



**SMACNA Architectural Sheet
Metal Manual 7th Edition**

Sheet Metal As An Architectural Element

- Long life building material with a long history of use
- Metals can be alloyed and formed to create unique metals and shapes to design unique buildings
- Metal roofs are enjoying a resurgence of interest and use partially driven by code mandated cool roofs and new LEED requirements
- Lowest-cost steep slope roof based on life cycle costing
- Architectural sheet metal is the original green roofing solution
- Many critical metal elements are invisible—Flashing!



Benefits Of Sheet Metal

- Properly designed and professionally constructed and installed by experienced contractors sheet metal elements can last for centuries
- Sheet metal fits all “green” building materials measures, especially recycled content
 - Recycled content: steel = 25%; roofing copper = >75%;
 - Energy efficiency per Florida Solar Research = light-colored metal roofs VERY energy efficient
- Soldered sheet metal joints are “sustainable” and do not require continuous maintenance—unlike ALL sealant protected joints



History of Architectural Metals

- First used by the ship building industry—lead used in the 1500s with rolled copper use starting in late 1600s
- New York City Hall used copper for roofing circa 1764
- A copper roof was used on the rebuilt Old Senate Chamber in 1819; replaced in a 1900 renovation
- The slate roof on the White House was replaced with sheet iron in 1804
- The copper roof on the Old Church of Christ in Philly lasted from the 1830s to 1967; substrate failed
- Early metal roofs were batten-style or flat-seamed until rolled tin production became common later in the 19th century with standing seam coming into general use



ASMM Contents

- **Roof Drainage Design & Systems**
- **Roof Edging and Perimeters (Gravel-Stop & Fascia)**
- **Copings**
- **Flashing**
- **Building Expansion**
- **Metal Roof Systems**
- **Wall Systems**



ASMM Contents - New for 7th Edition

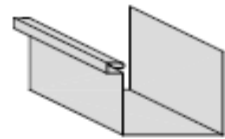
- **Wall and Roof Penetrations**
- **Louvers, Screens and Skylights**
- **Interior Architectural Sheet Metal Elements**
- **Other Metal Elements**
- **Historical Restoration**
- **Quality Control Procedures**
- **Appendices – A through N**
 - **Soldering**
 - **Underlayments**
 - **Adhesives**



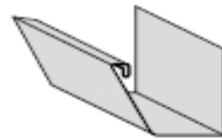
Roof Drainage Design

- Roof Area
- Rainfall Intensity
- Metal Selection
- Gutter Style/Design & Sizing
- Downspout Style & Sizing
- Expansion Allowances
- Fastening Method Selection
- Flashing Requirements

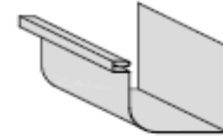




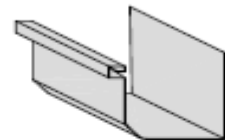
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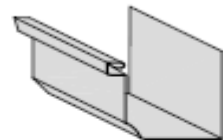
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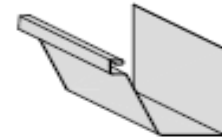
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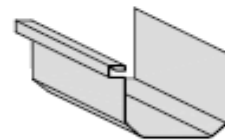
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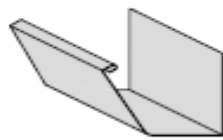
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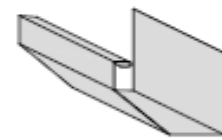
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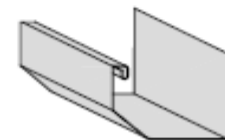
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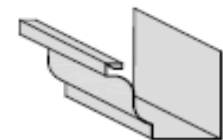
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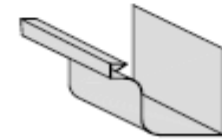
STYLE I



STYLE J



STYLE K



STYLE L

FIGURE 1-2 RECTANGULAR GUTTER STYLES

Built-in Gutters

- Poses greatest risk of water intrusion
- Soldered or welded joints only
 - Stainless steel and copper recommended
- Use high-quality membrane underneath as a secondary underlayment
- Specific shapes address water freezing
- Attention to expansion allowances/design
- Min. two downspouts per roof section



Expansion Allowances

- Gutter-specific expansion tables based on girth/profile/metal & predicted annual ΔT
- Expansion of Building Materials table with various expansion coefficients
 - Must be used for fascia and copings with consideration of both metal and substrate
- Flat seam roof expansion guidance over 30 feet ...use batten seam design to allow for expansion
- Copings and fascia also require joints that accommodate expansion between sections



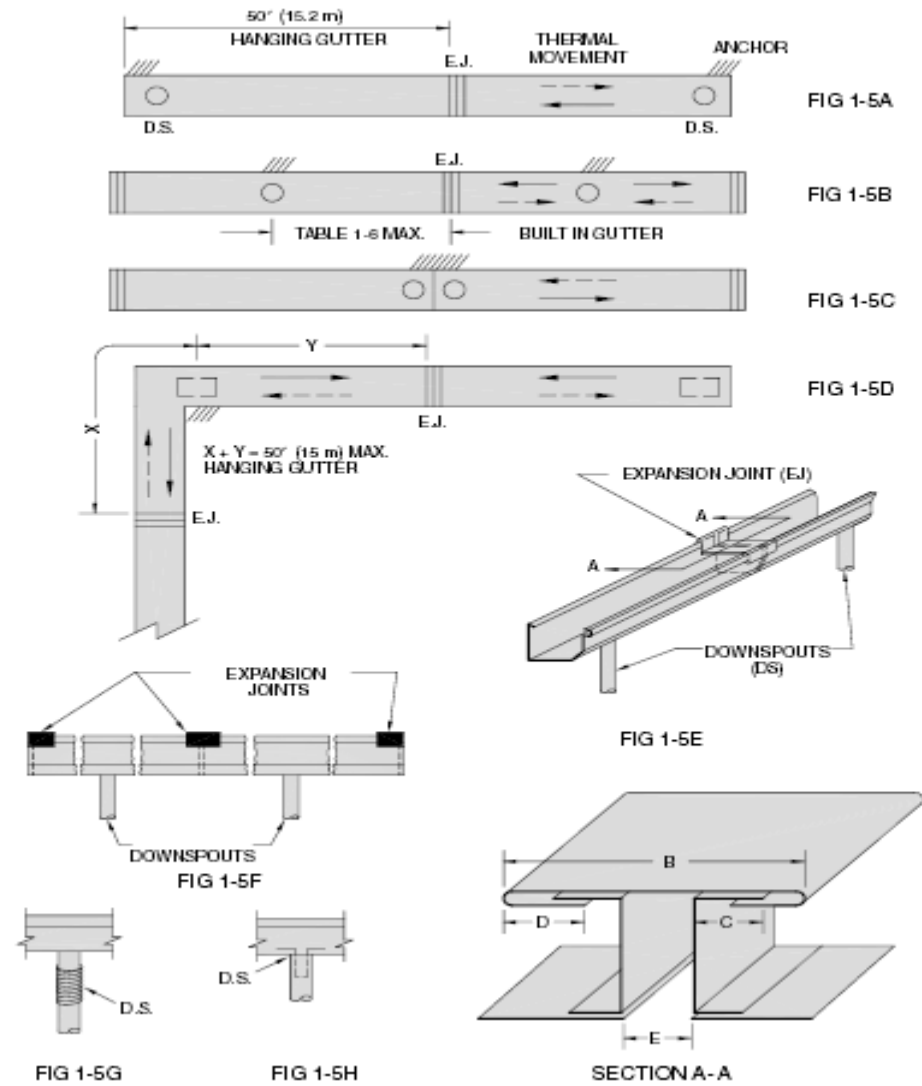


FIGURE 1-5 ALLOWANCES FOR GUTTER EXPANSION

Roof Edging and Perimeter

- Chapter covers a multitude of fascia design methods for flat roofing systems
- Water should **NOT** be allowed to flow over the edge of built-up roofs!
- Be careful with ladders and never step on the tops of fascia
- Other reasons for “controlled” roof access beyond security



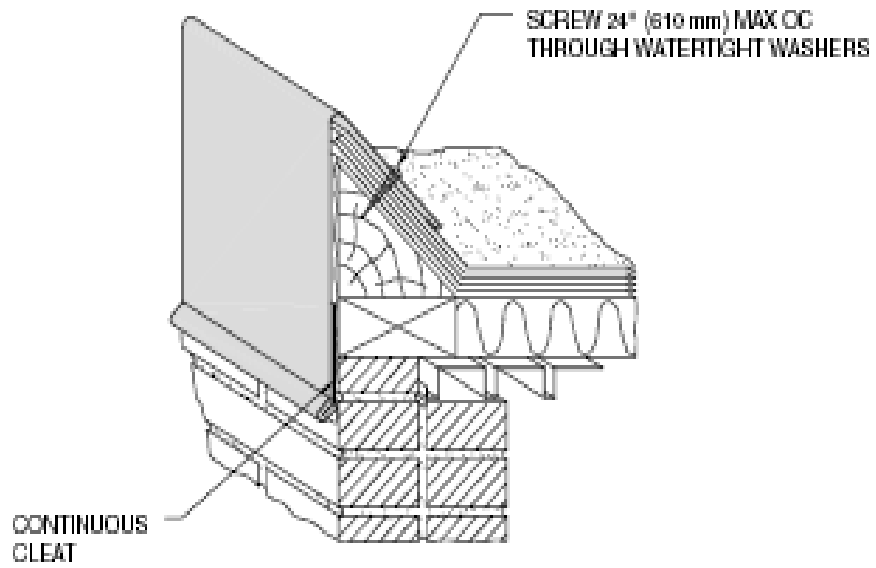


FIG 2-6A

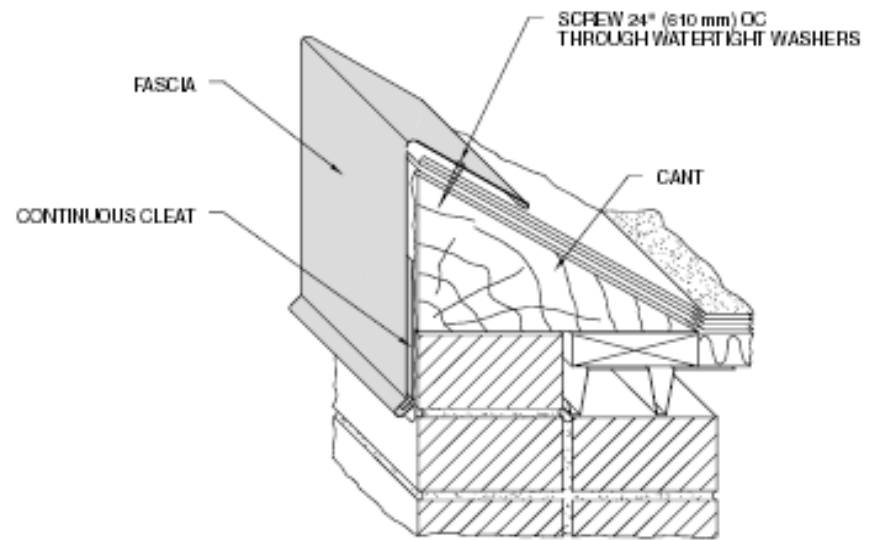


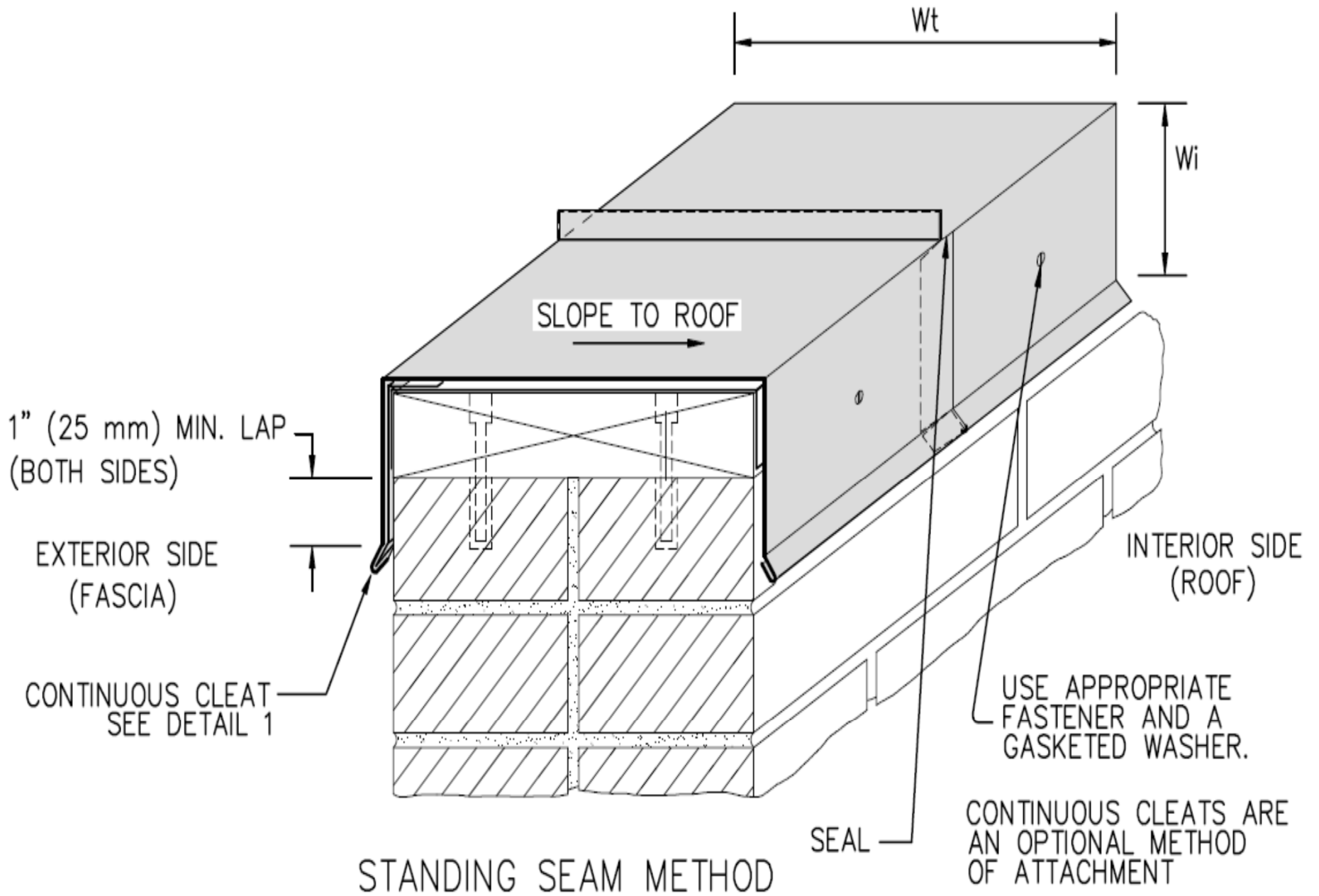
FIG 2-6B

FIGURE 2-6 CAP FASCIA - INSTALLATION

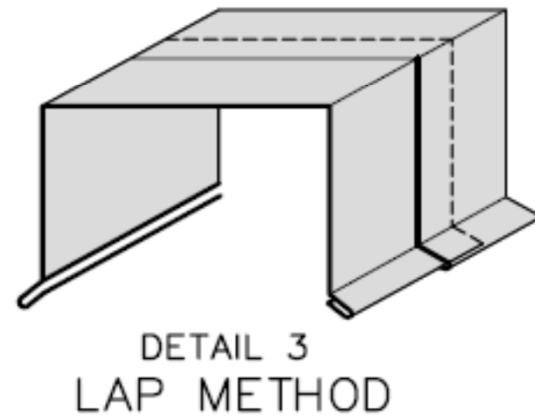
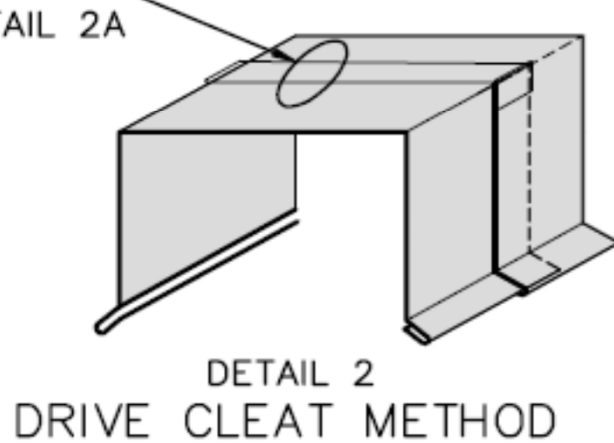
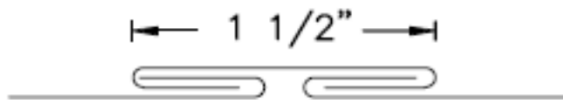
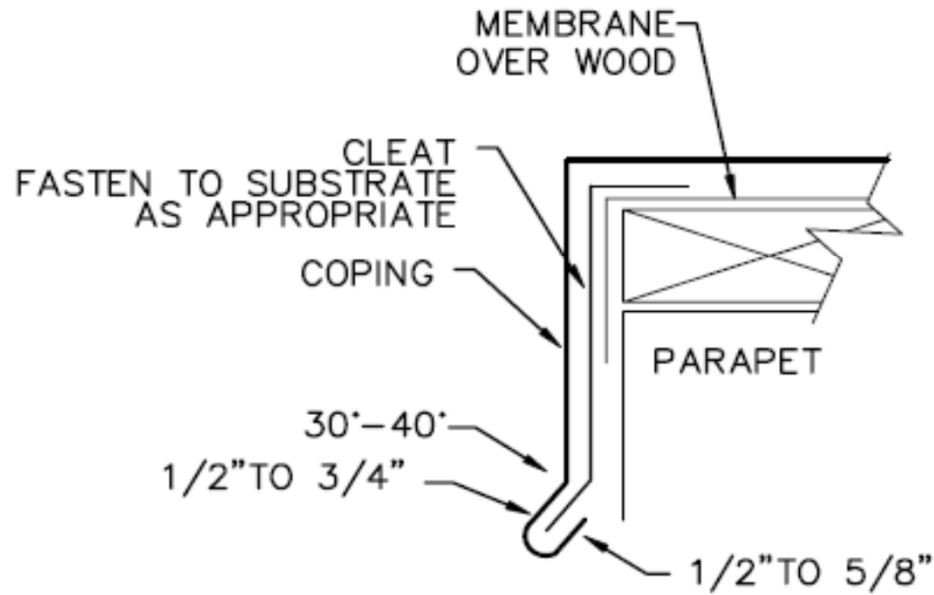
Copings

- **The horizontal, top surface is the most vulnerable point for water to enter a wall**
 - Water entering top of wall can “travel” distances
- **Copings provide a permanent water stop and reduce wall-related maintenance**
- **Metal copings provide an attractive, finished appearance**
- **Design for expansion with appropriate joints between coping sections**

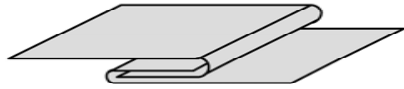




W_i, W_t AND JOINT SELECTIONS
ARE FROM TABLE 3-1
W_t = WIDTH OF THE TOP
W_i = WIDTH OF THE INSIDE

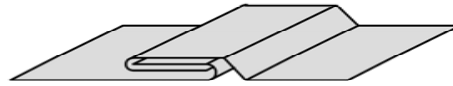


FLAT SEAM SIDING



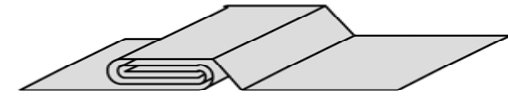
- 1. COMMON LOCK, HOOK SEAM OR CLINCH LOCK

SOLDERED FLAT SEAM ROOF AND DOWNSPOUTS



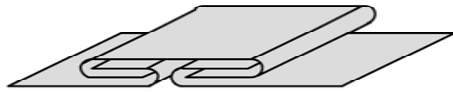
- 2. FLAT LOCK SEAM

OPTIONAL FLAT SEAM ROOF



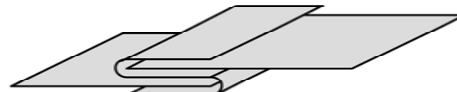
- 3. DOUBLE FLAT LOCK SEAM

DUCTWORK AND COPING



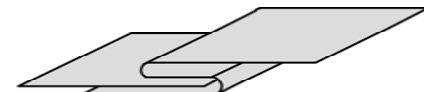
- 4. DRIVE CLEAT OR LOCK

FASCIA



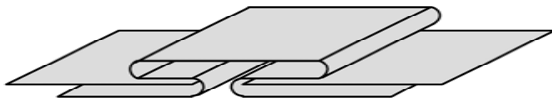
- 5. "S" CLEAT OR LOCK

FASCIA AND SIDING



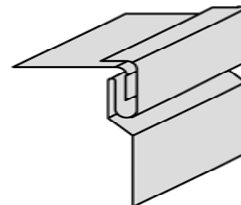
- 6. "S" POCKET

COPING AND FASCIA



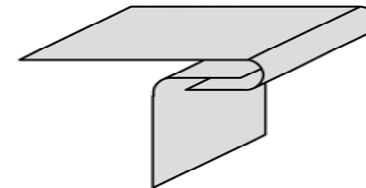
- 7. DOUBLE "S" SEAM

RADIUS AND CURVED COPING



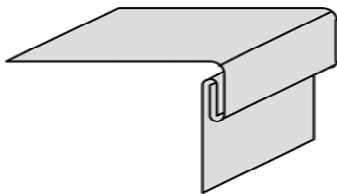
- 8. PITTSBURGH LOCK

EAVE EDGE AND EXPANSION JOINT



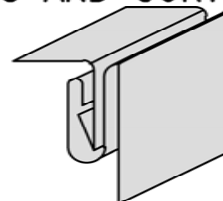
- 9. SINGLE CORNER SEAM

DOWNSPOUT AND CORNERSTONE BOX



- 10. DOUBLE CORNER SEAM

RADIUS AND CURVED COPING



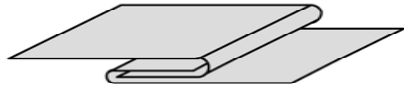
- 11. BUTTON LOCK CORNER SEAM

ANY APPLICATION



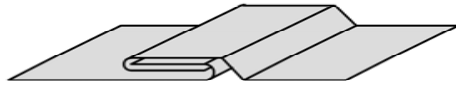
- 12. LAP SEAM

FLAT SEAM SIDING



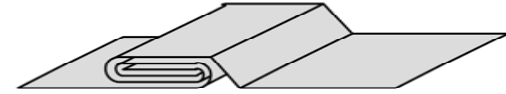
- 1. COMMON LOCK, HOOK SEAM OR CLINCH LOCK

SOLDERED FLAT SEAM ROOF AND DOWNSPOUTS



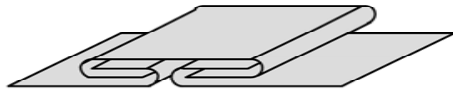
- 2. FLAT LOCK SEAM

OPTIONAL FLAT SEAM ROOF



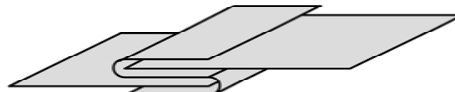
- 3. DOUBLE FLAT LOCK SEAM

DUCTWORK AND COPING



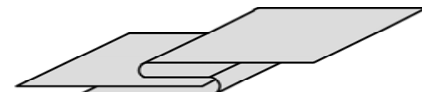
- 4. DRIVE CLEAT OR LOCK

FASCIA



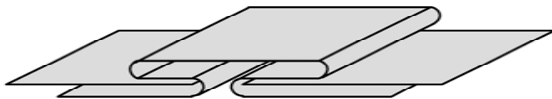
- 5. "S" CLEAT OR LOCK

FASCIA AND SIDING



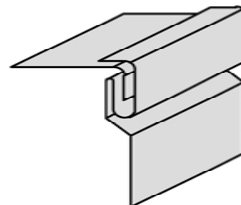
- 6. "S" POCKET

COPING AND FASCIA



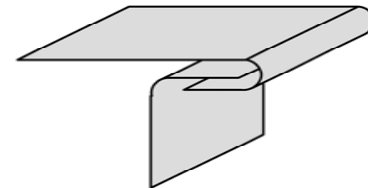
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RADIUS AND CURVED COPING



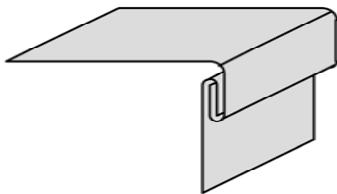
- 8. PITTSBURGH LOCK

EAVE EDGE AND EXPANSION JOINT



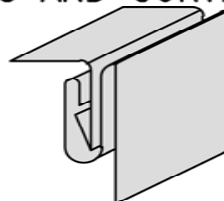
- 9. SINGLE CORNER SEAM

DOWNSPOUT AND CORNERSTONE BOX



- 10. DOUBLE CORNER SEAM

RADIUS AND CURVED COPING



- 11. BUTTON LOCK CORNER SEAM

ANY APPLICATION



- 12. LAP SEAM



Flashing

- **Third largest but most important chapter!**
- **Time-tested (old-fashioned) methods to prevent moisture intrusion**
- **Critical component for the protection of the substrate, structural elements, and interior**
- **Importance of flashing highlighted at national mold-related conferences**
- **Soldered metal joints = no/low maintenance**



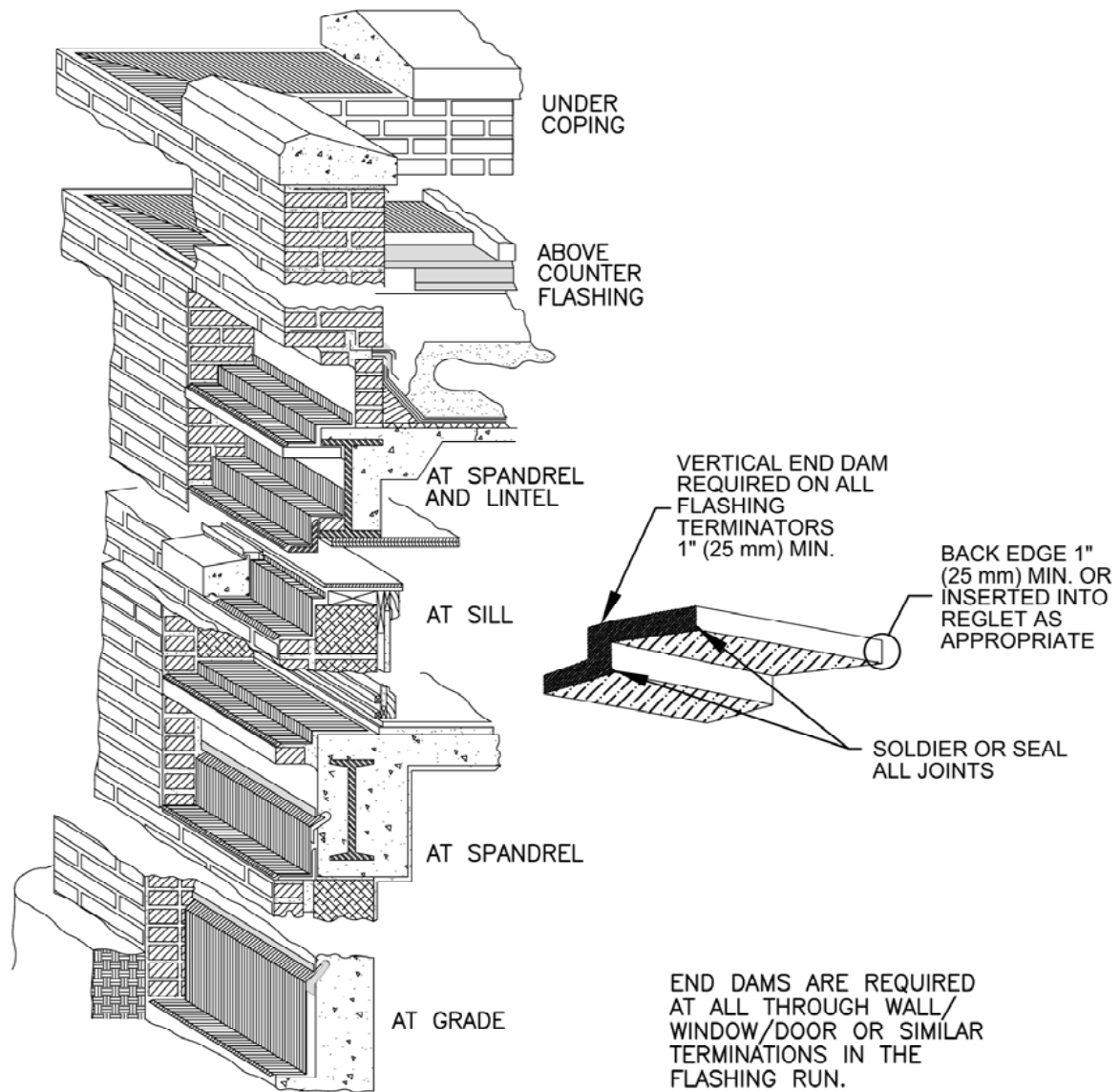


FIG 4-1A

Building Expansion

- **Expansion and contraction = important design factors for all structures**
- **Metal movement accommodated by specifically-designed expansion joints**
- **Proper width of expansion joints based on the total amount of movement**



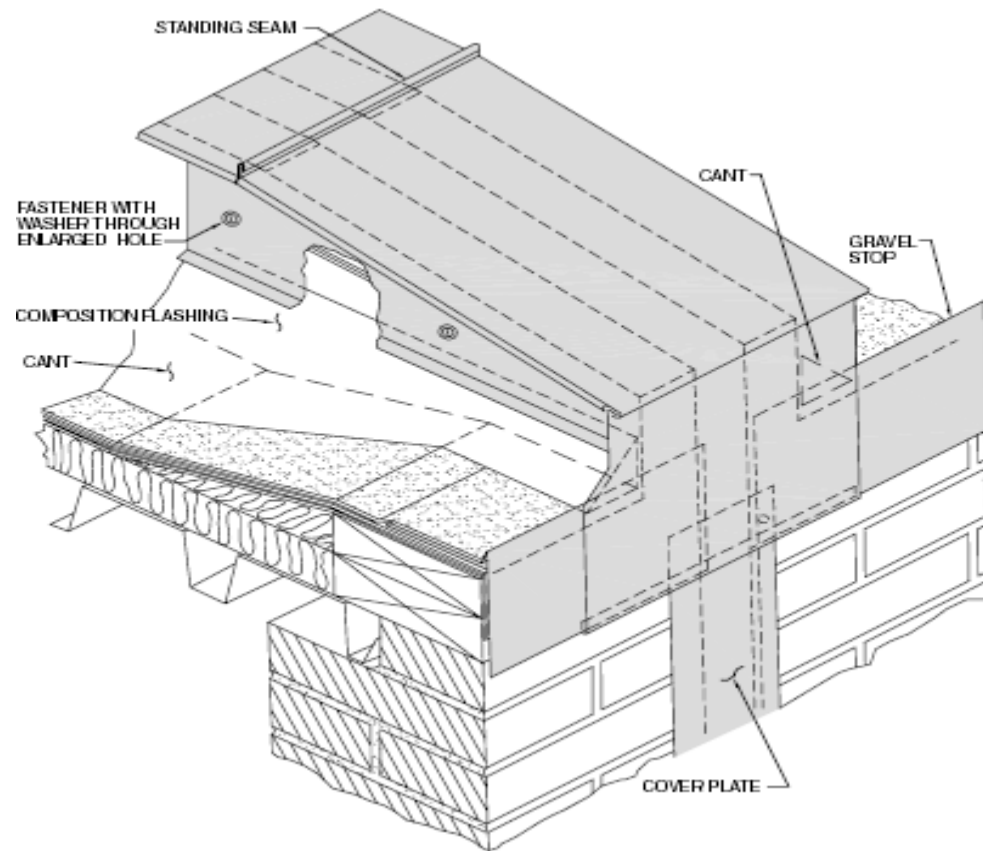


FIGURE 5-3 BUILDING EXPANSION JOINTS – ROOF AT GRAVEL STOP

Metal Roofing

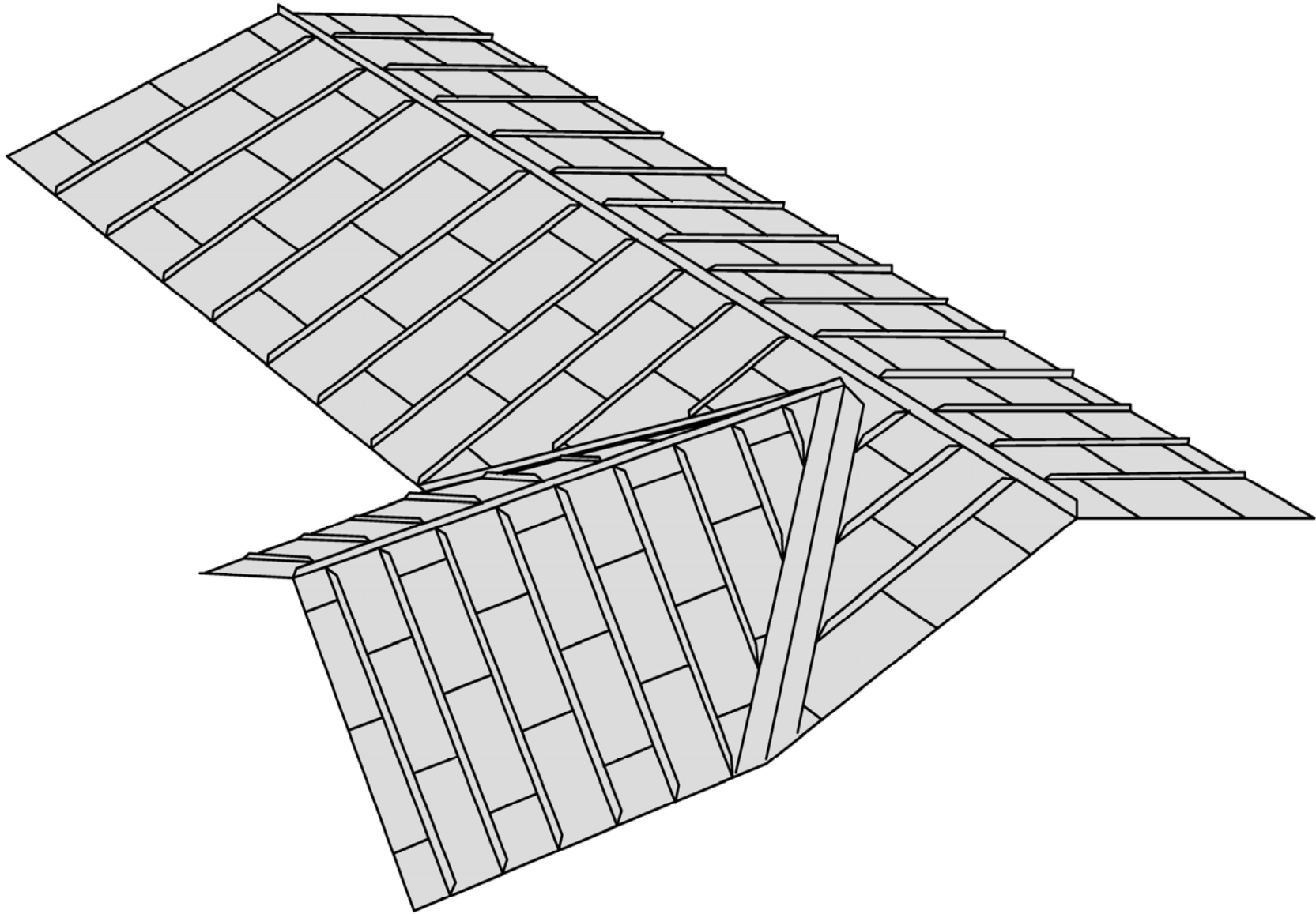
- **Early consultation with experienced metal roofing contractors recommended**
- **Two structural types:**
 - **Non-structural requires continuous support**
 - » **CUSTOM**
 - **Structural spans use intermittent supports**
 - » **MANUFACTURED**
- **Compatibility of all materials and galvanic reactions need to be considered**
- **Support/underlayment system VERY critical**



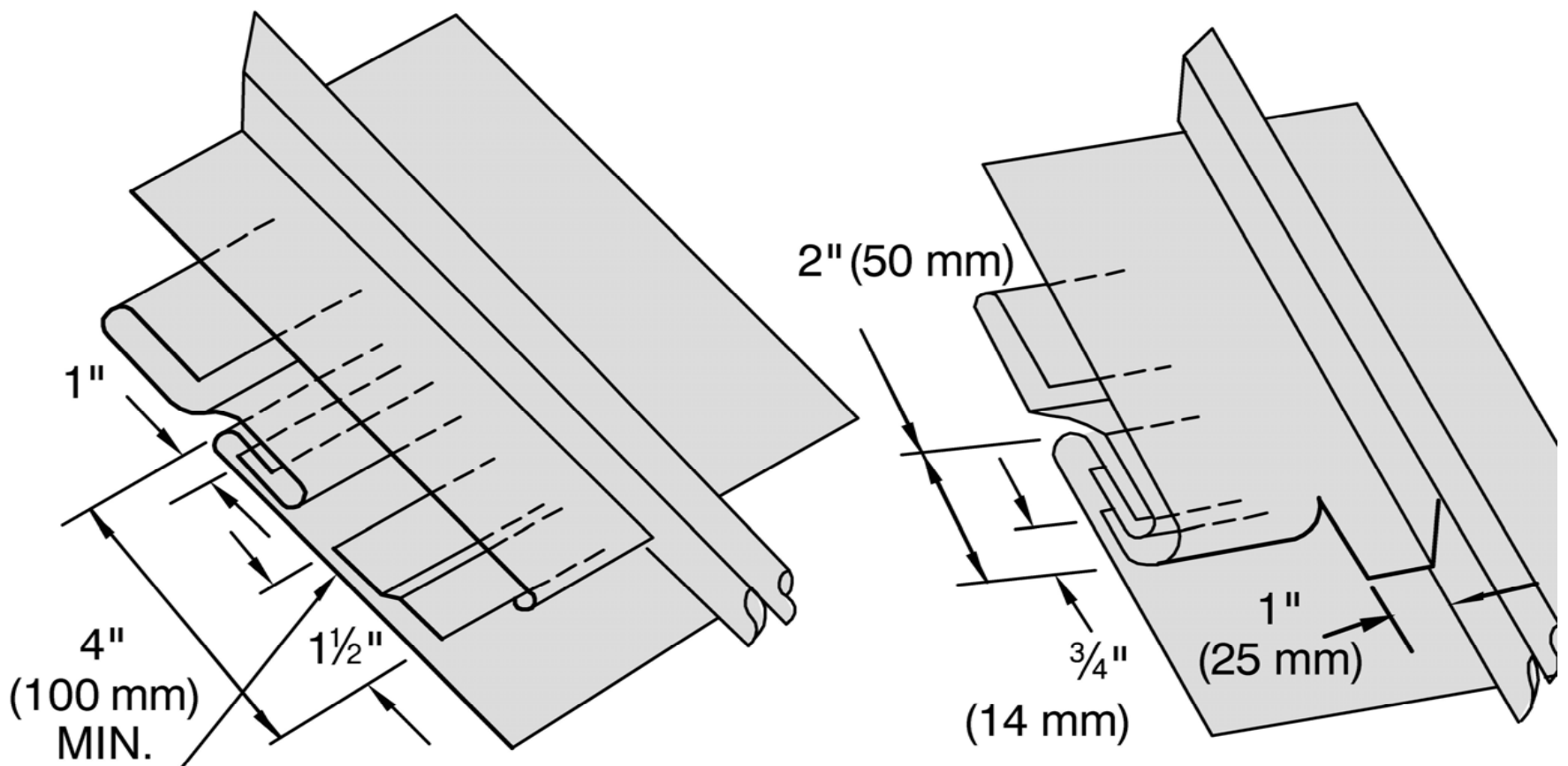
Standing Seam Roofs

- Recommended for roof slopes of 1 in./ft or greater
- Construction options may vary with slope
- Designers should consult local contractors for recommendations based on local conditions, experience and forming equipment
- Very thick metal specified only after checking availability of forming equipment





CUSTOM STANDING SEAM ROOF



4"
(100 mm)
MIN.

1"

1½"

2" (50 mm)

¾"
(14 mm)

1"
(25 mm)

CONTINUOUSLY-
SOLDERED
CLEAT

PITCH
(3:12 TO 6:12)

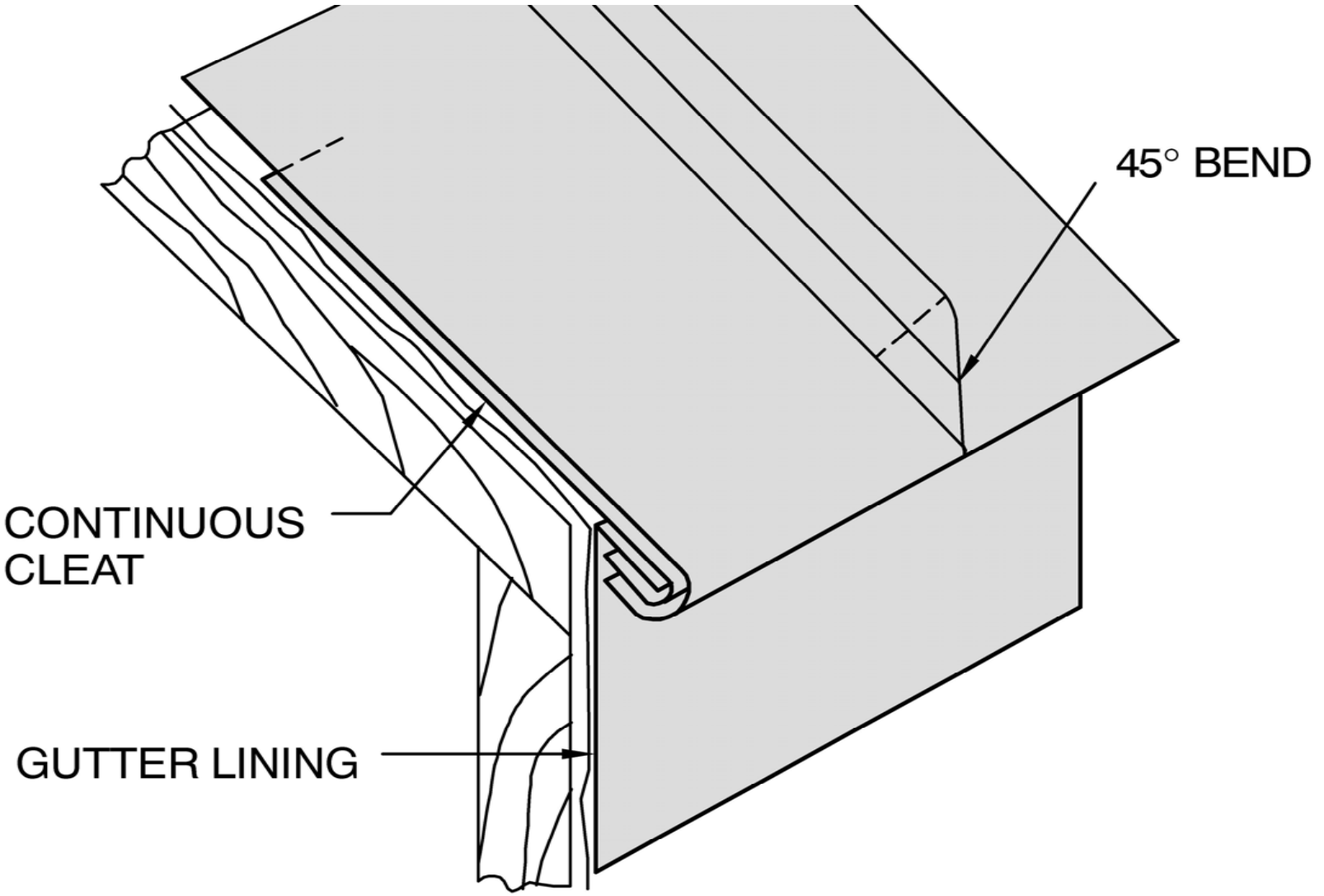
PITCH OVER
(6:12)

A

B

TRANSVERSE SEAMS





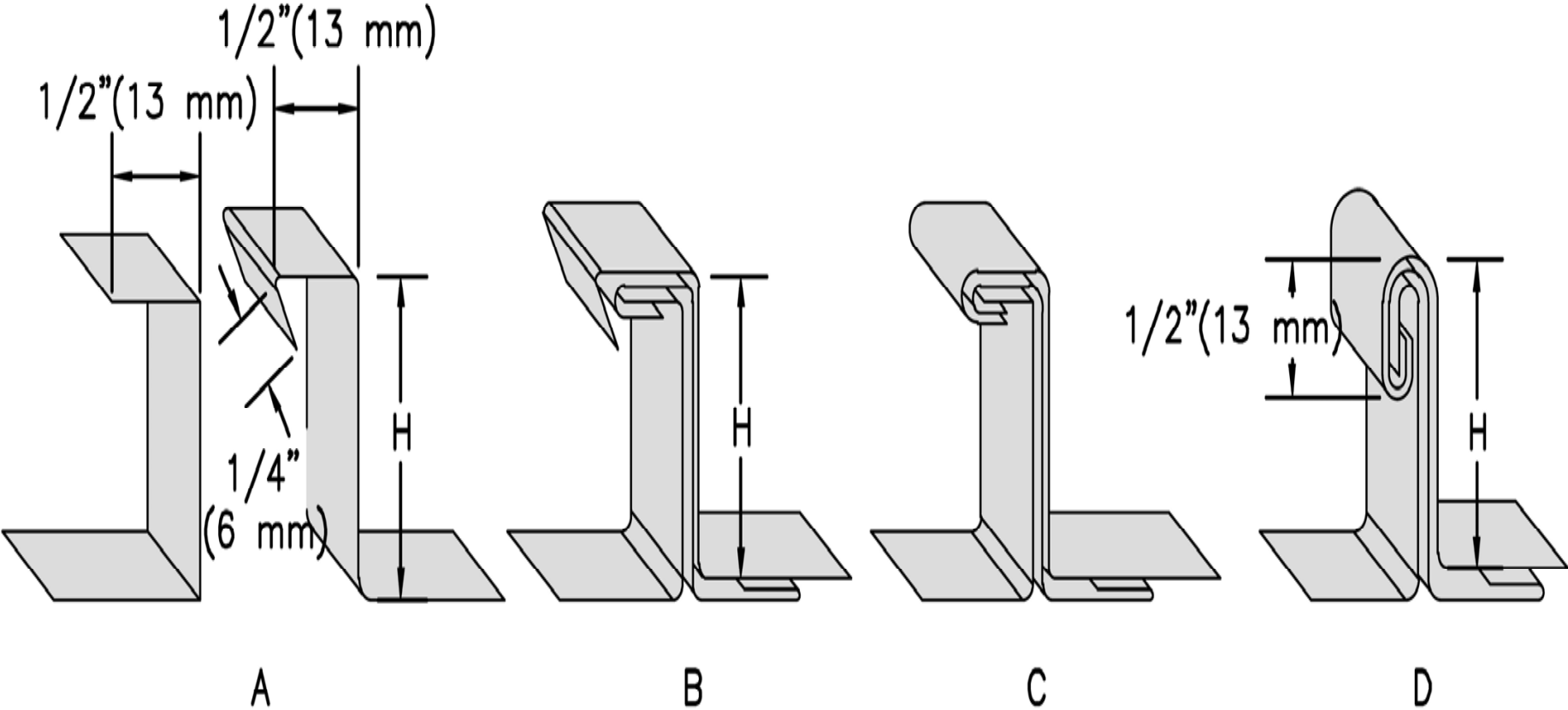
45° BEND

CONTINUOUS
CLEAT

GUTTER LINING

AT EAVE

CUSTOM STANDING SEAM ROOF



PAN METHOD
DETAIL 1



Batten Seam Roofs

- **Recommended for slopes of 3 in./ft or greater**
 - Sealing methods to accommodate lesser slopes
- **Copper or aluminum metal**
- **Prominent ribs amplify a roof's shape**
- **Offers architects the widest range of individual expression**
 - Size & shape of battens
 - Intersecting battens at various angles
 - Use in combination with other roof types



Copper, double lock, standing seam roof

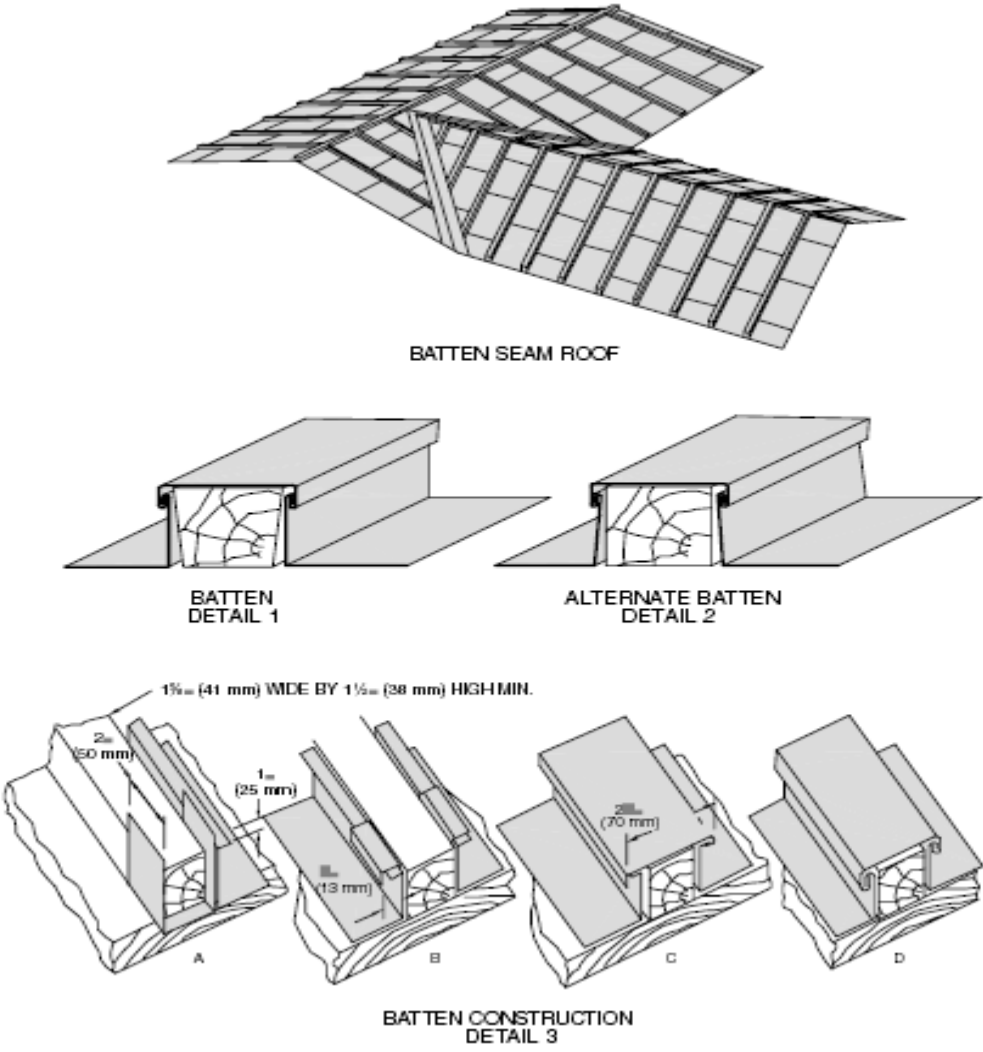
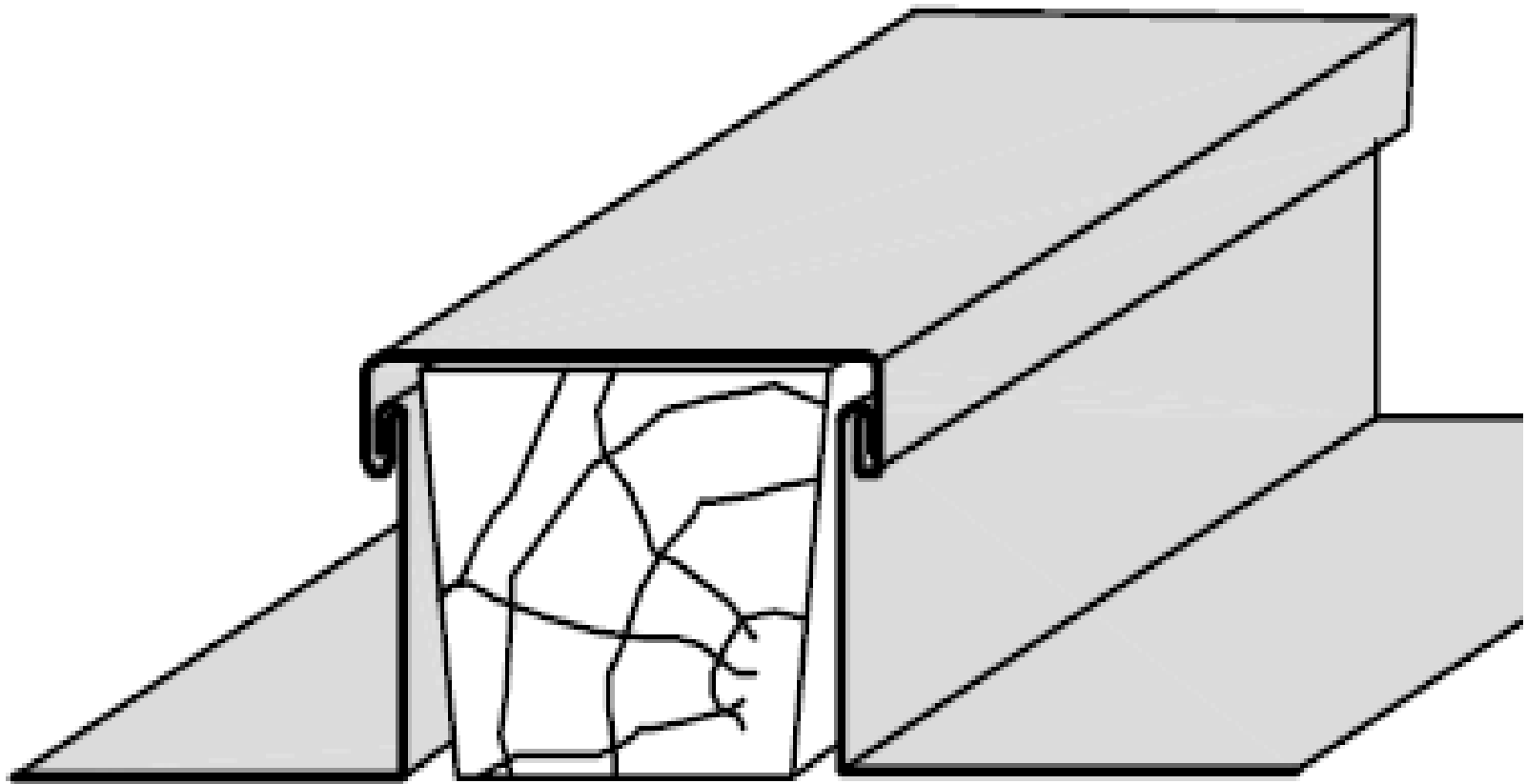


FIGURE 6-8 BATTEN SEAM ROOFS



BATTEN
DETAIL 1

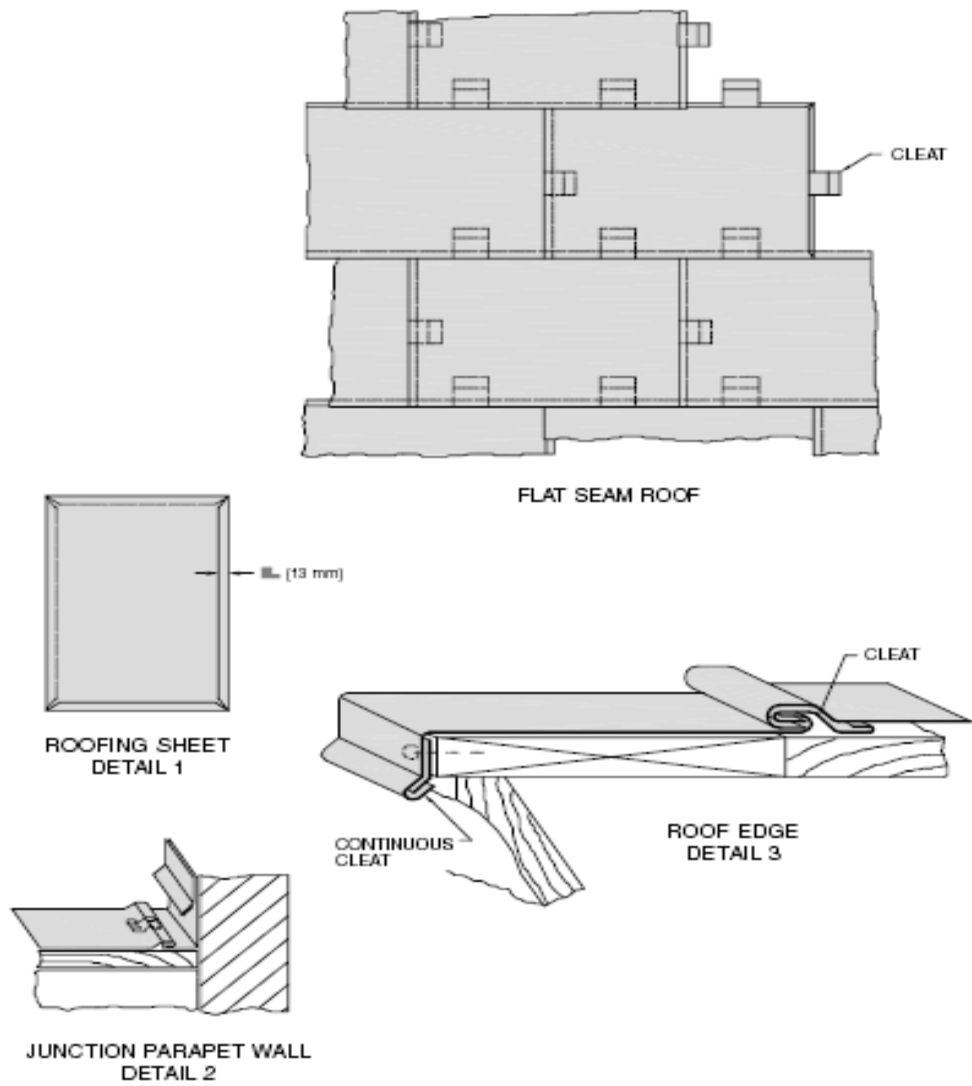


FIGURE 6-3 FLAT SEAM ROOFS

FLAT SEAM STAINLESS STEEL PANELS DISNEY CONCERT HALL, LOS ANGELES



Flat Seam Roofs

- Used in low/no slope areas or areas subject to flooding or standing water
- Typically made from 20" x 28" sheets – relative geometry is important for expansion and contraction, sheet use efficiency, and wind load.
- Copper or stainless steel is recommended
- Lock and seal all joints, solder joints on slopes less than 3:12
- Tapered-batten expansion joints required on sections exceeding 30 feet

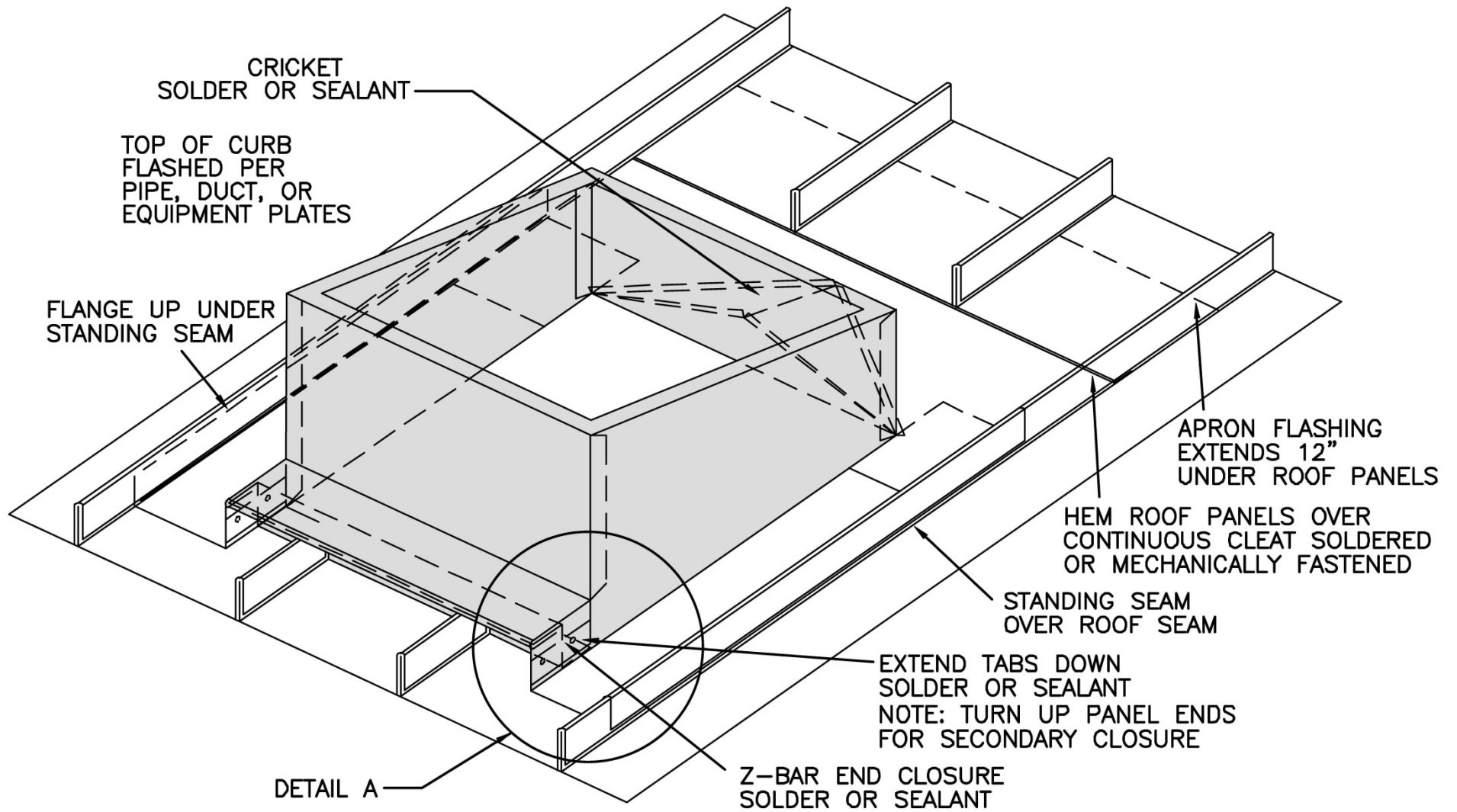




Penetrations

- Created separate chapter in 7th edition to place all roof/wall penetrations in one chapter
- Potential source of leaks especially high side
- Custom roofs and curb frames can be soldered and made as assemblies
- Penetrations in manufactured roofs typically chalked with sealants=service item

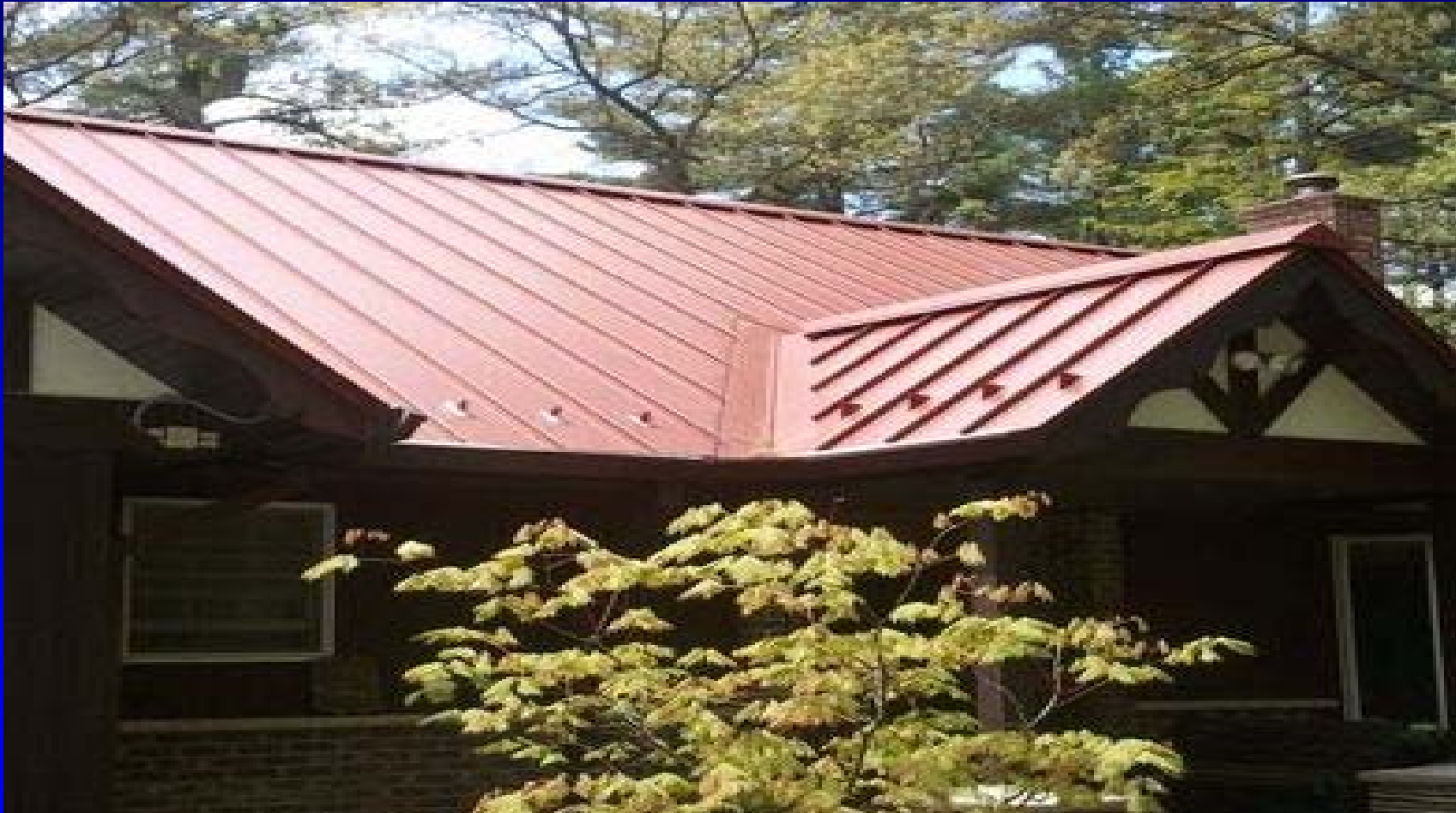








Snow Guards



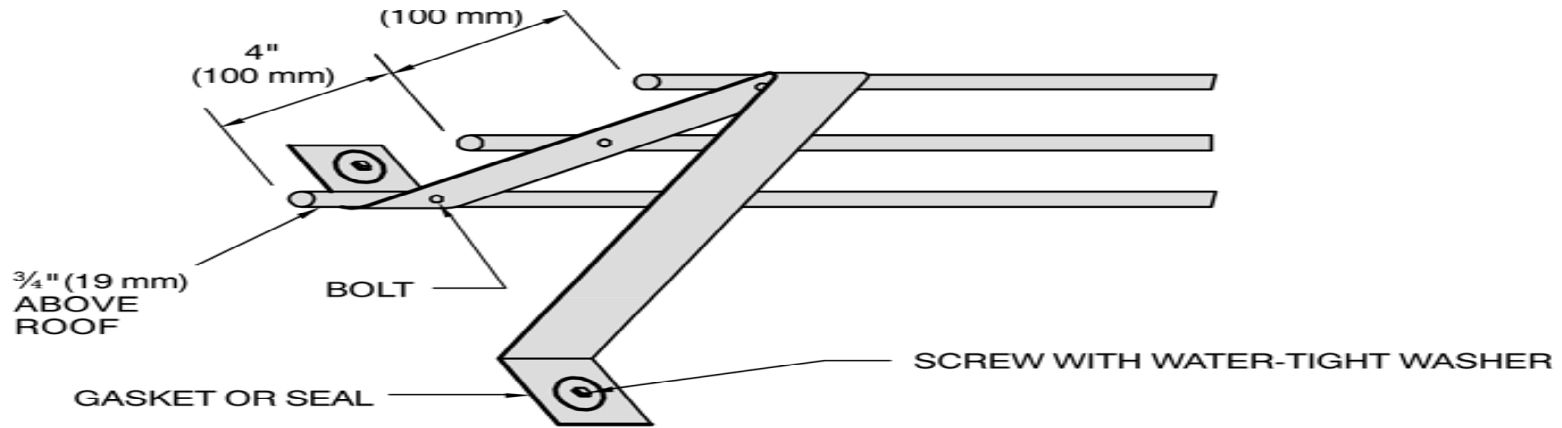


FIG 11-5A

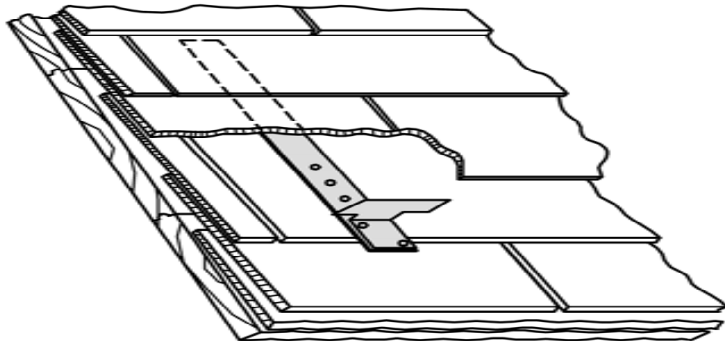


FIG 11-5B

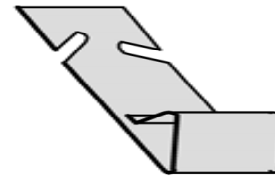


FIG 11-5C

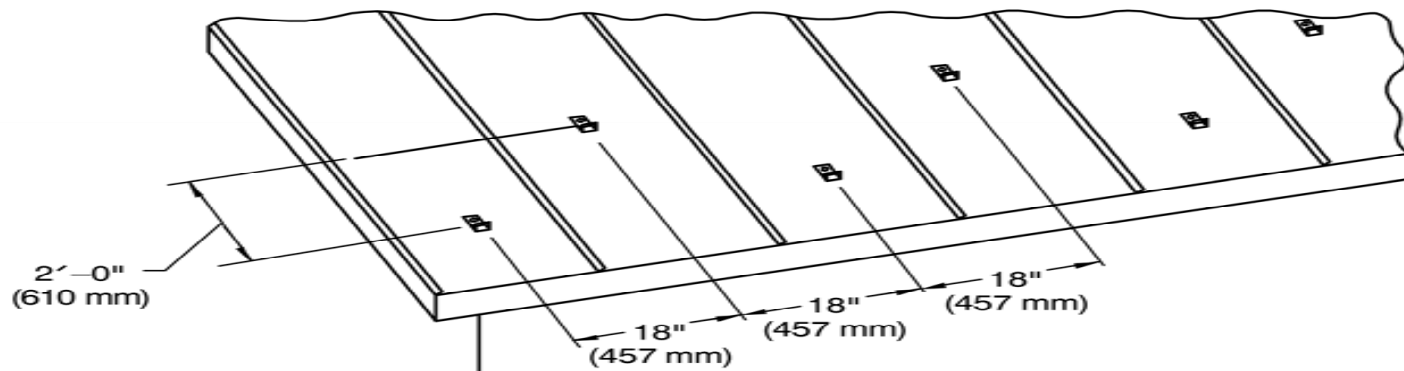


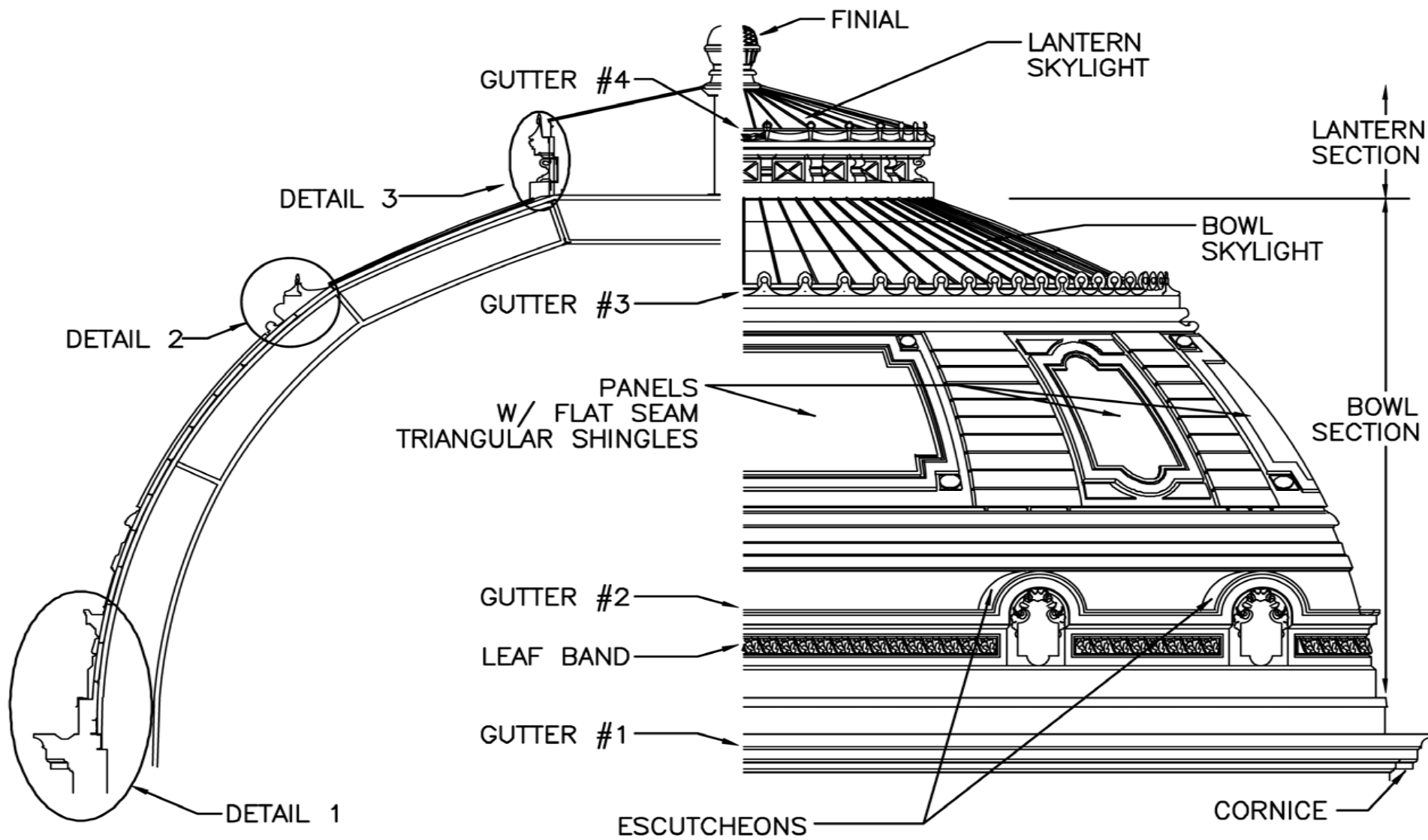
FIG 11-5D



Historic Restoration

- **Detailed commentary and drawings**
- **Experience and expertise especially critical in historical metal restoration**
 - **Contractors should be qualified!**
- **Many older/large cities have historic metal architectural features=community fabric**
 - **Cornices**
 - **Domes**
 - **Cupolas**











Appendices

- **Metal Applications and Specifications**
- **Galvanic Corrosion < Critical Design Issue**
- **Sheet Metal Roof Test Report**
- **Custom Fabricated Metal Roof Specs**
- **Moisture and Maintenance of Envelopes**
- **Fasteners**
- **Soldering Qualification**



Galvanic Corrosion

- **Not well understood by many designers**
- **Metals adjacent in the galvanic chart indicate compatible metals**
- **Contact not required, runoff from incompatibles can create corrosion**
- **Beware of HVAC condensate via copper pipes to galvanized gutter, for example**



Galvanic Scale

- ANODIC/CORRODED END/LEAST NOBLE
- Zinc
- Aluminum
- Galvanized Steel
- Cadmium
- Mild Steel, Wrought Iron
- Cast Iron
- Stainless Steel, types 304 and 316
- Lead–tin Solder
- Lead
- Brass, Bronze
- Copper
- Stainless Steel, types 304 and 316 (passive)
- CATHODIC/PROTECTED END/MOST NOBLE



Fastening Method Selection

- **Appendix for fasteners and soldering**
 - Screws best, stainless best, treated wood
- **Commentary and illustrations throughout detailing clips, cleats, reglets**
- **Solder “old fashioned” method is best**
 - Solder = permanent, sealants = continuous maintenance << Sustainability is the nature and important advantage of solder!



Sheet Metal Roof Test

- **UL Standard 580/Factory Mutual**
- **Static Water Penetration**
- **Dynamic Water Penetration**
- **Structural Load**
- **Deflection**
- **Considerations for High Wind Areas**



Fascia Pulloff Testing (Wind Uplift)



Pull Numbers

Table 1 Summary of Results

Test	High Load		Low Load		Average Load	
	(psf)	(lb)	(psf)	(lb)	(psf)	(lb)
SPRI Test RE-1 Roof Edge Termination	--	830	--	662	--	744
SPRI Test RE-2 Edge Flashing Pull-off	270	1835	190	1274	230	1558
SPRI Test RE-3 Coping Pull-off	250	2036	240	1926	240	1989



Soldering Pre-Qualification

- Specified method to demonstrate competence in soldering
- Only use qualified workers where leaks are not desired
- Suggested prequalification method provided in Appendix K
- Be concerned with results not methods





Contractor's Qualification Checklist

- **Jointly developed by AIA & SMACNA**
 - Design limited only by imagination, not contractor skills
 - Positive impacts on project completion schedule
 - Ensures proper installation, increases architect's options for creativity
 - Qualifies contractor based on proven experience record
 - Assures two most important characteristics of architectural elements—**aesthetics & water tightness**



**HISTORIC PRESERVATION
CONTRACTOR PERSONNEL EXPERIENCE QUALIFICATION FORM**

Specification Section _____

Company Name _____

Individual Name _____

Years with Organization _____

Job Title _____

Years of Experience Prior to Present Organization _____

List Preservation Projects in Past Five Years: _____

1. Project Name and Location: _____

Nature of Work (Describe specific, specialized historic preservation skills required by Craftsman on this project)

Time Period Worked: _____

2. Project Name and Location: _____

Work Assignment: _____

Nature of Work (Describe specific, specialized historic preservation skills required by Craftsman on this project)

Time Period Worked: _____



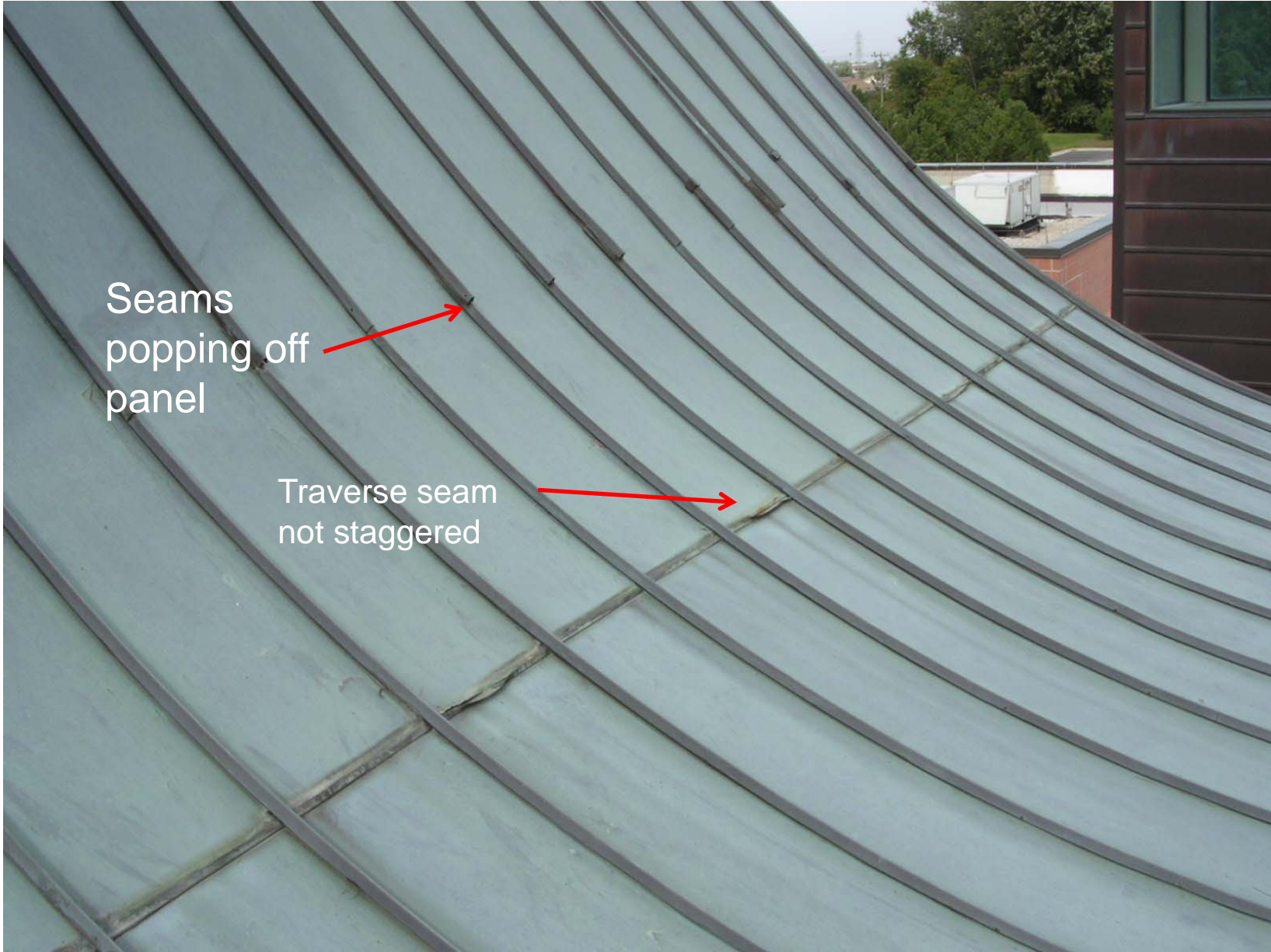
Questions?
Comments?
Suggestions?



Instructors can consider reviewing and discussing these “Don’t “ photos.



No drip edge snap
on standing seam
on low slope



Seams
popping off
panel

Traverse seam
not staggered



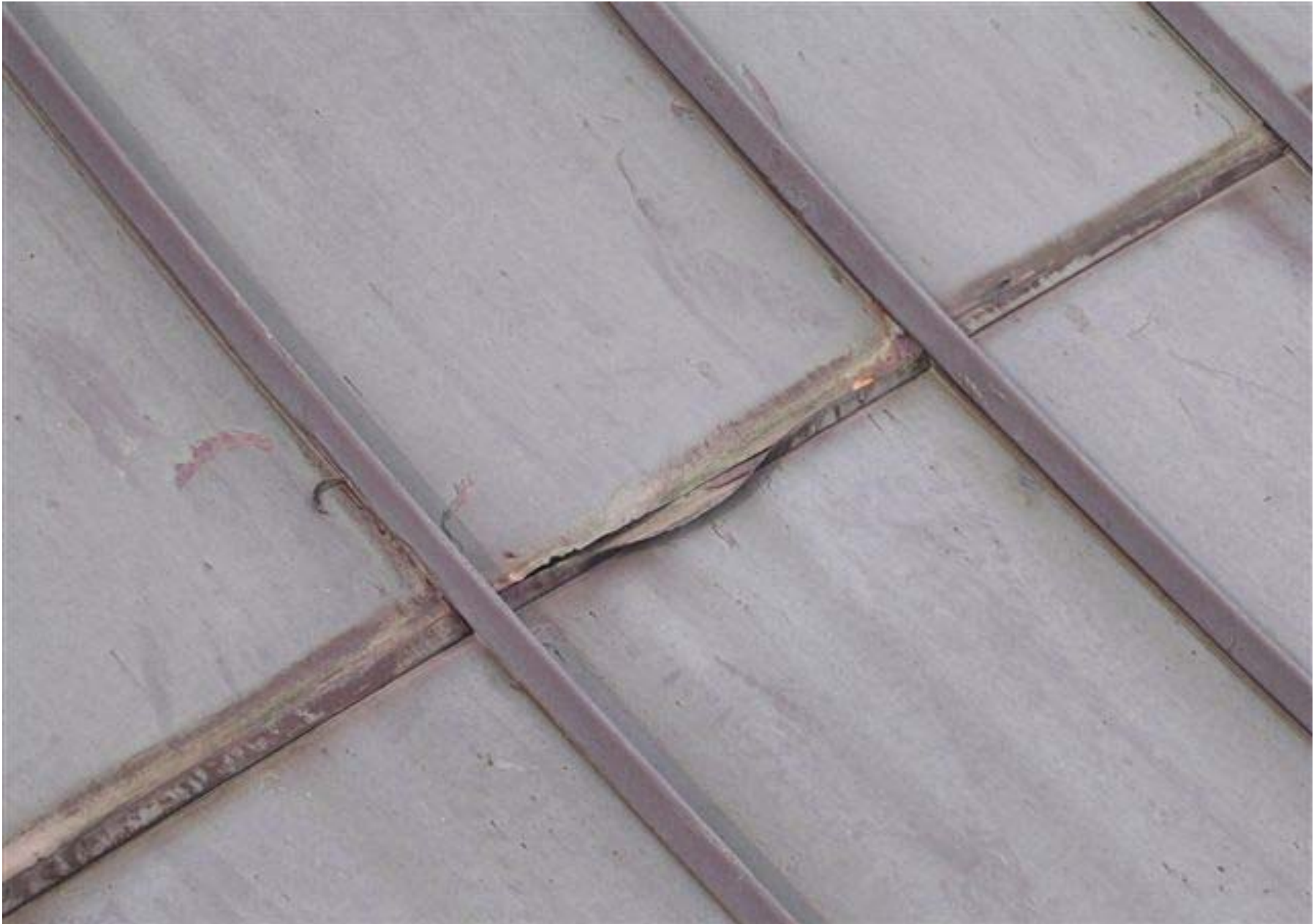


Through wall
counter flashing
installed upside
down no sealant
at seams water
running back in



Note stainless steel flashing back pitched no sealant or solder in joint







No drip edge





