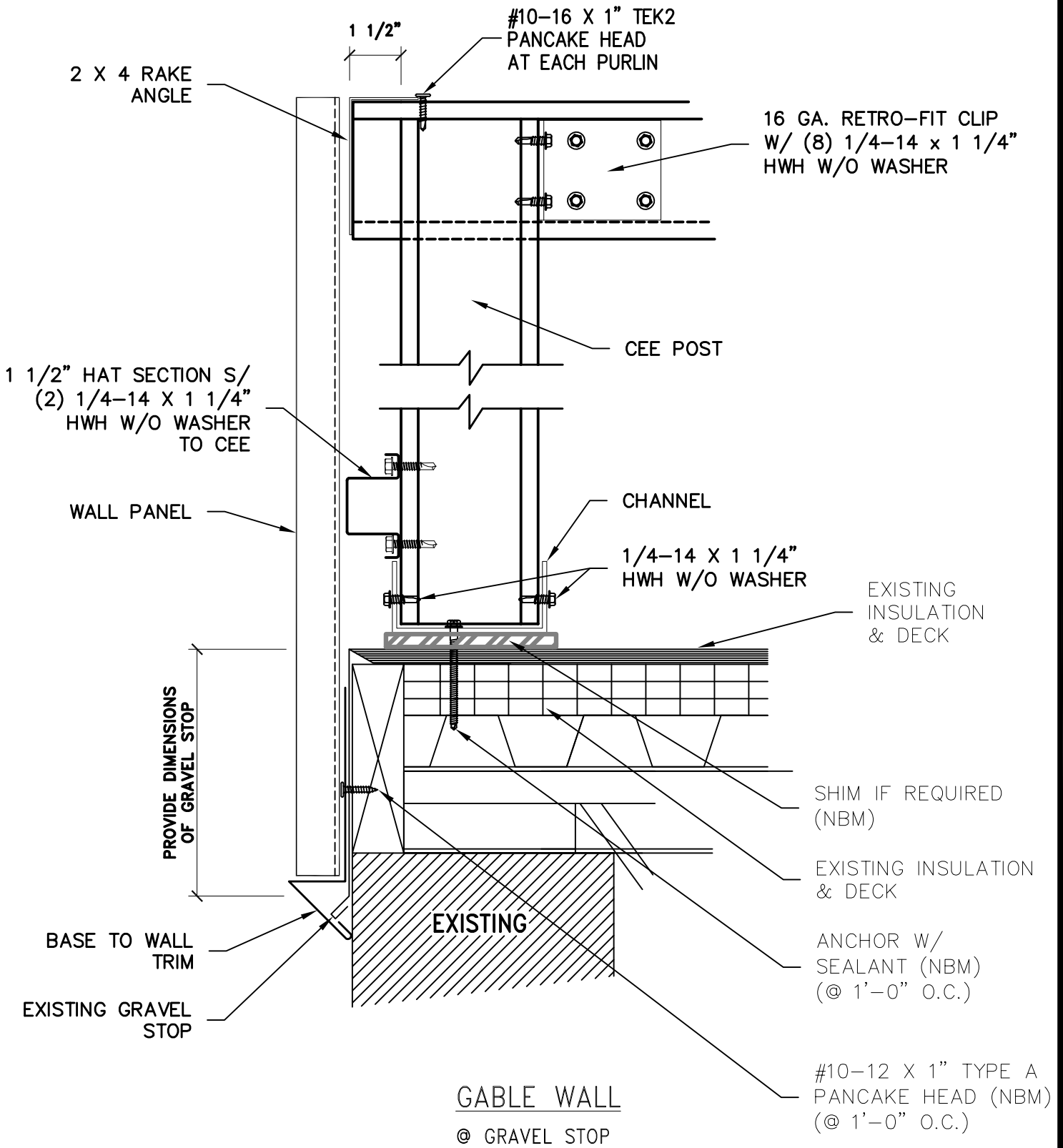


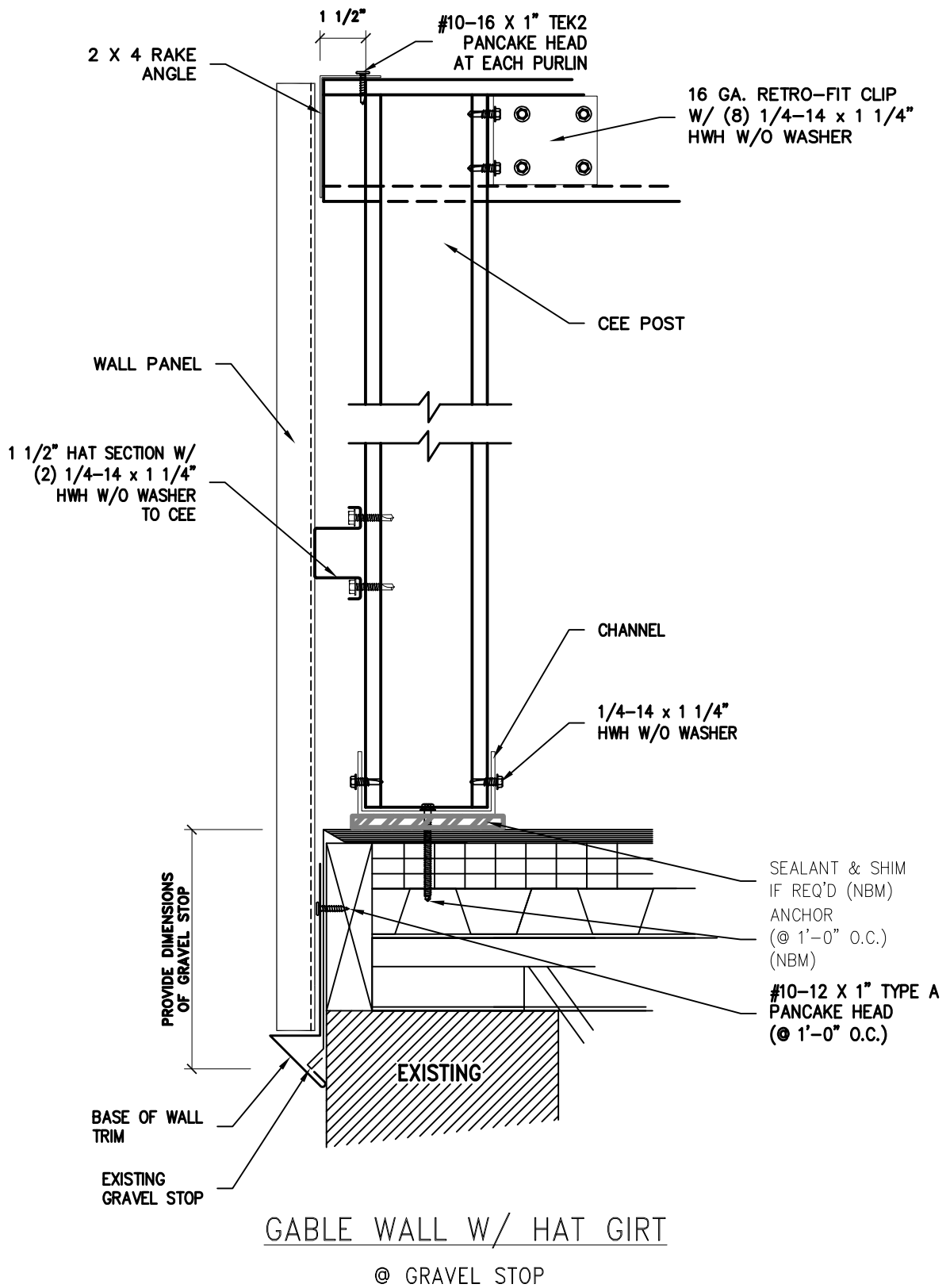


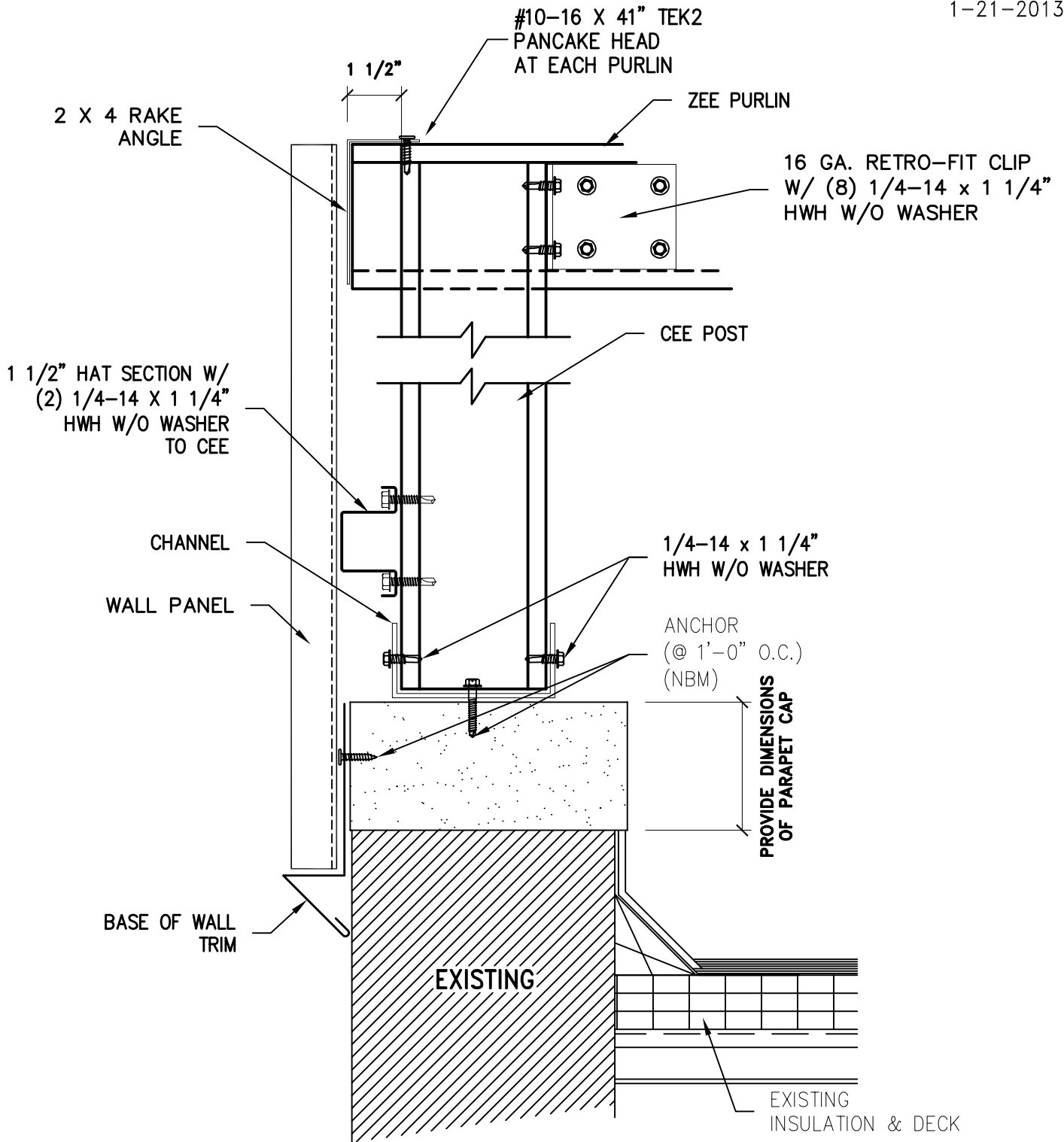
LOW SLOPED GABLE

@ GRAVEL STOP









GABLE WALL

© LOAD-BEARING PARAPET



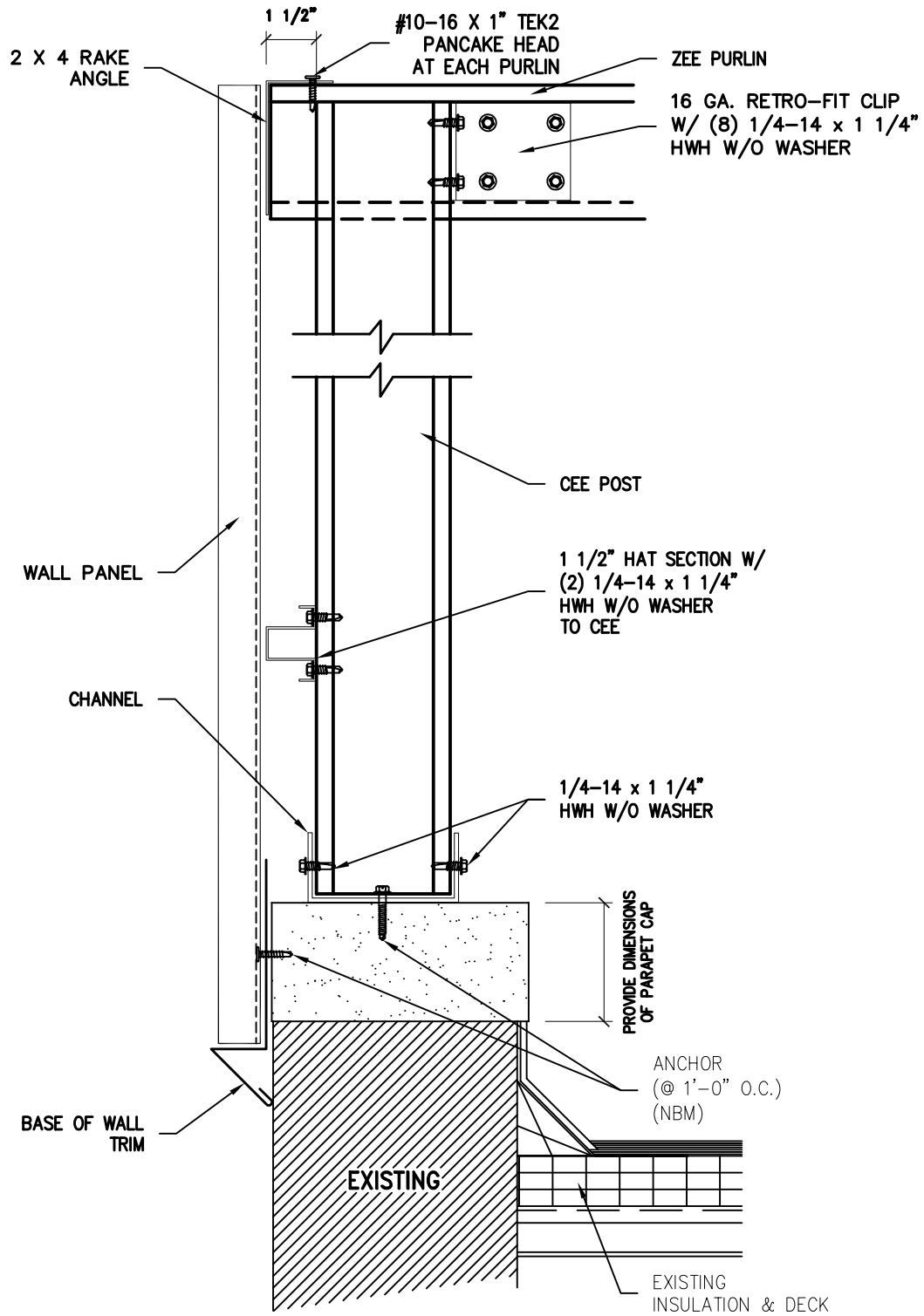
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Gable Conditions

Page

10-38



GABLE WALL W/ HAT GIRT

@ LOAD-BEARING PARAPET



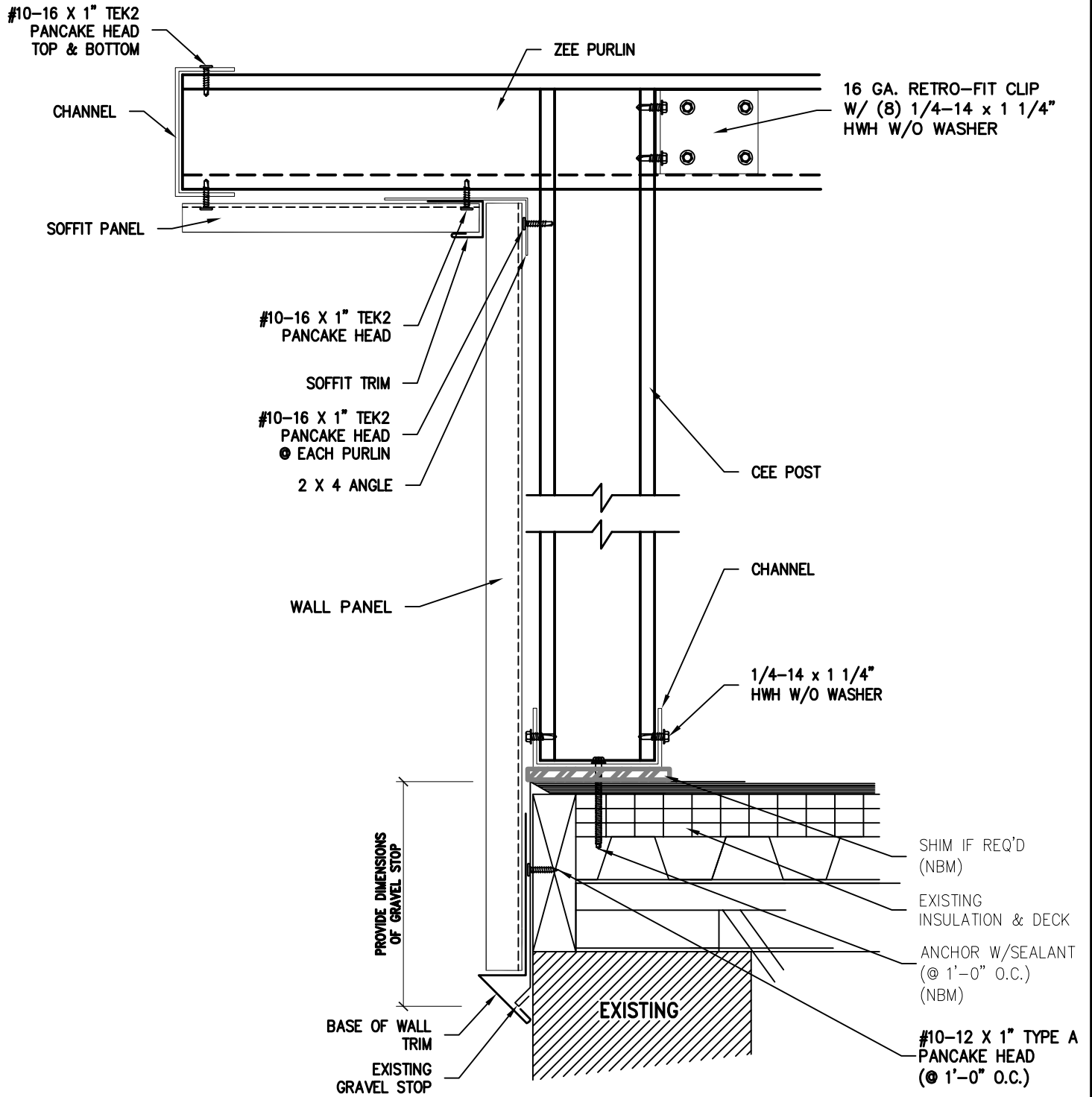
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Gable Conditions

Page

10-39



GABLE WALL W/ PURLIN EXTENSION

@ GRAVEL STOP



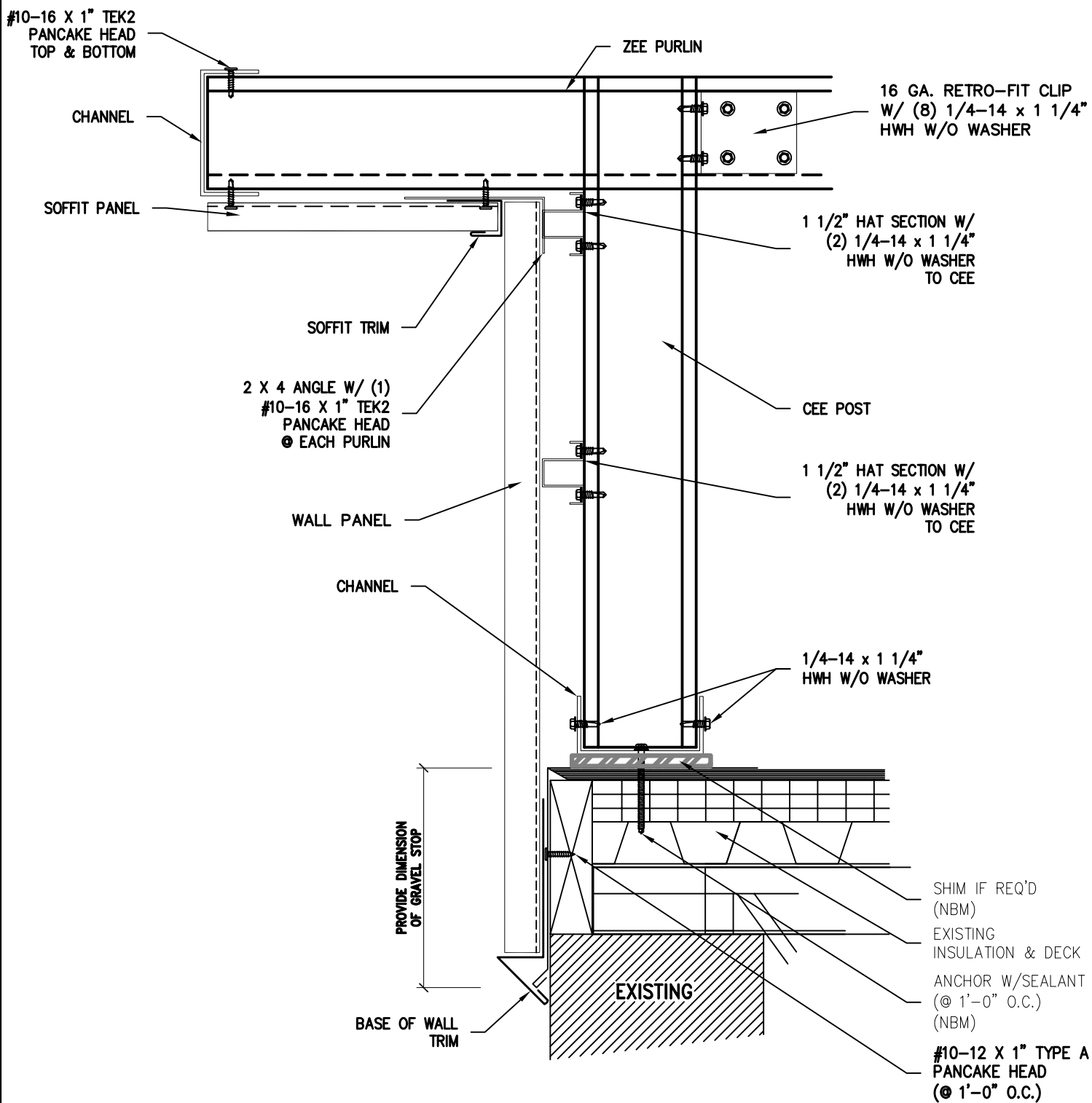
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Page

Gable Conditions

10-40



GABLE WALL W/ GIRT & PURLIN EXTENSION

@ GRAVEL STOP



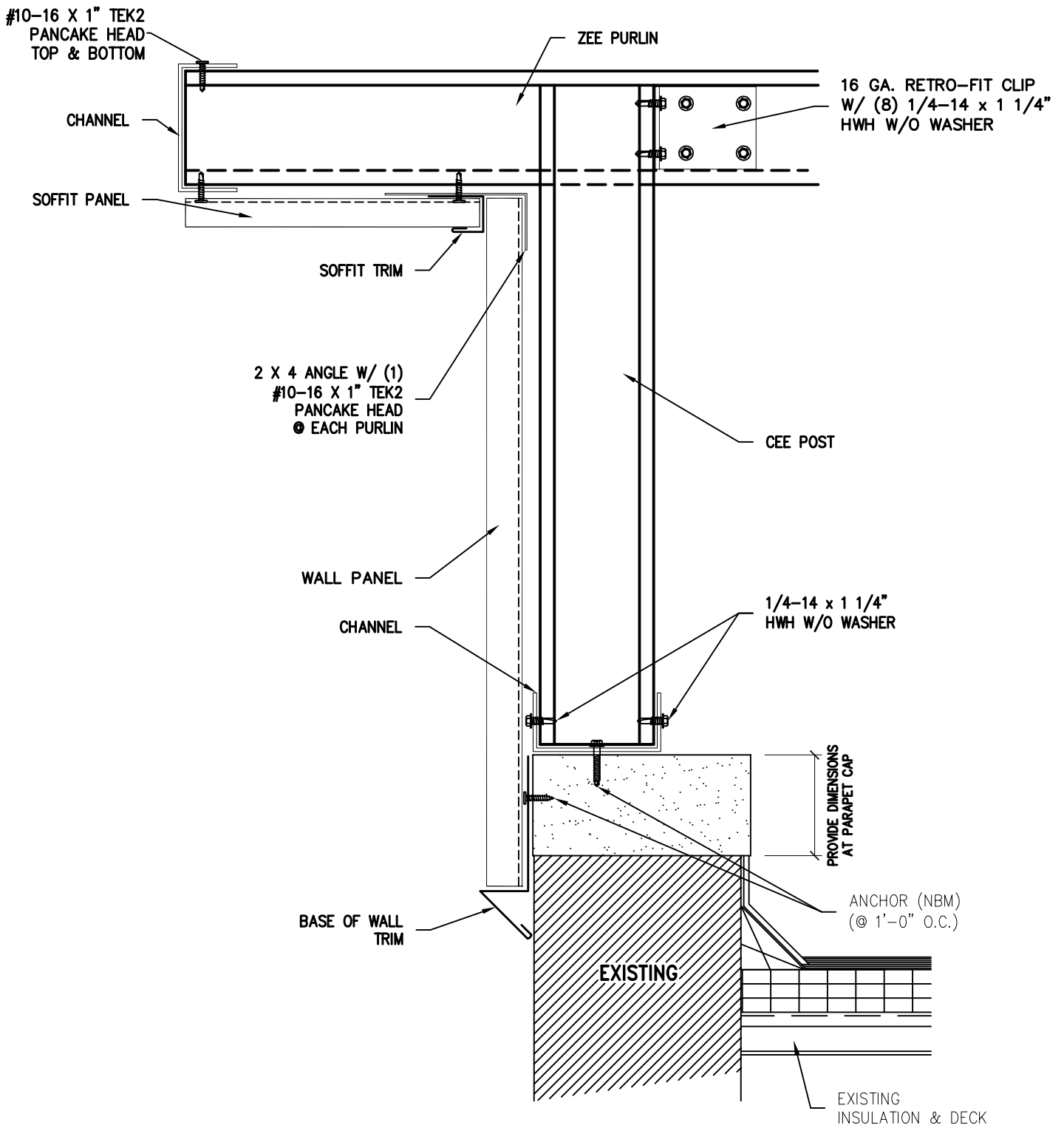
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Page

Gable Conditions

10-41



GABLE WALL W/ PURLIN EXTENSION

@ LOAD-BEARING PARAPET



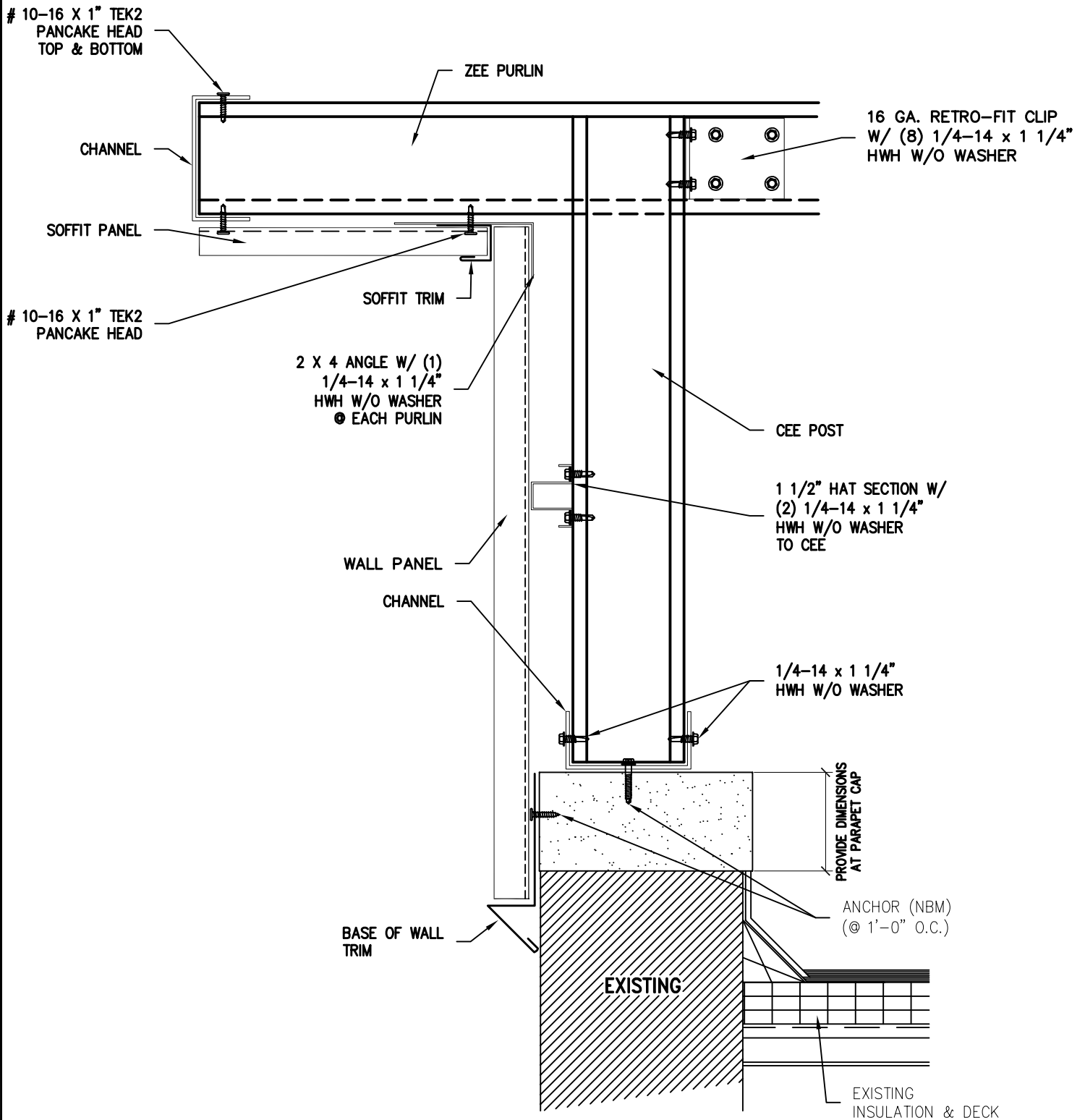
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Gable Conditions

Page

10-42



GABLE WALL W/ GIRT & PURLIN EXTENSION

@ LOAD-BEARING PARAPET



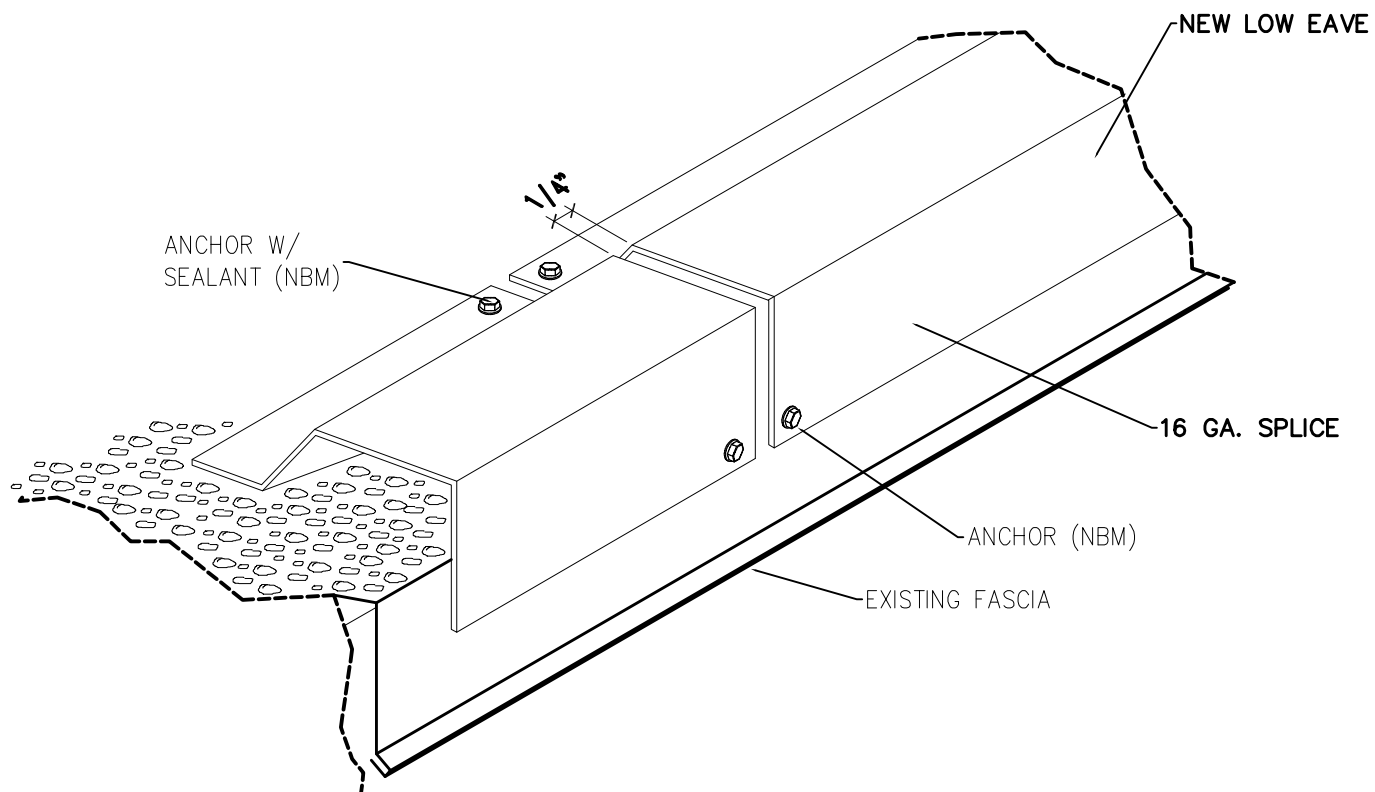
McElroy Metal, Inc.
Retrofit Framing Systems

Perimeter Framing

Page

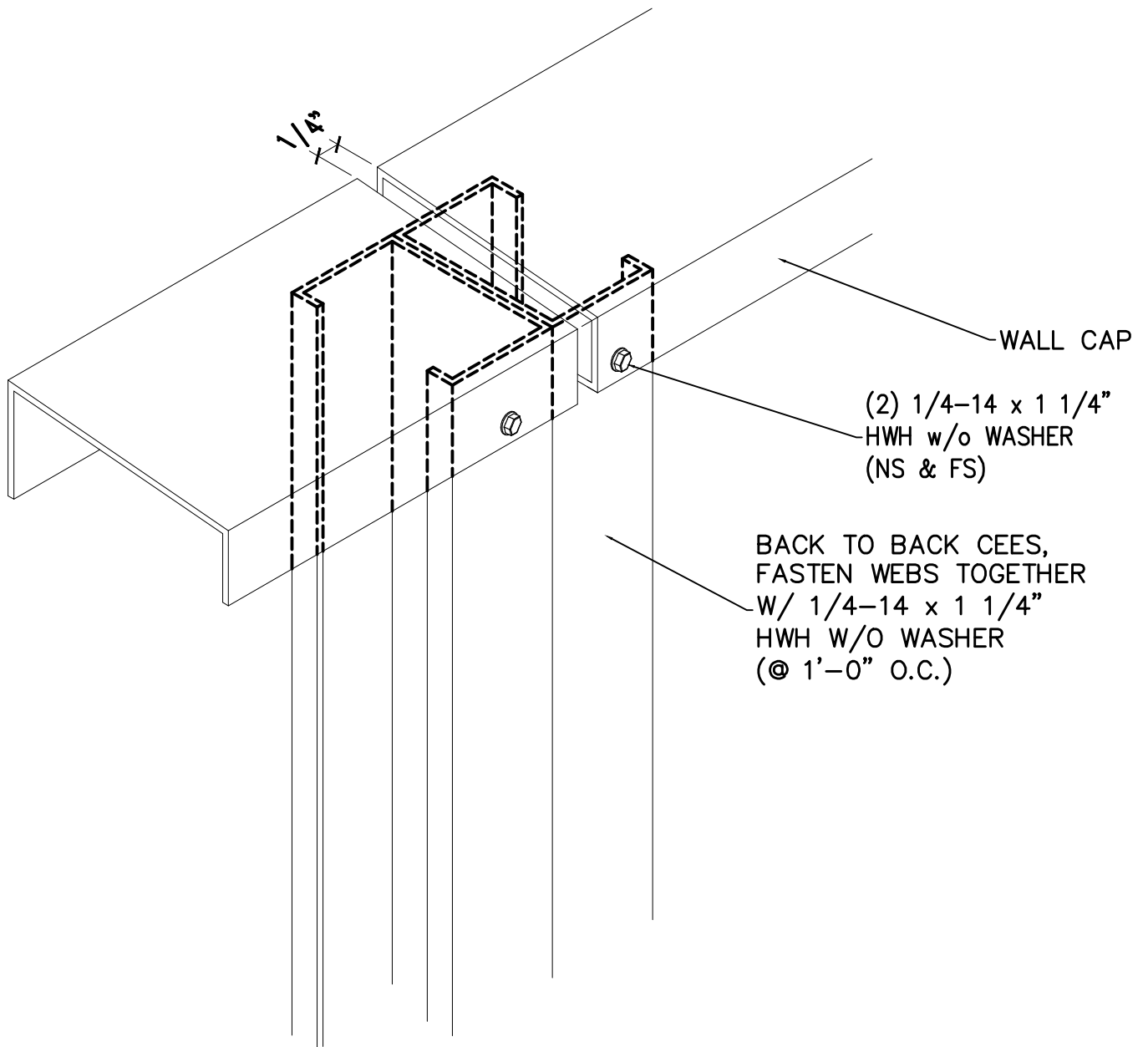
Gable Conditions

10-43



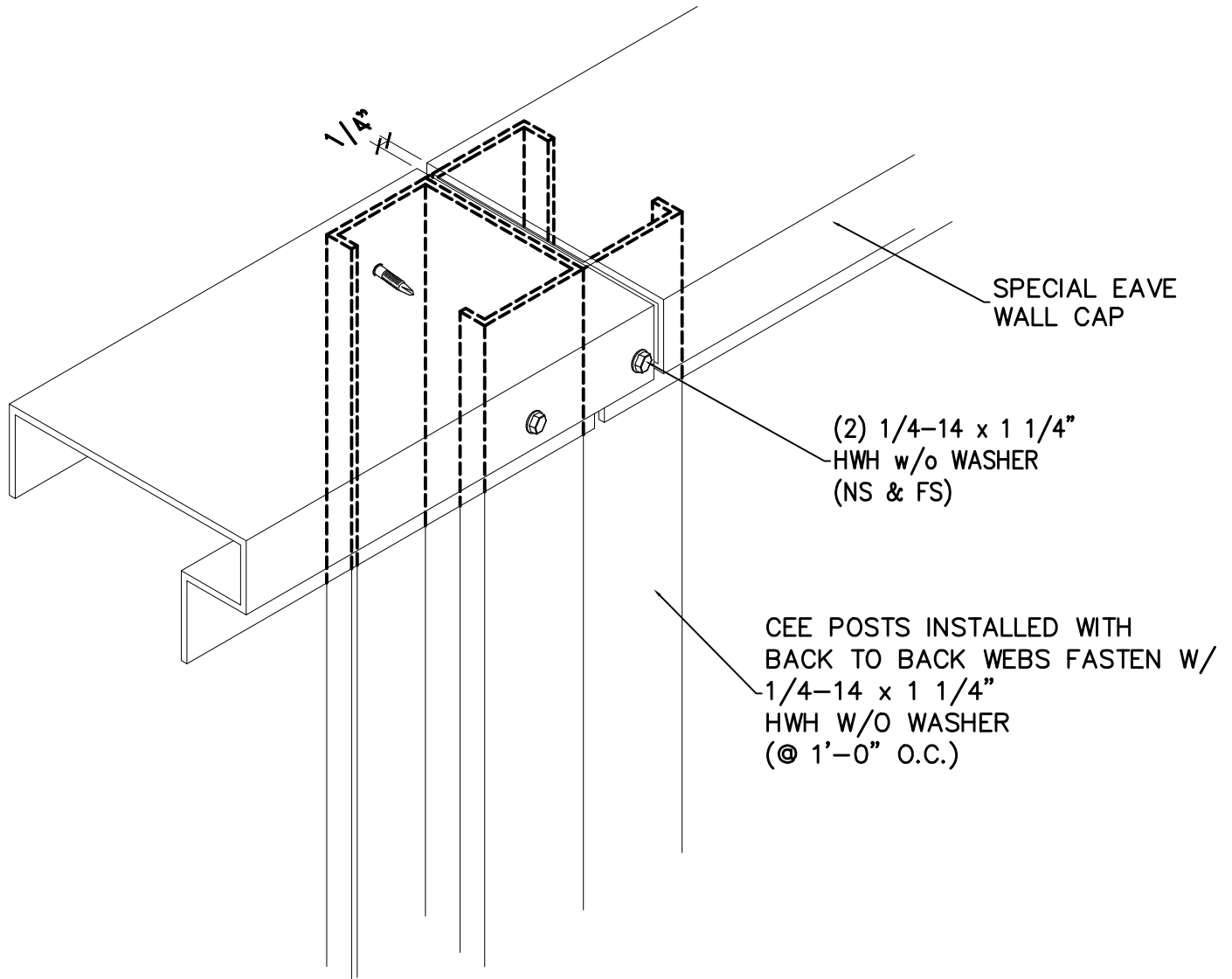
LOW EAVE PLATE SPLICE





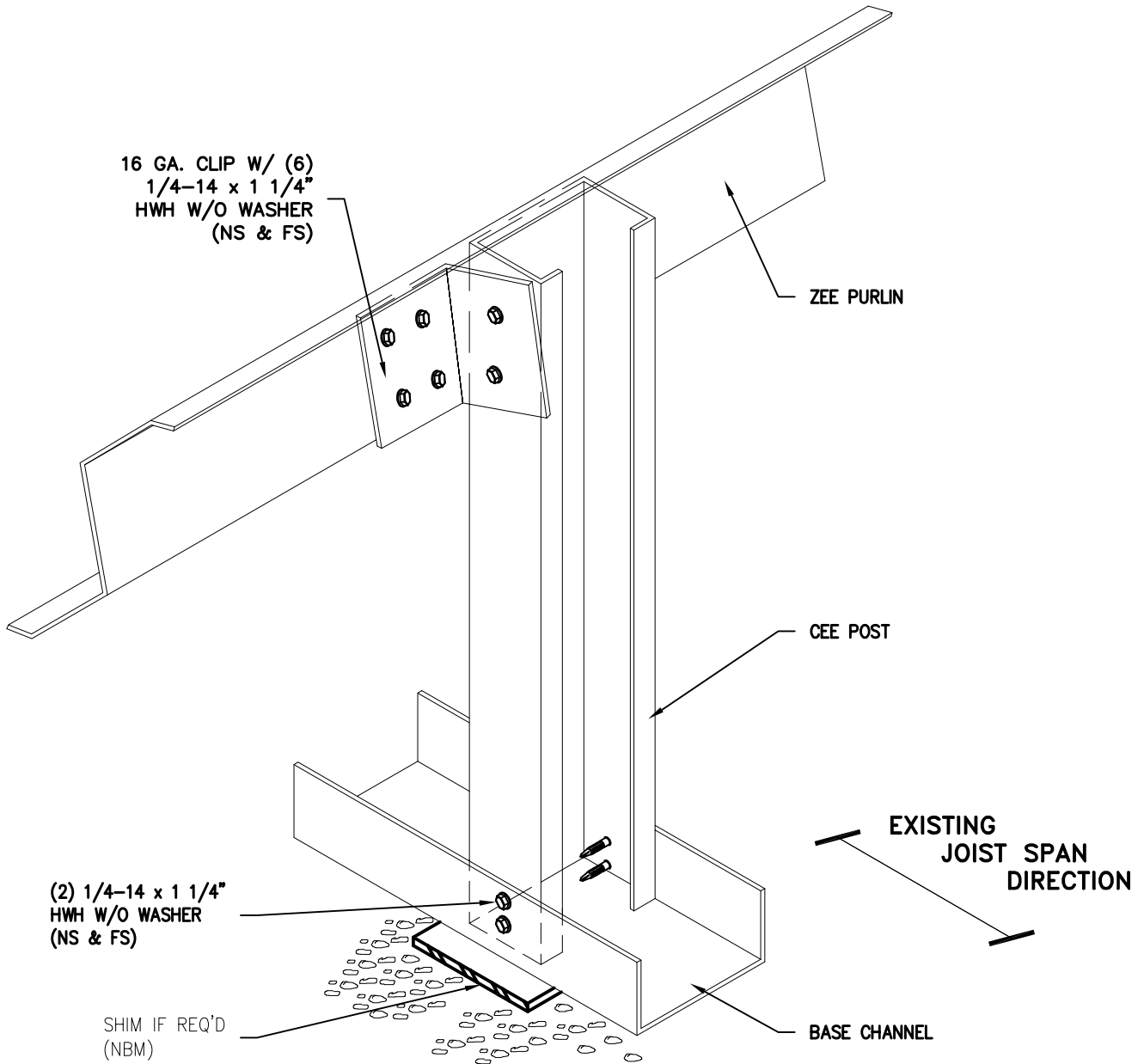
LOW & HIGH EAVE WALL CAP SPLICE





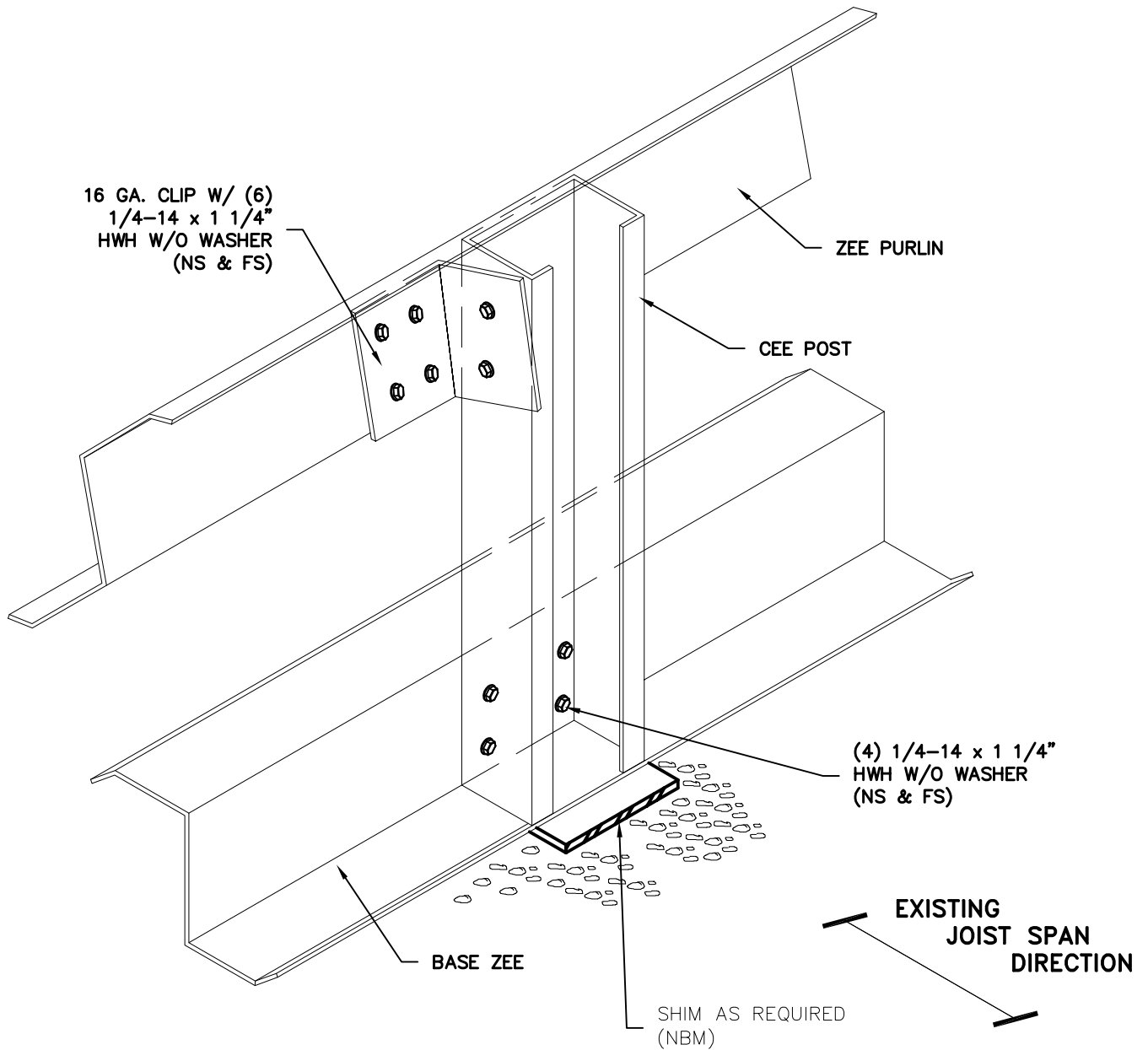
SPECIAL LOW EAVE WALL CAP SPLICE





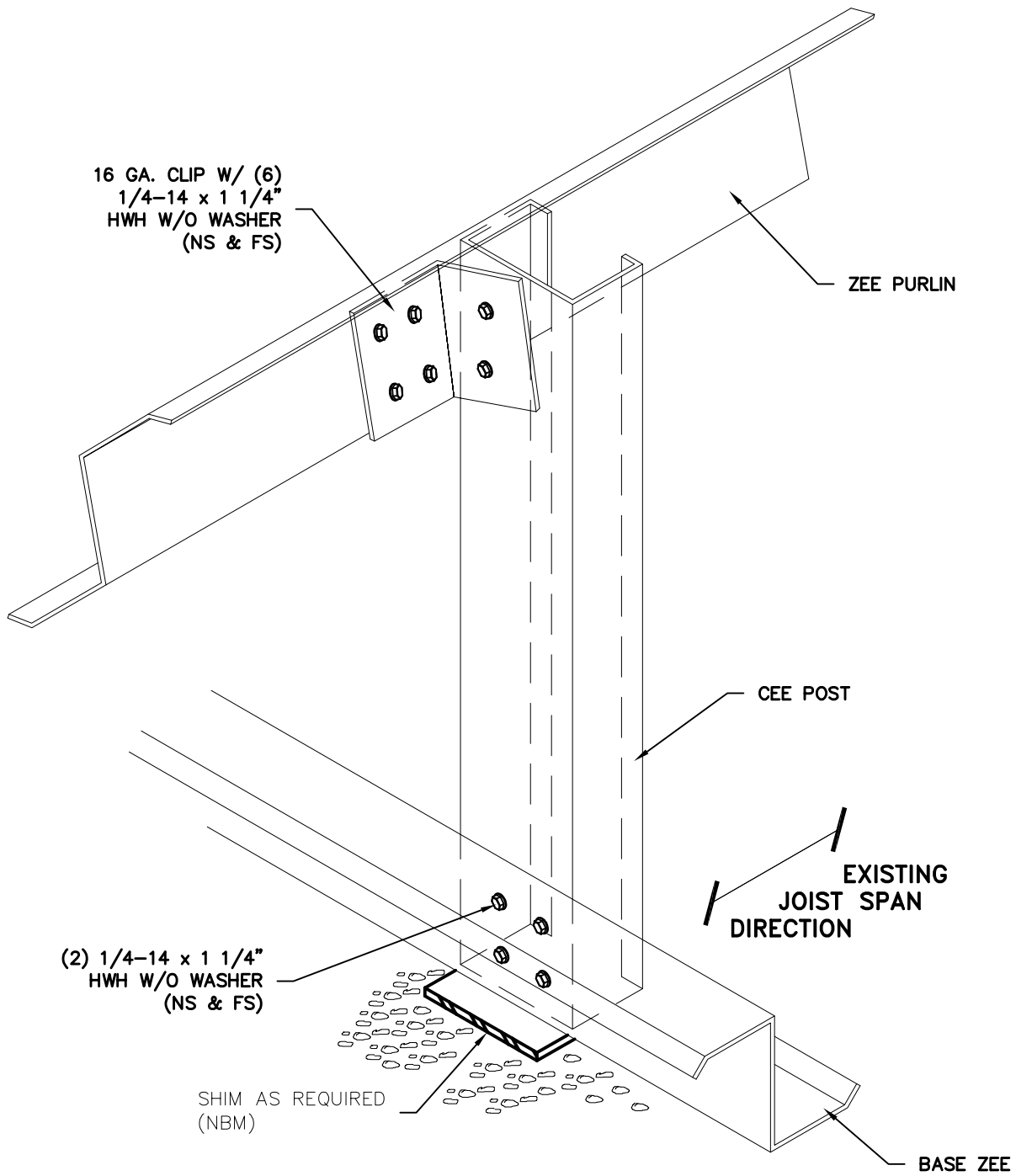
POST WITH BASE SHOE
(PARALLEL CONDITION)





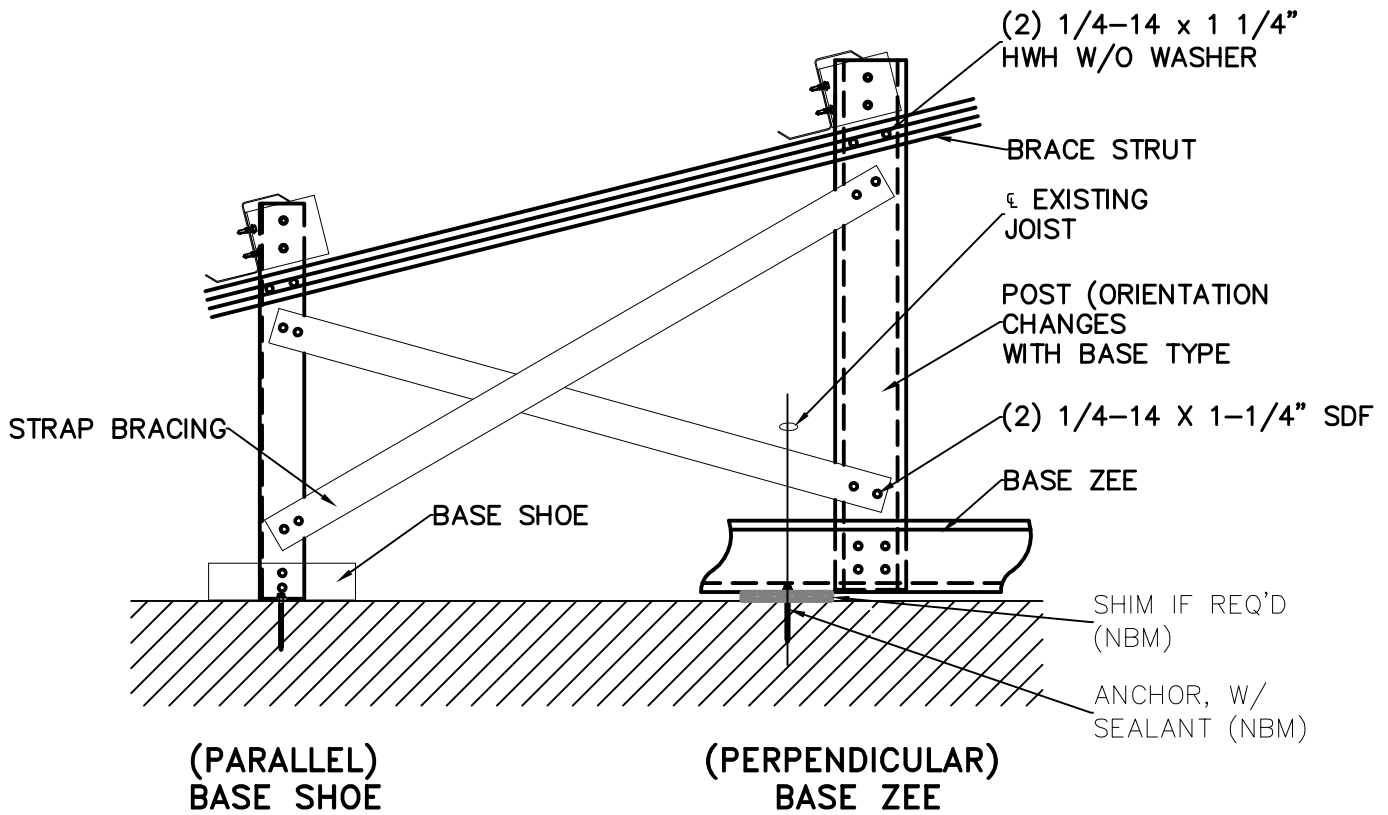
POST WITH BASE ZEE
(PARALLEL CONDITION)





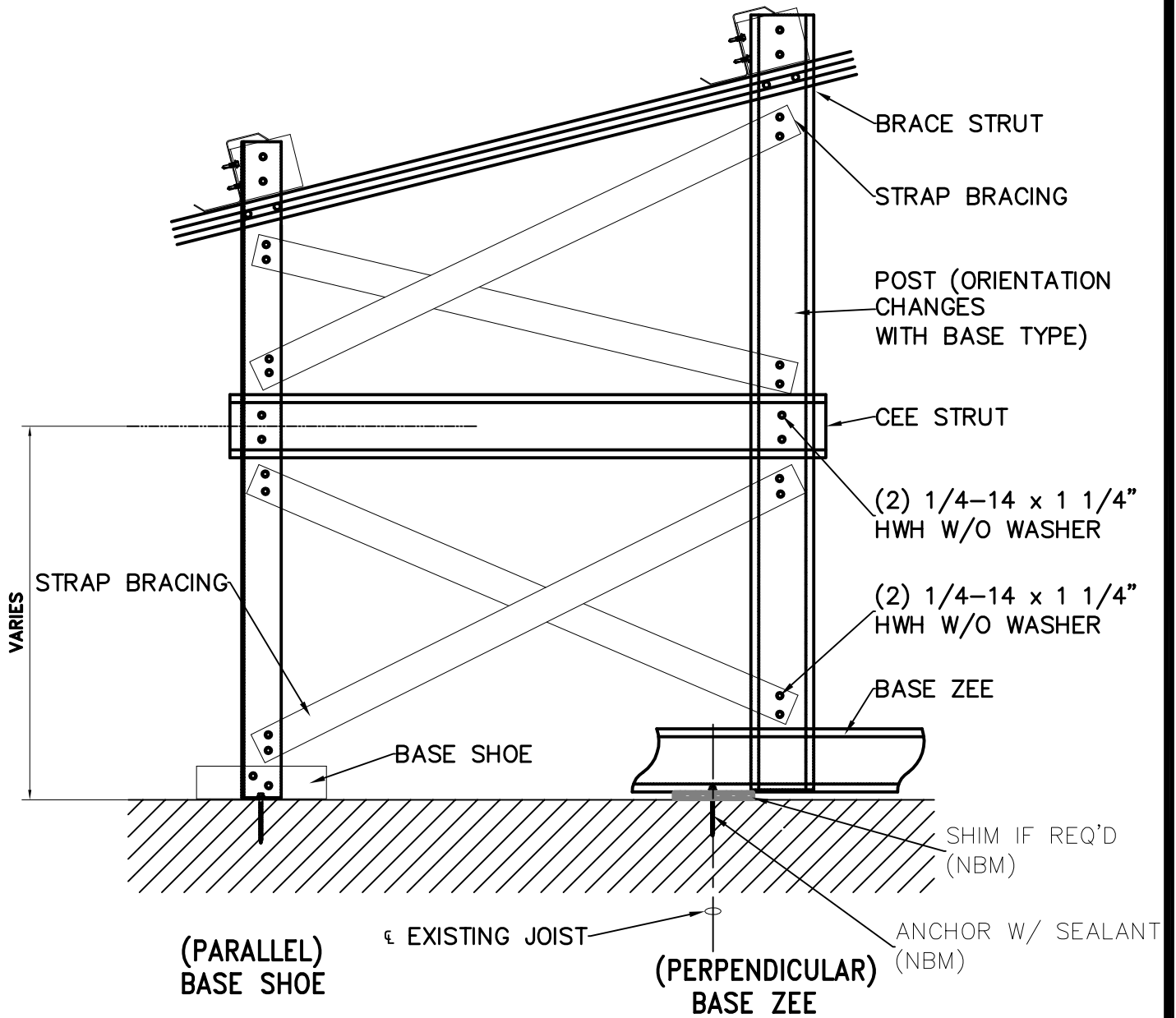
POST WITH BASE ZEE
(PERPENDICULAR CONDITION)





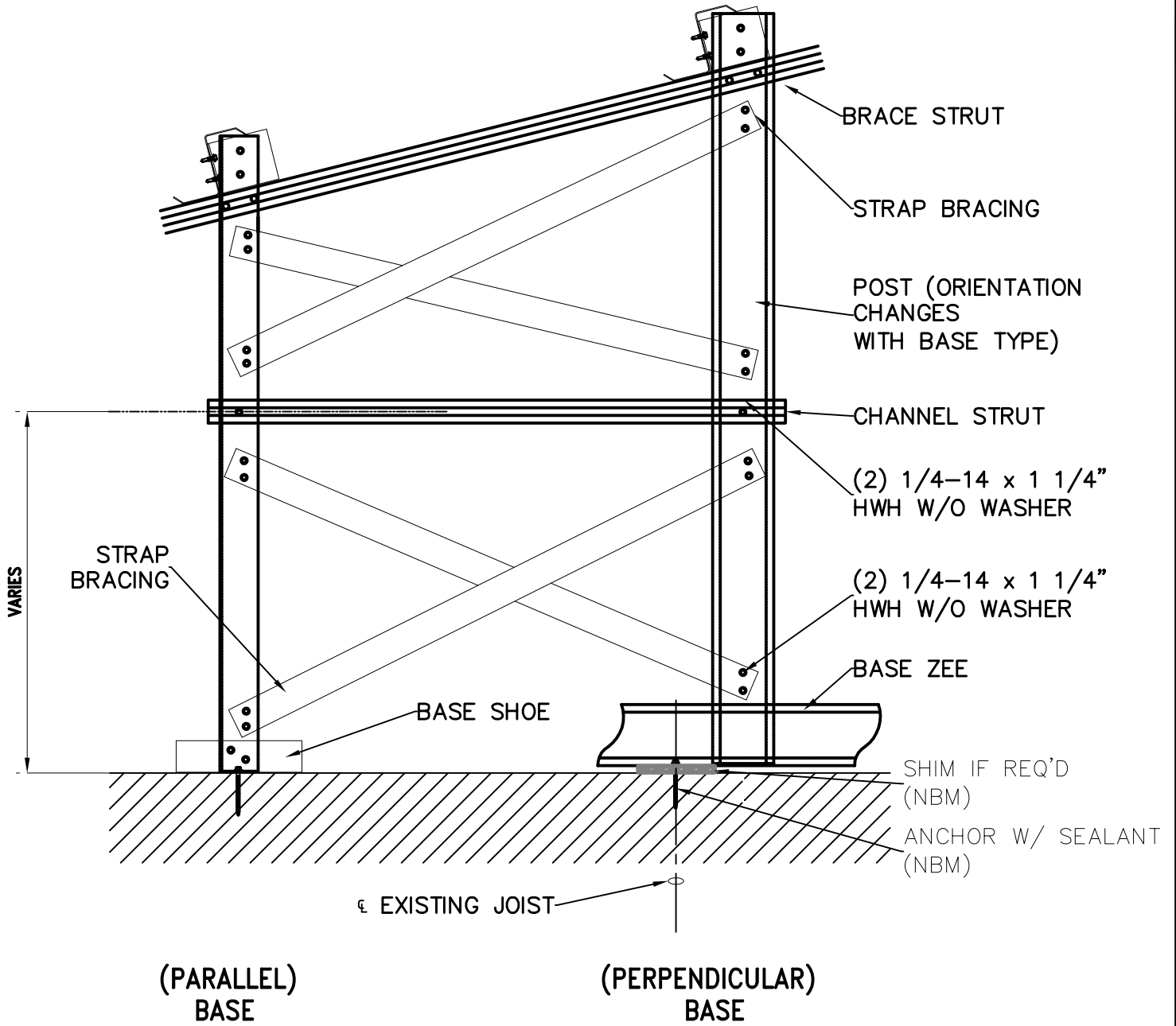
TRANSVERSE ANGLE & STRAP BRACING





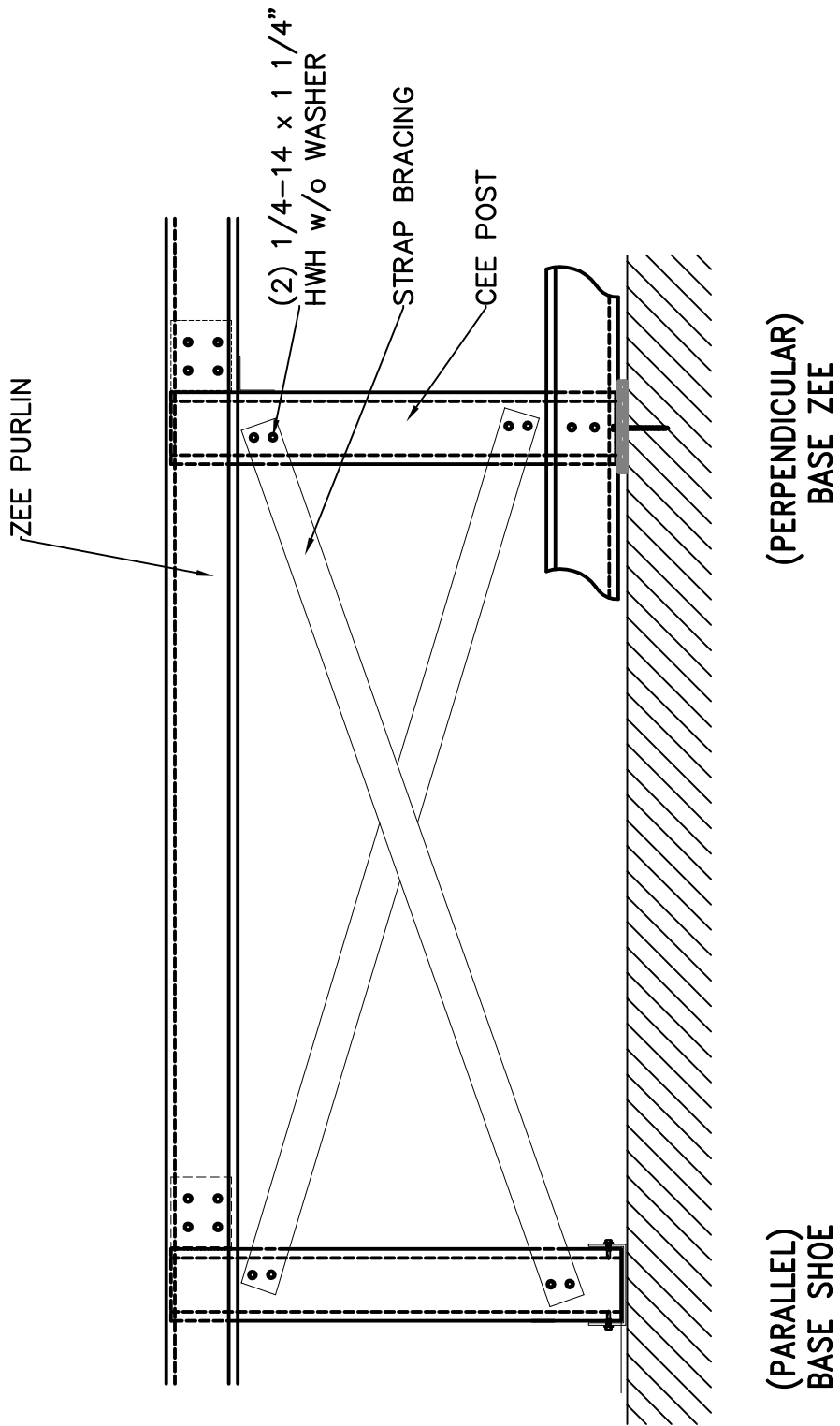
TRANSVERSE CEE STRUT BRACING





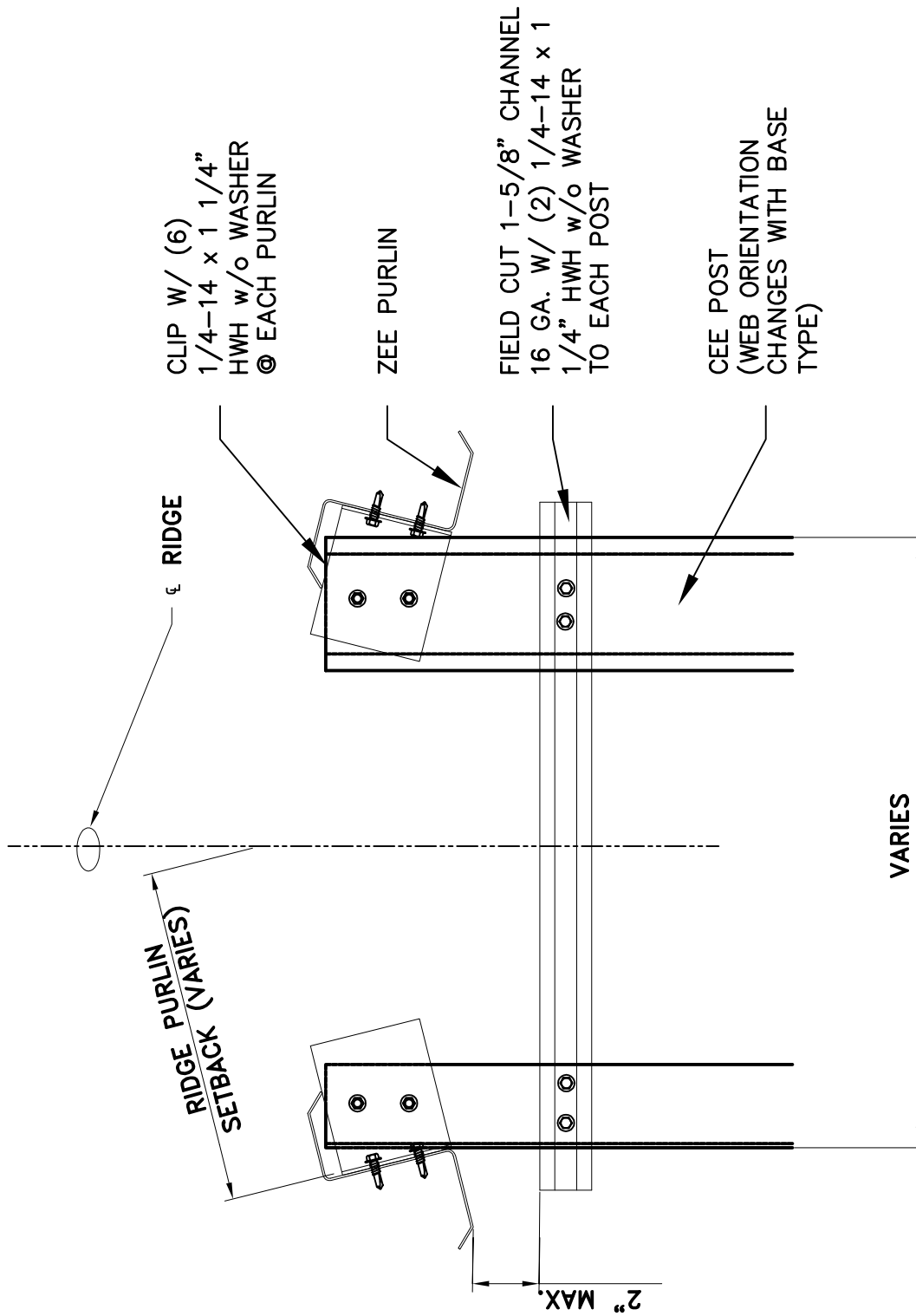
TRANSVERSE CHANNEL STRUT BRACING





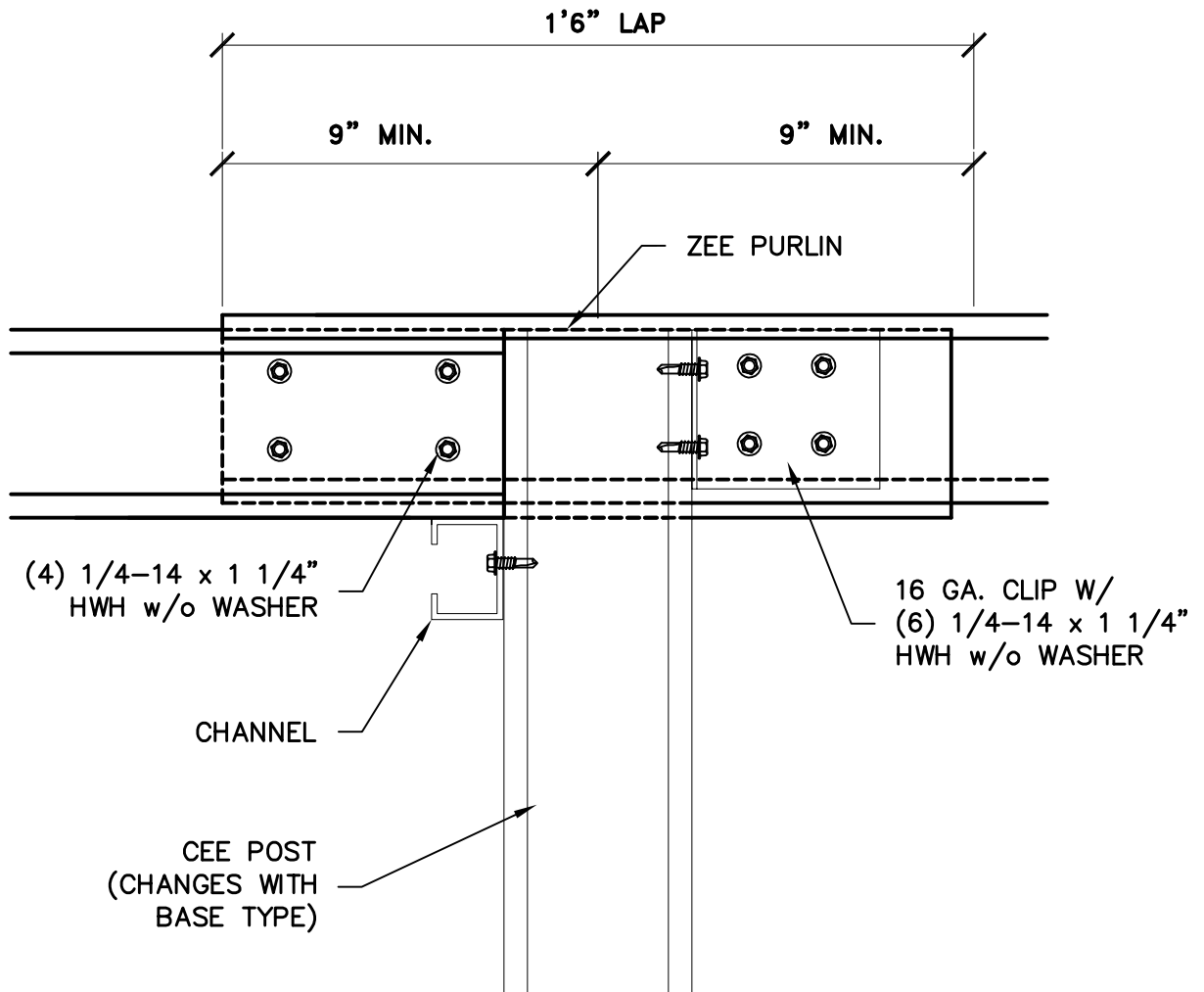
LONGITUDINAL BRACING





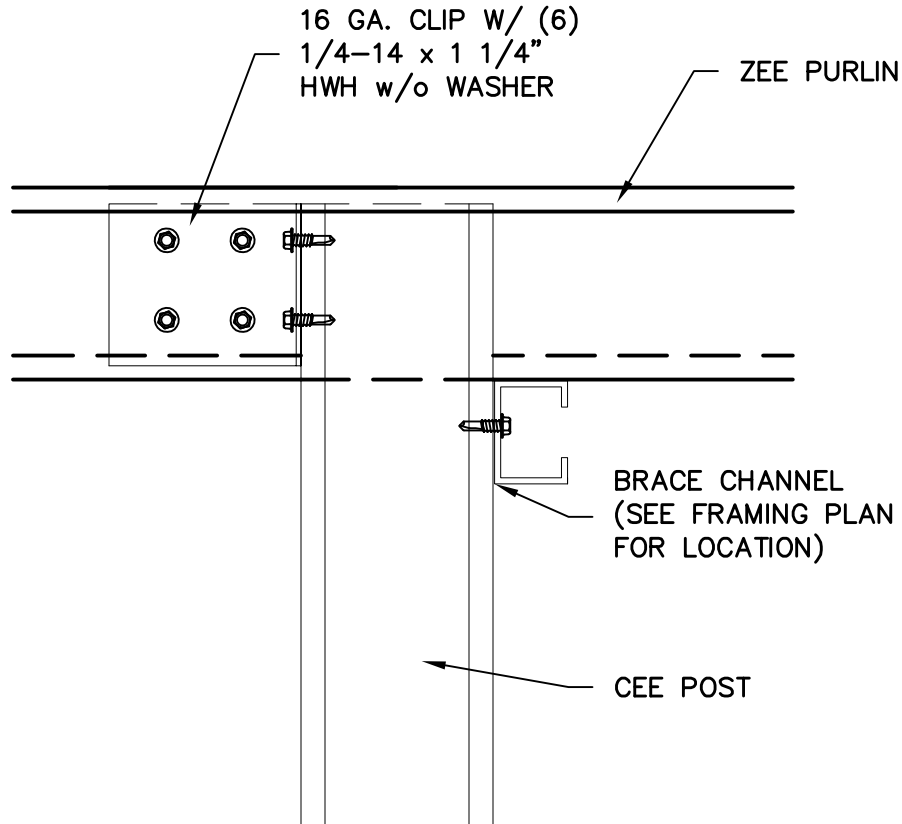
RIDGE PURLIN STABILIZATION





PURLIN LAP LOCATED @ POST





POST TO PURLIN CONNECTION

OCCURS W/ STD. BASE SHOE &
W/ BASE ZEE @ PARALLEL CONDITION



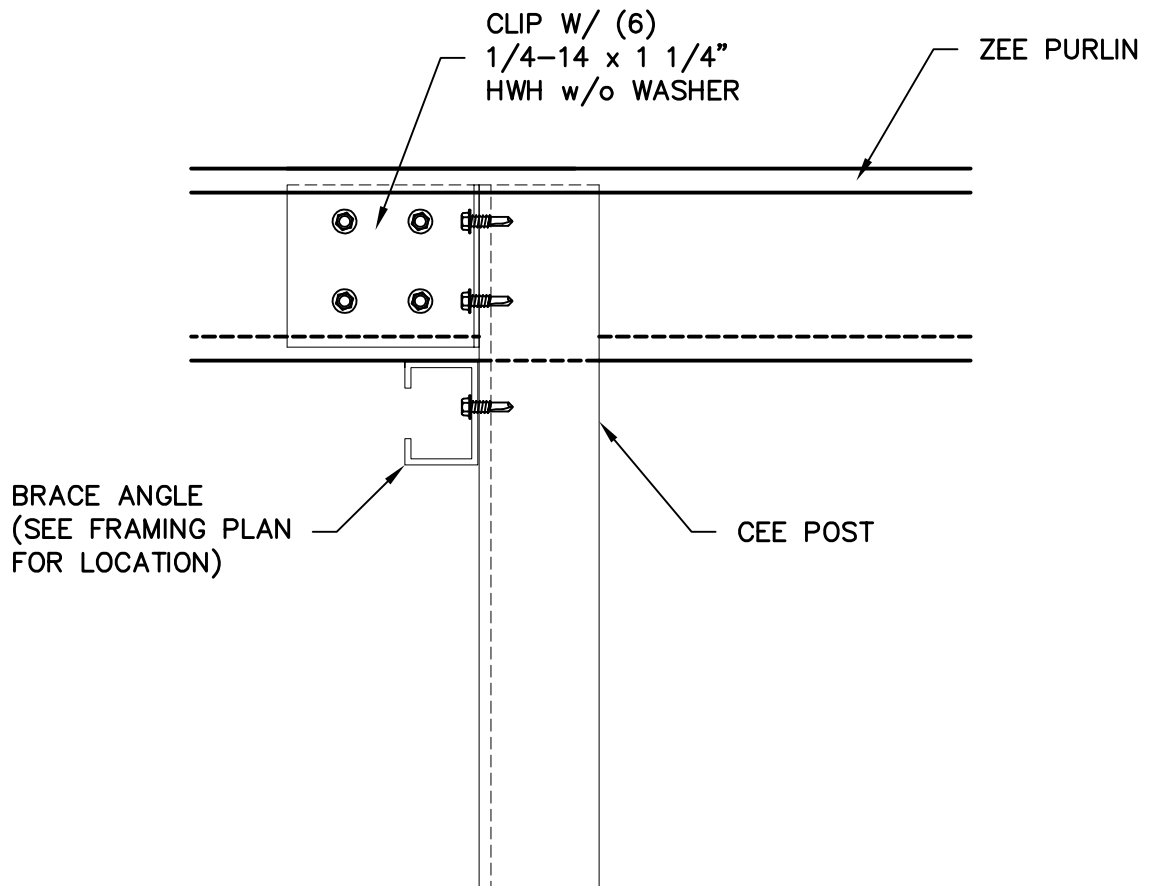
McElroy Metal, Inc.
Retrofit Framing Systems

Interior Framing

Post & Purlin System Details

Page

10-56



POST TO PURLIN CONNECTION

OCCURS W/ BASE ZEE @
PERPENDICULAR CONDITION



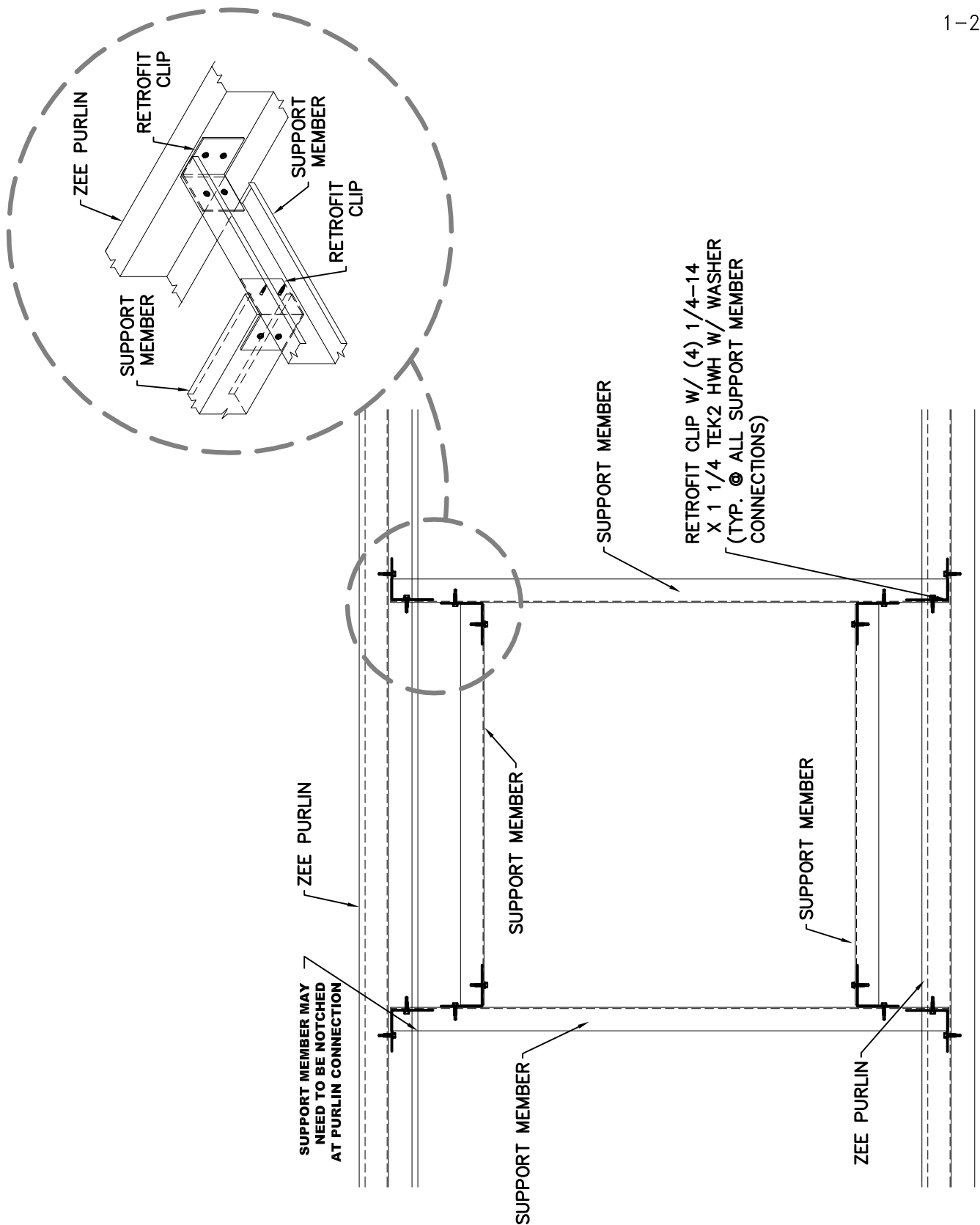
McElroy Metal, Inc.
Retrofit Framing Systems

Interior Framing

Post & Purlin System Details

Page

10-57



ROOFTOP ACCESSORY SUB-FRAMING



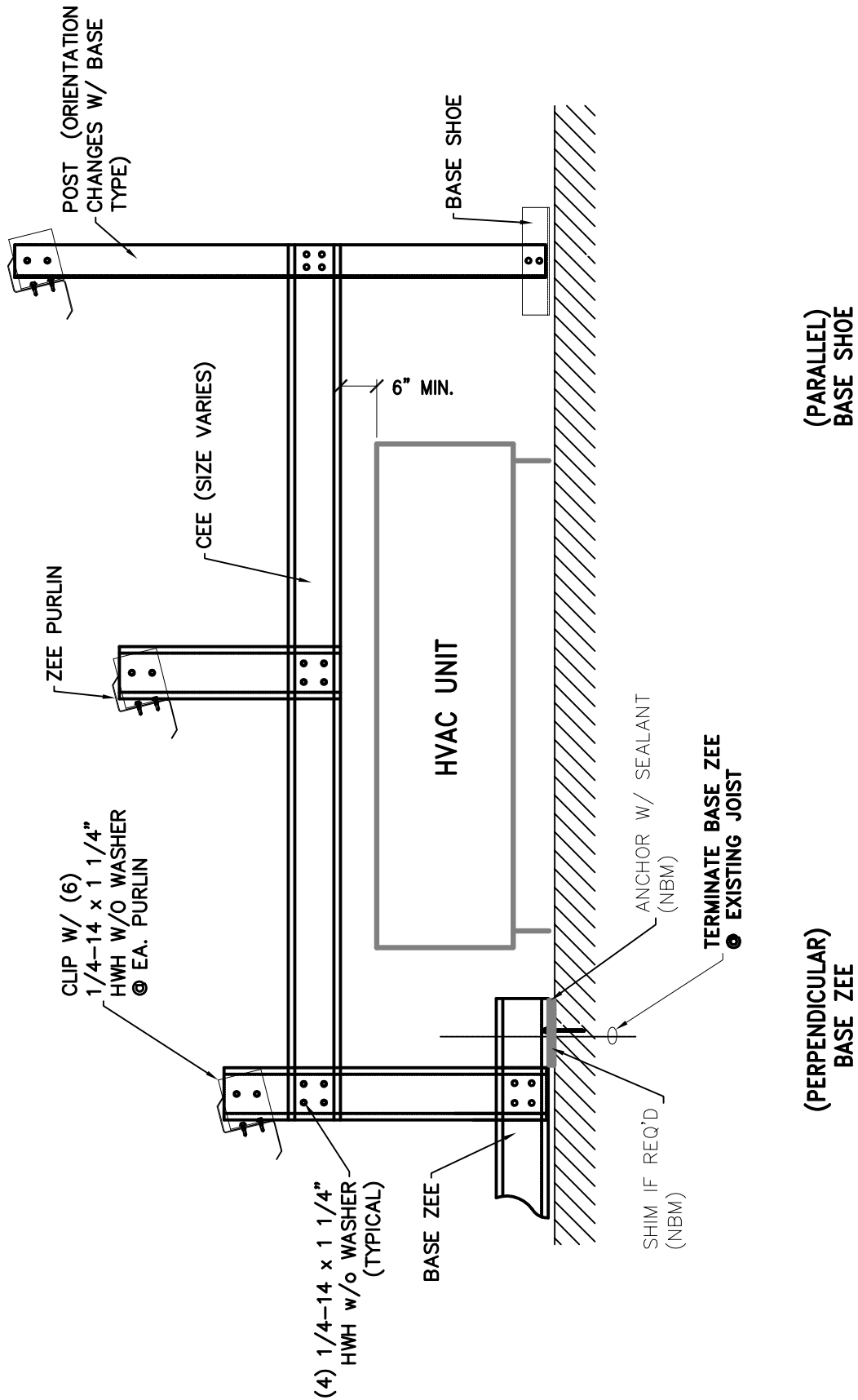
McElroy Metal, Inc.
Retrofit Framing Systems

Interior Framing

Post & Purlin System Details

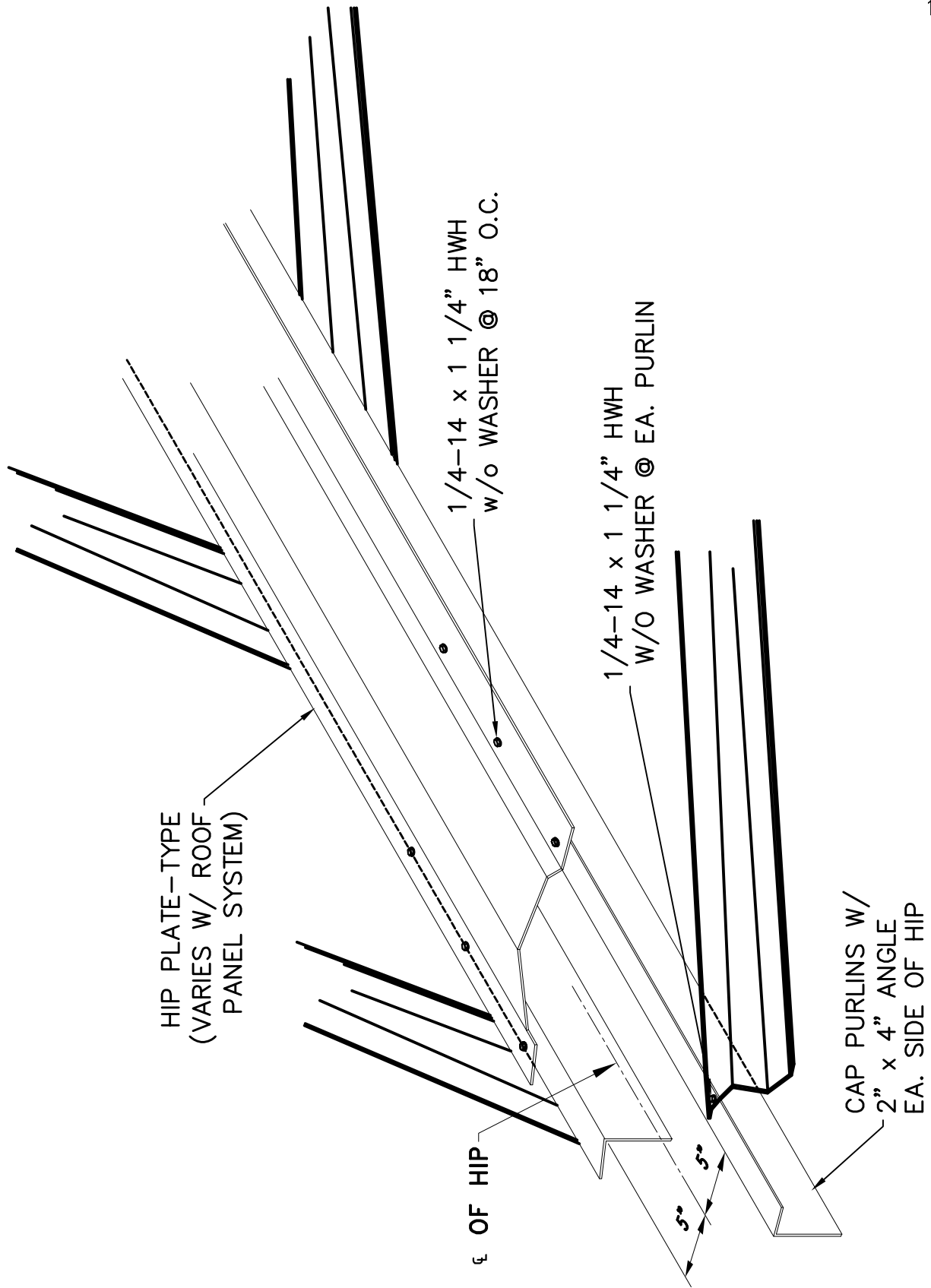
Page

10-58



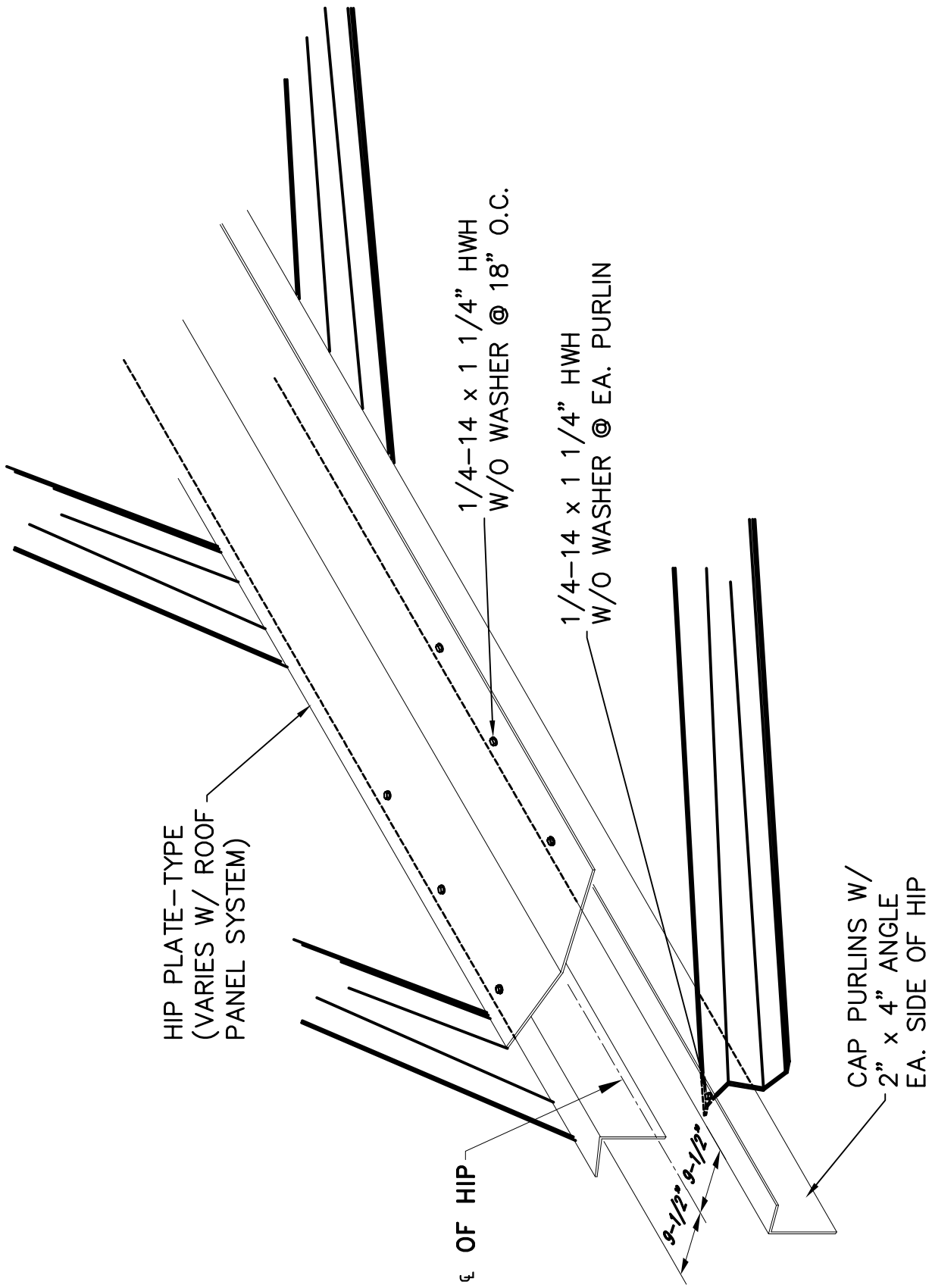
HVAC EQUIPMENT FRAME-OVER





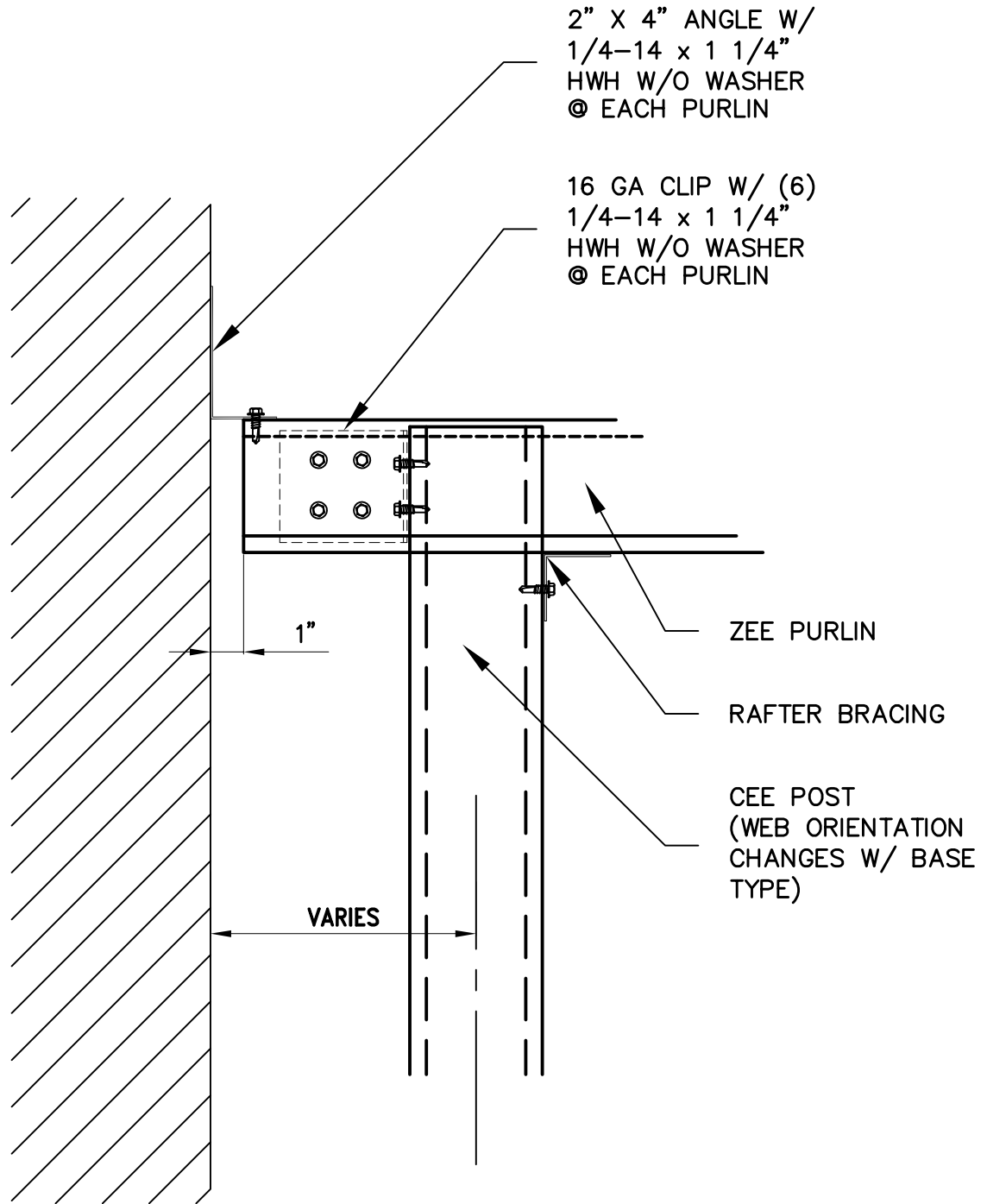
HIP FRAMING





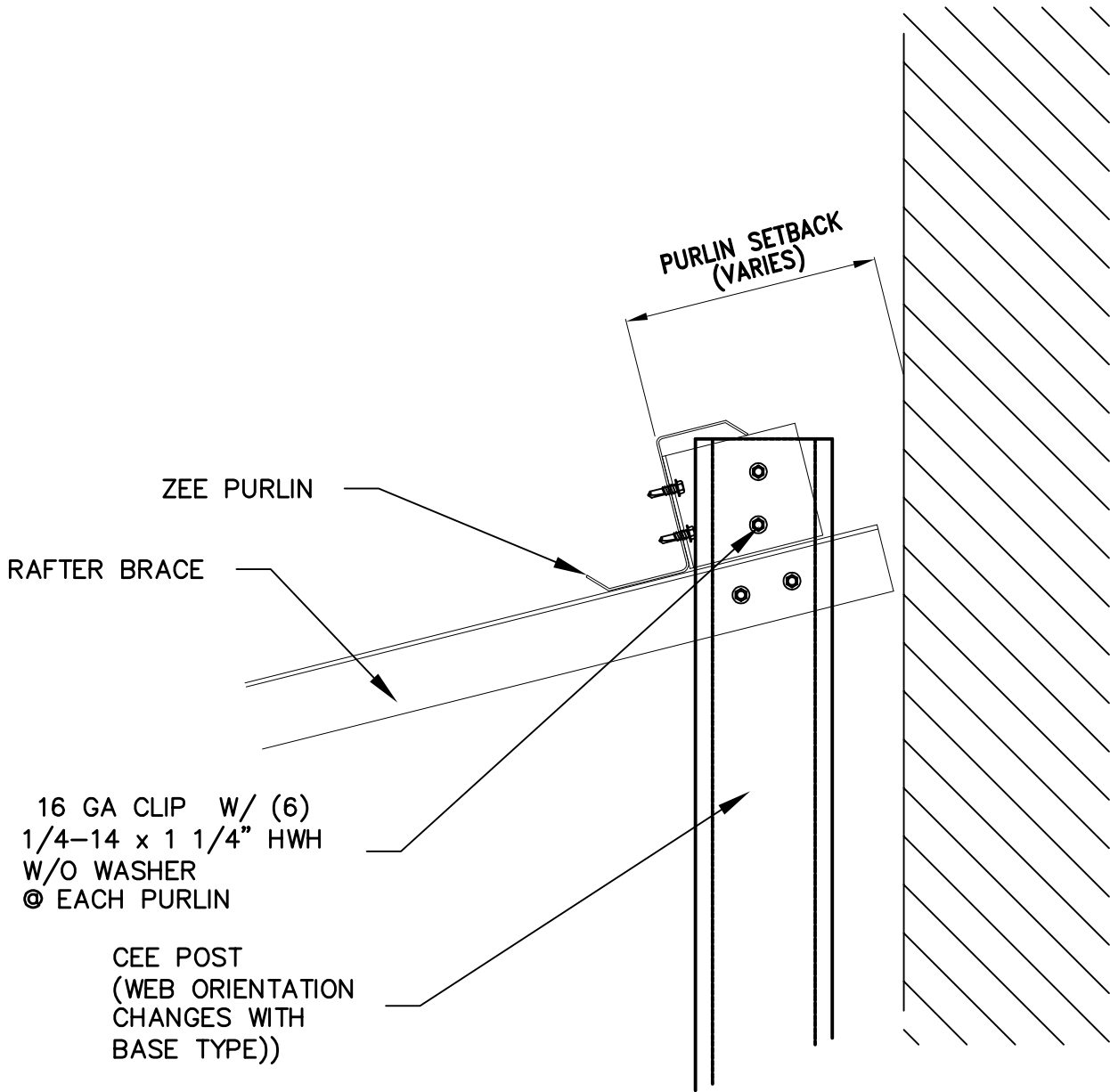
VALLEY FRAMING





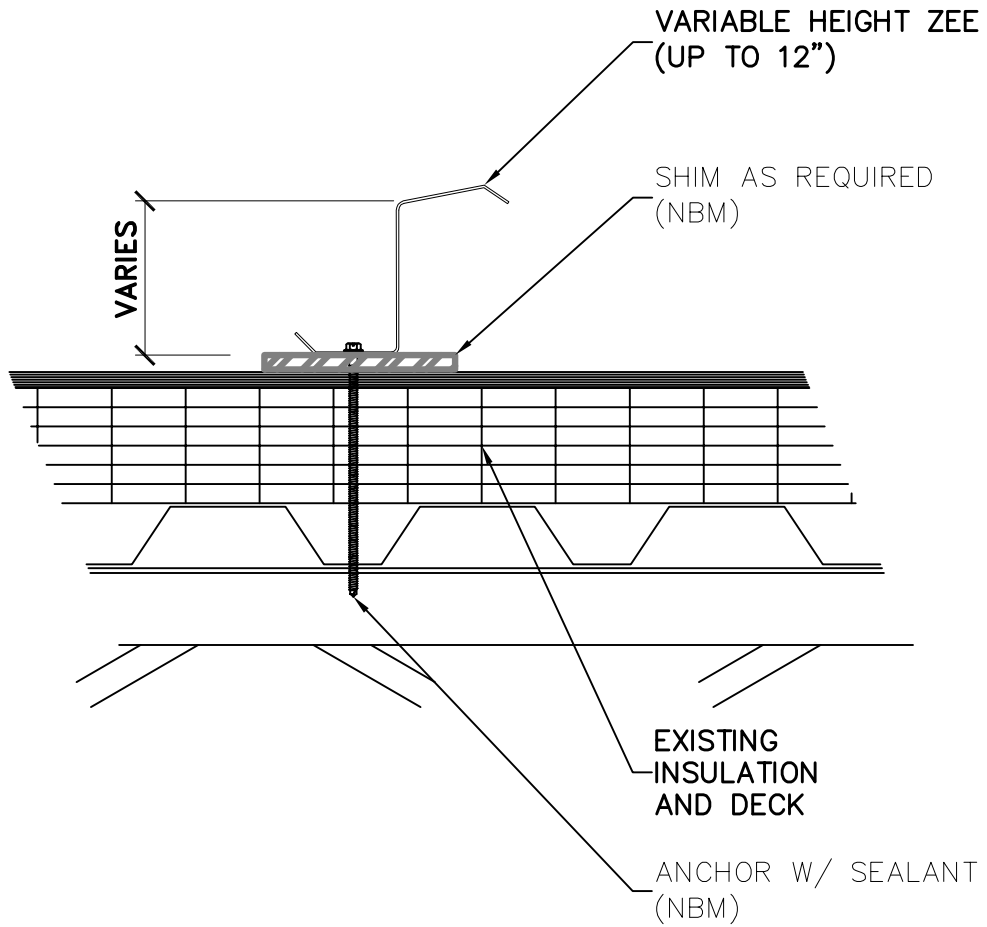
RAKE-TO-WALL TRANSITION





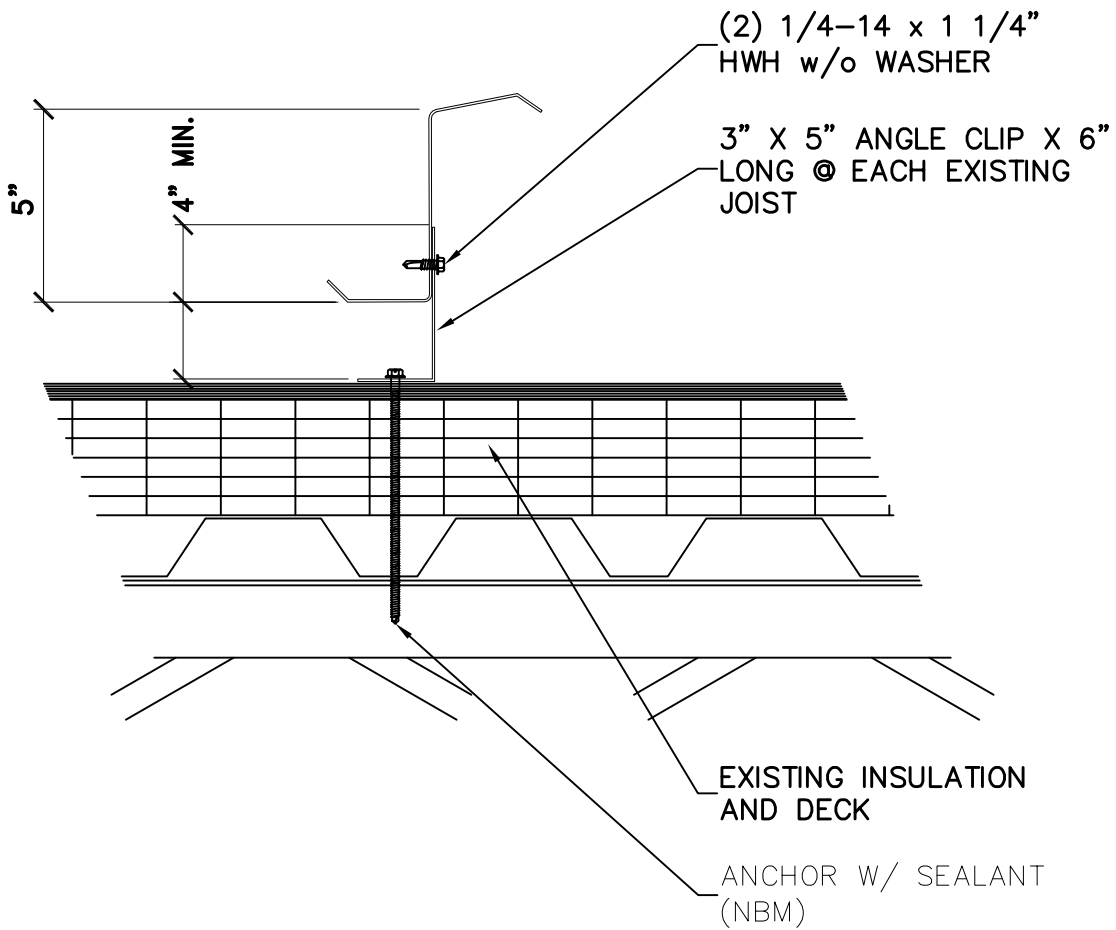
ROOF-TO-WALL TRANSITION





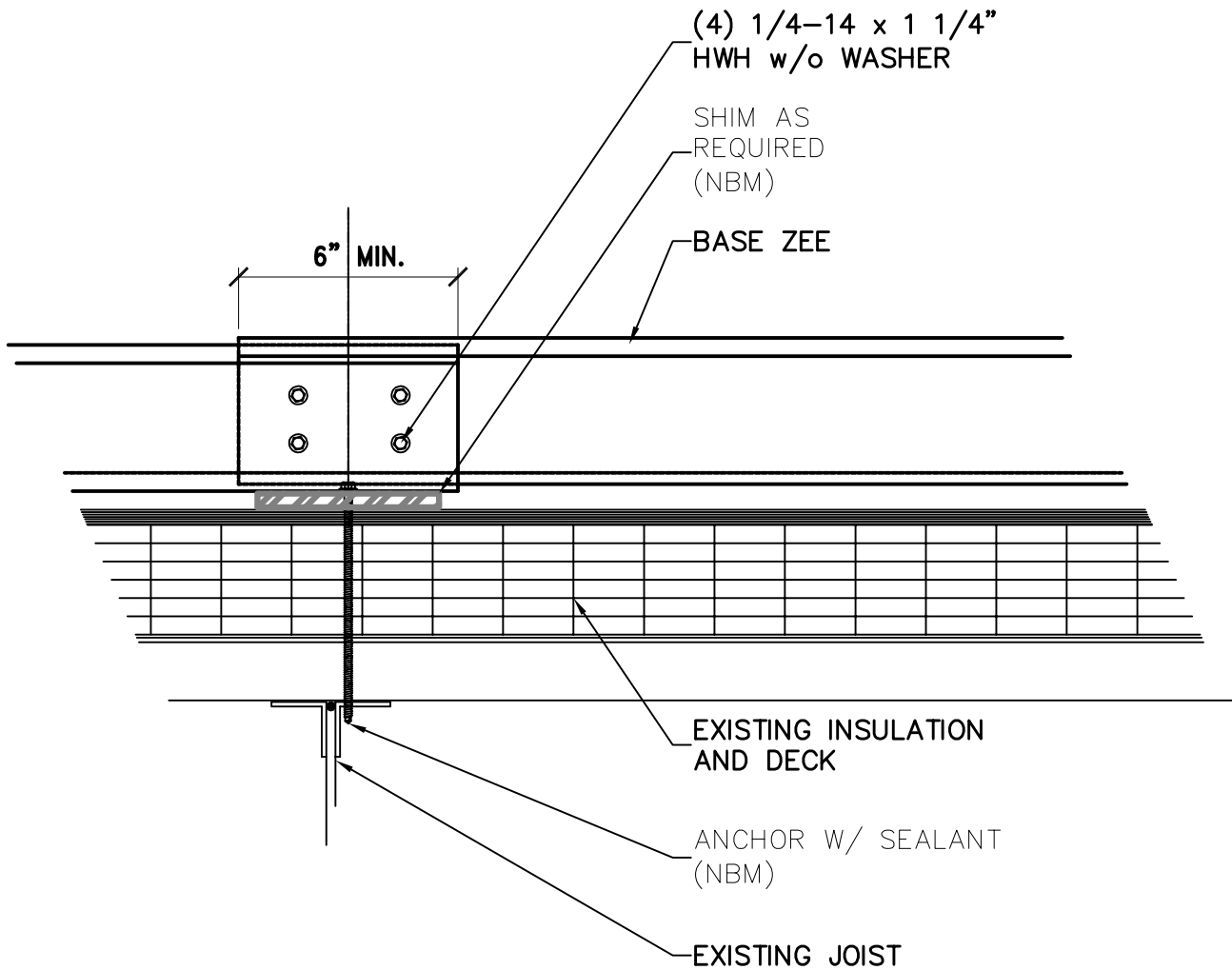
VARIABLE HEIGHT PURLIN





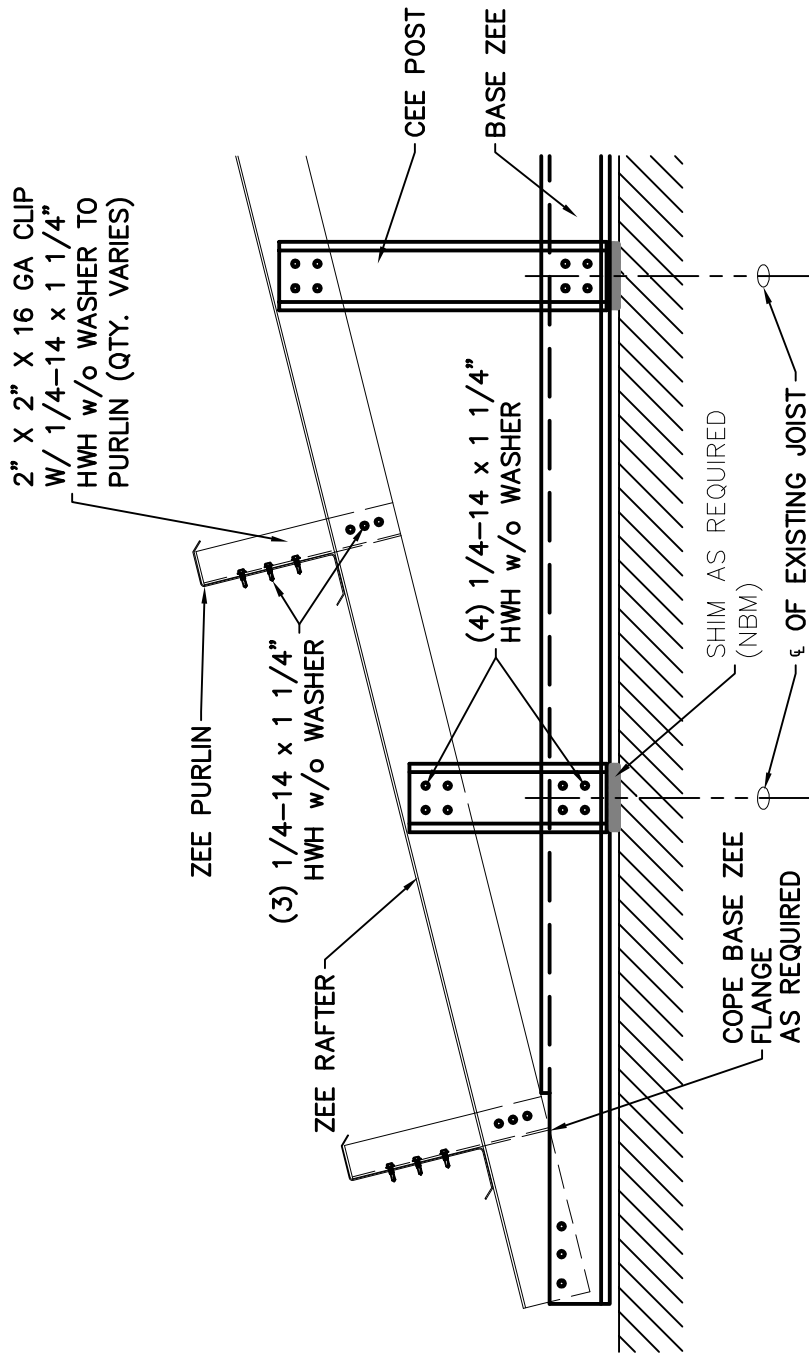
VARIABLE HEIGHT ZEE W/ STAND OFF CLIP





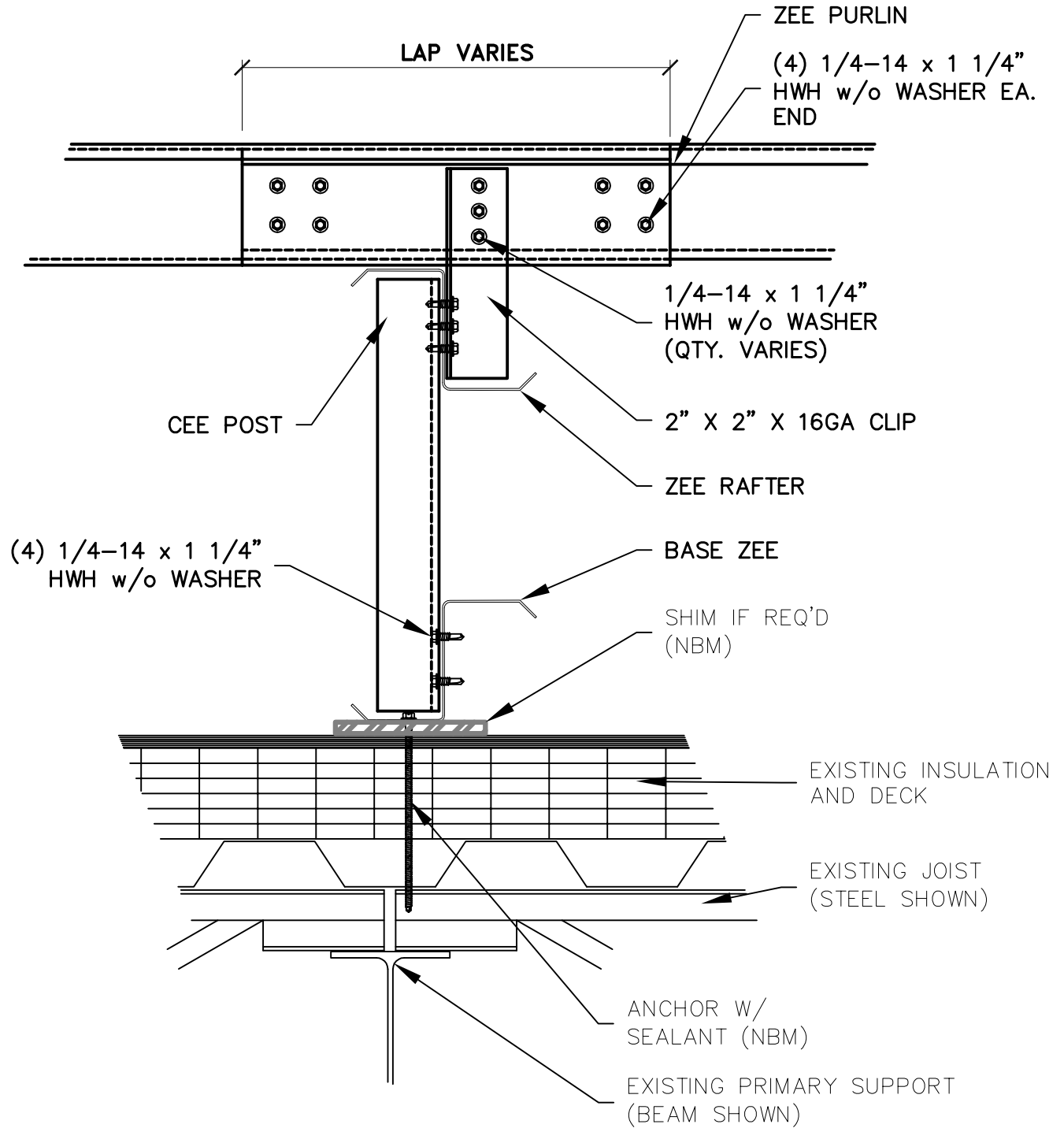
BASE ZEE/VARIABLE HEIGHT ZEE LAP





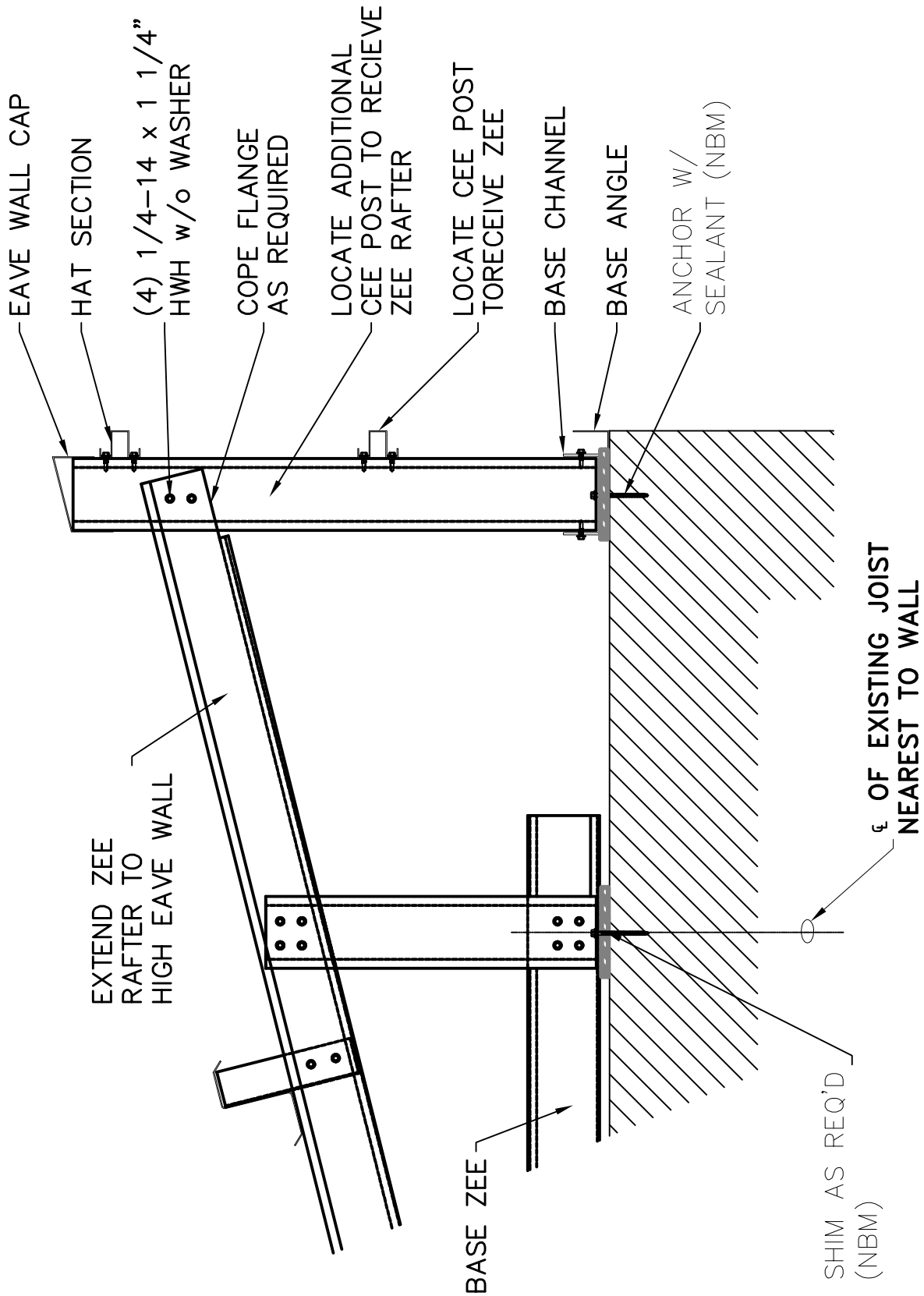
WIDE-SPAN FRAME ASSEMBLY ELEVATION





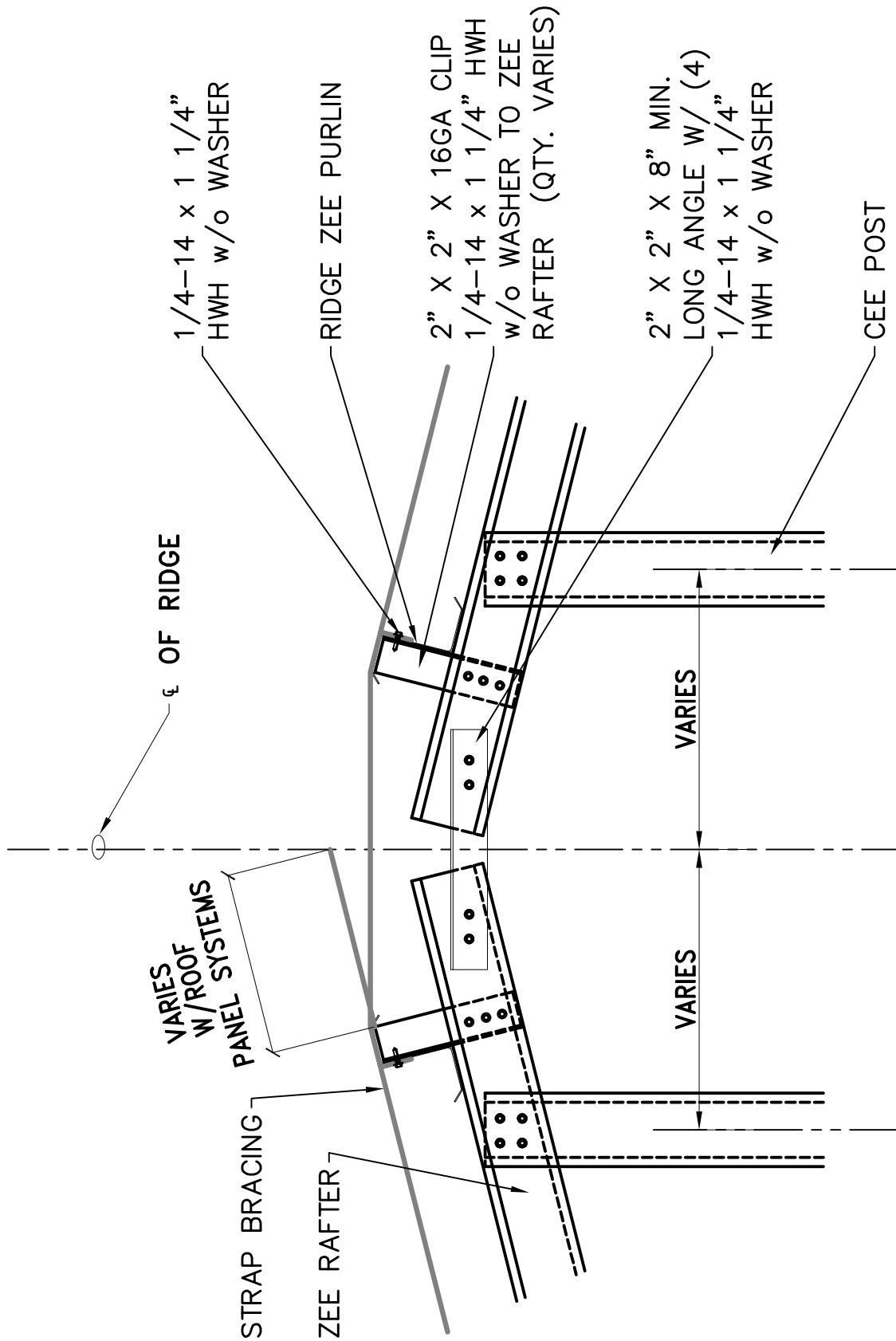
ASSEMBLY SECTION WIDE-SPAN FRAME





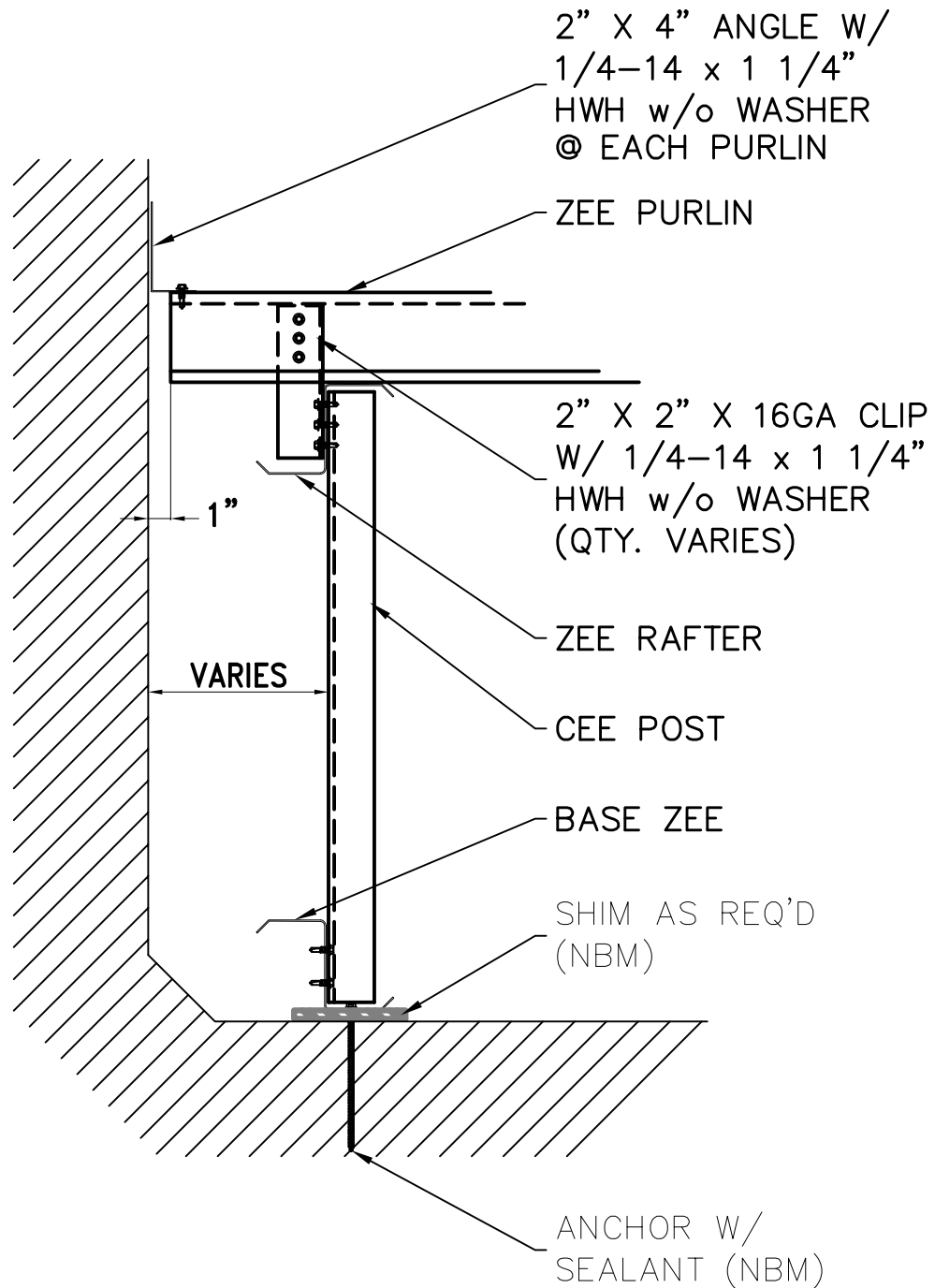
WIDE-SPAN CONNECTION
@ HIGH EAVE





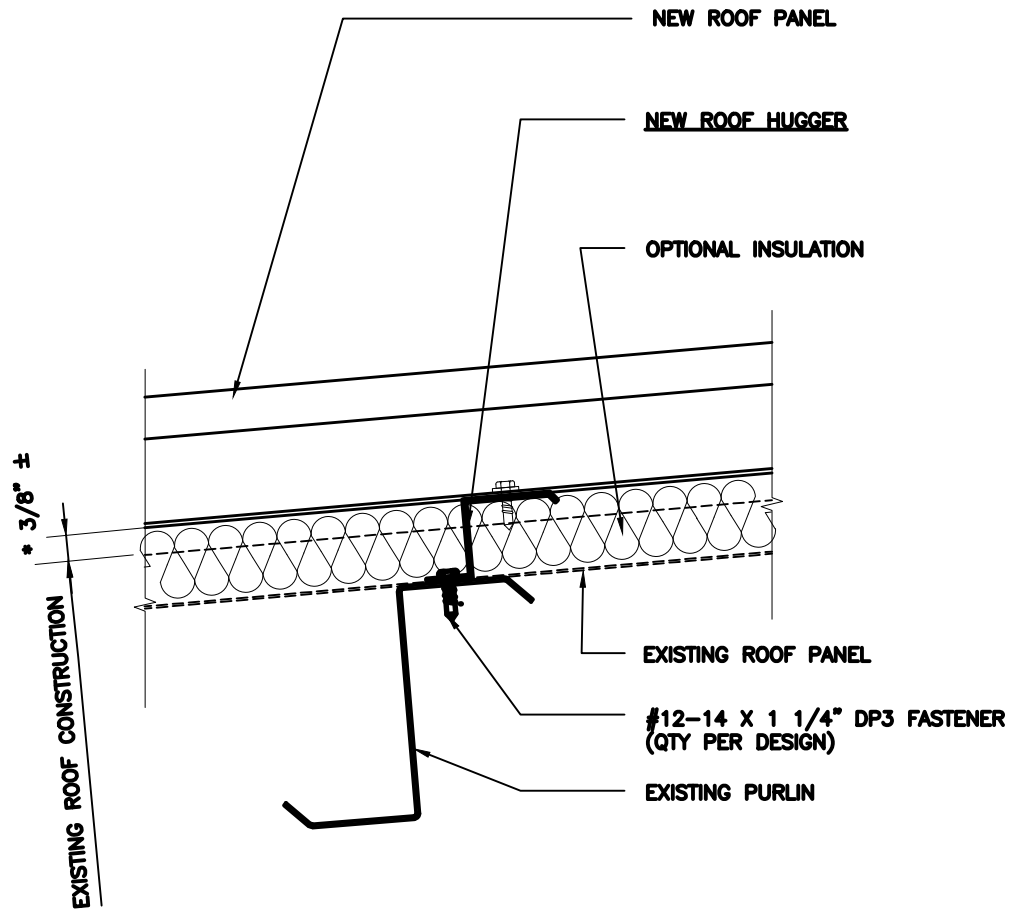
WIDE-SPAN RIDGE STABILIZATION





WIDE-SPAN RAKE-TO-WALL TRANSITION





* ROOF HUGGERS ARE MANUFACTURED TO ALLOW 3/8"-1/2" ABOVE EXISTING PANEL RIB/SEAM. THIS DIMENSION MAY VARY TO ACCOMMODATE MATERIAL UTILIZATION AND SCRAP REDUCTION ON CUSTOM ROOF HUGGERS

NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE

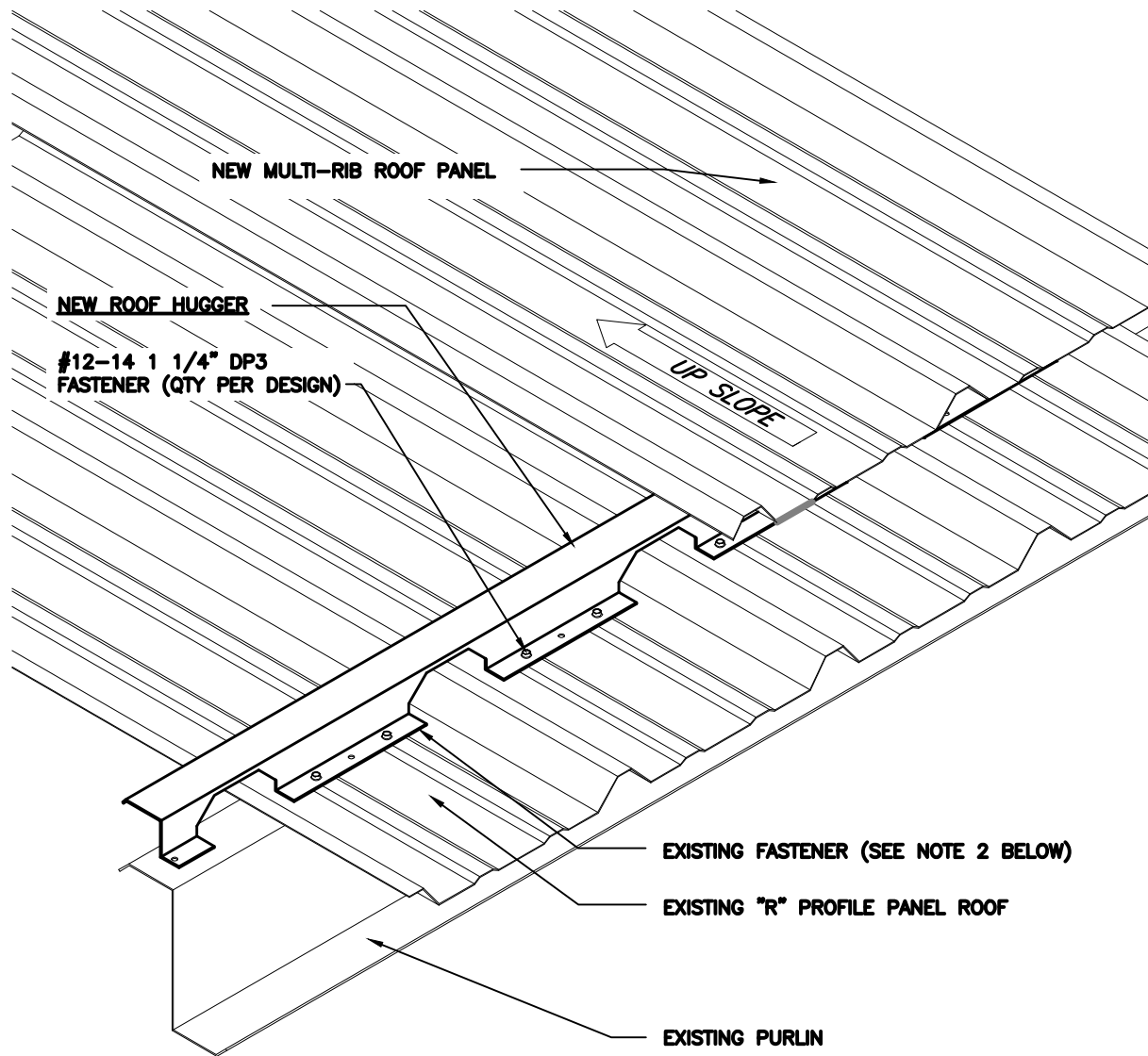


McElroy Metal, Inc.
Retrofit Framing Systems

HUGGER ATTACHMENT TO
EXISTING PURLIN

Page

10-72



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

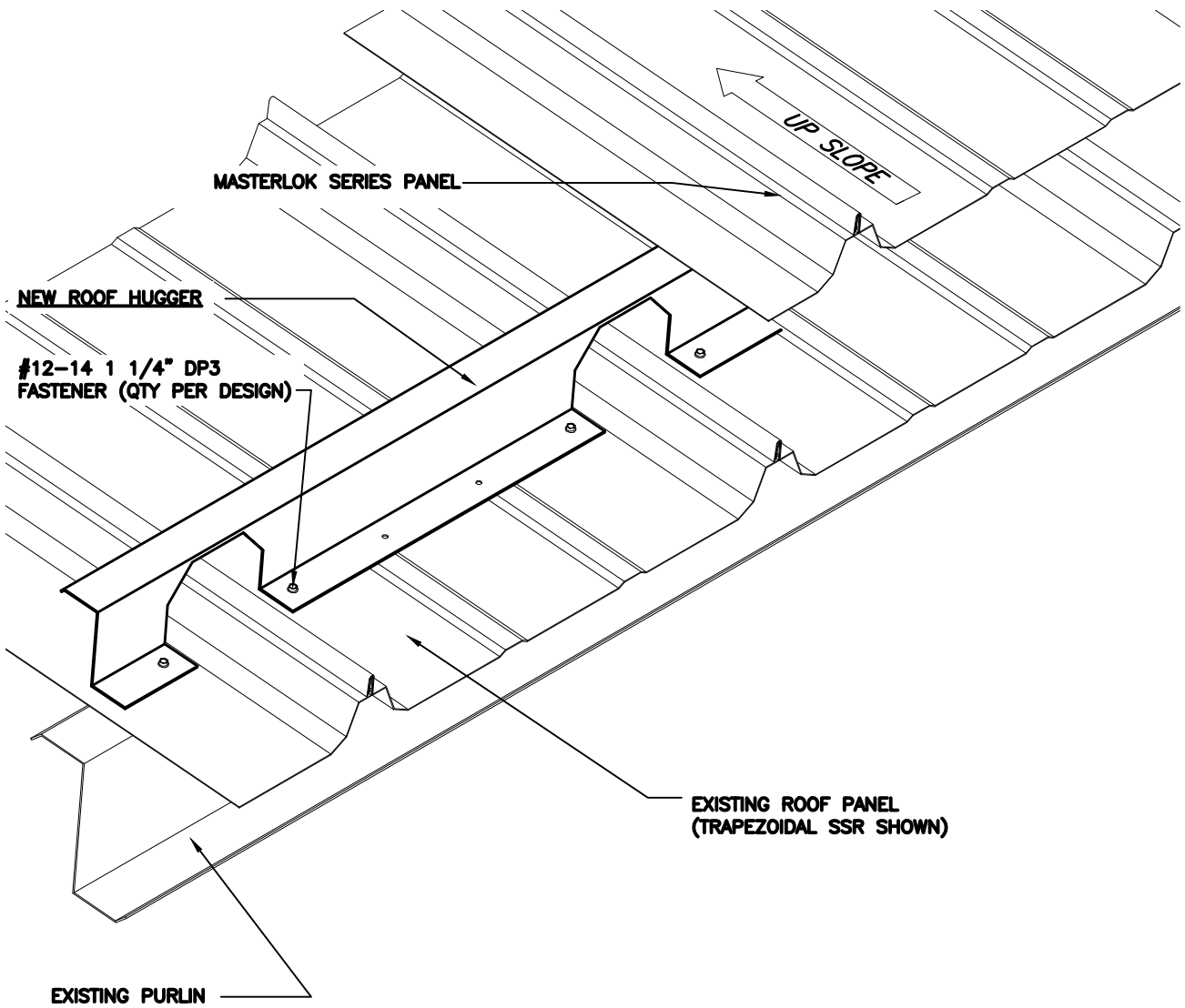


McElroy Metal, Inc.
Retrofit Framing Systems

HUGGER ATTACHMENT TO EXISTING PURLIN

Page

10-73



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

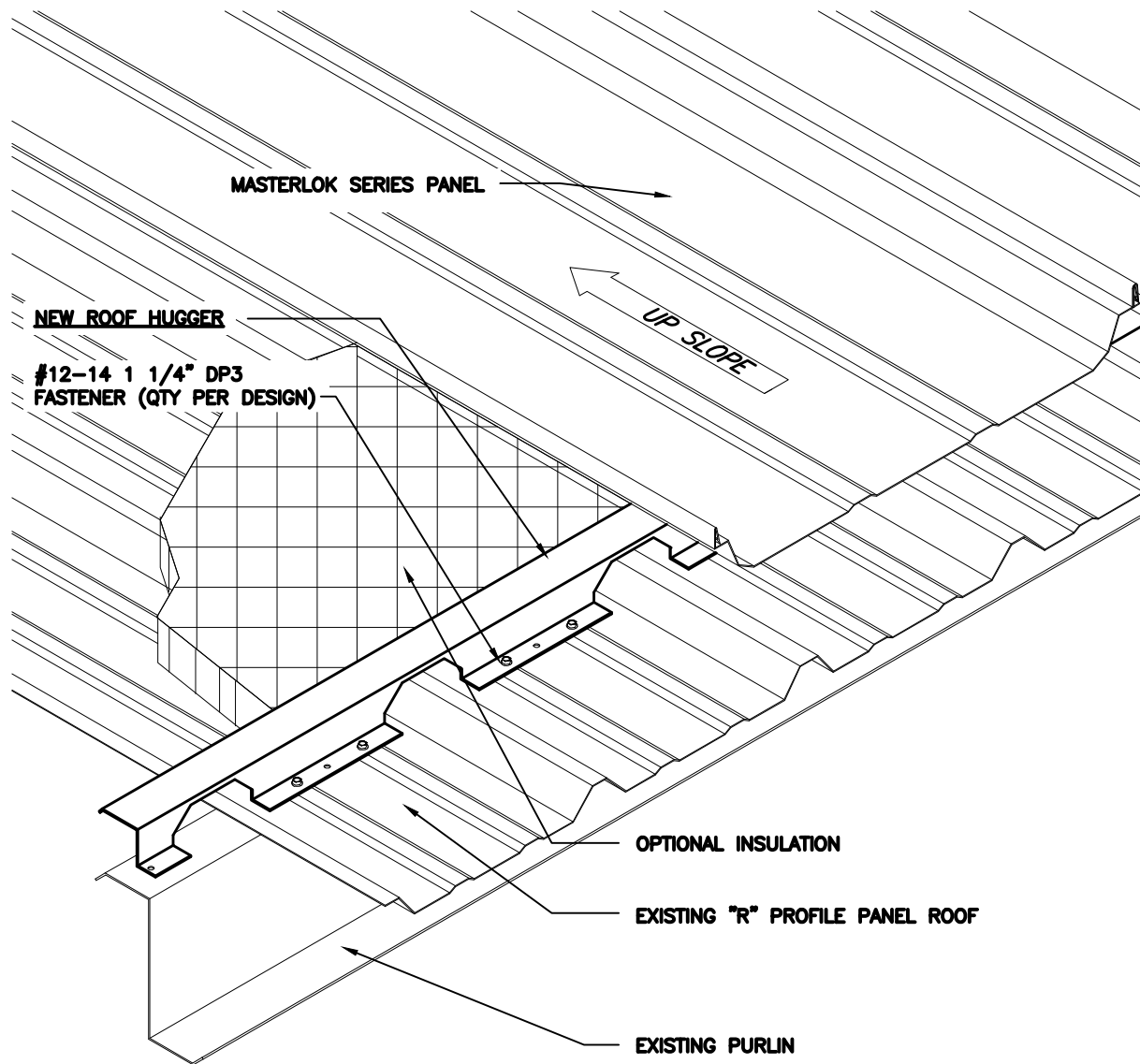


McElroy Metal, Inc.
Retrofit Framing Systems

HUGGER ATTACHMENT TO
EXISTING PURLIN

Page

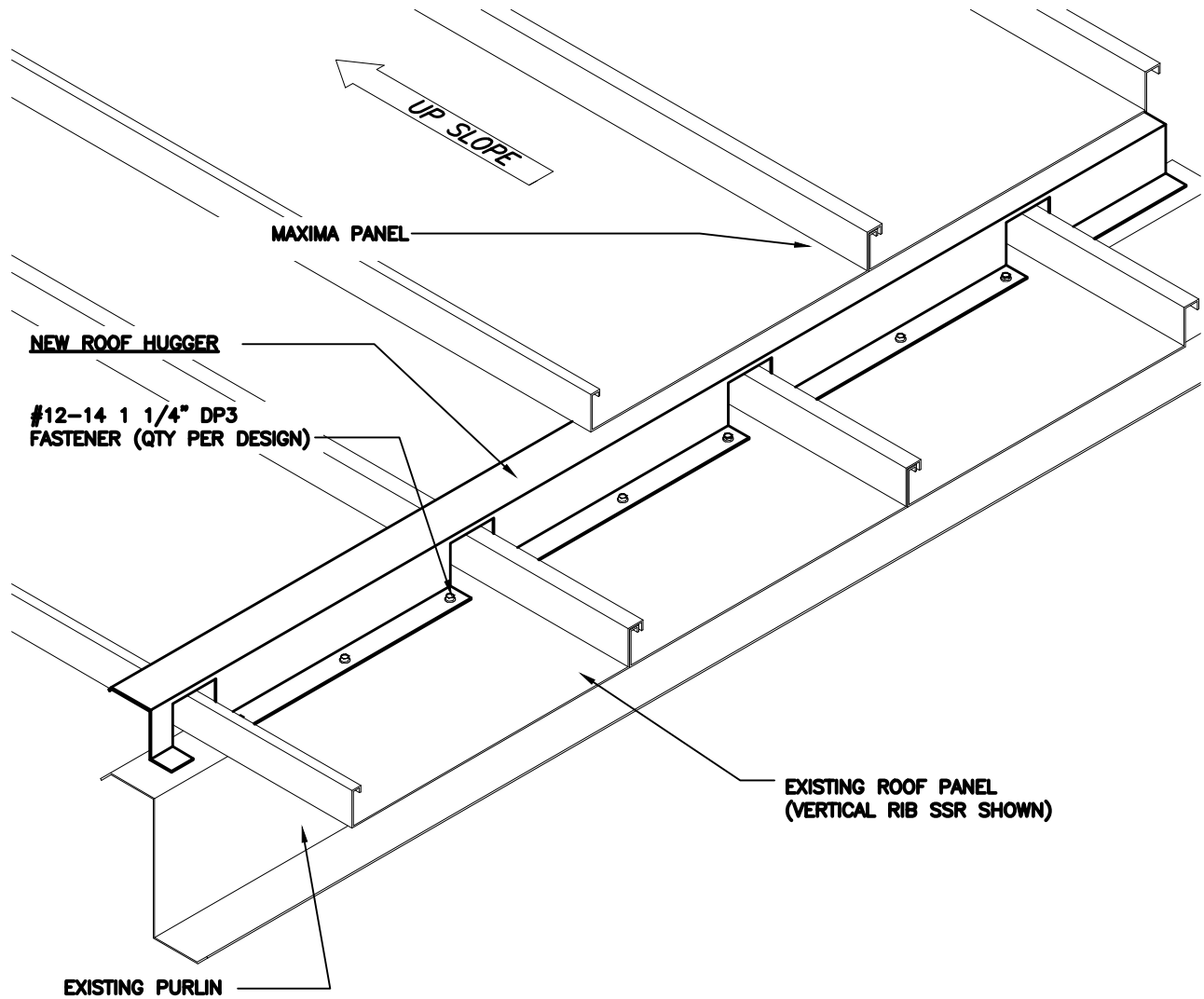
10-74



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.





NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

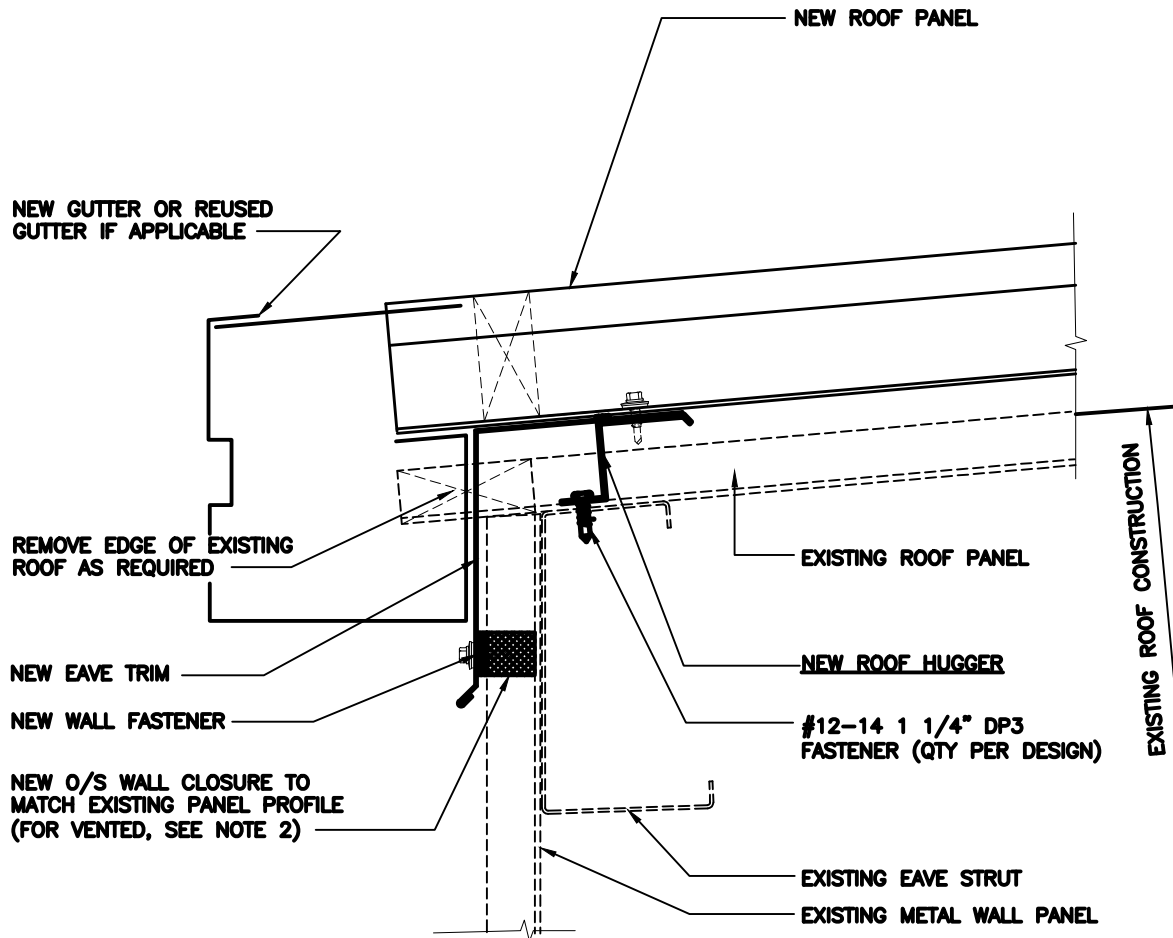


McElroy Metal, Inc.
Retrofit Framing Systems

HUGGER ATTACHMENT TO
EXISTING PURLIN

Page

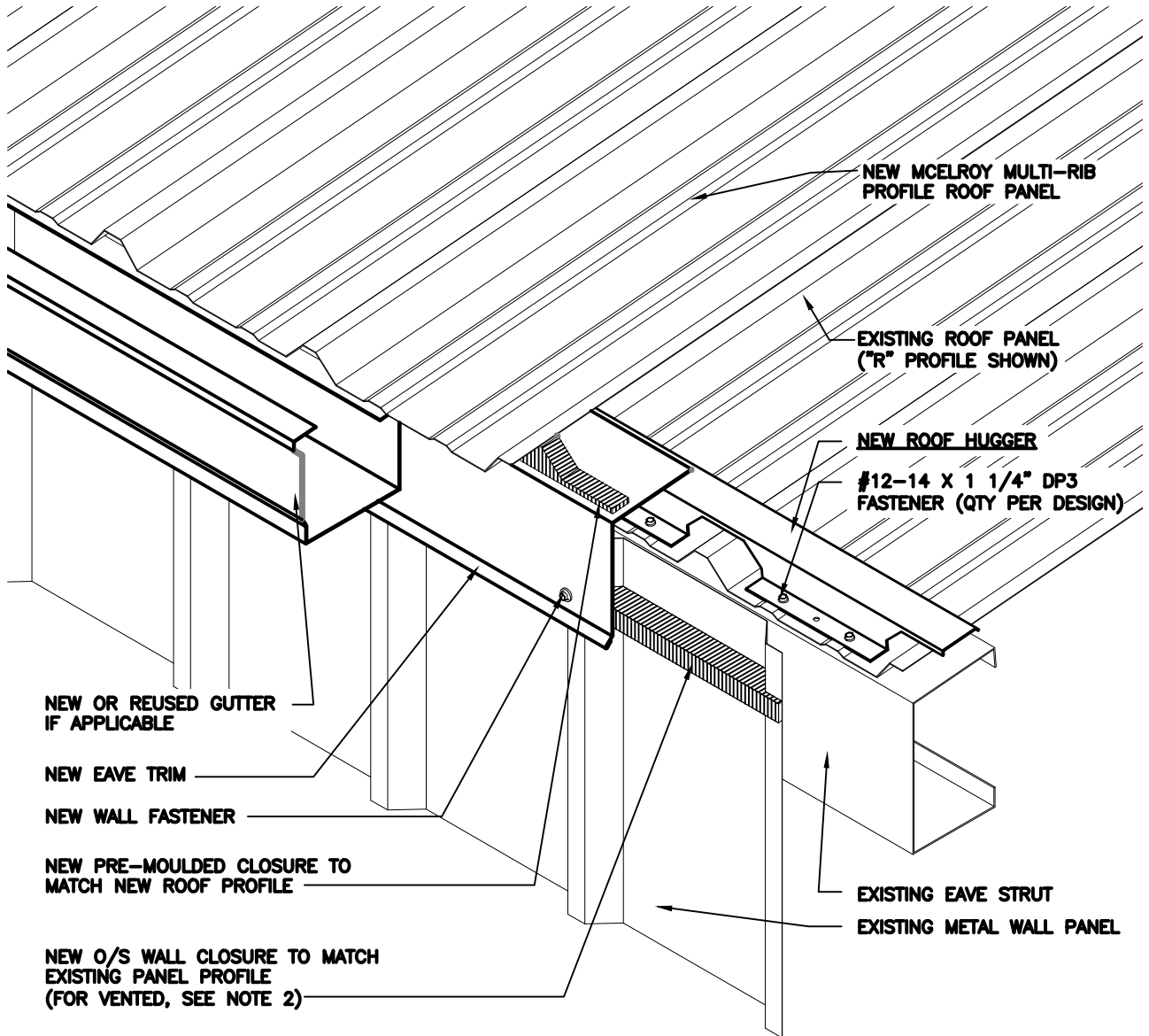
10-76



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.





NOTES:

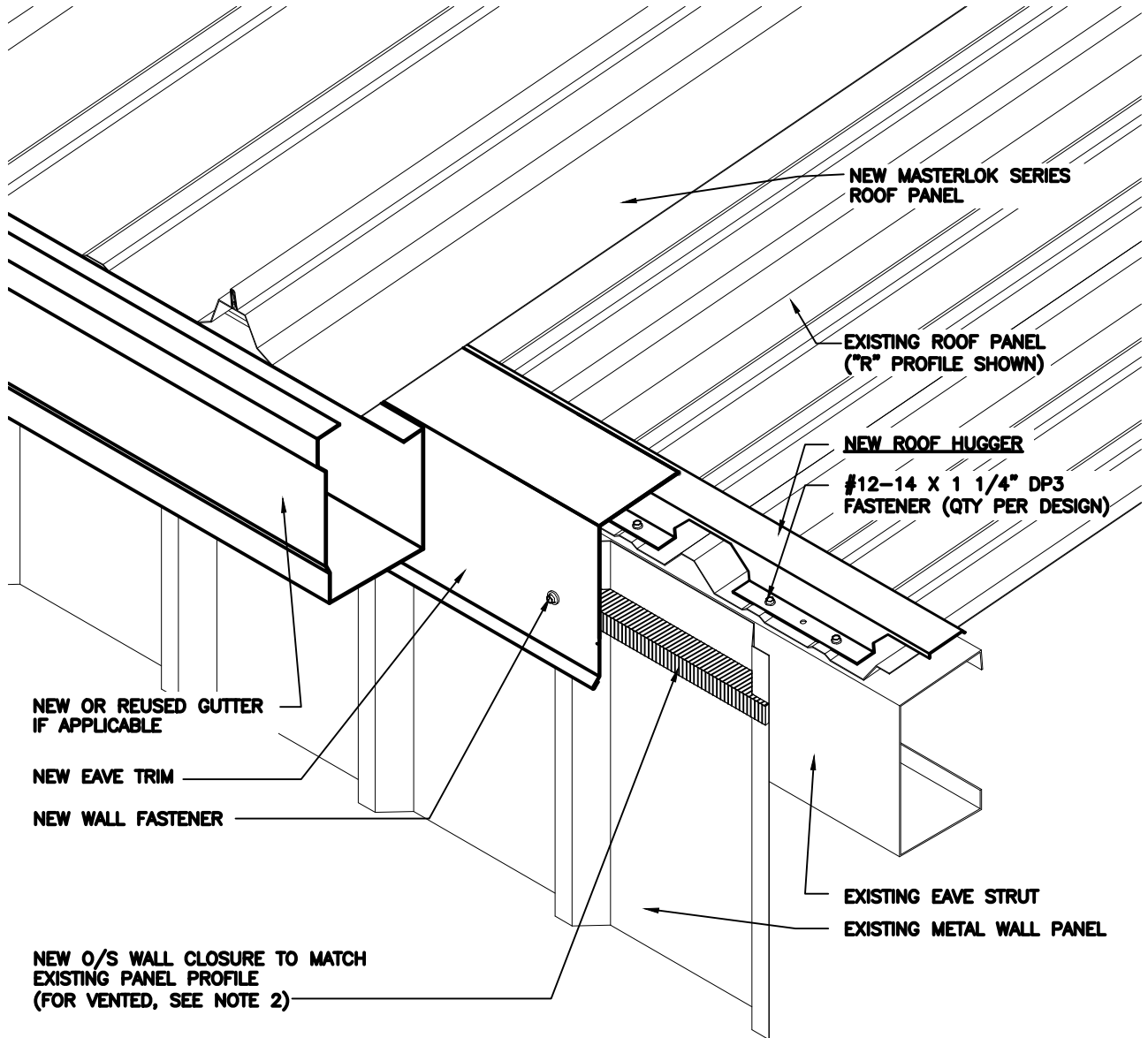
1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



McElroy Metal, Inc.
Retrofit Framing Systems

LOW EAVE

10-78



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



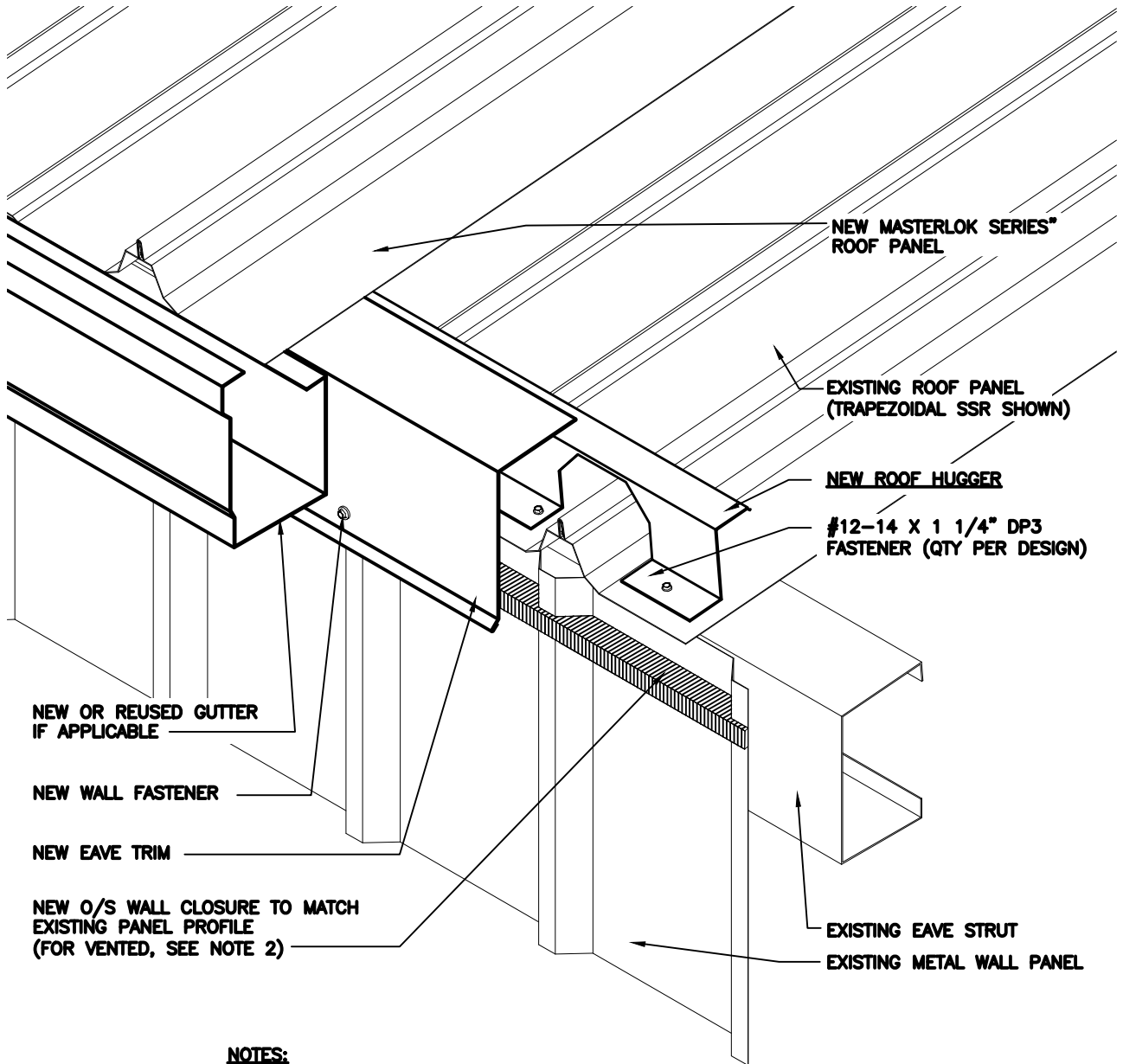
McElroy Metal, Inc.
Retrofit Framing Systems

LOW EAVE

NEW MASTERLOK SERIES
OVER EXISTING "R" PANEL

Page

10-79



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



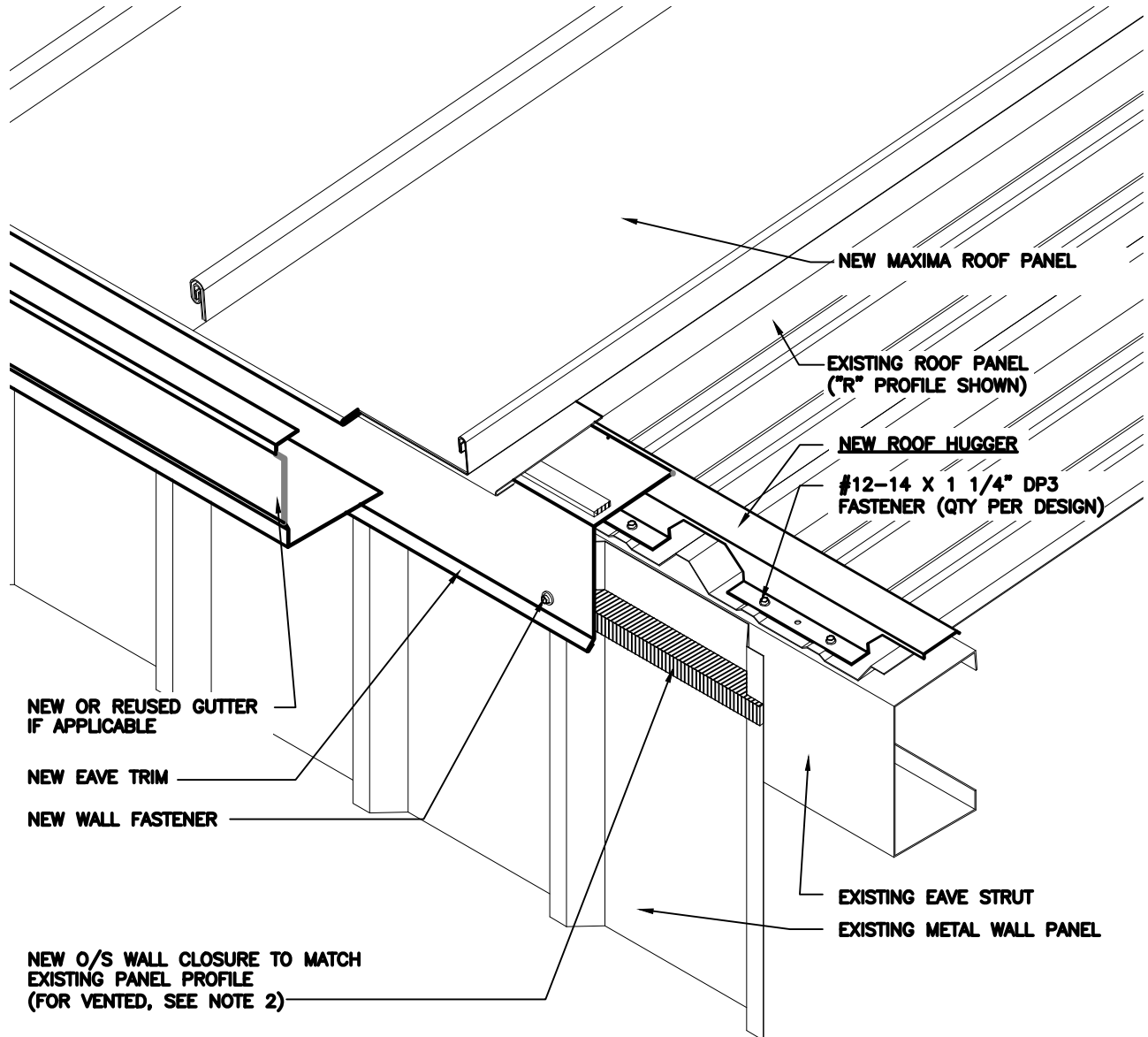
McElroy Metal, Inc.
Retrofit Framing Systems

LOW EAVE

NEW MASTERLOK SERIES PANEL
OVER EXISTING TRAPEZOIDAL PANEL

Page

10-80



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



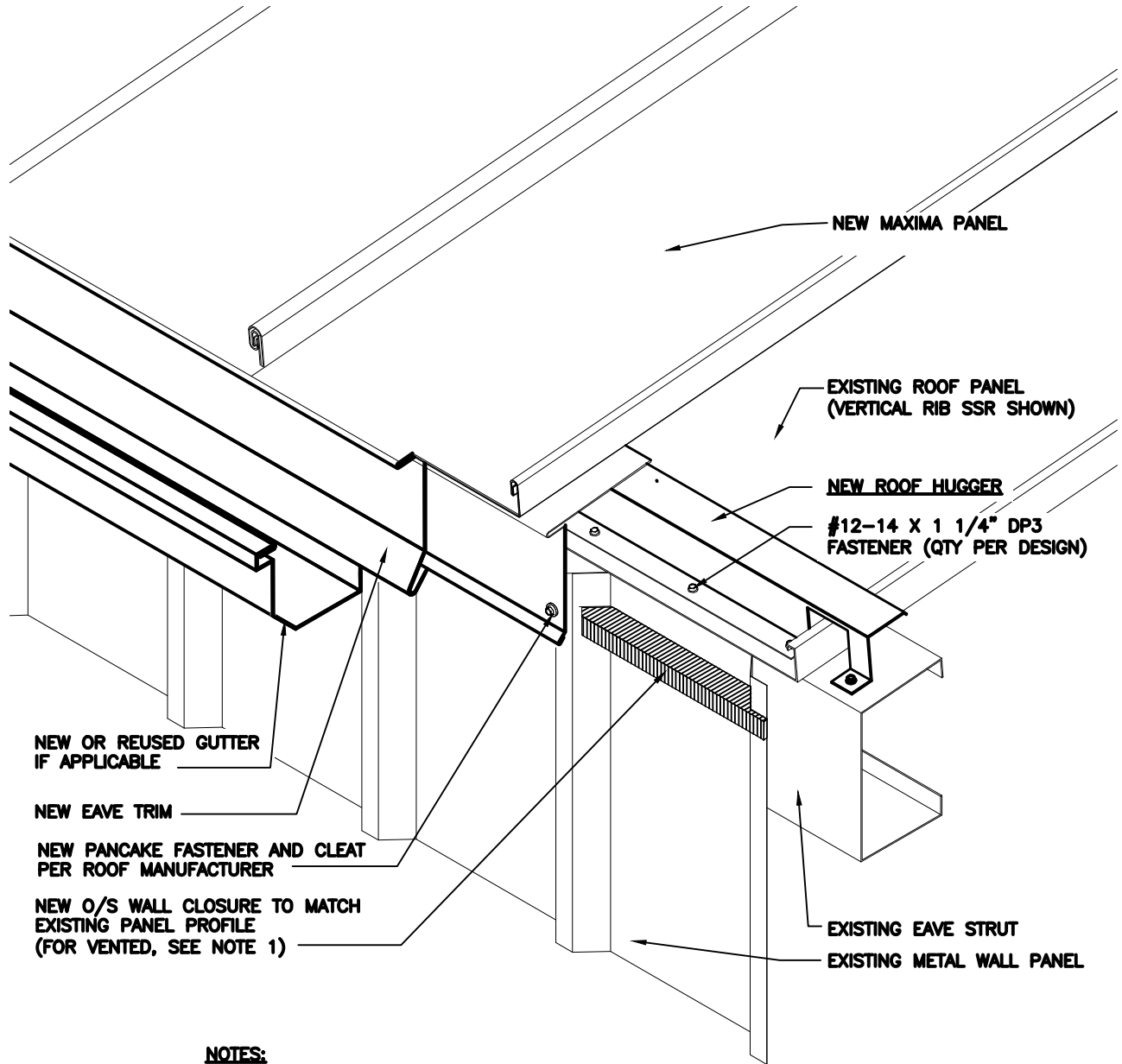
McElroy Metal, Inc.
Retrofit Framing Systems

LOW EAVE

NEW MAXIMA PANEL OVER
EXISTING "R" PROFILE PANEL

Page

10-81



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



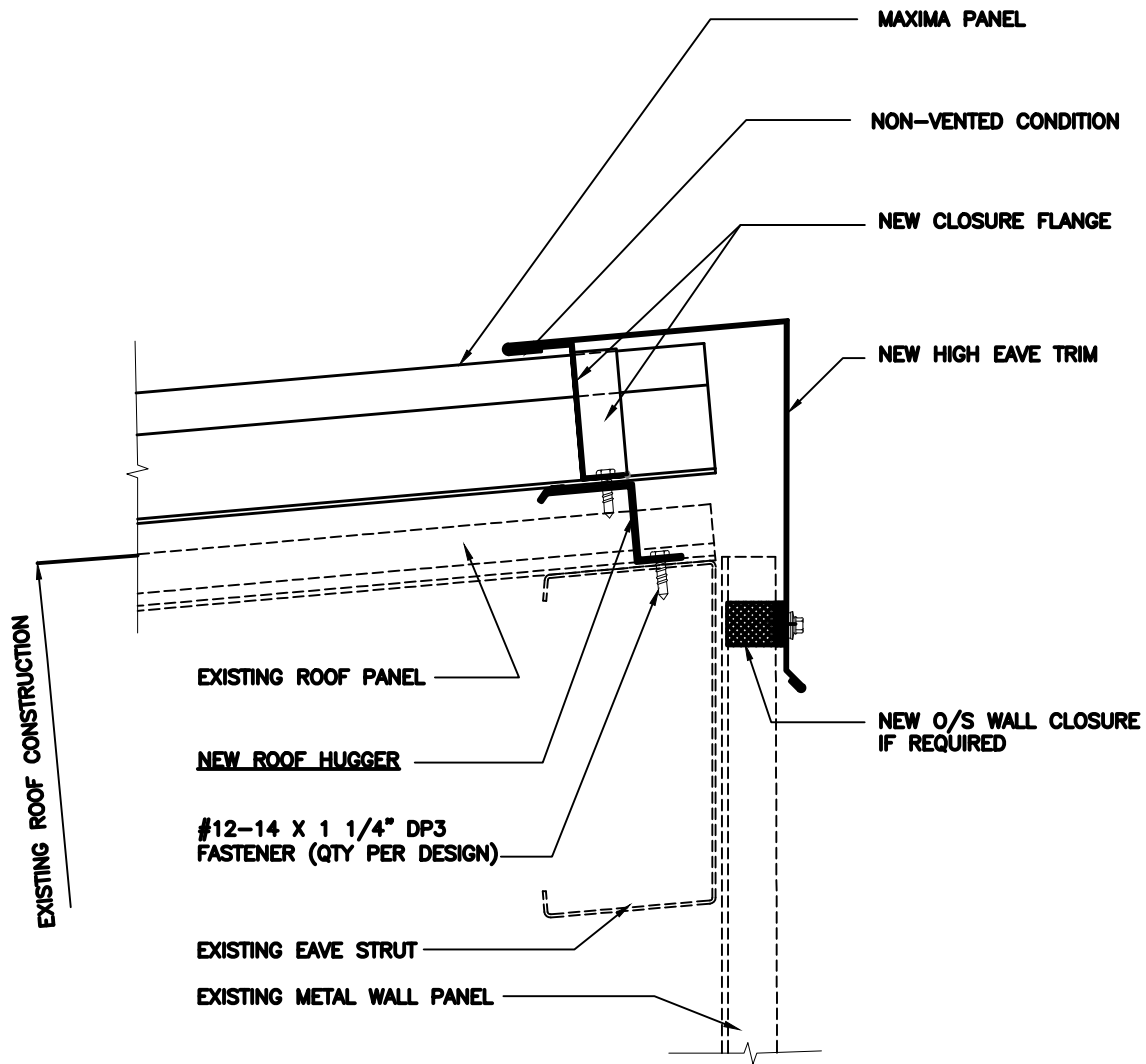
McElroy Metal, Inc.
Retrofit Framing Systems

LOW EAVE

NEW MAXIMA PANEL OVER EXISTING
VERTICAL RIB SSR PANEL

Page

10-82



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

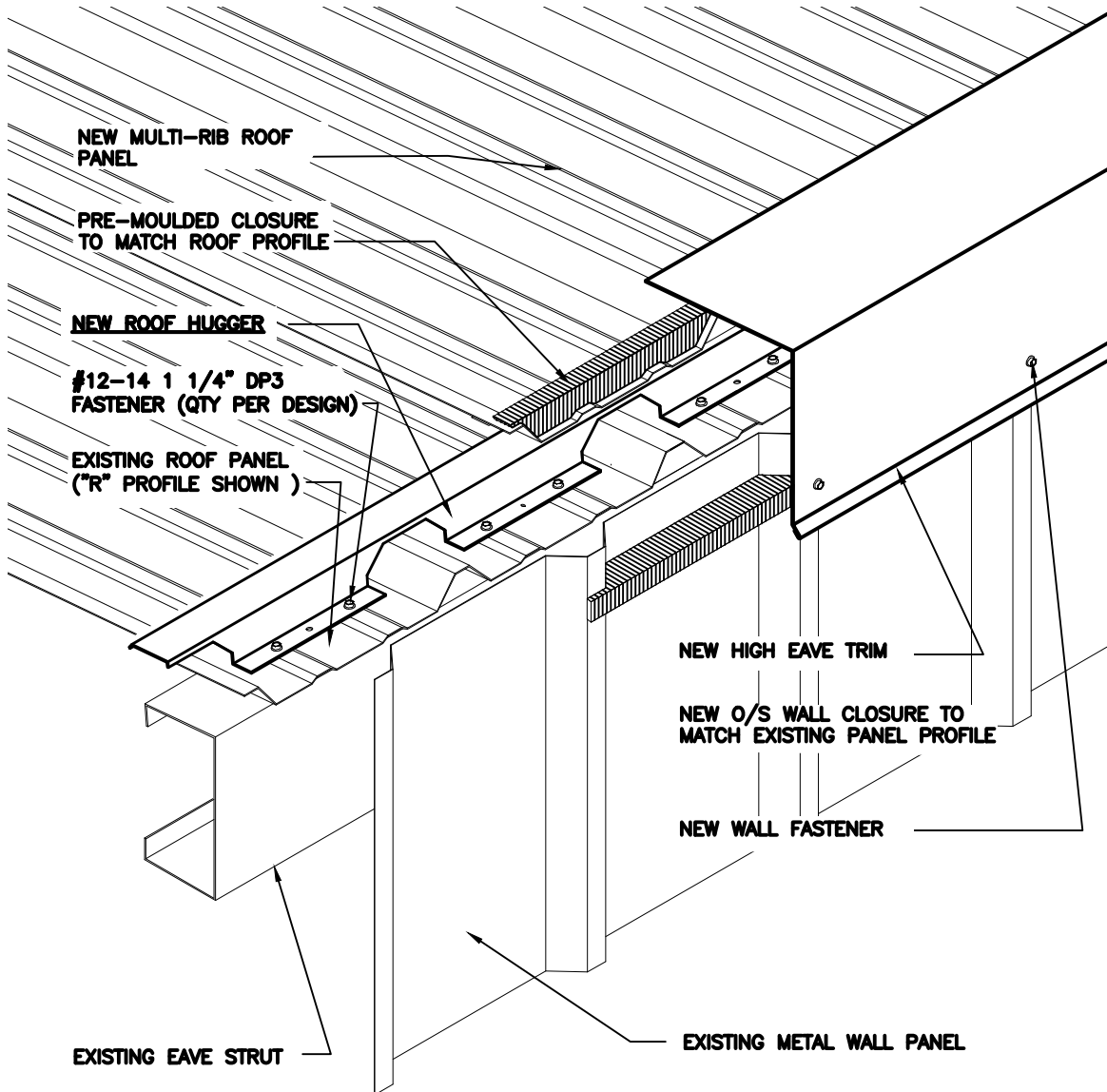


McElroy Metal, Inc.
Retrofit Framing Systems

HIGH EAVE WITH
NON-VENTED CONDITION

Page

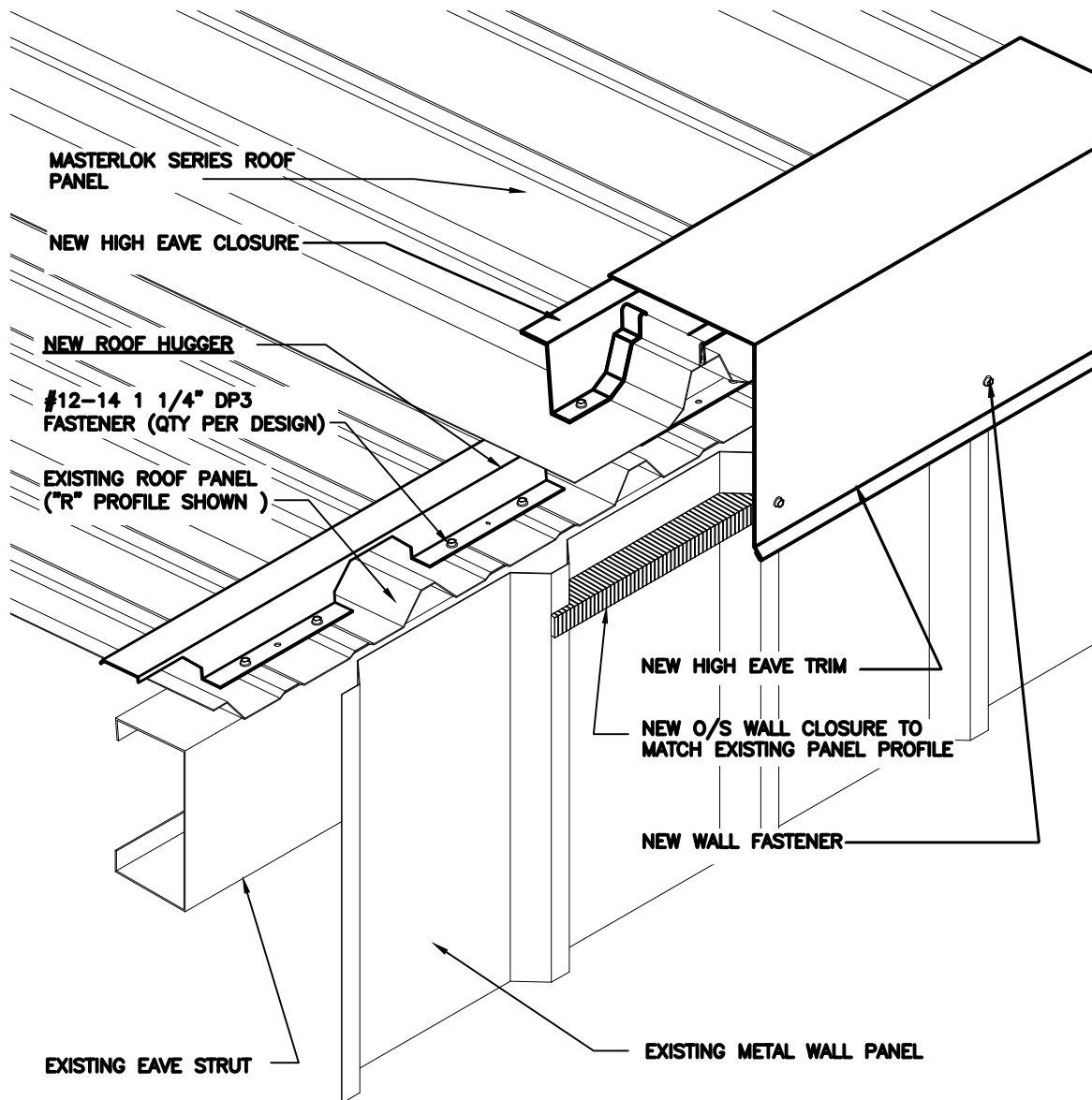
10-83



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



**NOTES:**

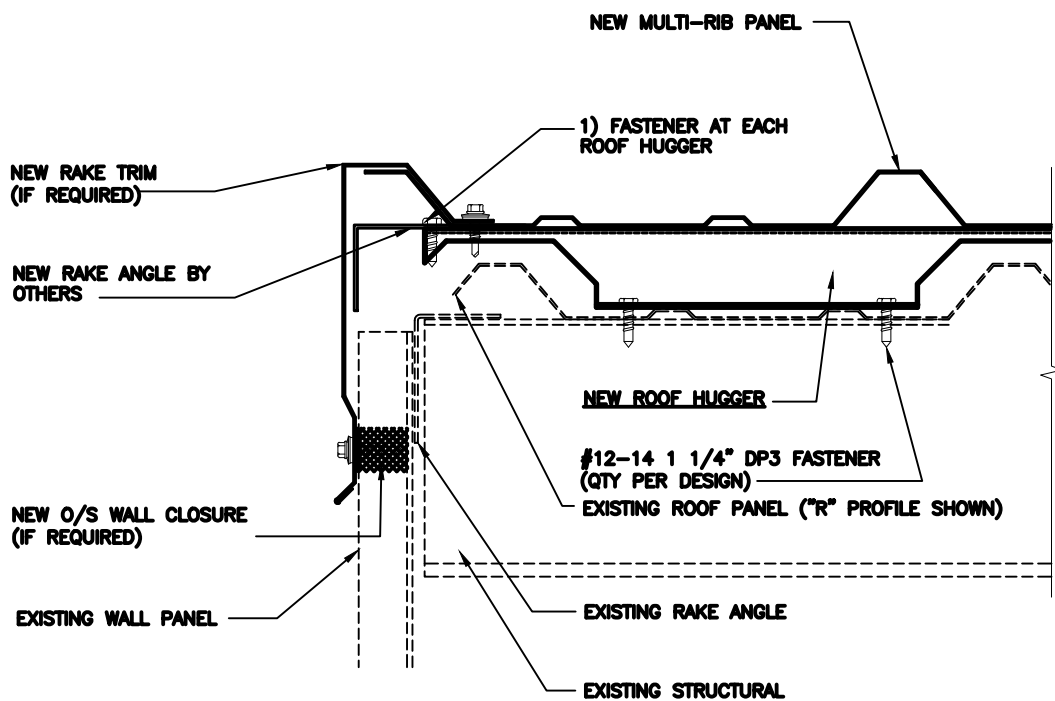
1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



McElroy Metal, Inc.
Retrofit Framing Systems

HIGH EAVE

10-85



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

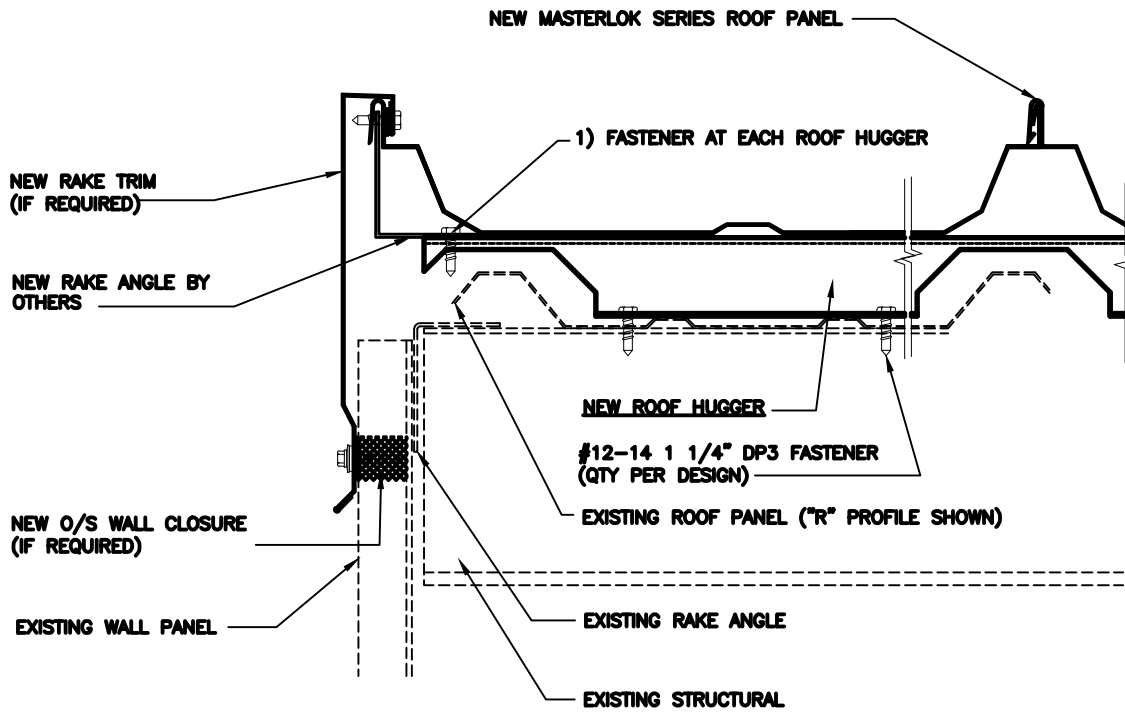


McElroy Metal, Inc.
Retrofit Framing Systems

RAKE/ENDWALL

Page

10-86



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

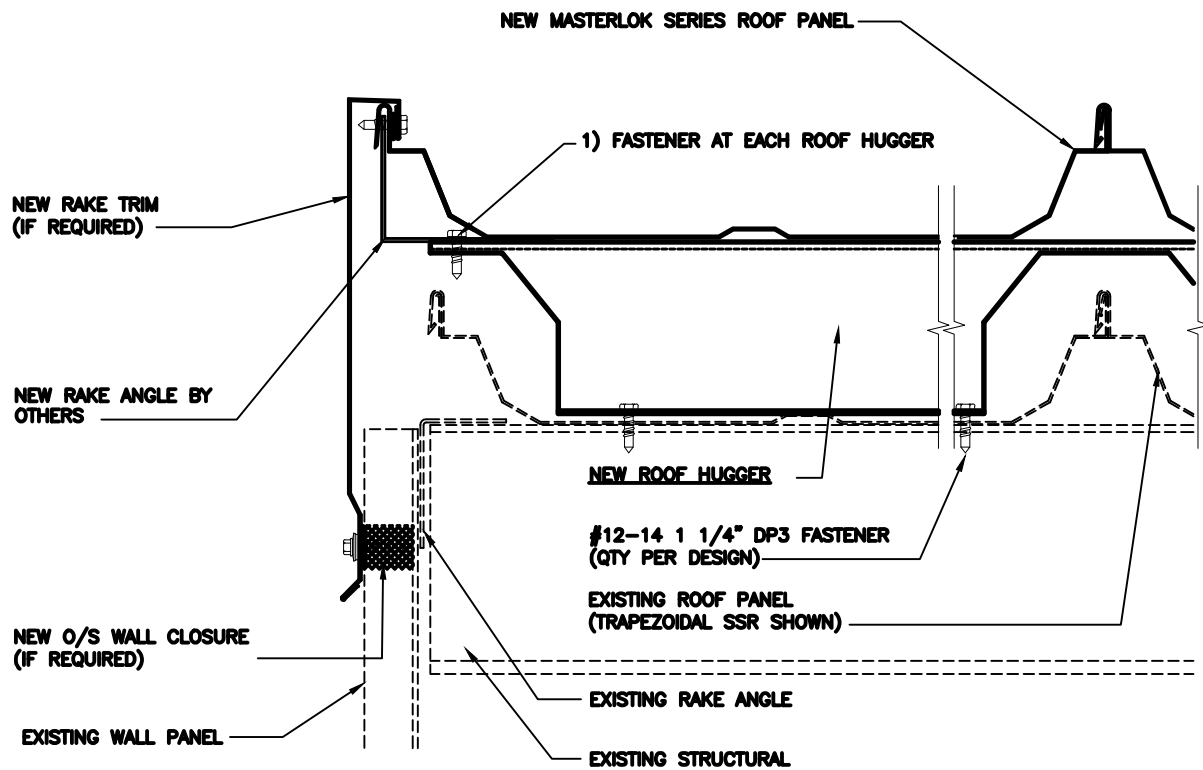


McElroy Metal, Inc.
Retrofit Framing Systems

RAKE/ENDWALL

Page

10-87



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

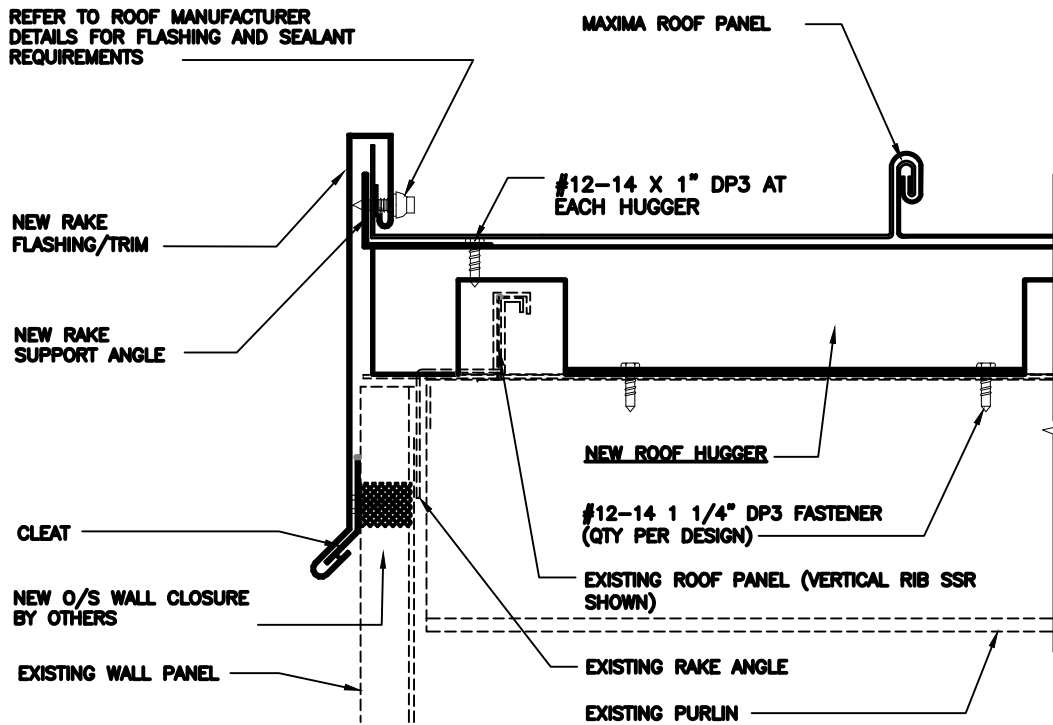


McElroy Metal, Inc.
Retrofit Framing Systems

RAKE/ENDWALL

Page

10-88



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

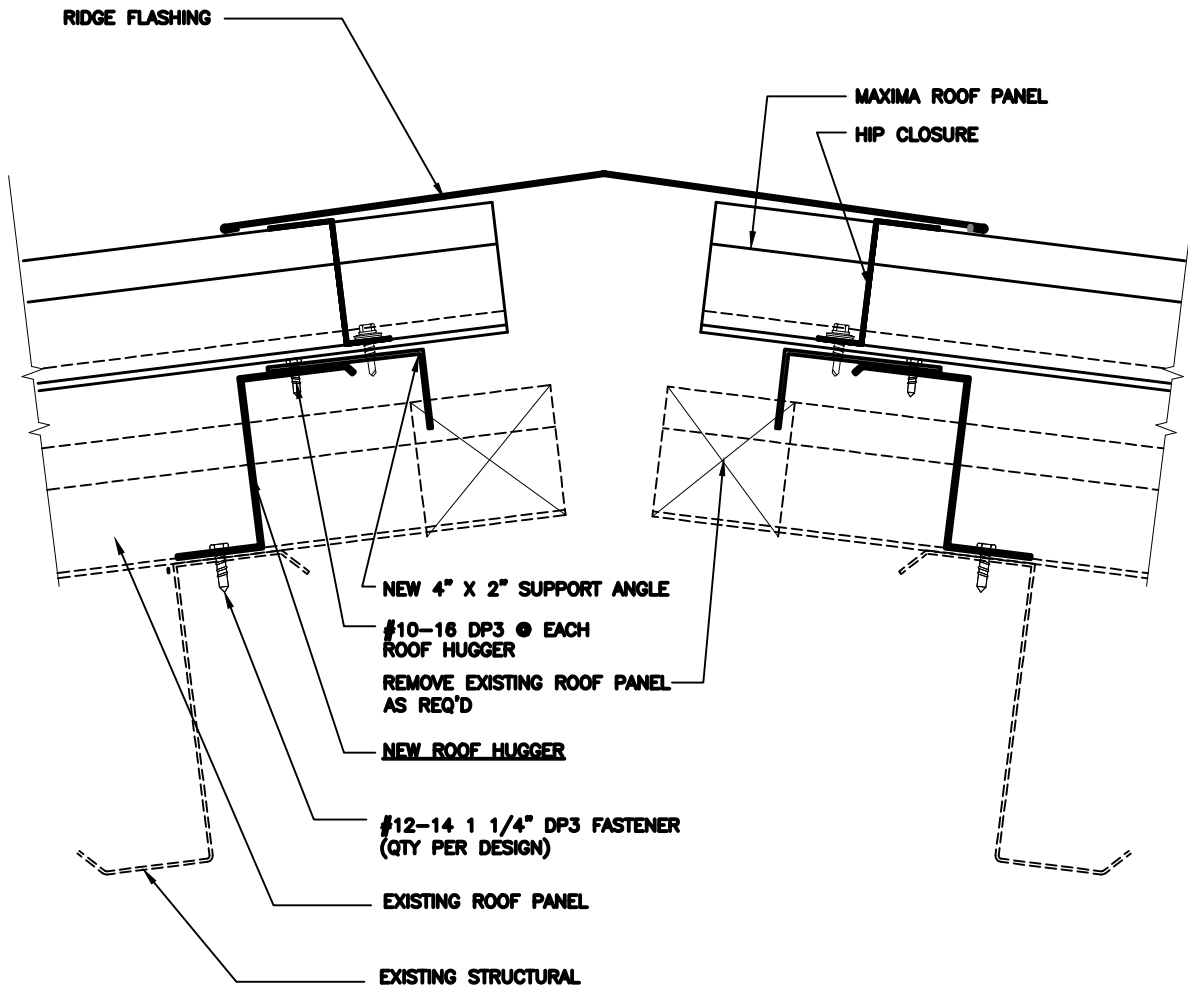


McElroy Metal, Inc.
Retrofit Framing Systems

RAKE/ENDWALL

Page

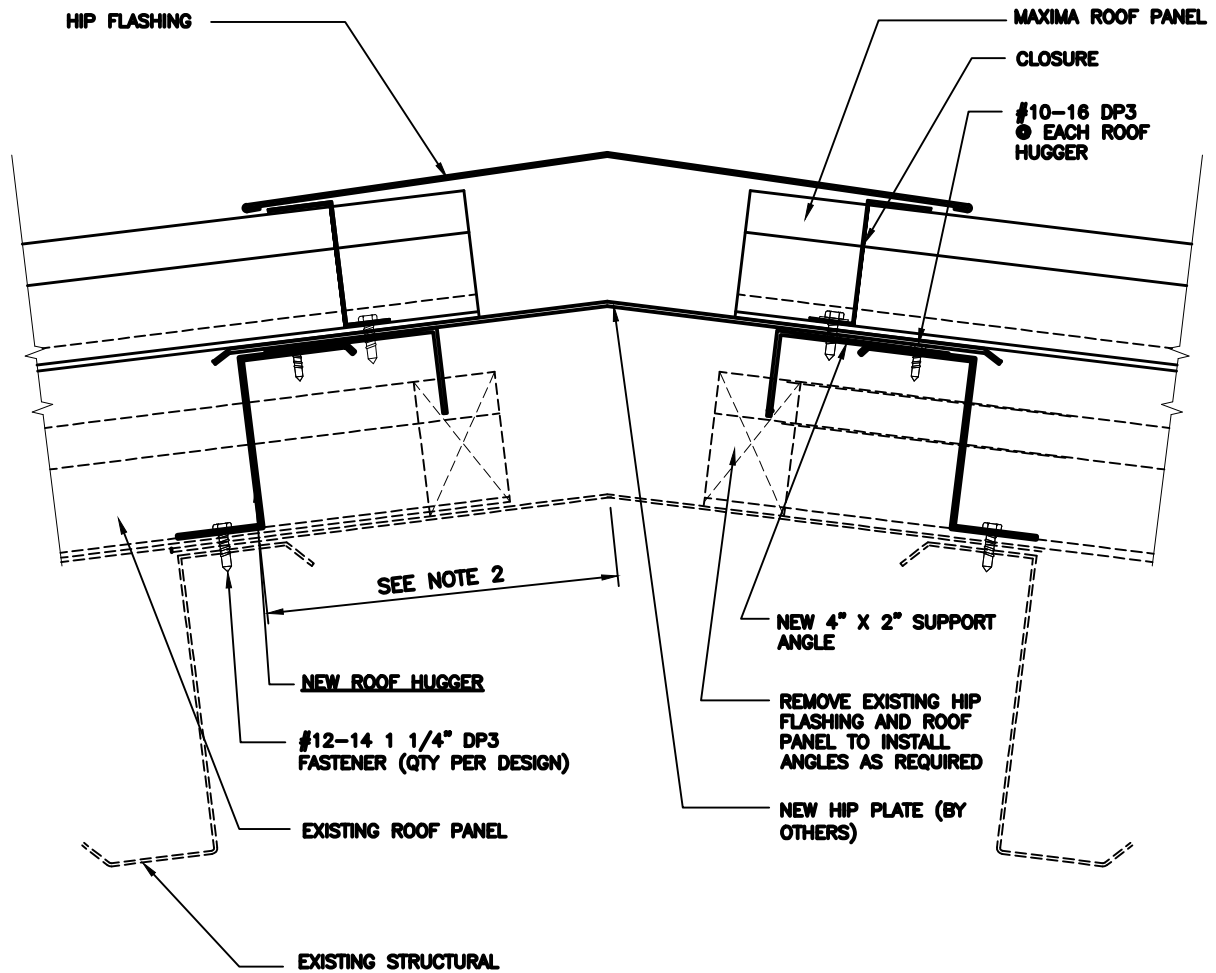
10-90



NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.





NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.

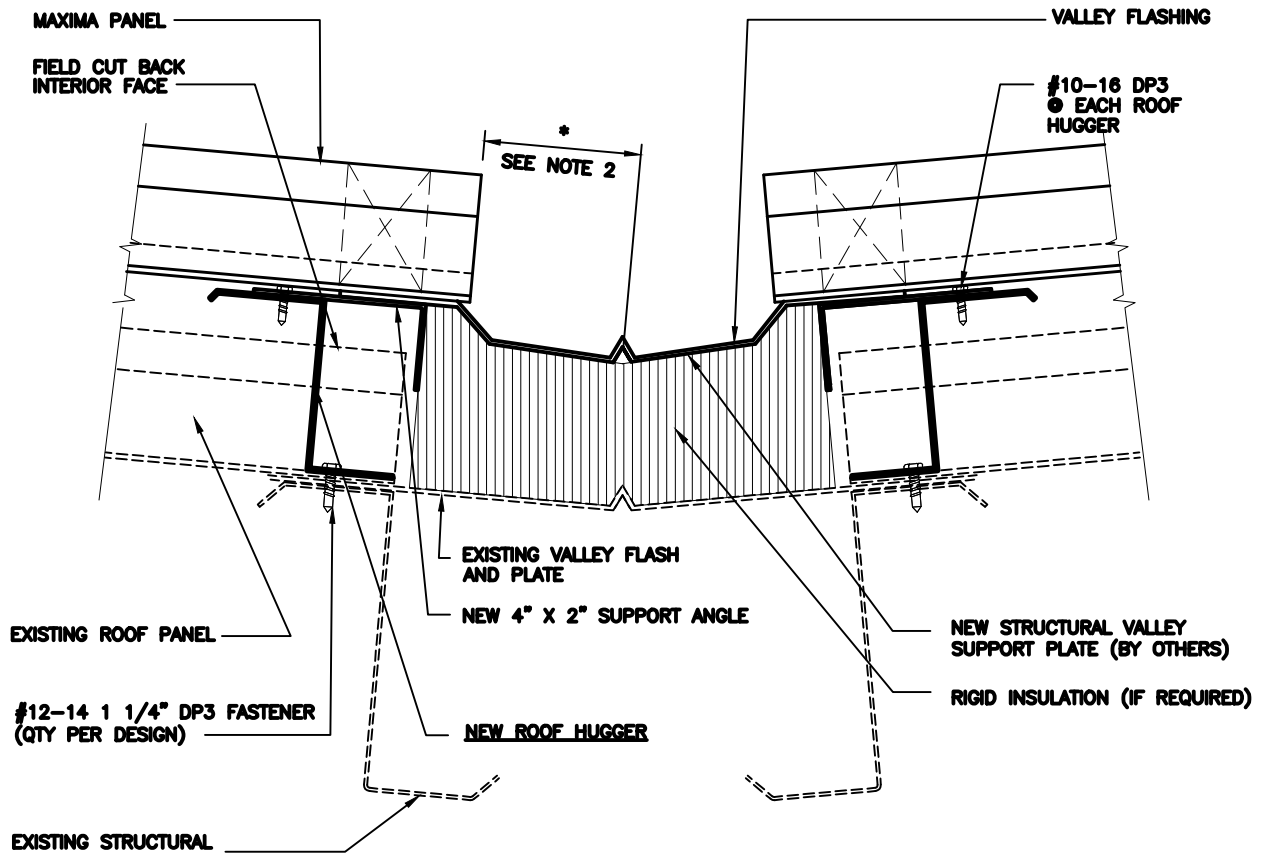


McElroy Metal, Inc.
Retrofit Framing Systems

HIP

Page

10-92



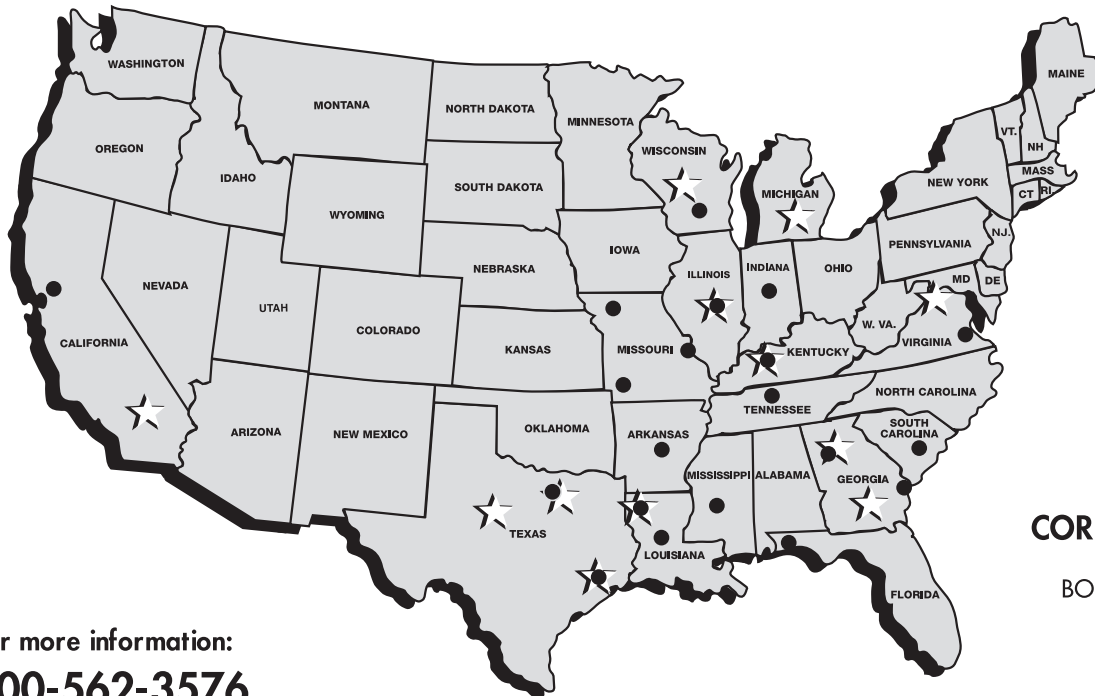
NOTES:

1. ALL FASTENERS BY MCELROY METAL UNLESS NOTED OTHERWISE.
2. NEW ROOF SYSTEMS TO BE INSTALLED PER MCELROY METAL'S INSTALLATION DOCUMENTS.
3. SEE ROOF HUGGER INSTALLATION INSTRUCTIONS FOR INFORMATION CONCERNING EXISTING FASTENERS BEING REMOVED OR LEFT IN PLACE.



☆ MANUFACTURING LOCATIONS ● SERVICE CENTERS

★ MANUFACTURING AND SERVICE CENTER



CORPORATE OFFICE

1500 HAMILTON RD.
BOSSIER CITY, LA 71111
Ph: (800) 562-3576
Fax: (318) 747-8029

For more information:
800-562-3576
www.mcelroymetal.com

MANUFACTURING LOCATIONS

ADELANTO, CA
HOUSTON, TX
MERKEL, TX

ASHBURN, GA
LEWISPORT, KY
PEACHTREE CITY, GA

BOSSIER CITY, LA
MARSHALL, MI
SUNNYVALE, TX

CLINTON, IL
MAUSTON, WI
WINCHESTER, VA

**MCELROY METAL
SERVICE
CENTER**

5215 Leo St.
Alexandria, LA 71301

1500 Hamilton Rd.
Bossier City, LA 71111

3052 Yadkin
Chesapeake, VA 23323

10460 Revere Rd.
Clinton, IL 61727

3215 Highway 59
Diamond, MO 64840

409 Lovejoy Road
Ft. Walton Beach, FL 32548

3014 Lincoln Court
Garland, TX 75041

11625 N. Houston Rosslyn Rd.
Houston, TX 77086

10504 E. 59th Street
Indianapolis, IN 46236

9435 U.S. Hwy 60 W.
Lewisport, KY 42351

3036 Progress Road
Madison, WI 53716

514 Cave Road
Nashville, TN 37210

8304 Hwy. 70 E.
North Little Rock, AR 72117

613 North Bierdeman Rd.
Pearl, MS 39208

5300 83rd Street
Sacramento, CA 95826

1365 Dean Forest Rd.
Savannah, GA 31405

7355 Oakley Industrial Blvd.
Union City, GA 30291

165 North Outer Road
Valley Park, MO 63088

1144 Silstar Rd.
West Columbia, SC 29170

30000 US Hwy. 69
Winston, MO 64689

Website: www.mcelroymetal.com • E-mail: info@mcelroymetal.com