METAL ROOF SYSTEMS:
Design & Installation Considerations

AIA Continuing Education Provider

2025

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AEP Span

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

LEARNING OBJECTIVES

At the end of this course, participants will be able to:

- List the advantages and disadvantages of Architectural Roofing vs. Industrial Roofing
- State the specification considerations related to a metal roof installation
- Discuss the environmental impact of metal roofs versus alternative roofing materials
- List the design and installation issues that help facilitate a successful metal roof solution

INTRODUCTION

This section reviews:

- The pros and cons of Architectural Roofing vs. Industrial Roofing
- Exposed fastener roof systems and standing seam roof assemblies
- Specification considerations that are critical to a successful installation

ARCHITECTURAL ROOFING & INDUSTRIAL ROOFING

Architectural Roof System

- Specified for performance, life cycle costs, as well as aesthetic reasons
- Non-structural metal roofing usually requires a solid substrate beneath it

Low Slope Industrial Roof System

- Selected more for its function, performance, and when cost is the major factor of a project feasibility
- Structural metal roofing attaches directly to secondary structural members

ARCHITECTURAL ROOFING & INDUSTRIAL ROOFING

ARCHITECTURAL ROOFING	
Advantages	**Disadvantages**
Aesthetically pleasing with clean architectural lines	May require solid supportive substrate
Concealed attachments, fasteners and sealants	Requires a more skilled installer
Design flexibility - variety of rib profiles, styles and colors	Does not stabilize purlins or other steel framing
Adaptable to varying roof slopes and conditions	
Positive interlocking panel ribs and thermally responsive clips	

INDUSTRIAL ROOFING	
Advantages	**Disadvantages**
Lower cost than architectural types	Designed for function rather than appearance
Lower than normal slopes (1/4 : 12) applications	Limited color selection
Structurally responsive over open framing	Detail limitations for hip and valley conditions
Taller than normal rib provides water tightness assurance at low slopes	May have some exposed fasteners and closures
Positive interlocking panel ribs for long length capabilities	

EXPOSED FASTENER ROOF SYSTEMS

Exposed Fastener panels by definition

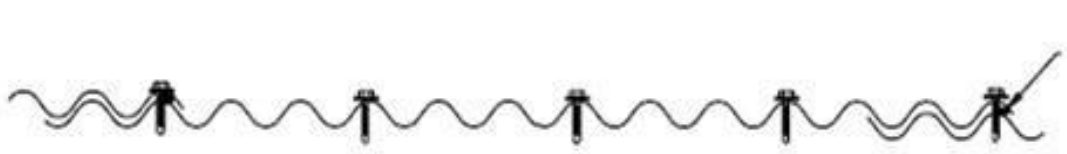
- Through-fastened
- Nestable
- Relies on laps and sealant for waterproofing
- The profile can vary widely, including sinewave, trapezoidal, and box

Additional characteristics

- Economical performance value option
- Durable and lightweight
- Can be installed on a roof or vertically/ horizontally in a wall application
- Varying gauges

EXPOSED FASTENER ROOF SYSTEMS

- An exposed fastener panel relies on a visible fastening device and requires field-applied sealant to improve the weather tightness of the assembly.
- Panels are “pinned” at every attachment point, thus not allowing for thermal movement.
- Over time, the expansion and contraction of the panels can create an elongated hole at the screw location and jeopardize the weather tightness and attachment of the panel.
- Typically, exposed fastener panels should only be used on shorter panel runs and are not recommended for slopes less than 1:12.
- In these cases, a standing seam metal roof is preferred.



Corrugated: Roof Application (32” Coverage)

Roof or Wall Application (36” Coverage)

STANDING SEAM ROOF SYSTEMS

Standing Seam

- Tall seam resist leaks

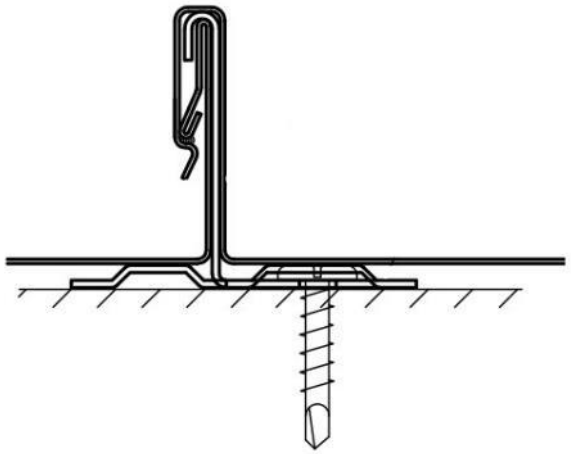
Factory Applied Sealant

- Ease of installation
- Assures weather tightness

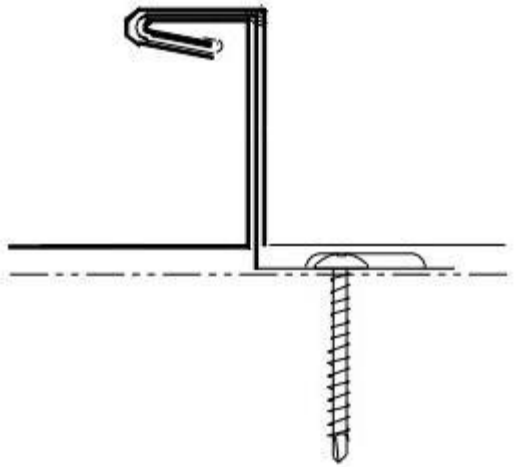
Floating Clip/Concealed Fastener

- Allows thermal movement

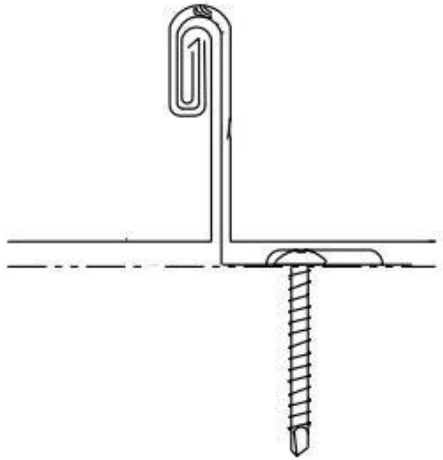
STANDING SEAM CONFIGURATIONS



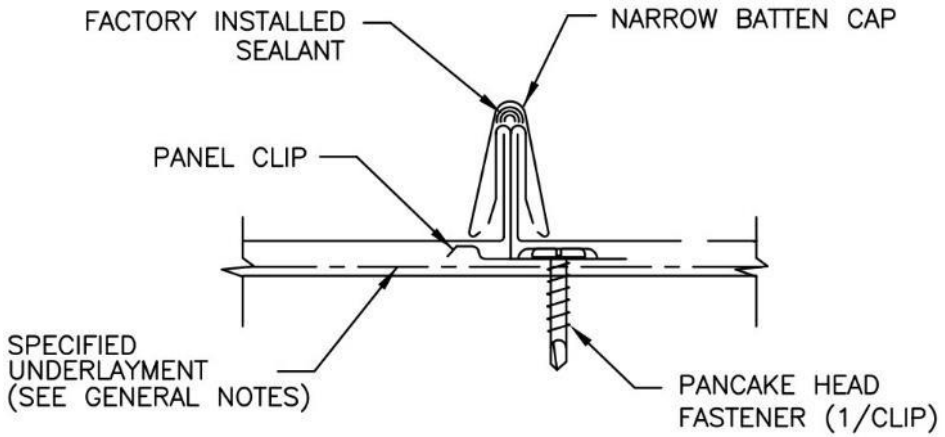
Snap Style



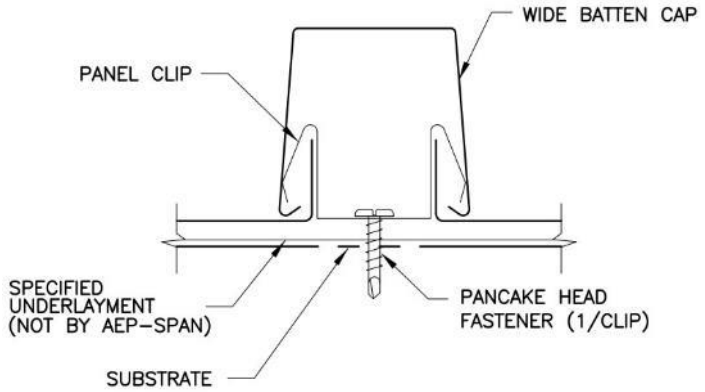
90 Degree Mechanically Seamed



180 Degree Mechanically Seamed



Narrow Batten Seam



Wide Batten Seam

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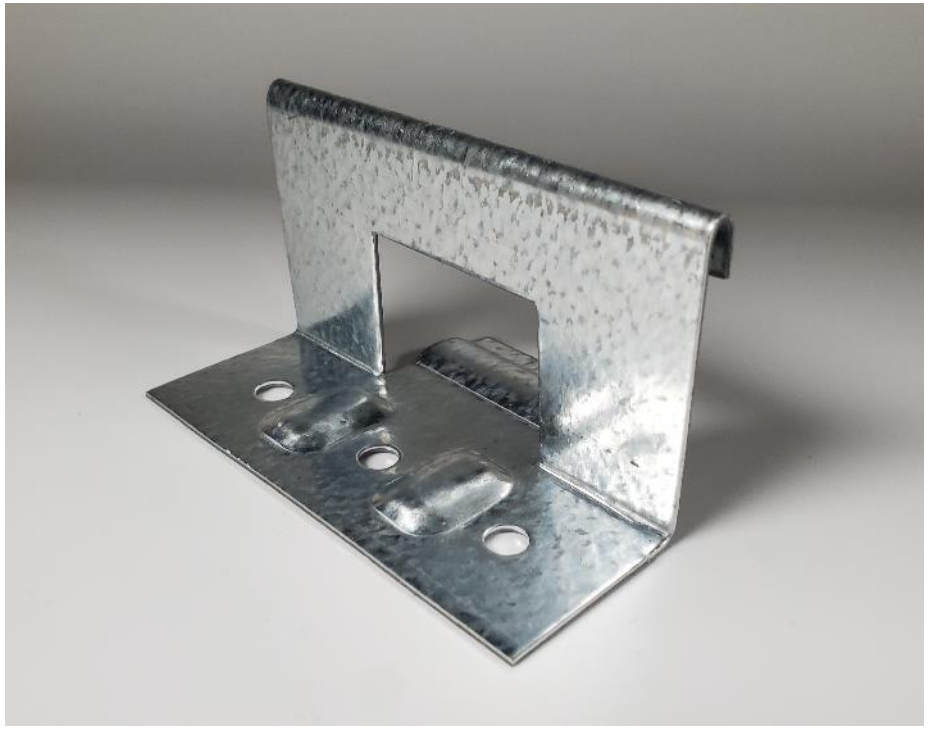
STANDING SEAM SYSTEMS

- Standing seam systems offer performance coupled with aesthetics.
- A standing seam panel is one with no visible or exposed fastening device and can provide for sufficient attachment and thermal movement through the use of a thermally-responsive clip and fastener.
- Clips are attached to the substrate and entrap the vertical panel legs.

THERMALLY RESPONSIVE CLIPS

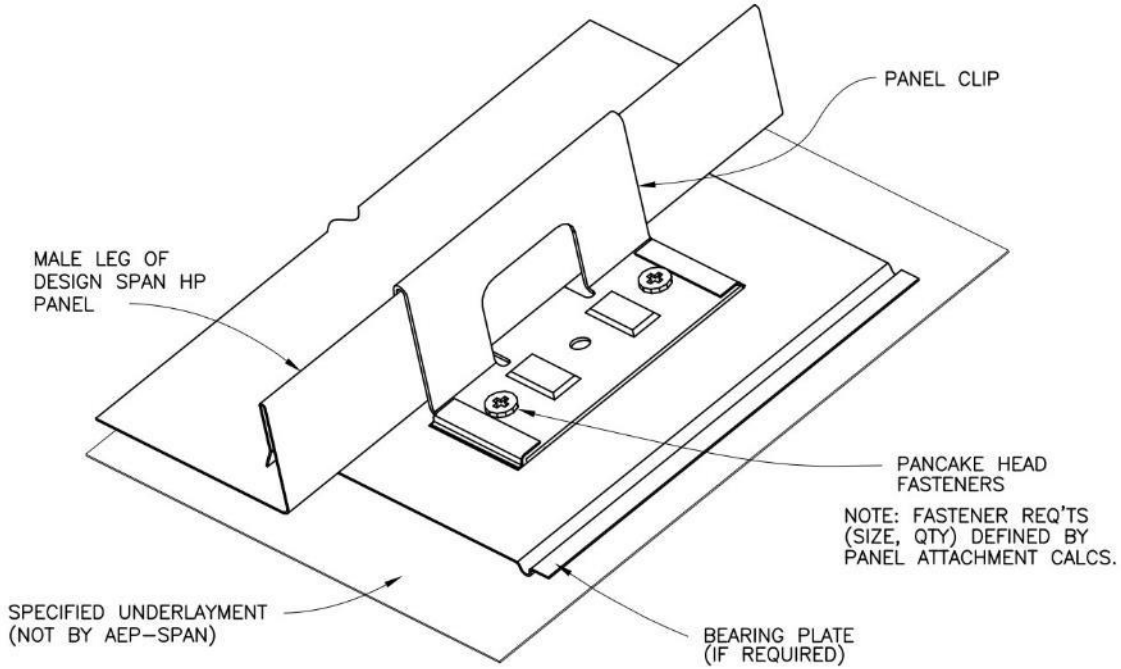


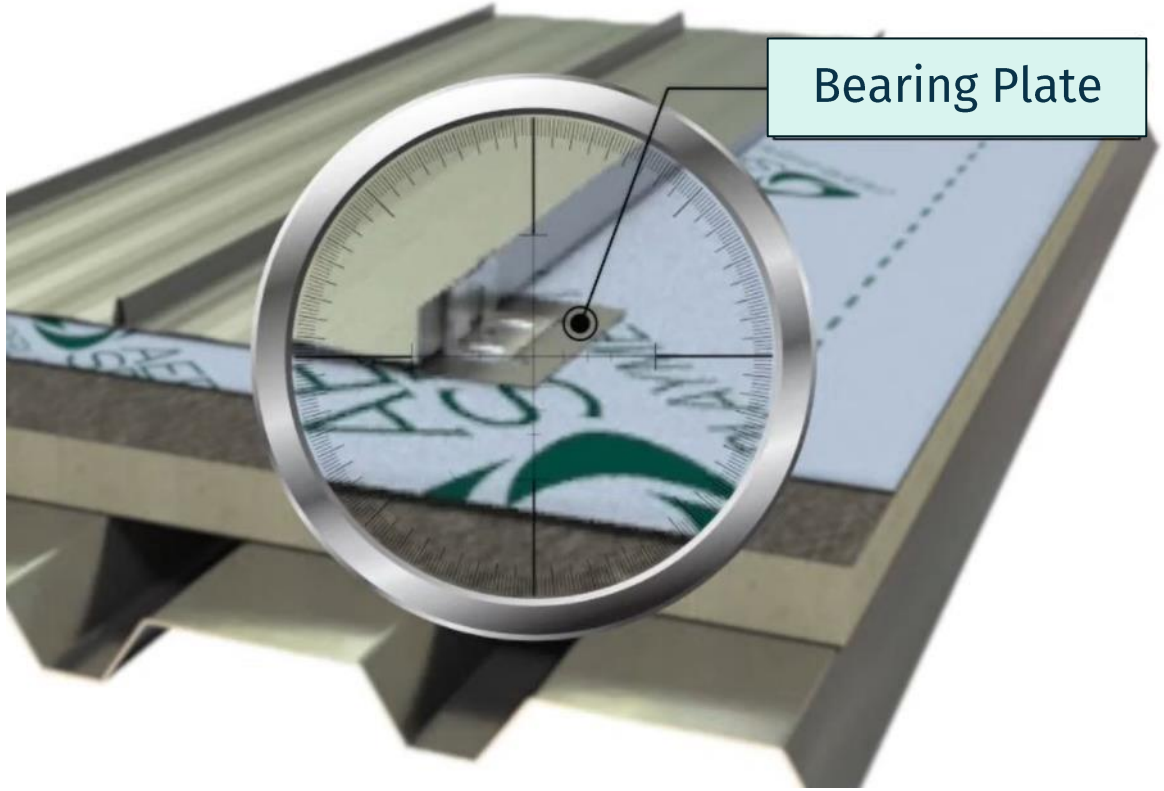
One-piece clips allow snap-together metal roof panels to thermally move over the top of the clip.

Two-piece clips allow for mechanically seamed panels to float back and forth under thermal load along the base of the clip. Floating clips allow for +/- 1 inch of thermal movement.

BEARING PLATES

Bearing plates are used when installing panels over rigid insulation to disperse the load of the clip and prevent the clip from overly compressing the insulation.



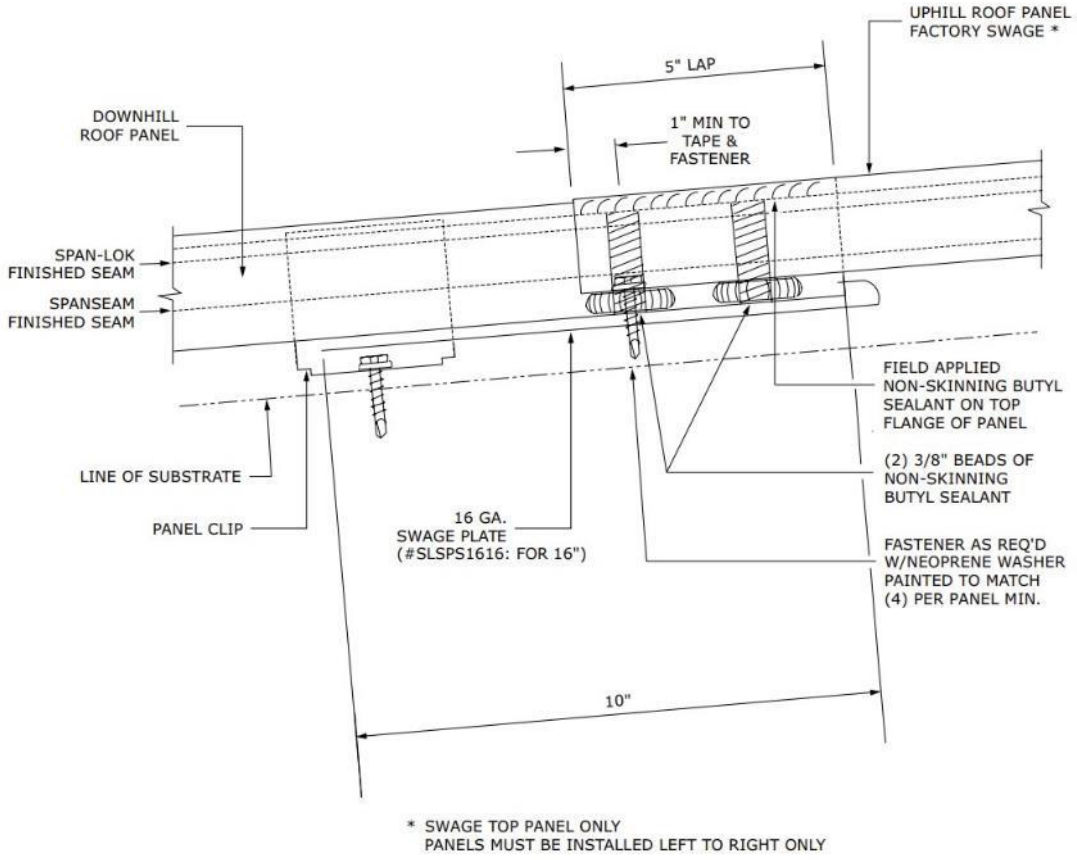


CONTINUOUS STANDING SEAM PANELS

Continuous standing seam panels can be used for long run, low slope installations, but it is important to be aware of the limitations.

CONTINUOUS STANDING SEAM PANELS

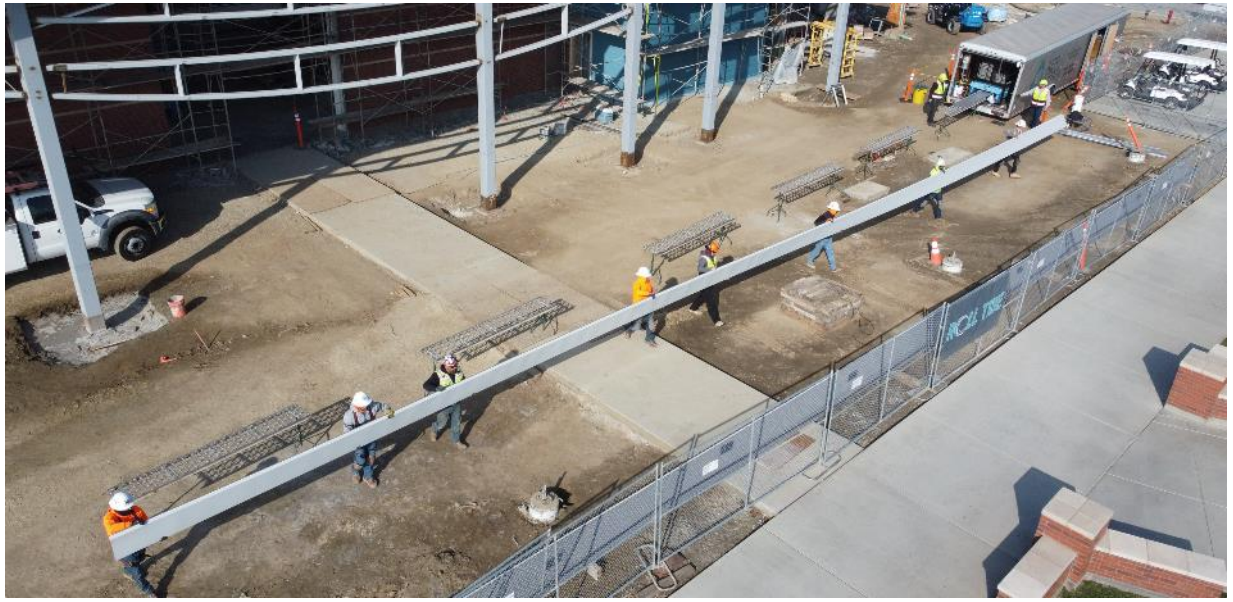
Continuous standing seam panels at extra long lengths are prone to installation damage and present greater installation challenges.

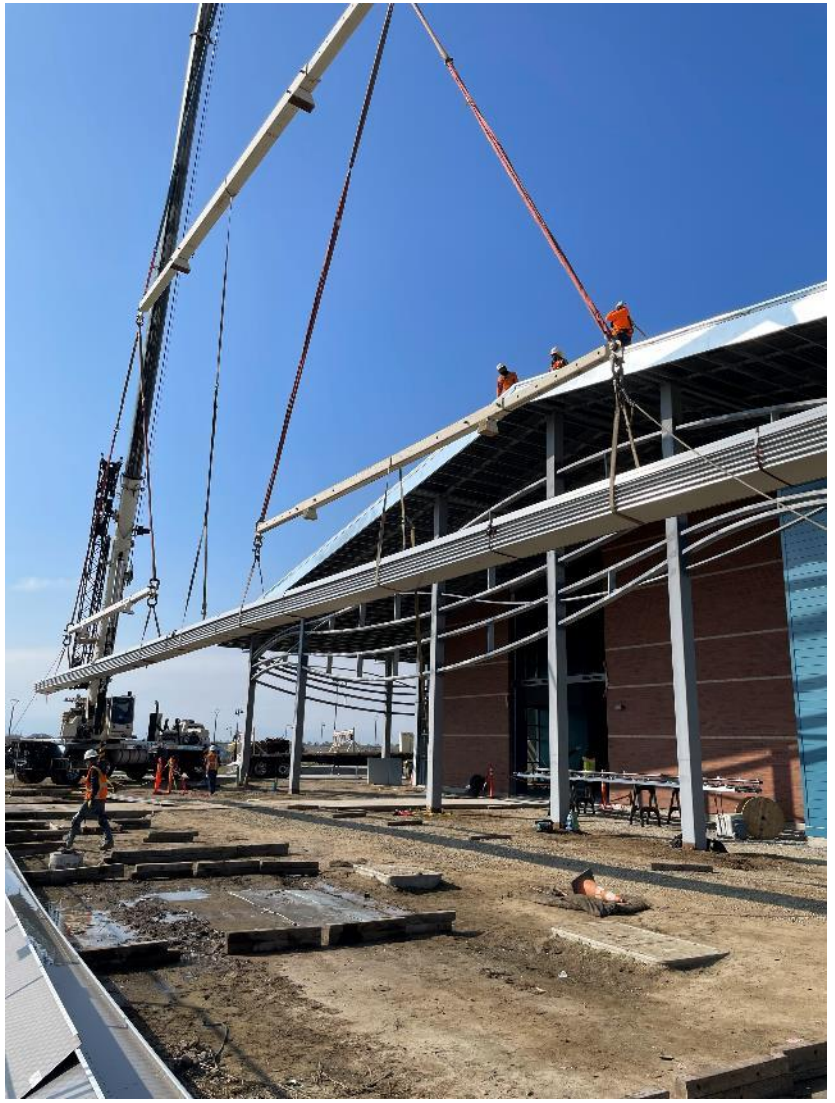


Brigham Young Sports Complex was built with continuous panels.

CONTINUOUS STANDING SEAM PANELS

- If continuous panels are required, ensure you deal with a quality supplier.
- Some manufacturers offer mobile factory-quality roll formers.
- Asking for mobile roll former UL certification is recommended.



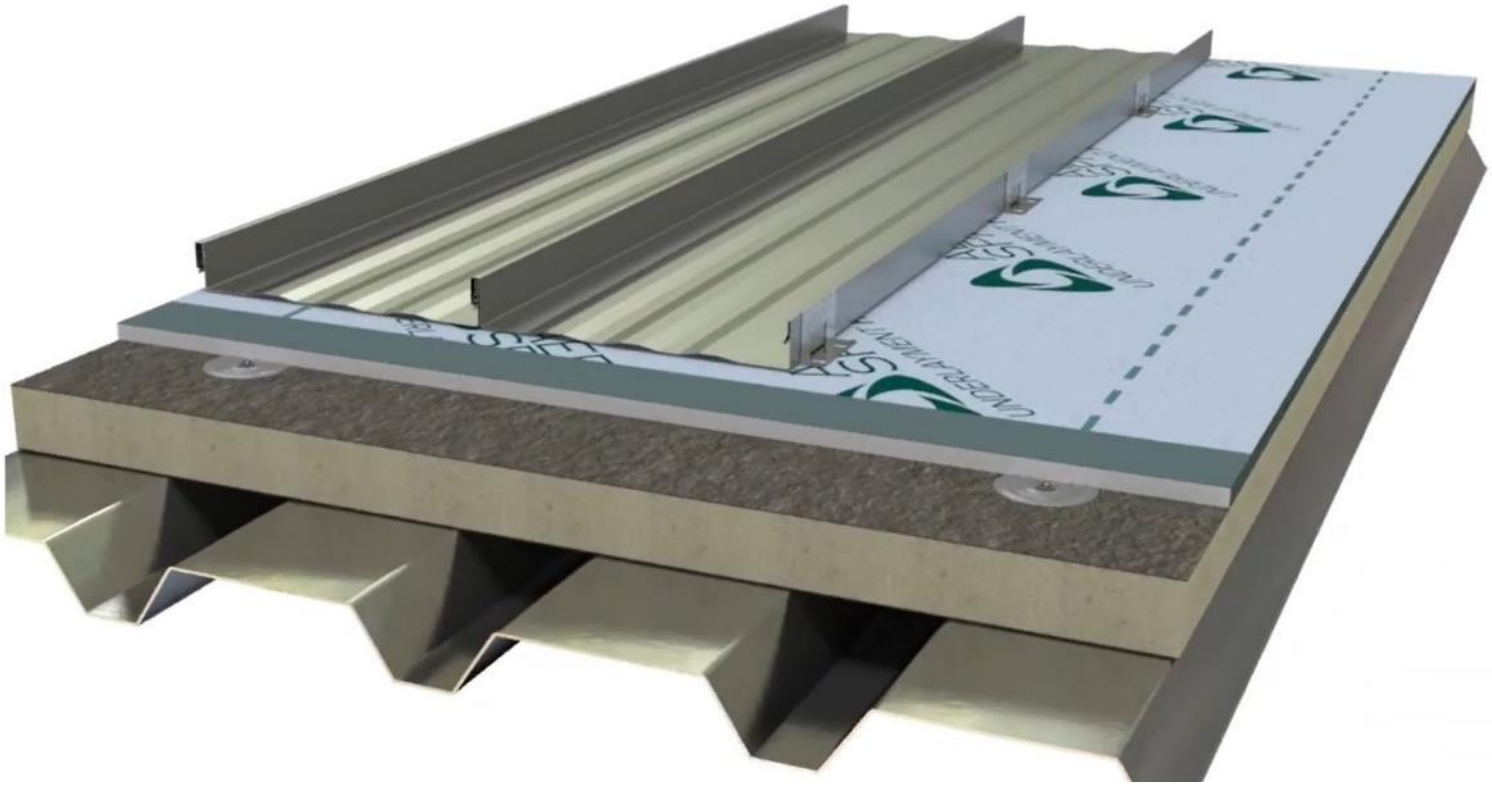


SUBSTRATES & ASSEMBLIES

- Available in the market are non-structural metal roofing panels, designed to shed water in sloped applications over solid substrates, as well as structural metal roofing panels designed to resist standing water over both solid substrates and open framing conditions.
- With limitations based on wind uplift and condensation control, metal roofing can be installed over wood substrates.
- Metal roofing can also be installed over steel substrates.
- Selecting the proper substrate is critical to the success of the roofing installation.
- A poor substrate can result in severe oil canning, potentially leading to premature failure.

UNDERLAYMENT MATERIALS

Choice of the underlayment will depend on several factors, including condensation control, snow density, rainfall density and heat developed.



UNDERLAYMENT MATERIALS

Vapor Retarders and Underlayment

- Vary with building conditions and roof assembly
- Generally designed to be installed on the warm side of the insulation or directly underneath the metal panel

30-40 Mil Peel-and-Stick Membranes

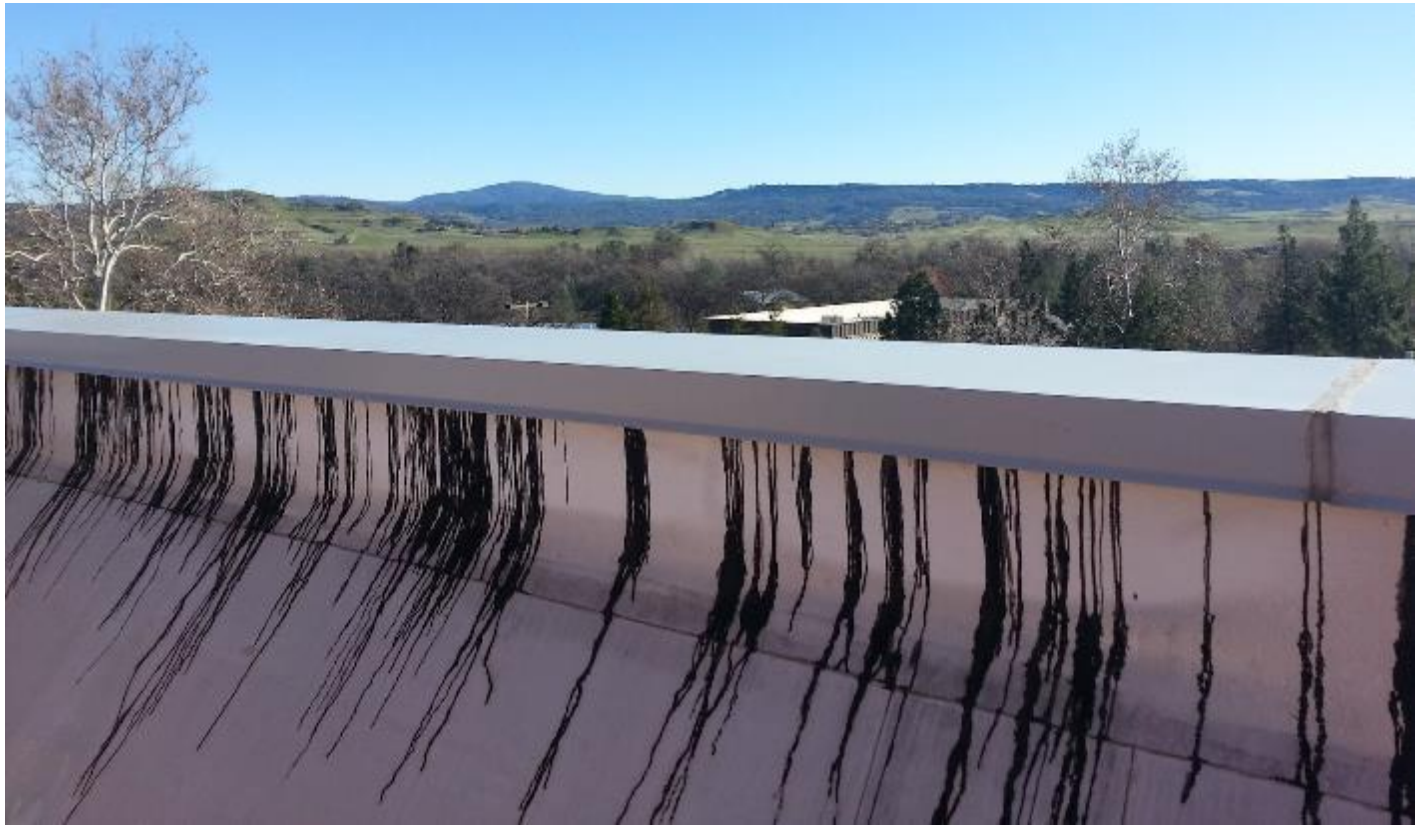
- Act as waterproof underlayment in critical roof areas
- Can also be used as vapor barriers to provide early construction dry-in capabilities and a secondary roof membrane between the metal roof and the substrate

UNDERLAYMENT MATERIALS

- A high-temperature underlayment should be used under metal due to the temperatures that may be reached below the metal panels
- A #30 asphalt impregnated felt may re-emulsify under the potential temperatures and leak down the sides of the structure

Underlayment should be:

- High-temperature rated
- 40 mil
- Self-healing
- Peel-and-stick/self-adhesive
- Non-sanded



GAUGE

Exposed Fastened Roof Panels

- Heavier gauge material is generally used to accommodate requirements for positive loading only
- 26, 24, and 22 gauge are industry standards
- 20 and 18 gauge are available non-standard for select profiles when required for added durability

Standing Seam Roof Panels

- Generally offered in 24 or 22 gauge steel
- Exposed fastened and standing seam panels can be provided in aluminum, copper, or stainless steel

SECTION 1

QUESTIONS?

METALLIC COATINGS

- Al-Zn is the most widely used metallic coating for the corrosion protection of steel.
- Galvalume® and Zincalume® are two common trade names of Al-Zn.
- The aluminum component (55%) of Al-Zn provides corrosion protection and corrosion warranty, while the zinc component (45%) provides the sacrificial characteristic that protects material edges and cuts.

METALLIC COATINGS

- When used for low slope roofing, Al-Zn coated sheet generally lasts for over 40 years without corrosion failure.

- Hot-dipped steel sheets are available bare (unpainted) with up to a 25-year warranty (against rust and perforation).

- Zinc-coated steel (often seen as G-60 or G-90 galvanized) is not warrantable, therefore, it is recommended to specify Al-Zn coated products.

PAINT

Paint options for metal roofs include:

GOOD	Polyester
BETTER	Siliconized Modified Polyester (SMP)
BEST	Kynar 500, also known as Polyvinylidene Fluoride (PVDF)

SMP coatings are generally used on 26-gauge industrial products and pre-engineered building systems and have a 20-year comprehensive warranty.

Both SMP and Polyester paint coatings complement the industry with economical paint systems that have decreased chalk and fade values, compared to Kynar.

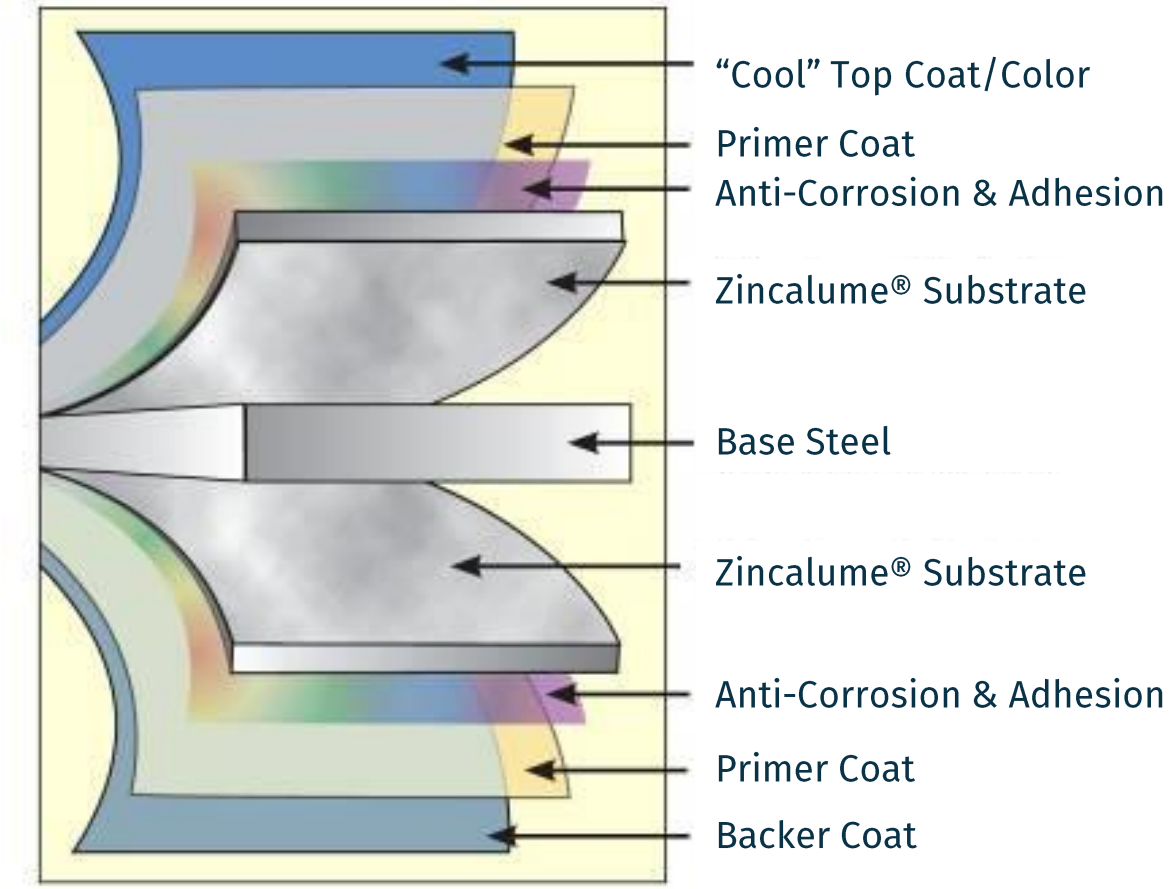
PAINT

- The chalk and fade qualities of Kynar 500 outperform polyester powder, urethane, silicone polyester and acrylic coatings and may be warranted for up to 40 years (comprehensive and limited to normal atmospheric conditions).
- When Kynar 500 is coupled with a Zincalume®/Galvalume® substrate, the product exhibits exceptional properties.
- For severe corrosive or saltwater environments, paint manufacturers have developed alternatives to the industry standard 1.0 mil Kynar based coatings.

PAINT

- Coatings have been developed that meet the standards for “Cool Roofing” for both solar reflectance and thermal emittance.

- Many premier roofing systems are being utilized that not only provide a high degree of weather tightness and longevity, but are also helping to keep the building energy efficient.



PAINT WARRANTY

- When specifying paint, check the warranty carefully and verify the warranty coverage.
- It is also important to review the warranty “remedy” the manufacturer is willing to provide.

Sheet Metal Roofing

Section 07600

1.06 GUARANTEE

Provide Manufacturer’s standard 25-year paint warranty including coverage against cracking, flaking, or peeling (loss of adhesion), change color (fade) more than 5 Hunter delta-E units or chalk in excess of number 8.

Example of how warranties could be called out in specifications to ensure the warranty coverage is comprehensive.

SEALANTS

Sealants protect against moisture intrusion into the roof at exposed panels and flashing edges or laps conditions.

Non-Curing Butyl (tube applied)

- Should be used in any areas on a metal roof that is subject to dynamic movement of the panel
- Protects against capillary action
- Allows the panels and flashing to react thermally without compromising the integrity of the sealant
- Will never dry out or break down, provided it is not exposed to sunlight

SEALANTS

Extruded Butyl Tape

- Available in rolls up to 50 feet long
- Used where long continuous beads of sealants are required in highly sensitive areas
- Should be used in all non-exposed applications as it will break down when exposed to sunlight
- The same as non-curing butyl sealants, except it is available in a variety of thicknesses, widths, and lengths based on specific applications
- Most metal roofing details will call for the type and application of butyl tape

Butyl tape installed under cleat at the valley pan to prevent infiltration and compressed from fasteners evenly spaced at 12” OC

Single Component Urethane (tube applied)

- This type of sealant is used for any area of the roof that requires sealant to be exposed to sunlight.
- Often these sealants are used for application of the metal roofing flashing when they are integrating with another non-metal surface, such as masonry block, stucco walls, etc.

SPECIFYING A METAL ROOF SOLUTION

- **Material Quality & Source**
- **Testing** (manufacturer can provide actual test data)
  - Wind uplift ASTM E1592 test to ultimate failure
  - Air and water infiltration ASTM E1680 and E1646
  - Testing is best run or at least witnessed by an ANSI accredited third party. ASTM is a standard that explains how to run a test; it doesn't define the competency needed to perform the test.
- **Manufacturer Qualifications:**
  - How metal panel is manufactured
  - Level of manufacturer experience
- **Attachment of the roof to the substrate**
- **Installer Qualification** (level of experience, manufacturer-approved)
- **Finish warranty and weather-tight warranty**
- **Verify Submittals:** Material gauge, Testing (check for UL certification), and require stamped attachment calculation and check manufacturer's references

ENERGY EFFICIENT FEATURES OF METAL ROOFING

Metal Roofing:

- Contains recycled content
- Is sustainable
- Lasts much longer than most roofing materials
- Is 100% recyclable at the end of its useful life

Various software programs available to calculate a product's environmental and social impact for Designer/Architect use.

COOL METAL ROOFING

- Some coatings/finishes qualify metal as a recognized cool roof product.
- A cool metal roof has infrared reflective pigments in the paint for higher reflectivity values, even in darker colors.
- Cool metal roofing has high solar reflectance values and high emissivity values exceeding 80%.
- A cool metal roof will reflect the solar heat back into the atmosphere, lowering both the inside temperature of the building and the surrounding environment, thereby reducing the heat island effect.
- Additionally, the life expectancy of the roof is increased due to less expansion and contraction.

Dark Color - Cool Roof
Heat is reflected into the atmosphere rather than absorbed into the building

COOL METAL ROOFING

When specifying a cool metal roof solution, look for paints with high Solar Reflectance Values.

PRODUCT DESCRIPTION	CRRC and CA Title 24						LEED									OTHER
	via CRRC product approvals (www.coolroofs.org)					CA Title 24	via Accredited Independent Testing Laboratory (using ASTM C1549, C1371, & E1980)									
	CRRC Reference Number	Solar Reflect - ance (Init.)	Thermal Emitt - ance (Init.)	SRI Initial	SRI 3YR Aged		Solar Reflect - ance (Init.)	Thermal Emitt - ance (Init.)	SRI (Init.)	Low Slope	Steep Slope	3YR Aged SRI	Low Slope	Steep Slope		LRV
	Based on CRRC Color Families						Actual tested performance			Leed V4 (Initial SRI)		LEED v4 (Aged SRI) Based on CRRC Color Families				
COLONIAL RED	0818-0016	0.25	0.83	22	22		0.34	0.85	35			22				9
DARK BRONZE	0818-0018	0.25	0.83	22	22		0.32	0.84	32			22				8
FOREST GREEN	0818-0012	0.25	0.83	22	22		0.30	0.84	29			22				9
LEAF GREEN	0818-0015	0.25	0.83	22	22		0.30	0.85	30			22				11
MATTE BLACK	0818-0046	0.25	0.83	22	22		0.30	0.84	29			22				5
METALLIC CHAMPAGNE	0818-0038	0.35	0.75	32	32		0.48	0.84	54		✓	32		✓		33
METALLIC COPPER	0818-0006	0.35	0.75	32	32		0.48	0.83	53		✓	32		✓		29
METALLIC SILVER	0818-0003	0.35	0.75	32	32		0.57	0.82	65		✓	32		✓		50
MIDNIGHT BRONZE	0818-0055	0.25	0.83	22	22		0.28	0.84	27			22				7
OLD TOWN GRAY	0818-0009	0.35	0.83	35	35		0.40	0.85	43		✓	35		✓		27
PARCHMENT	0818-0047	0.45	0.83	49	49		0.51	0.84	58		✓	49		✓		40
PEBBLE	0818-0059	0.32	0.83	31	31		0.43	0.85	48		✓	31				27
REGAL BLUE	0818-0008	0.25	0.83	22	22		0.30	0.84	29			22				10
REGAL WHITE	0818-0049	0.70	0.83	84	79		0.73	0.84	88	✓	✓	79	✓	✓		75
SAGE GREEN	0818-0056	0.35	0.83	35	35		0.38	0.84	41		✓	35		✓		21

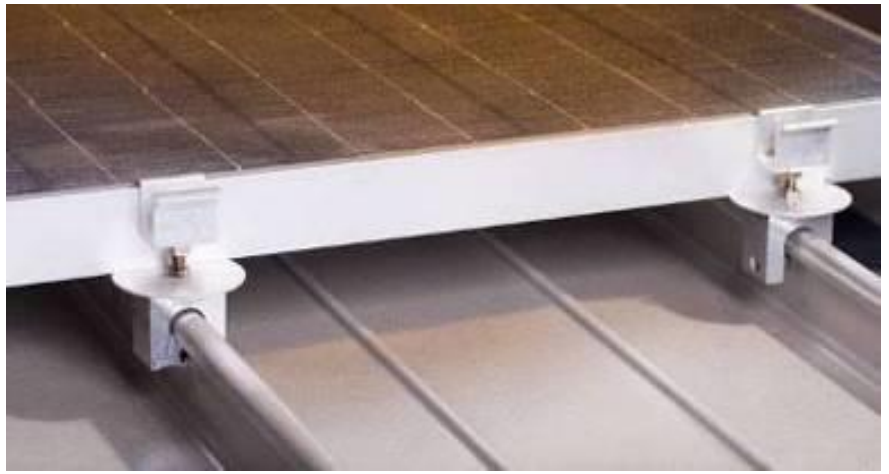
N (CEC) REQUIREMENTS

CRRC COOL ROOF RATING COUNCIL MEMBER

NS BLUESCOPE Coated Products North America

MODULAR SOLAR PANELS

- A metal roof solution can incorporate photo voltaic panels to improve the energy efficiency of a building.
- It is recommended to use a system that clamps to the panel, usually with a set screw.
- Clamp attachment is the ideal choice as it eliminates the need for multiple penetrations.



Set Screw

MODULAR SOLAR PANELS

There are multiple manufacturers of roof clamps that are suitable for PV applications. Some utilized an integral clamp, as shown on the previous slide. Other options include framing grids attached directly to the clamps.

MODULAR SOLAR PANELS

- Exposed copper should be minimized or eliminated due to concerns with dissimilar metals and electrolysis. This can impact any material warranties on the panel.

- Warranty: Clamp on systems will not void a warranty, but it should be noted that seam damage from a clamp on system is not covered by most manufacturers. Specific torque setting from the clamp manufacturer should be followed.

MODULAR SOLAR PANELS

SECTION 2

QUESTIONS?

DESIGN AND INSTALLATION CONSIDERATIONS

The design and installation considerations related to metal roof assemblies include:

- Wind uplift
- Air & water infiltration rates
- Expansion & contraction
- Drag load
- Installation details

WIND UPLIFT

- Wind is one of the essential factors in roof design.
- The non-continuous attachment of metal roofs makes them particularly susceptible to wind uplift.
- Poor design, faulty construction, or the selection of non-compatible materials, can result in severe wind damage to the roof.

WIND UPLIFT: KEY FACTORS

- **Exposure:** ASCE 7 defines three exposure categories:
    1. Exposure B (roughest)
    2. C
    3. D (smoothest)

- **Basic wind speed:** greater speed = greater wind uplift

- **Building height:** the taller the building, the greater the wind speed and wind loads

- **Roof slope:** the lower the slope, the greater the uplift

- **Internal pressure:** ASCE 7 supplies positive and negative internal pressure coefficients for use in load calculations

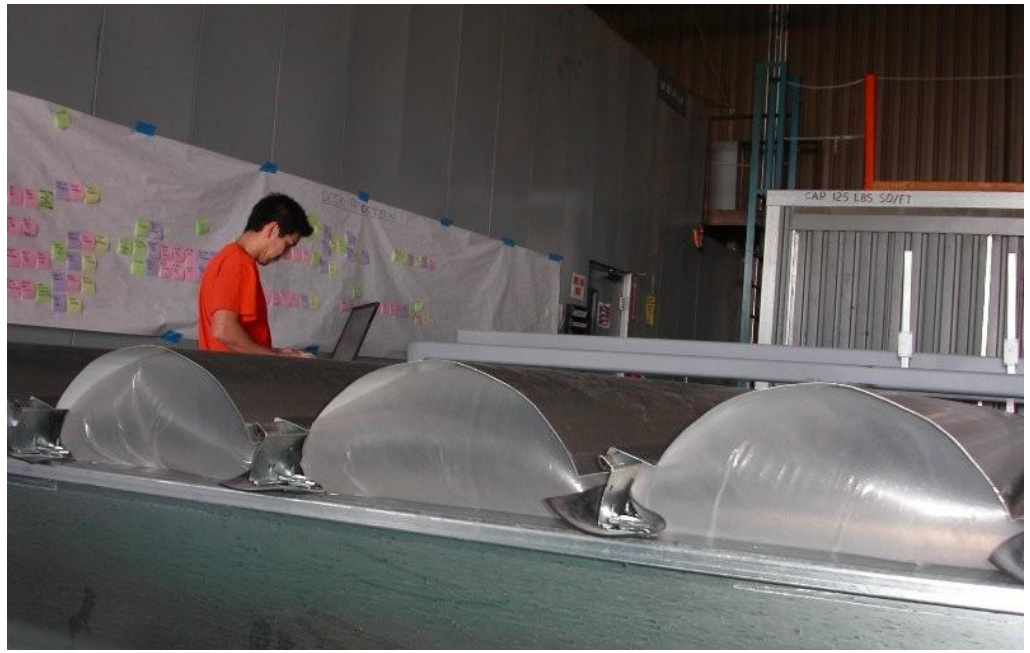
(Source: www.wbdg.org/resources/env_wind.php)

WIND UPLIFT

- Structural standing seam panels are tested under ASTM E1595 Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.

- All standing seam metal roof panels should be tested under the UL 580 uplift test, as well, many manufacturers test under ASTM and Factory Mutual.

- Metal roofing systems can be designed by a professional engineer to meet local code-specific wind uplift requirements.



Uplift Panel Testing

AIR & WATER INFILTRATION RATES

- Standing seam panels can provide adequate air and water infiltration control and are often tested through ASTM E1680 (air) and E1646 (water).

- With proper sealant placement, exposed fastener panels can also provide adequate air and water infiltration control.

- Structural standing seam roof panels that require mechanical seaming in the field and also require panel-to-panel end laps due to long lengths will often be tested under ASTM E2140.

EVALUATION REPORTS

Several key certification bodies issue Product Approval Reports including:

- IAPMO-UES ‘Evaluation Reports’
- ICC-ES ‘Evaluation Service Reports’
- Intertek ‘Research Reports’
- UL ‘Evaluation Reports’

The process for an Evaluation Report:

Certification Body develops Evaluation Criteria

⬇

Product Manufacturer seeking Approval Report, submits all independent test data, performance calculations, etc. as required by Evaluation Criteria

⬇

Certification Body evaluates manufacturer’s performance data against requirements stated within Evaluation Criteria

⬇

If approved, Certification Body publishes product approval report

EVALUATION REPORTS

EVALUATION REPORT

Number: 309

Originally Issued: 09/09/2014 Revised: 02/04/2025 Valid Through: 09/30/2026

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SINGLE SKIN STEEL ROOF AND WALL PANELS WITH CONCEALED FASTENERS

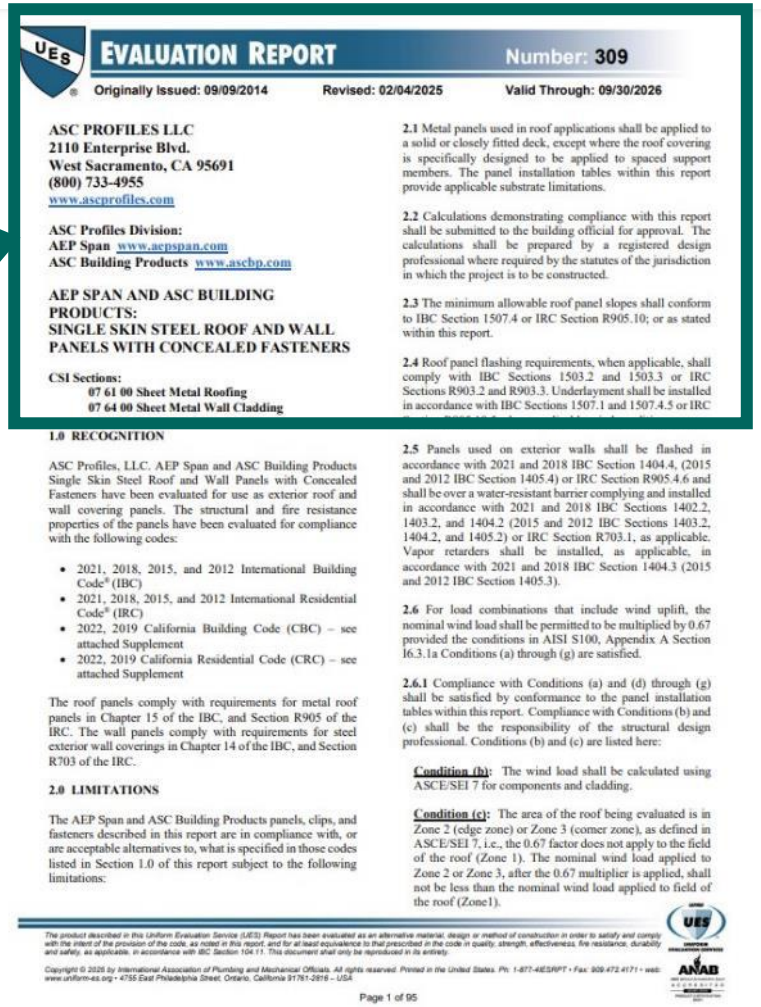
CSI Sections:
07 61 00 Sheet Metal Roofing
07 64 00 Sheet Metal Wall Cladding

2.1 Metal panels used in roof applications shall be applied to a solid or closely fitted deck, except where the roof covering is specifically designed to be applied to spaced support members. The panel installation tables within this report provide applicable substrate limitations.

2.2 Calculations demonstrating compliance with this report shall be submitted to the building official for approval. The calculations shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

2.3 The minimum allowable roof panel slopes shall conform to IBC Section 1507.4 or IRC Section R905.10; or as stated within this report.

2.4 Roof panel flashing requirements, when applicable, shall comply with IBC Sections 1503.2 and 1503.3 or IRC Sections R903.2 and R903.3. Underlayment shall be installed in accordance with IBC Sections 1507.1 and 1507.4.5 or IRC Section R905.10.5 where applicable wind conditions occur.



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SINGLE SKIN STEEL ROOF AND WALL PANELS WITH CONCEALED FASTENERS

CSI Sections:
07 61 00 Sheet Metal Roofing
07 64 00 Sheet Metal Wall Cladding

1.0 RECOGNITION

ASC Profiles, LLC. AEP Span and ASC Building Products Single Skin Steel Roof and Wall Panels with Concealed Fasteners have been evaluated for use as exterior roof and wall covering panels. The structural and fire resistance properties of the panels have been evaluated for compliance with the following codes:

- 2021, 2018, 2015, and 2012 International Building Code® (IBC)
- 2021, 2018, 2015, and 2012 International Residential Code® (IRC)
- 2022, 2019 California Building Code (CBC) – see attached Supplement
- 2022, 2019 California Residential Code (CRC) – see attached Supplement

The roof panels comply with requirements for metal roof panels in Chapter 15 of the IBC, and Section R905 of the IRC. The wall panels comply with requirements for steel exterior wall coverings in Chapter 14 of the IBC, and Section R703 of the IRC.

2.0 LIMITATIONS

The AEP Span and ASC Building Products panels, clips, and fasteners described in this report are in compliance with, or are acceptable alternatives to, what is specified in those codes listed in Section 1.0 of this report subject to the following limitations:

2.1 Metal panels used in roof applications shall be applied to a solid or closely fitted deck, except where the roof covering is specifically designed to be applied to spaced support members. The panel installation tables within this report provide applicable substrate limitations.

2.2 Calculations demonstrating compliance with this report shall be submitted to the building official for approval. The calculations shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

2.3 The minimum allowable roof panel slopes shall conform to IBC Section 1507.4 or IRC Section R905.10; or as stated within this report.

2.4 Roof panel flashing requirements, when applicable, shall comply with IBC Sections 1503.2 and 1503.3 or IRC Sections R903.2 and R903.3. Underlayment shall be installed in accordance with IBC Sections 1507.1 and 1507.4.5 or IRC

2.5 Panels used on exterior walls shall be flashed in accordance with 2021 and 2018 IBC Section 1404.4, (2015 and 2012 IBC Section 1405.4) or IRC Section R905.4.6 and shall be over a water-resistant barrier complying and installed in accordance with 2021 and 2018 IBC Sections 1402.2, 1403.2, and 1404.2 (2015 and 2012 IBC Sections 1403.2, 1404.2, and 1405.2) or IRC Section R703.1, as applicable. Vapor retarders shall be installed, as applicable, in accordance with 2021 and 2018 IBC Section 1404.3 (2015 and 2012 IBC Section 1405.3).

2.6 For load combinations that include wind uplift, the nominal wind load shall be permitted to be multiplied by 0.67 provided the conditions in AISI S100, Appendix A Section l6.3.1a Conditions (a) through (g) are satisfied.

2.6.1 Compliance with Conditions (a) and (d) through (g) shall be satisfied by conformance to the panel installation tables within this report. Compliance with Conditions (b) and (c) shall be the responsibility of the structural design professional. Conditions (b) and (c) are listed here:

Condition (b): The wind load shall be calculated using ASCE/SEI 7 for components and cladding.

Condition (c): The area of the roof being evaluated is in Zone 2 (edge zone) or Zone 3 (corner zone), as defined in ASCE/SEI 7, i.e., the 0.67 factor does not apply to the field of the roof (Zone 1). The nominal wind load applied to Zone 2 or Zone 3, after the 0.67 multiplier is applied, shall not be less than the nominal wind load applied to field of the roof (Zone1).

EVALUATION REPORTS

EVALUATION REPORT Number: 309

Originally Issued: 09/09/2014 Revised: 02/04/2025 Valid Through: 09/30/2026

TABLE 1.5 - Inward (positive) uniform load capacities (12" Span-lok hp / SpanSeam panel):

12in Span Lok hp & SpanSeam									
Gauge	Span	Condition	Positive (Inward) Uniform Load Capacity (lbs/ft²) / Span (ft. - in.)						
			2' - 0"	2' - 6"	3' - 0"	3' - 6"	4' - 0"	4' - 6"	5' - 0"
24	Single Span	ASD, W/Ω	354	283	236	202	177	143	116
		LRFD, ϕW	567	454	378	324	283	227	184
		L/180	*2502*	*1281*	*741*	*467*	*313*	*220*	*160*
		L/60	*>5k*	*3843*	*2224*	*1401*	*938*	*659*	*480*
	Double Span	ASD, W/Ω	212	169	141	121	103	83	68
		LRFD, ϕW	339	271	226	194	156	125	102
		L/180	*>5k*	*3086*	*1786*	*1125*	*753*	*529*	*386*
		L/60	*>5k*	*>5k*	*>5k*	*3374*	*2260*	*1587*	*1157*
	Triple Span	ASD, W/Ω	241	193	160	138	120	102	83
		LRFD, ϕW	385	308	257	220	192	154	126
		L/180	*4722*	*2417*	*1399*	*881*	*590*	*415*	*302*
		L/60	*>5k*	*>5k*	*4197*	*2643*	*1771*	*1244*	*907*
22	Single Span	ASD, W/Ω	534	427	356	305	242	191	155
		LRFD, ϕW	855	684	570	489	383	303	245
		L/180	*3233*	*1655*	*958*	*603*	*404*	*284*	*207*
		L/60	*>5k*	*4965*	*2873*	*1810*	*1212*	*851*	*621*
	Double Span	ASD, W/Ω	258	206	172	147	129	115	95
		LRFD, ϕW	412	330	275	236	206	177	144
		L/180	*>5k*	*3987*	*2307*	*1453*	*973*	*684*	*498*
		L/60	*>5k*	*>5k*	*>5k*	*4359*	*2920*	*2051*	*1495*
	Triple Span	ASD, W/Ω	293	234	195	167	147	130	117
		LRFD, ϕW	469	375	312	268	234	208	179
		L/180	*>5k*	*3123*	*1807*	*1138*	*763*	*536*	*390*
		L/60	*>5k*	*>5k*	*>5k*	*3415*	*2288*	*1607*	*1171*

Inward (gravity) load capacities based on panel gauge and span

Outward (uplift) panel capacities based on gauge, substrate, fastener, and fastener spacing

EVALUATION REPORT Number: 309

Originally Issued: 09/09/2014 Revised: 02/04/2025 Valid Through: 09/30/2026

TABLE 1.6 – Outward (negative) uniform load capacities (12", No. 22 and 24 gauge Span-lok hp / SpanSeam with Standard Clip)

12" Span-lok hp & SpanSeam, 22-24ga, with Std. Clip																						
Substrate		Fastener		Attachment Spacing, (ft-in)																		
		# per clip	Size	1' - 0"		1' - 6"		2' - 0"		2' - 6"		3' - 0"		3' - 6"		4' - 0"		4' - 6"		5' - 0"	
				Maximum **Panel / Clip** Negative (Outward) Uniform Load Capacity, (lbs/ft²)																		
				217	345	200	318	183	291	166	263	149	236	132	209	115	182	98	155	81	128
				Panel System Negative (Outward) Uniform Load Capacity, (lbs/ft²)																		
				ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW	ASD W/Ω	LRFD ϕW
Cold Formed Steel (Gr 50 min.)	≥12ga (.1050")	2	#10	217	345	200	318	183	276	147	220	122	184	105	157	92	138	82	122	73	110
		2	#12	217	345	200	318	183	291	166	251	139	209	119	179	104	157	93	139	81	125
		2	1/4"	217	345	200	318	183	291	166	263	149	236	132	207	115	181	98	155	81	128
	14ga (.0700")	2	#10	217	345	163	245	122	184	98	147	82	122	70	105	61	92	54	82	49	73
		2	#12	217	345	186	278	139	209	111	167	93	139	80	119	70	104	62	93	56	84
		2	1/4"	217	345	200	318	161	242	129	193	107	161	92	138	81	121	72	107	64	97
	16ga (.0590")	2	#10	206	310	138	206	103	155	83	124	69	103	59	88	52	77	46	69	41	62
		2	#12	217	345	156	235	117	176	94	141	78	117	67	101	59	88	52	78	47	70
		2	1/4"	217	345	181	272	136	204	109	163	91	136	78	116	68	102	60	91	54	81
	18ga (.0459")	2	#10	161	241	107	161	80	120	64	96	54	80	46	69	40	60	36	54	32	48
		2	#12	183	274	122	183	91	137	73	110	61	91	52	78	46	68	41	61	37	55
		2	1/4"	211	317	141	211	106	158	85	127	70	106	60	91	53	79	47	70	42	63
	20ga (.0354")	2	#10	124	186	83	124	62	93	50	74	41	62	35	53	31	46	28	41	25	37
		2	#12	141	211	94	141	70	106	56	84	47	70	40	60	35	53	31	47	28	42
		2	1/4"	163	244	109	163	81	122	65	98	54	81	47	70	41	61	36	54	33	49
Cold Formed Steel (Gr 33	≥12ga (.1050")	2	#10	217	345	170	254	127	191	102	153	85	127	73	109	64	95	57	85	51	76
		2	#12	217	345	193	289	145	217	116	174	96	145	83	124	72	108	64	96	58	87
		2	1/4"	217	345	200	318	167	251	134	201	112	167	96	143	84	126	74	112	67	100
	16ga (.0590")	2	#10	143	214	95	143	71	107	57	86	48	71	41	61	36	54	32	48	29	43
		2	#12	162	244	108	162	81	122	65	97	54	81	46	70	41	61	36	54	32	49
		2	1/4"	188	282	125	188	94	141	75	113	63	94	54	81	47	71	42	63	38	56
	18ga (.0459")	2	#10	111	167	74	111	56	83	44	67	37	56	32	48	28	42	25	37	22	33
		2	#12	126	190	84	126	63	95	51	76	42	63	36	54	32	47	28	42	25	38
		2	1/4"	146	219	98	146	73	110	59	88	49	73	42	63	37	55	33	49	29	44

EXPANSION & CONTRACTION

- Most metal roof forms owe their design, in large part, to the necessity of providing for expansion and contraction.
- The rate of expansion and contraction differs with each metal.

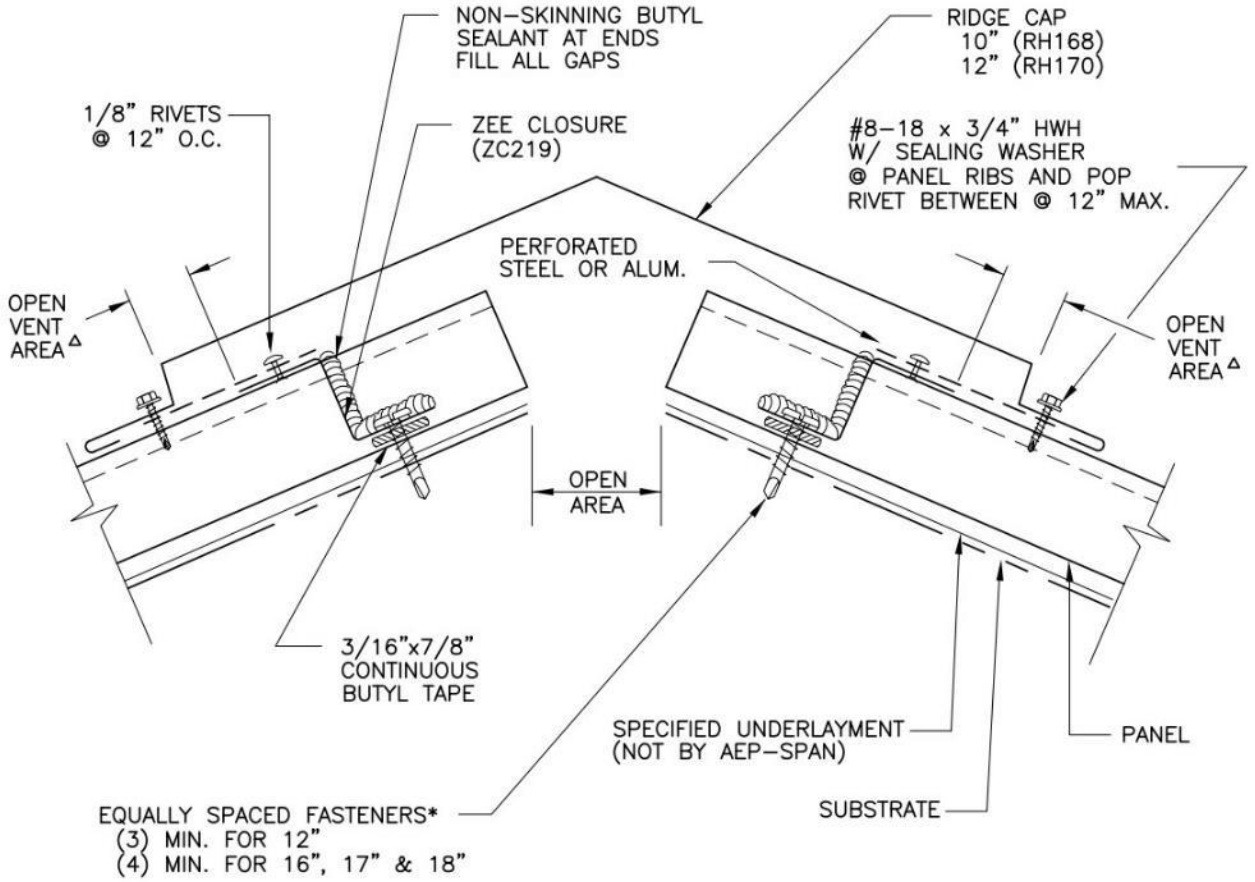
Table 2. Expansion and contraction

Metal	Coefficient of thermal expansion (inches per) inch per degree F°	Linear movement per 150° F, change per 8 feet	
		Decimal (in.)	Fraction (in— approx)
Steel Med	0.0000067	0.0965	6/64
Iron-wrt	0.0000067	0.0965	6/64
Nickel Copper Alloy (Monel)	0.0000077	0.1109	7/64
Stainless Steel (300-series)	0.0000098	0.1411	9/64
Copper	0.0000098	0.1411	9/64
Aluminum	0.0000128	0.1843	12/64
Lead	0.0000162	0.2338	15/64
Zinc	0.0000173	0.2491	16/64

The movement of metal can be calculated using this table. Note the distance that an 8-foot sheet will expand or contract with a 150-degree variation in temperature.

DESIGNING TO ACCOMMODATE MOVEMENT

There are three ways to accommodate thermal movement: at the low end of the panel, at the high end, or both. Typically, panels are pinned at the high end or upslope of the panel.

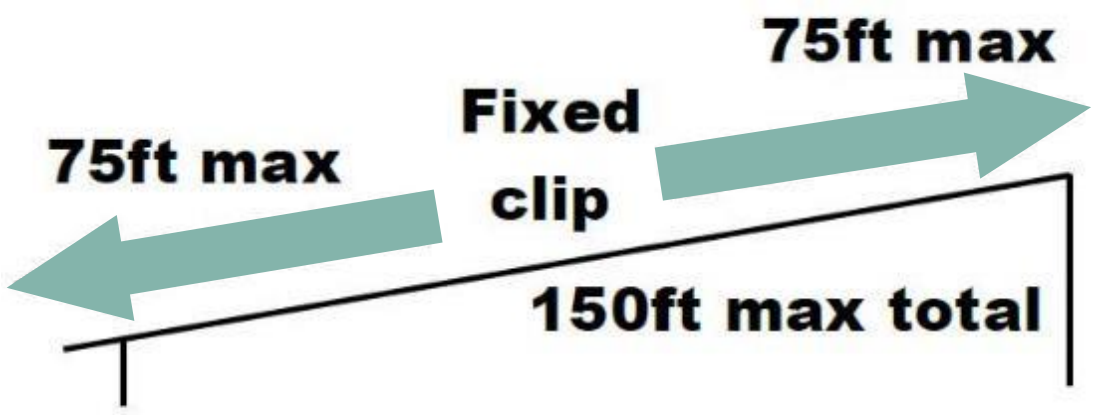


DESIGNING TO ACCOMMODATE MOVEMENT

- To accommodate movement at the high end of the panel, the low end is pinned to the structure, and the high end “floats” to accommodate the thermal movement.
- To allow expansion and contraction at both the high and low ends of the panels, pinning is required somewhere in the middle of the panel, usually at a lap.
- It is important that the panels are not pinned in more than one location as this would not allow the panel to expand and contract in a controlled manner.

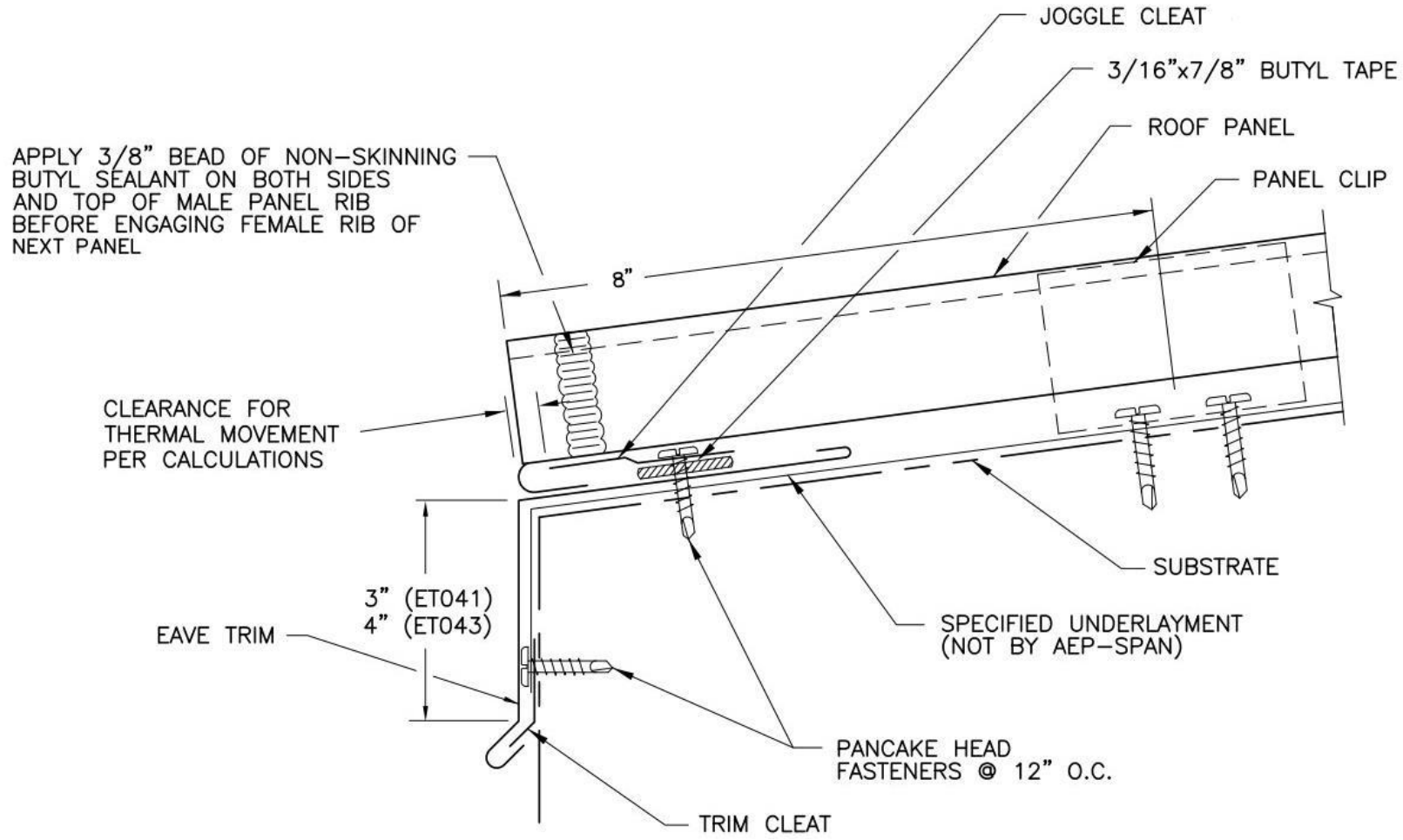
Typical installation, panel pinned at ridge
(using fasteners under ridge cap)

Long-length installation with
fixed clip at panel’s midpoint



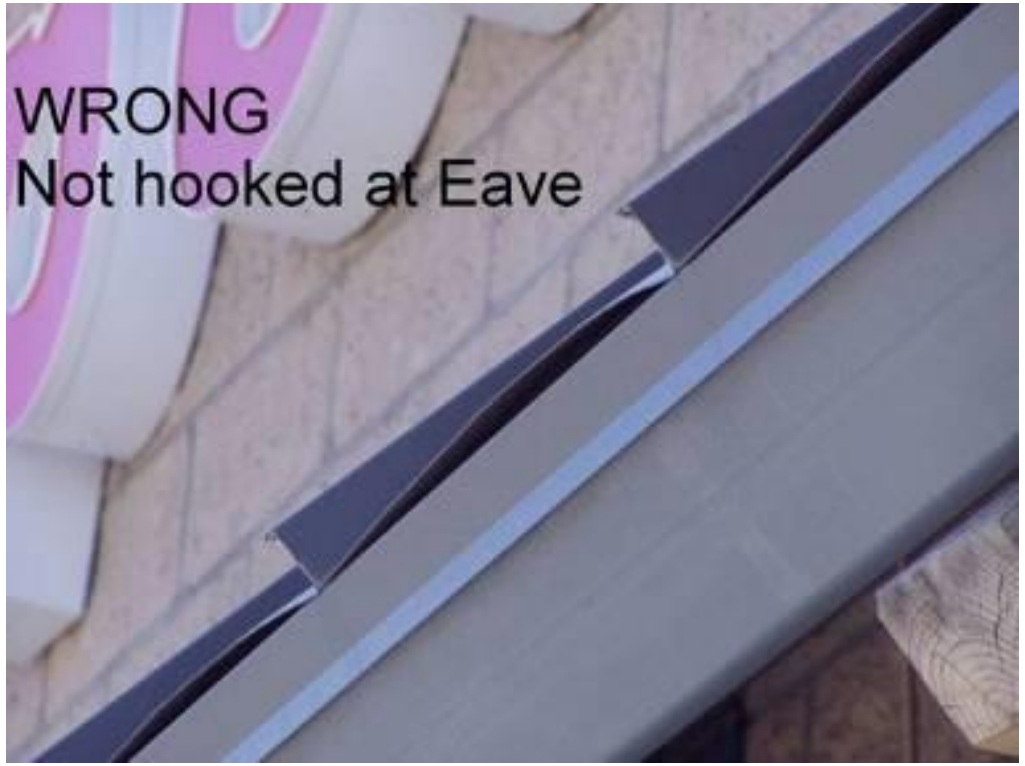
DESIGNING TO ACCOMMODATE MOVEMENT

If panels are fixed at the high end or ridge condition, free movement is required at the panels low end or eave line.



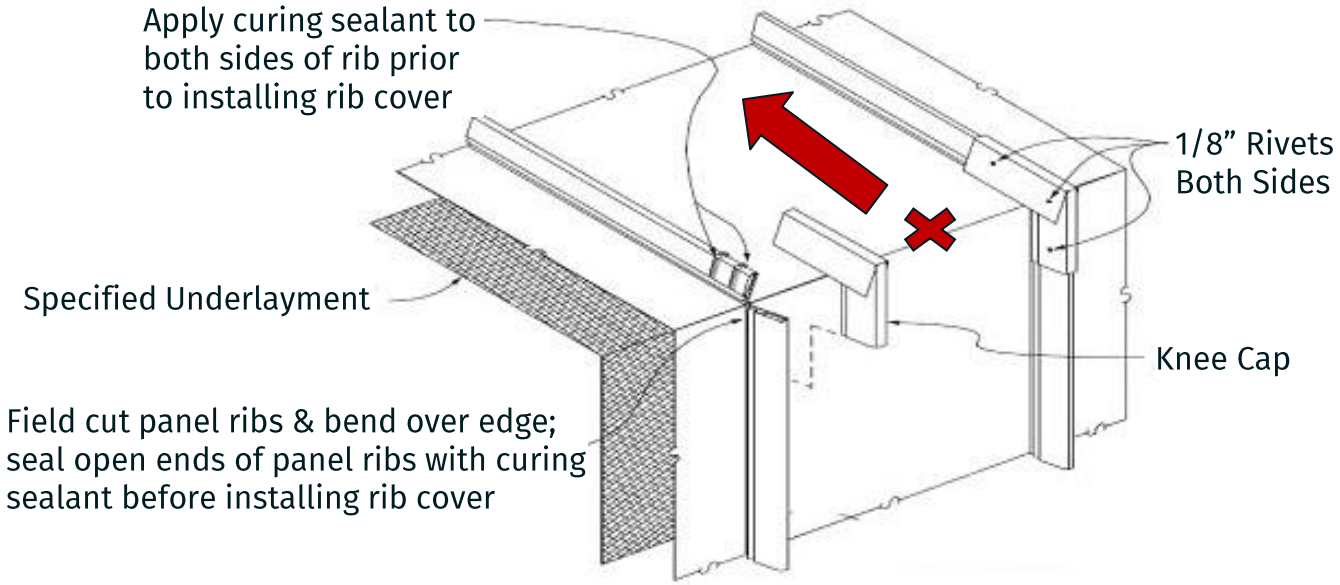
DESIGNING TO ACCOMMODATE MOVEMENT

Correct eave detail is critical for the long-term success of the roof installation.



DESIGNING TO ACCOMMODATE MOVEMENT

A knee joint is used to cover the cut vertical panel rib of a standing seam roofing panel that transitions onto the fascia in one continuous piece.



Design Caution:

- Snow and ice will tear a knee cover off, so they should not be used in snow areas.
- Turning panels down for fascia may establish an unwanted point of panel fixity.

DESIGNING TO ACCOMMODATE MOVEMENT

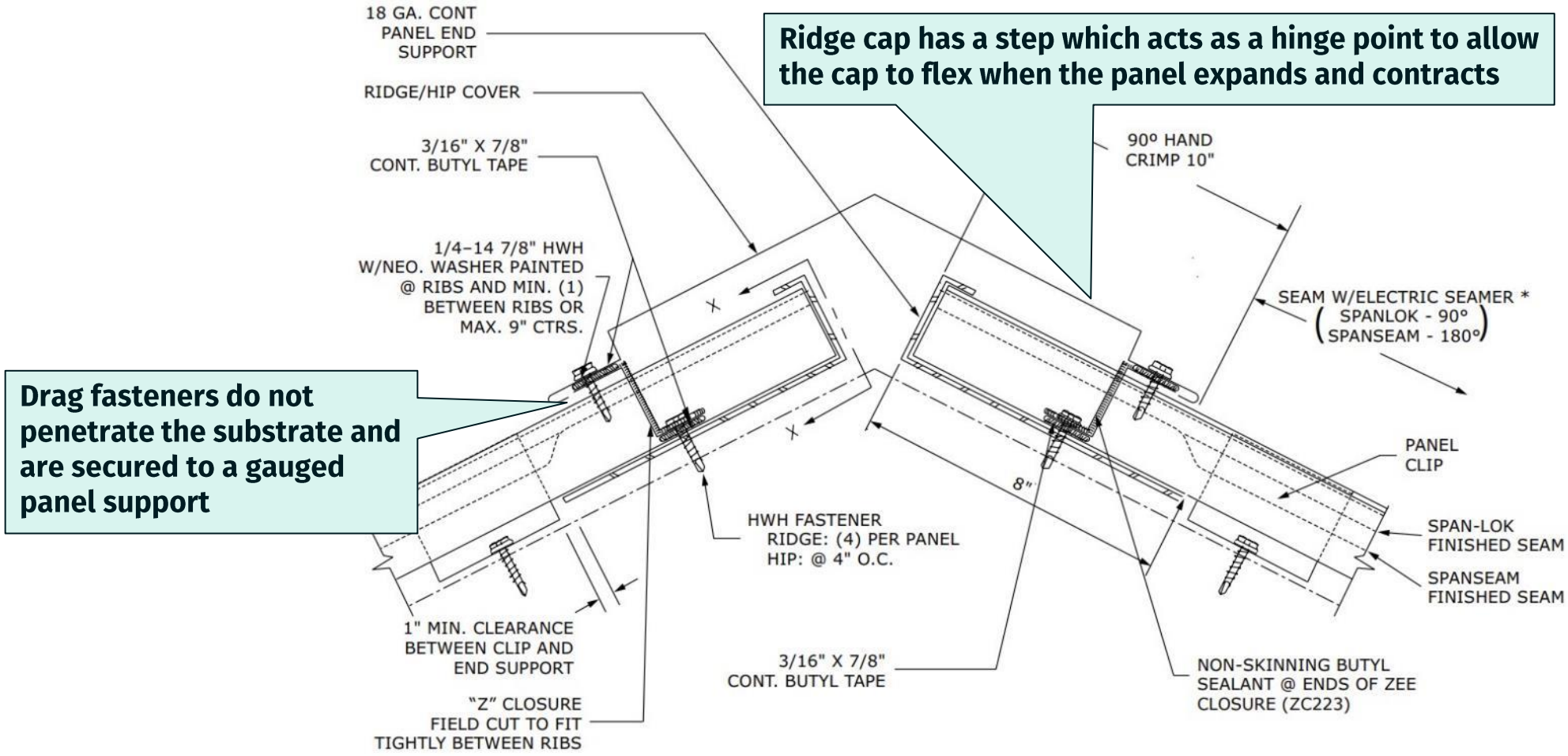
- Care must be taken when utilizing knee joints in roof to fascia transitions, as this detail may establish an unwanted point of panel fixity.

- This detail should not be utilized in climates where snow accumulation may occur.

Image of a failed knee joint in Snow Country

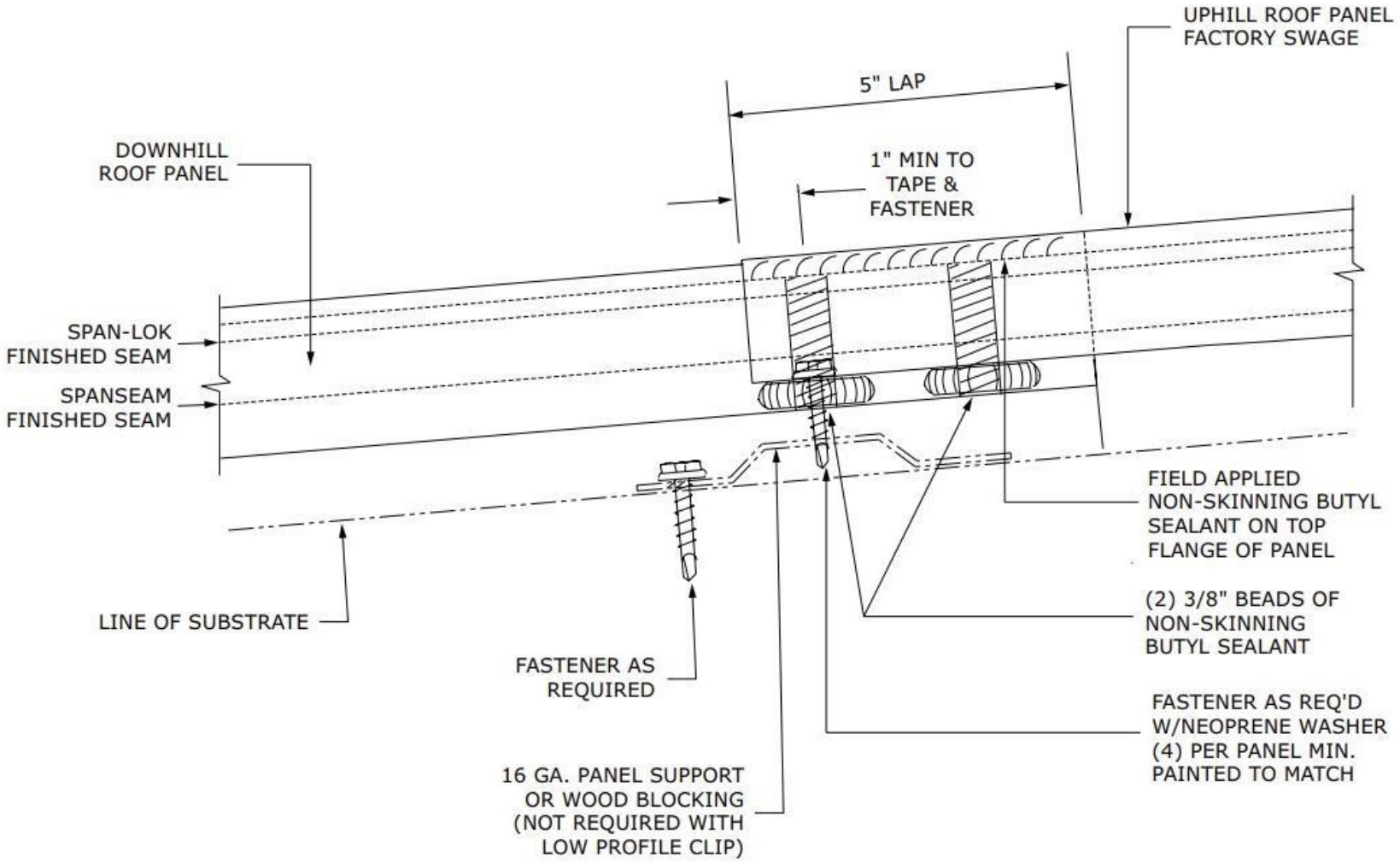
DESIGNING TO ACCOMMODATE MOVEMENT

A floating ridge or peak is required if the eave is fixed.



DESIGNING TO ACCOMMODATE MOVEMENT

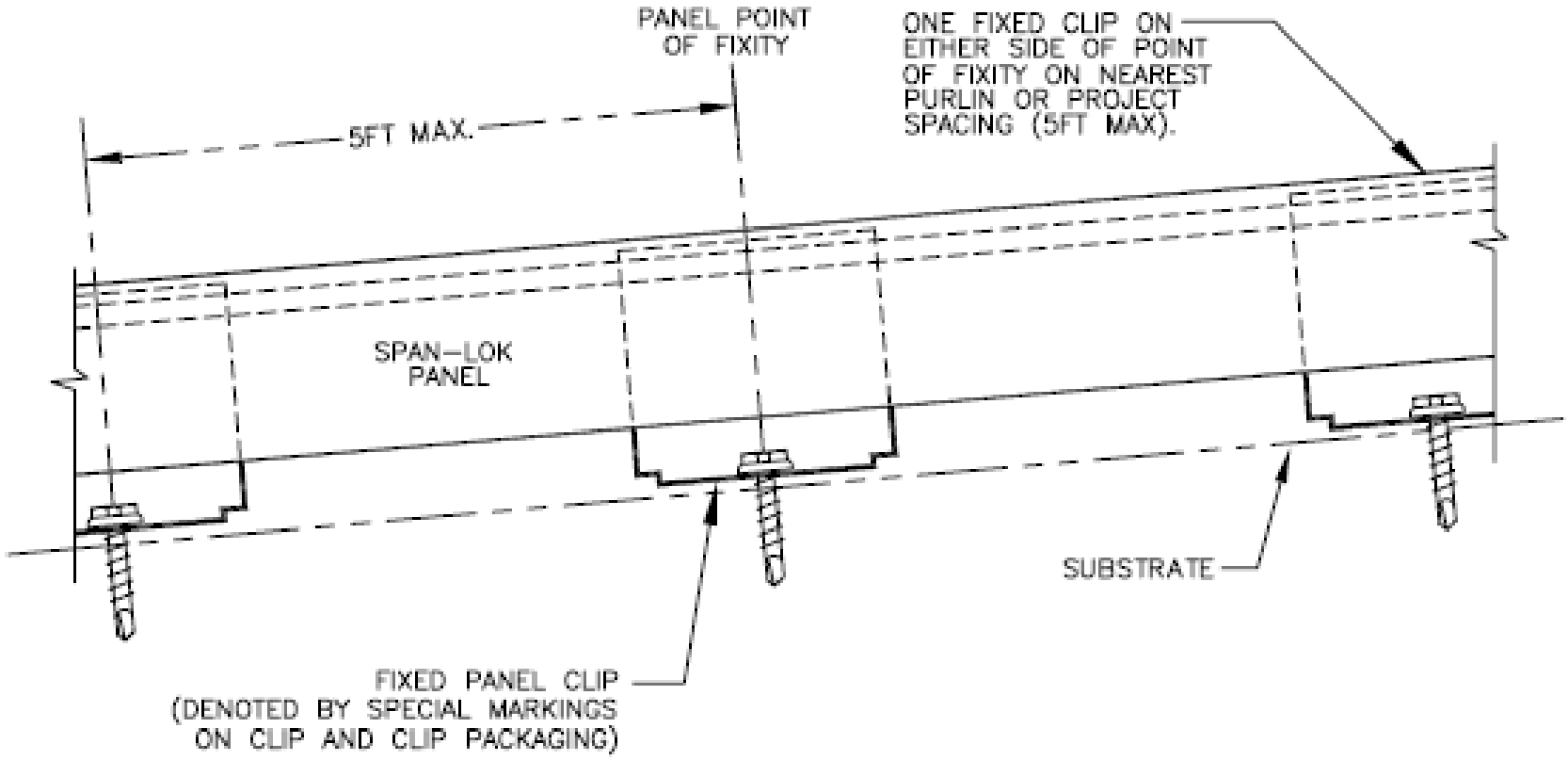
For longer roof runs, a fixed panel lap or fixed mid point may be utilized. Fixing a panel mid span requires both a floating ridge and floating eave.



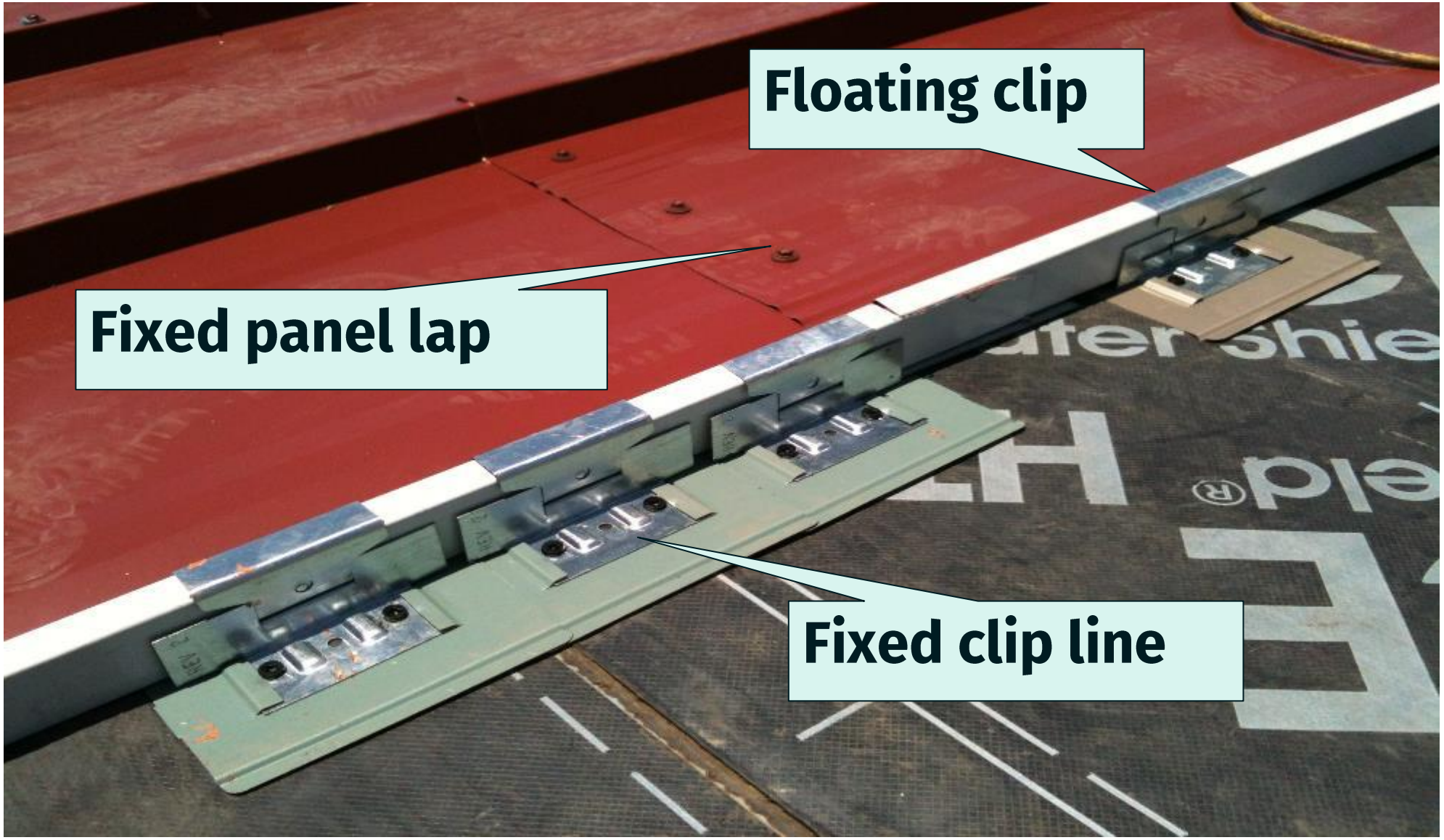
DESIGNING TO ACCOMMODATE MOVEMENT

DESIGNING TO ACCOMMODATE MOVEMENT

Fixed clip detail is utilized for continuous, long-length applications without a lap.

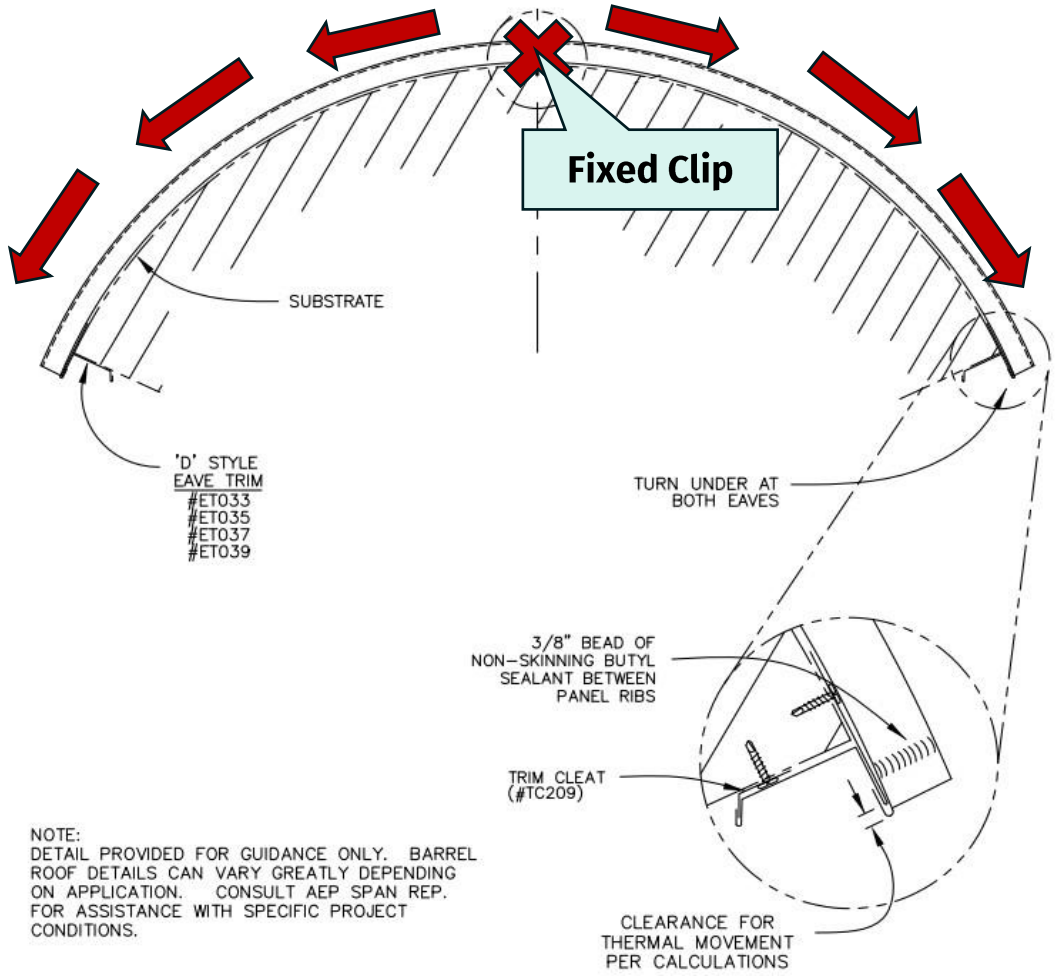


DESIGNING TO ACCOMMODATE MOVEMENT



DESIGNING TO ACCOMMODATE MOVEMENT

Fixed clip details are also utilized for radius applications to fix or pin the apex of a radius and allow expansion and contraction to both eaves.



DESIGNING TO ACCOMMODATE MOVEMENT

DRAG LOAD

The intensity of the drag load is a function of:

- the slope of the roof
- the length of the panels
- the loads involved

Snow and ice impart a live load, consequently, installations in cold and high-altitude climates have important design considerations.

Damaged panels caused by snow drag load.

COLD CLIMATE DESIGN

- Designers may need to address ice dam formation in cold climates.
- Cold roof systems may be the best for preventing ice dam formation. Cold roof designs ventilate the panel from below with an air gap between the panel and substrate.
- Generally, in heavy snowfall areas, you usually want to design as steep a roof pitch as possible and consider a self-adhered underlayment.
- If possible, valleys, gutters, roof elevation changes and penetrations should be minimized/eliminated in snow areas.

Damage caused by snow & ice build up

SNOW RETENTION DEVICES

- Roof ice melt systems can be incorporated to reduce ice dam formation not remedied by design, especially in those areas more susceptible to build up.

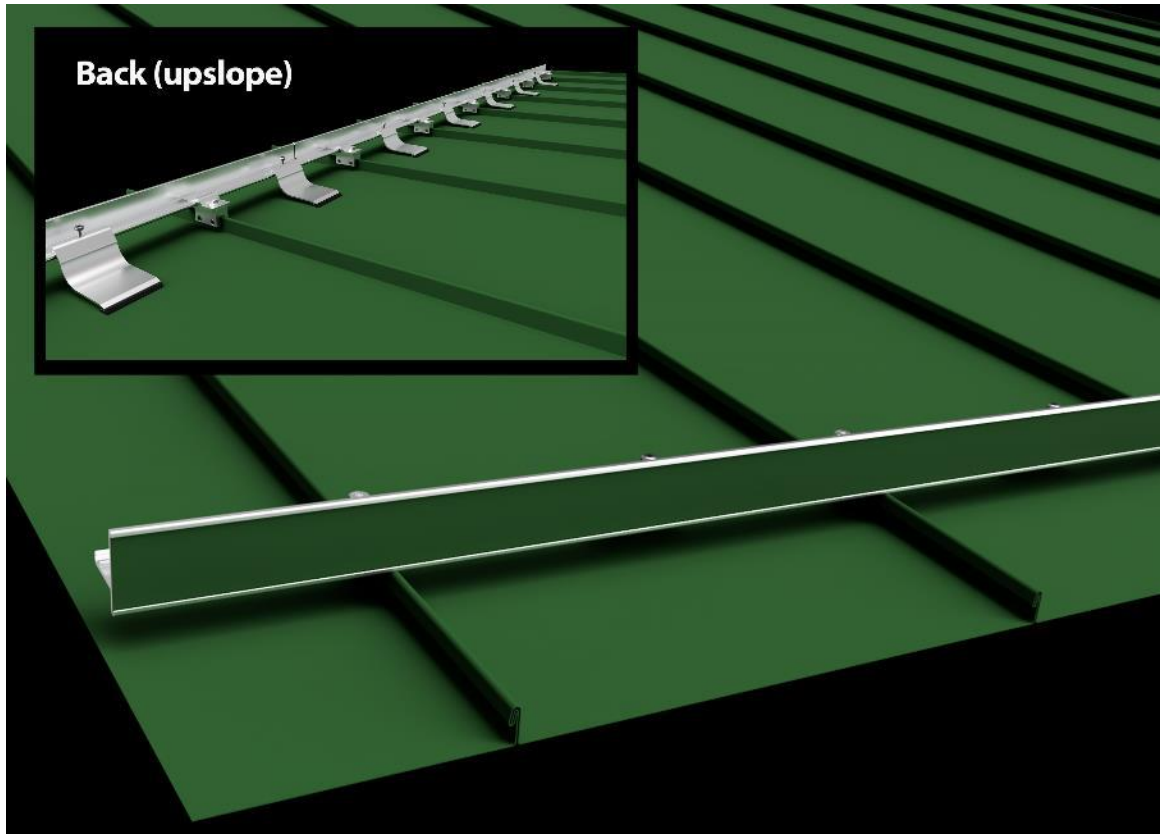
- Metal roof manufacturers recommend roof designs that limit the need for snow retention devices that may place unintended loads on the roof surface or structure.

- When snow retention devices are required, it is important that the snow retention device manufacturer engineer the connection and quantity of retention devices based on the expected site-specific loads.

Roof penetration protector

SNOW RETENTION DEVICES

Snow retention devices should be clamp-on set screw type with no penetrations.



WIDE VALLEY DESIGN

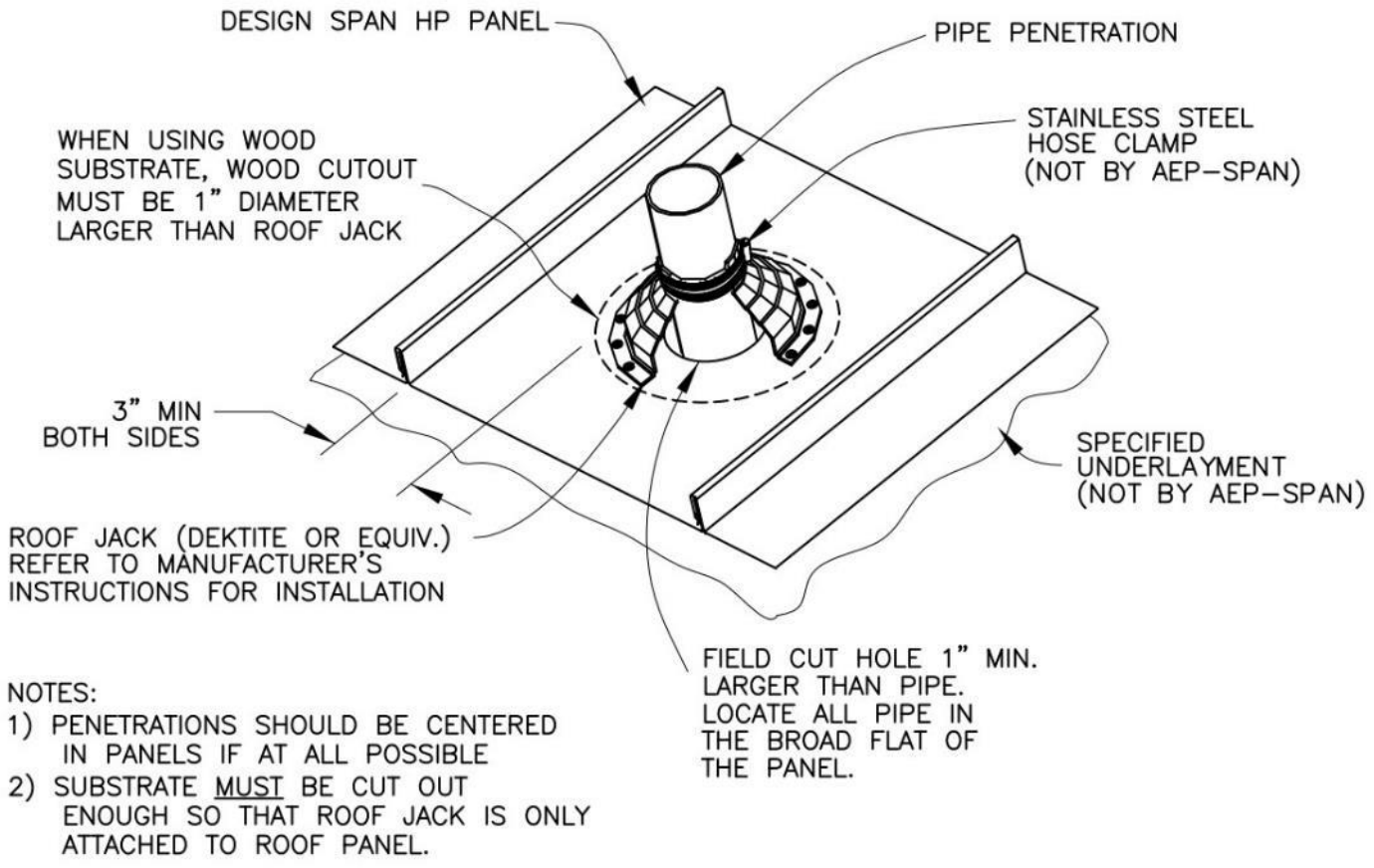
Valleys in snow areas require special consideration due to the accumulation of snow and ice from tributary roof areas.

Ribs crushed due to inadequate valley width

Snow conditions require a special valley design

PIPE BOOT DETAIL

Pipe boot detail, often used at a roof penetration, should ideally be located in the middle of the metal roof pan or centered on the rib.



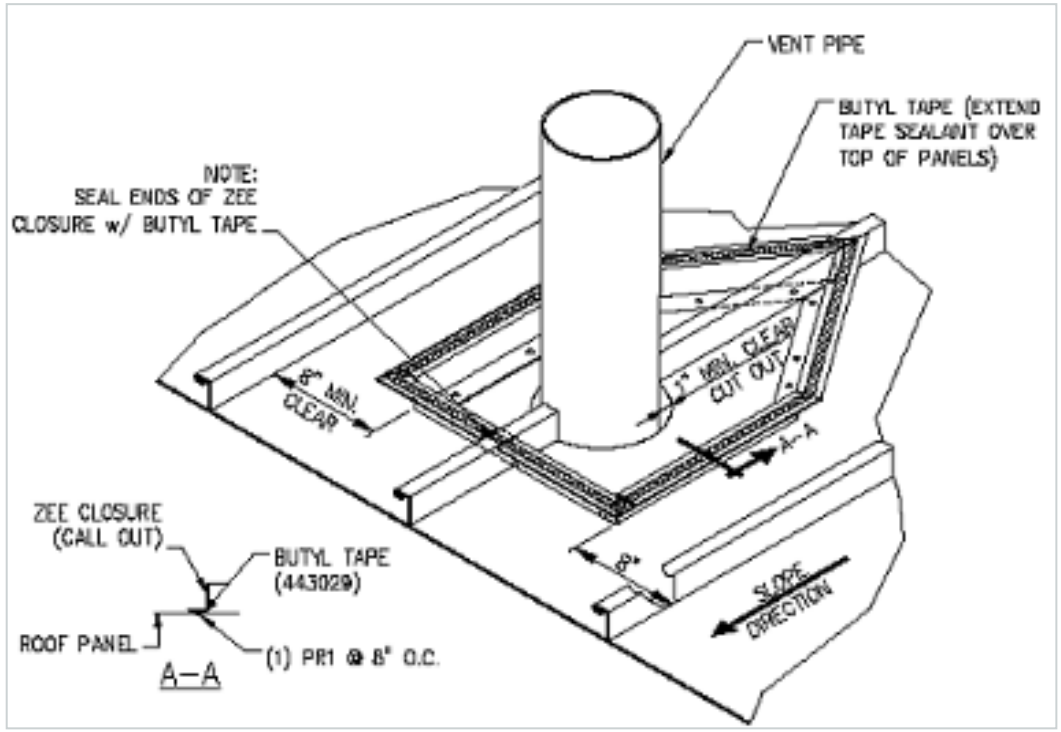
PIPE BOOT DETAIL

- Care should be taken when installing the pipe boot, and the manufacturer's recommendations should always be followed.
- The boot must be attached to the panel only and not fixed to the roof substrate. Fixing the boot to the substrate will also fix the panel and not allow for thermal movement.
- The pipe boot provides both waterproofing for the pipe penetration as well as longitudinal panel movement around the stationary pipe penetration.
- The hole in the panel must be large enough to provide adequate room for both panel movement as well as any anticipated pipe vibration which is common in generator exhaust and plumbing vents.

Drag load on pipe penetration. Pipe needs to be secure from underneath.

CUT RIB DETAIL

Cut rib home plate details should be used on all penetrations that come up through or near a vertical panel rib of a standing seam metal roof.



Cut Rib Home Plate Detail

Flashing and Pipe Boot

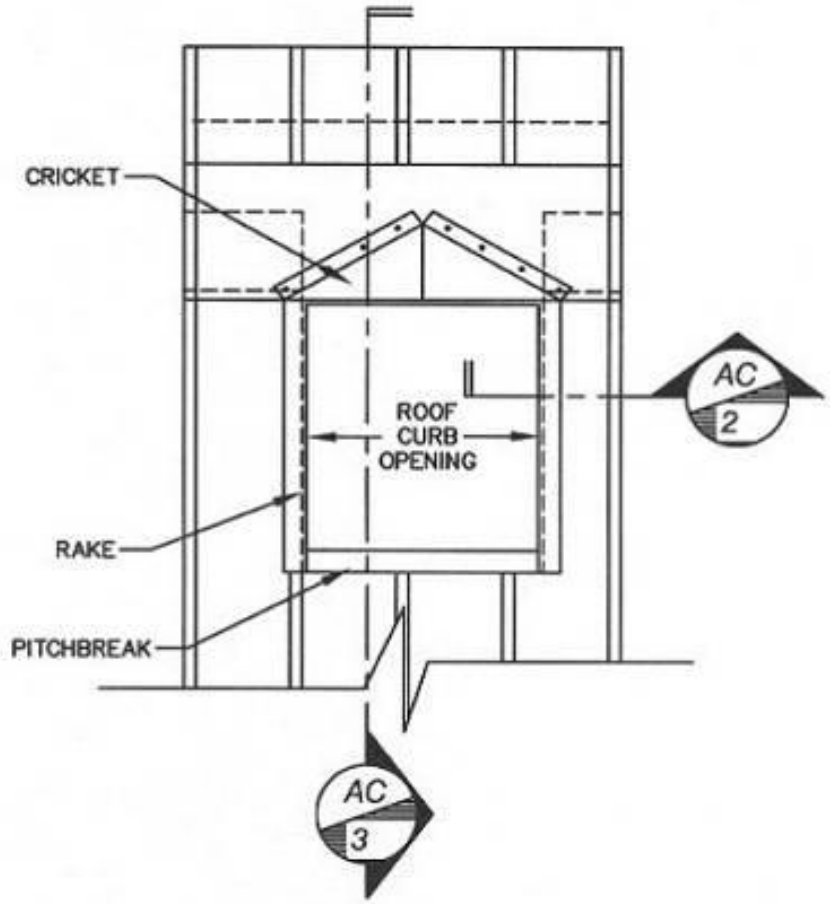
CUT RIB DETAIL

Incorrect: Standing Seam Penetrated

Correct: Cut Rib Detail

ROOF CURBS

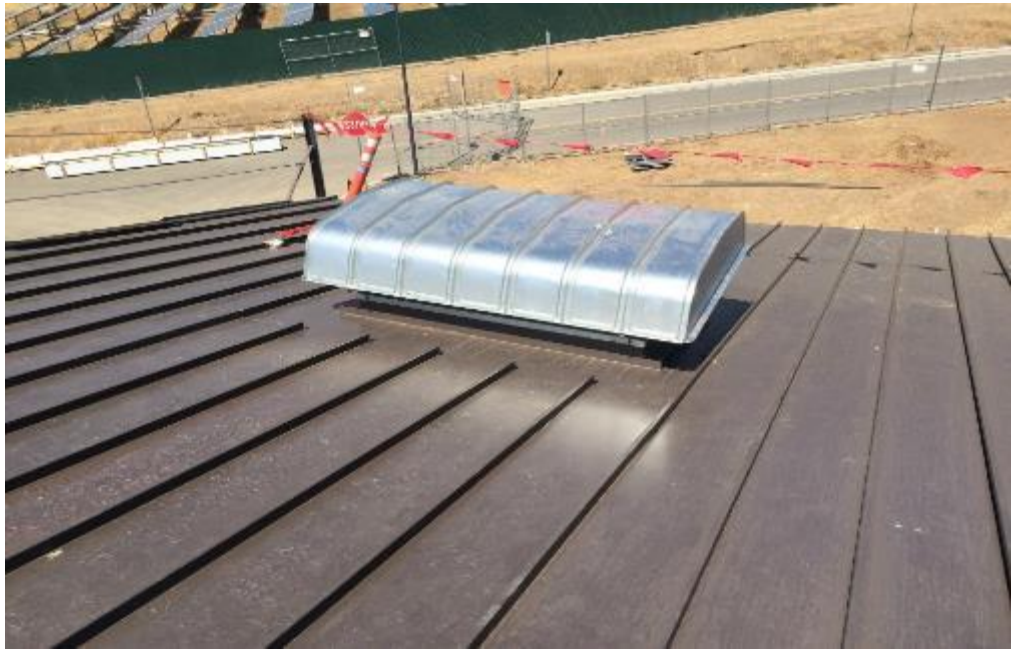
Whenever the penetrations are large or multiple, a curb is the correct solution.



ROOF CURBS

- Curbs are utilized for a varying array of roof top equipment such as skylights, solar tubes, HVAC equipment, and ventilators.

- Curbs allow for large equipment to be installed and still allow the panels to expand and contract around them.



CONCLUSION: FINAL QUESTIONS

Thank you for your time.

This concludes The American Institute of Architects Continuing Education Systems Course

QUESTIONS?

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