HAMMER & HAND

BEST PRACTICES MANUAL
2ND EDITION
2016

A guidebook of field-tested construction details from the maritime Pacific NW.

INTRODUCTION

This Best Practices Manual is the product of Hammer & Hand's ongoing work to document and internally codify our standard operating procedures for construction practice. It has evolved into a guidebook of field-tested construction details, many shaped by Hammer & Hand's experience in high performance passive building. We expect the information contained herein to grow, deepen, and evolve as it is informed by experience in the field and collaboration with the many professionals with whom we are honored to work.

The first edition of the manual focused on ensuring proper moisture management in buildings, with particular emphasis on our fluid-applied flashing approach to window and door installation, our preferred method for constructing ventilated rain screens, our approaches to new basement construction and basement retrofits, as well as other details. This edition includes those details, some of which have been refined, and adds sections about walls and roof assemblies, detailing key strategies for controlling heat, air, and moisture.

To our employees: this manual is a guide, not gospel. You will routinely encounter realities in the field that do not match "laboratory conditions," and will need to adapt accordingly. What needs to remain constant is that fieldwork is guided by sound building science, so be sure to consult with our in-house building science experts when adapting these details. Also, manufacturer's installation instructions and architect's construction drawings and specifications always take precedence over the details in this Best Practices Manual. Any discrepancies with this manual should trigger discussion with the architect about alternative approaches to their detailing. However, any alterations to architect's plans must be approved by the architect and such approval memorialized in an SK, ASI, RFI or other contractual method.

To our industry colleagues: we share this manual in the spirit of collaboration. These details have been developed through extensive in-the-dirt experience and informed by building science training and practice. From our experience in the maritime Pacific Northwest, they combine durability, performance, and constructability. That said, we know there are several ways to solve any building problem, and also respect that responsibility for the design of construction details ultimately rests with the architect. The details in this manual can be a starting point for discussion as we collaborate with you on a project. And you are free to draw upon them in any project you are designing, regardless of whether we're involved. This manual is also available online at: http://hammerandhand.com/bpm.

Thank you.

DISCLAIMER

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The information presented in this manual must be used with care by professionals who understand the implications of what they are doing. If professional advice or other expert assistance is required, the services of a competent professional shall be sought. The author and publisher shall not be liable in the event of incidental or consequential damages in connection with, or arising from, the use of the information contained within this H&H manual.

BEST PRACTICE DETAILS STEP-BY-STEP

FLASHING

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1.1 FLASHING

"The fundamental principle of water management is to shed water by layering materials in such a way that **water is directed downwards and outwards out of the building or away from the building.** The key to this fundamental principle is drainage. The most elegant expression of this concept is flashing. Flashings are the most underrated building enclosure component and arguably the most important." -Joe Lstiburek

A. Flashing Dimensions

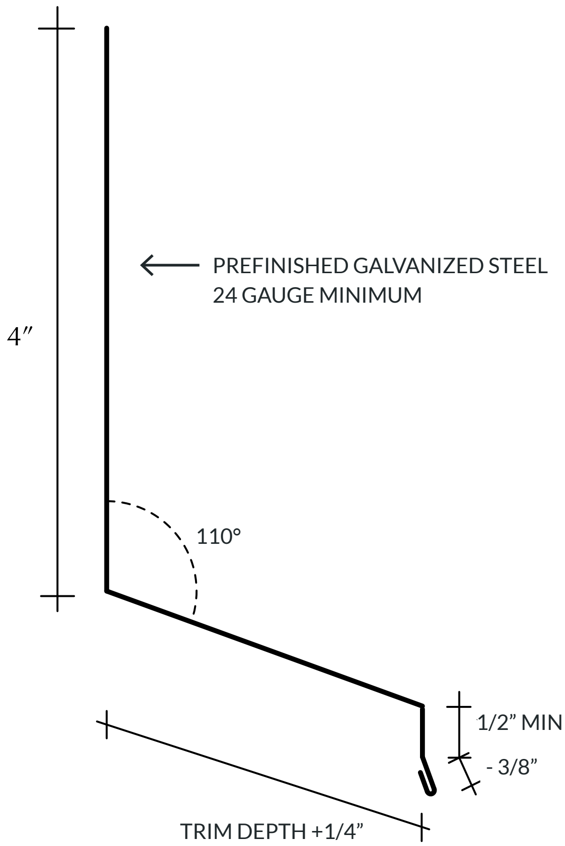


FIGURE 1.1 A

B. Flashing: Where to Install It

Flashings should be installed:

1. At all horizontal joints between different exterior finishes unless the upper finish overlaps the lower finish.
2. At every offset in cladding, changes in cladding substrate, and at all penetrations (horizontal transitions between siding, stone, brick, tile, or stucco).
3. Where stresses can be concentrated (such as at the rim joist/foundation joint).
4. Where drainage is compromised (such as a change from wall cladding to parging).
5. The top and bottom of windows, doors, and all penetrations (vents, lights, hose bibs, electrical outlets, electrical meters, etc).

C. Flashing: Important Points

1. Building paper lapping: Install in a shingled fashion with the upper sheet always overlapping the lower sheet by a minimum of 4”. This and the down and out principle shown below.

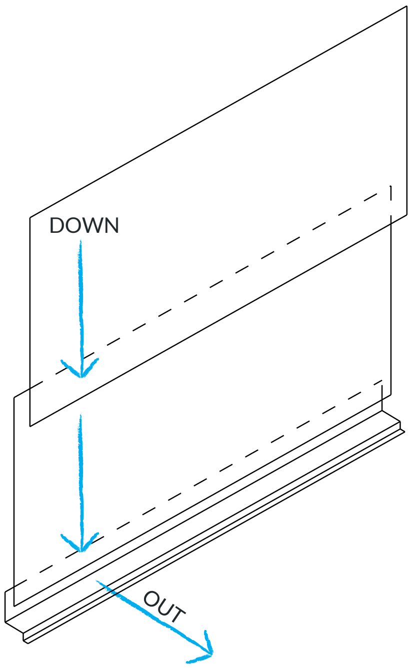


FIGURE 1.1 B

2. NEVER rely on any self-adhering membranes (tape, peel and stick) in lieu of properly shingled laps or fluid applied flashing.
3. Minimum flashing slope: 20 degrees.
4. Leave a 1/4” minimum gap between cladding termination and sloped metal drip flashings, shown in figure 1.1 C (this detail can also apply to other flashing details such as: belly bands, exterior penetrations, etc.).

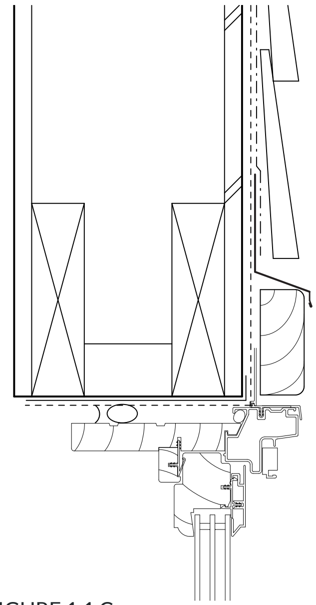


FIGURE 1.1 C

5. If above average shrinkage or differential movement is expected (wood to masonry transition or multi-story building) the minimum gap between flashing and the cladding should be increased to 1/2”.

D. Drip Edges

Flashing with a hemmed drip-edge breaks water surface tension and prevents water from running along the underside of the flashing and back into the wall.

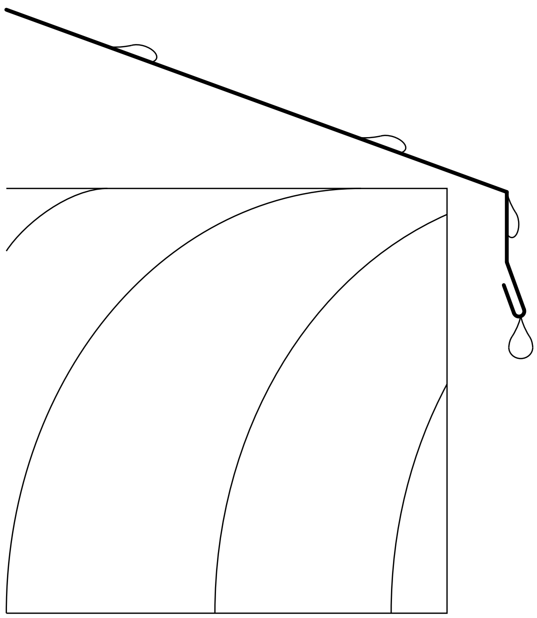


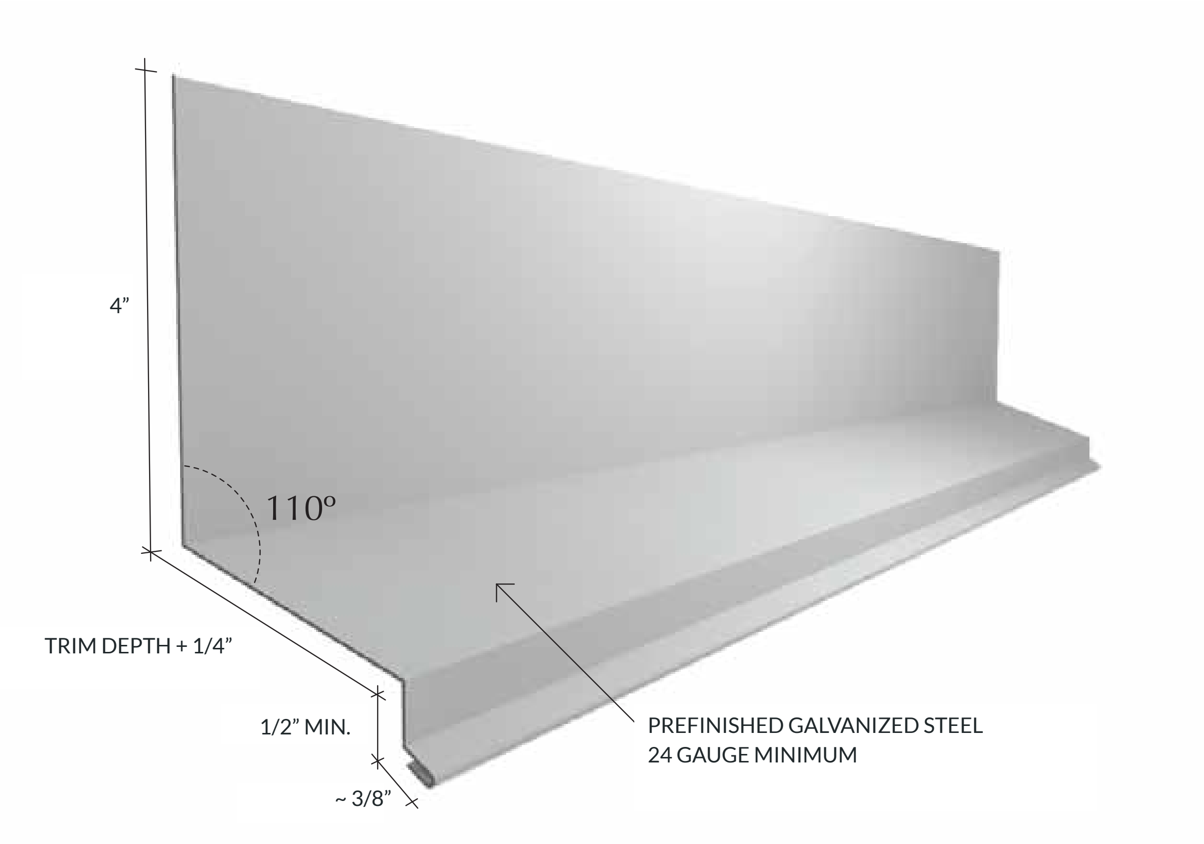
FIGURE 1.1 D

Important Note:

Flashing penetrations: Penetrations (pipes, cables, refrigerant lines, vents, etc.) must be flashed before the cladding is installed. It is nearly impossible to properly flash a penetration without removing the cladding around the penetration. Be sure to have a plan for all flashings through the building enclosure prior to cladding the building.

1.2 HEAD FLASHING

Head Flashing Specifications:

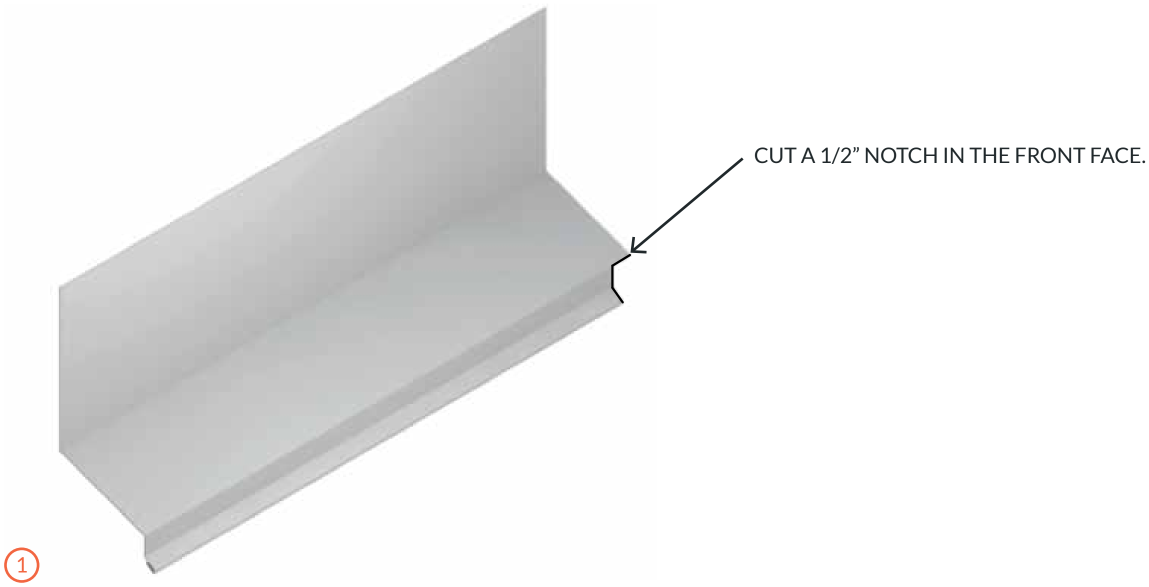


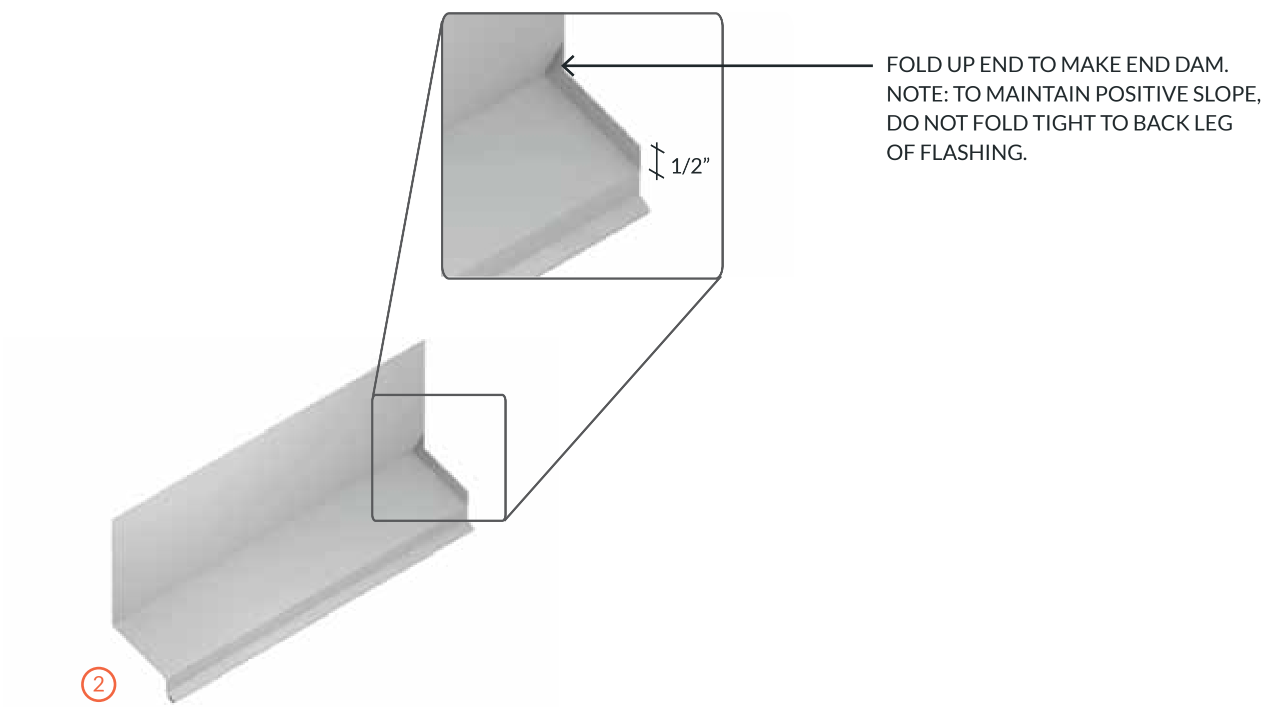
About Head Flashing:

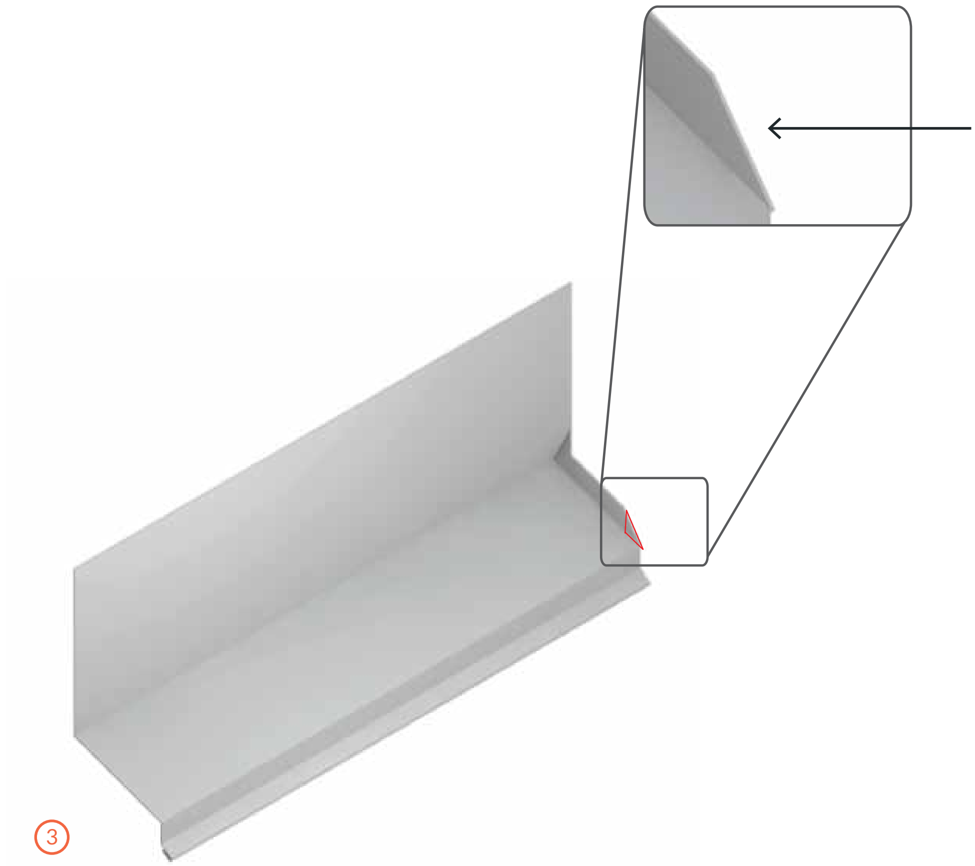
In high exposure locations, head flashing should incorporate an end dam to prevent water from running off the end of the flashing. At this location the cladding may need to be cut to fit around the projection of the end dam.

1

Making an End Dam






FORM A SAFETY EDGE BY
FOLDING DOWN OUTER
CORNER.
3

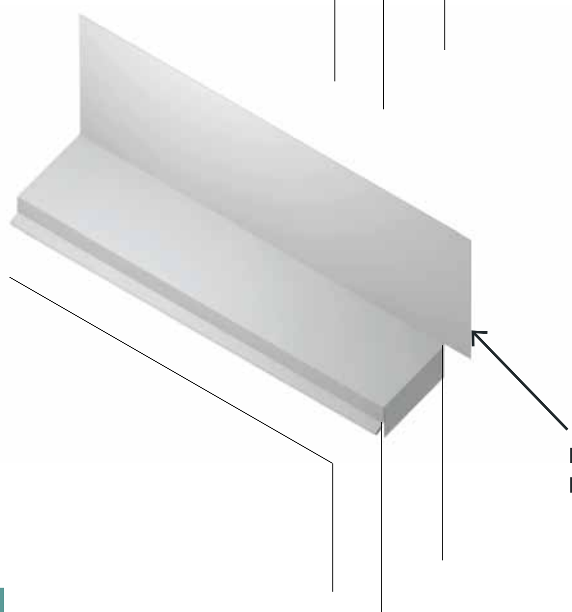
Making Folded Down Ends

1

- Clip flashing back to window casing at bends to create flaps for bending.
- Trim hemmed edge so it ends at the edge of the window casing and does not extend with the other tabs.

2

- Fold front tab back against side of casing.



3

- Fold down the horizontal part of flashing over the side of the window casing.
- Solder head flashing at the ends to make watertight.

BACK LEG OF FLASHING SHOULD EXTEND PAST HEAD CASING.

BEST PRACTICE DETAILS STEP-BY-STEP

SEALANT JOINTS

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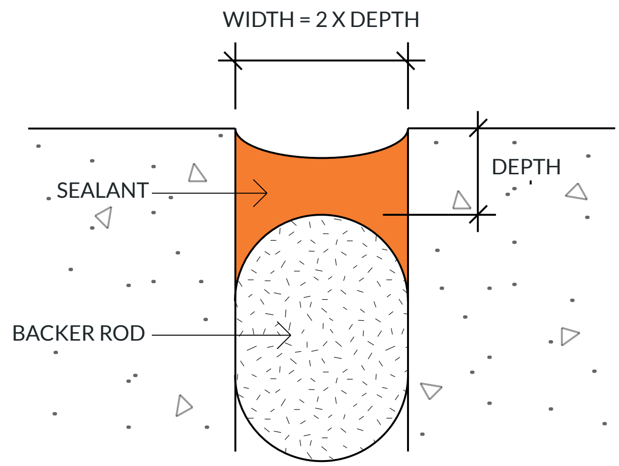
2.1 SEALANT JOINT DESIGN

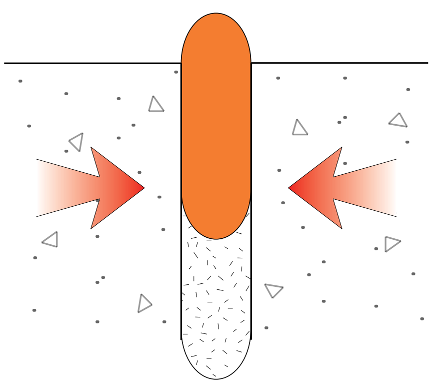
While the humble sealant joint may be uncelebrated, it is vital to building durability and longevity. Proper installation is key to sealant joint integrity and function throughout a life of expansion and compression, wetting and drying, exposure, and temperature fluctuation.

Note: Because sealants are just as good at keeping moisture in as they are in keeping it out, placing a bead of caulk in the wrong location can result in moisture accumulation, mold and rot, envelope failure, and hundreds of thousands of dollars in repair and remediation. If we know anything, we know that building envelopes will get wet – the question is, "where will the water go?" Make sure you know the answer throughout construction, especially as you seal joints.

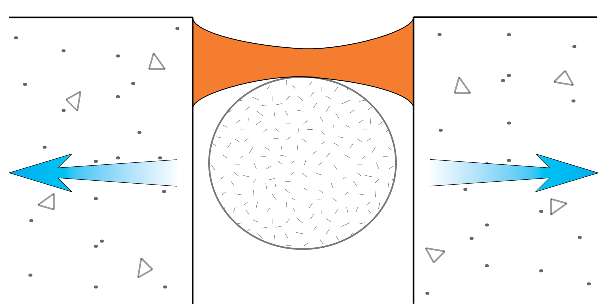
- Joint Rule of Thumb: Sealant should be hourglass-shaped and width should be twice depth (shown in diagram).
- Backer rod diameter should be 25% larger than the joint to be filled.
- Joint size should be 4x the expected amount of movement (usually about 1/2" of space on all sides of the window casement).
- Ideal joints are within a range of 1/4" at minimum and 1/2" at maximum. Joints outside this range require special design and installation.
- Always use the right tool: sealant is not caulk and should never be tooled with a finger (saliva interferes with bond).
- Substrates need to be clean, dry, and properly prepared (primer if necessary).
- When dealing with thermally sensitive materials, apply sealant under average temperature conditions because joints expand and contract with changes in temperature (see below).



Joint Expansion and Compression



HOT WEATHER CAUSES SUBSTRATES TO EXPAND, COMPRESSING THE JOINT.



COLD WEATHER CAUSES SUBSTRATES TO SHRINK, EXPANDING THE JOINT.

BEST PRACTICE DETAILS STEP-BY-STEP

WINDOWS & DOORS

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INTRODUCTION TO WINDOWS & DOORS

Rough openings are inherently dangerous spots on a building, like big holes in the hull of a ship. So it is vital to flash them well and install windows and doors in an airtight manner that also manages moisture and thermal transfer. Our preferred method outlined here – fluid applied flashing – is guided by three truths:

1. Windows will leak. Not all of them, but over a whole building, it's a matter of when, not if. We therefore need to detail our rough openings so that when a window leaks, the water can drain out harmlessly. (Note: this is why we place the air seal at the inside edge of the window, or door, assembly, to allow water to drain outboard of that seal.)

2. Origami is hard. The conventional way of flashing a window with papers and tapes depends on dozens of steps being performed perfectly every time: careful folds and precise manipulation of less-than-forgiving materials in the field. Simple mistakes, like reverse lapping, can be catastrophic to the assembly but can be covered up by subsequent layers of material, so checking work thoroughly can be impossible. Now multiply these risks by the number of windows on a building and you will understand why window installations can be anxiety inducing. Fluid applied flashing, by contrast, is more simple to apply in a few steps, and quality control is easy; if the applied layer is thick enough to be opaque, then it is thick enough to do its job. As long as proper materials are used, one fluid applied layer integrates seamlessly with the next, eliminating the risk of reverse lapping (except where the fluid applied system integrates with building paper). And unlike tapes that often require dry conditions for proper adhesion, many fluid applied flashing products are actually easier to apply on wet materials, a very common situation on Pacific Northwest construction sites. We can all sleep well at night.

3. Flashings should be vapor permeable. If flashings are not vapor permeable then moisture can build up behind them and cause rot. The high vapor permeability of fluid applied flashing ensures that construction moisture and seasonal water vapor migrating through the wall assembly does not accumulate behind the flashing and can readily dry.

3

3.1 NEW WINDOW INSTALLATION

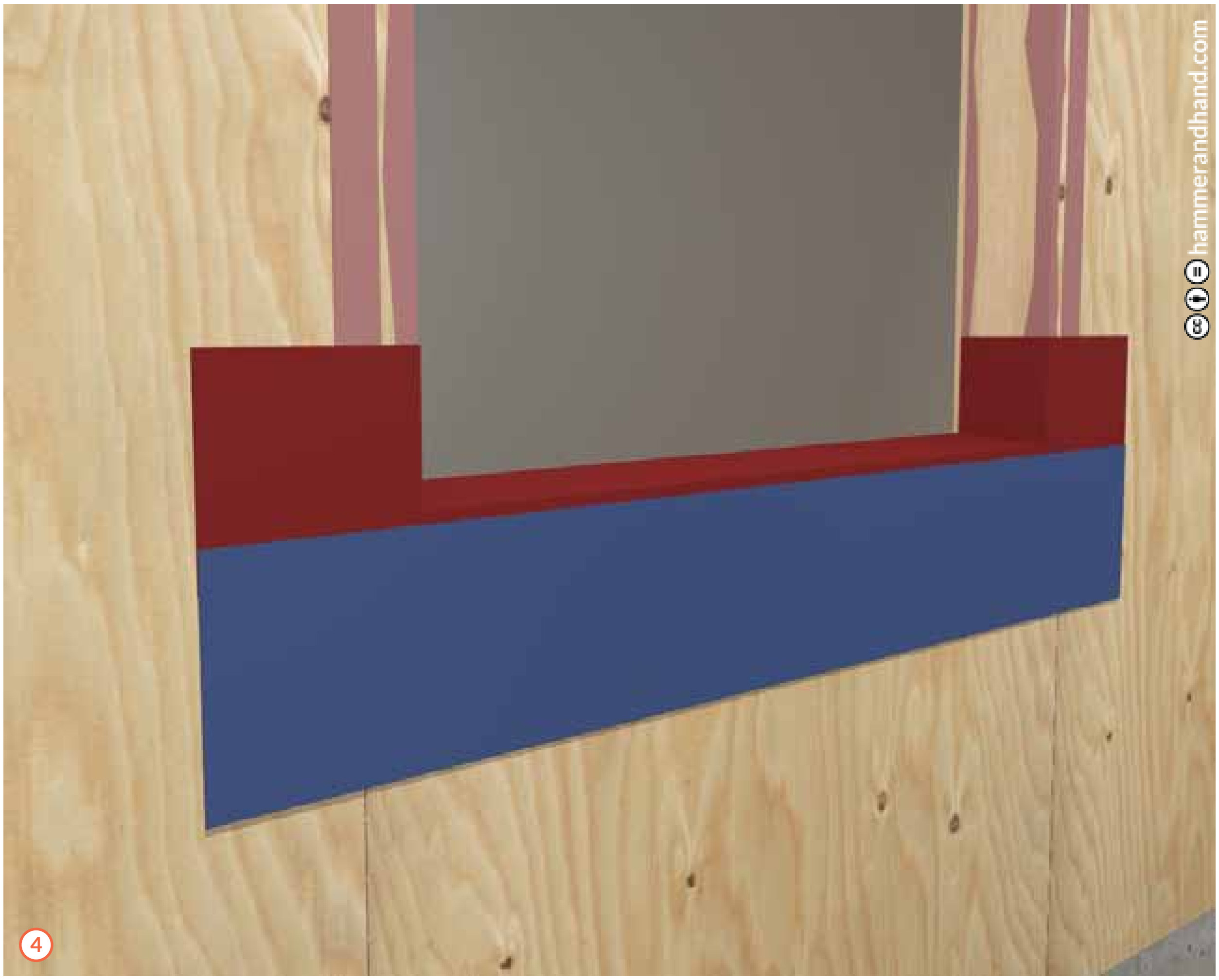
- Router or sand the rough opening (RO) to make clean edges for applying fluid flashing.
- Pass over outer edges with sand paper to get rid of any inconsistencies.
- ROs should be 1" larger than window dimensions, both width and height. If space requirements are not met, square or fix before continuing.

- Slope the sill using beveled siding or a wedge.
- Apply Joint & Seam Filler to all joints and voids larger than 1/4" that are to be covered in FastFlash.
- Ensure that all nails are set, apply pink Joint & Seam Filler and tool into place.

- Apply FastFlash to sill, extending 9" out from the RO to either side.
- Take care not to FastFlash too far below the RO because the transition strip will become embedded on contact and the water-resistive barrier (WRB) will not be able to slip underneath.
- Recommended: spread FastFlash 2" down from the bottom of the RO.

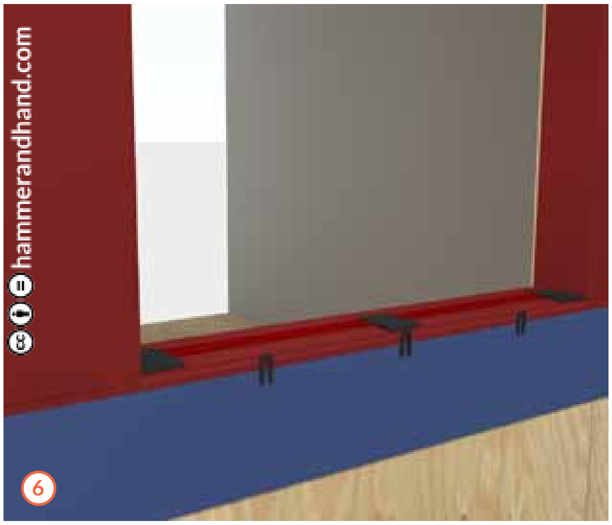
3

Transition Strip Installation:



- Install transition sheet.
- Must extend down from sill at least 4” farther than FastFlash to adequately lap over WRB to be installed later.

- FastFlash around the rest of the RO and tool over top edges of transition strip to avoid reverse lapping.



- Provide complete, level support for windows, where framing allows, by installing plastic or decay-resistant wood shims.
- Use horseshoe shims to hold window flange off of the sheathing so water can drain if the window fails.
- RECOMMENDED: 1/16 or 1/8" horseshoe shims.

- Insert window in RO and fasten according to manufacturer's specifications.

- Apply Joint & Seam Filler to head and side flanges and tool. For special cases where flanges must be taped for warranty purposes seek additional guidance for suitable alternative.
- NEVER seal the sill.

3

Interior View

- Insert backer rod.

- Apply sealant on top of the backer rod and tool into place (see Sealant Joints section).

- Slide WRB under transition strip.

- Apply WRB around window.

- Complete WRB face, lapped.
- Make sure WRB is lapped over the built-in flashing at the top of the window and taped.

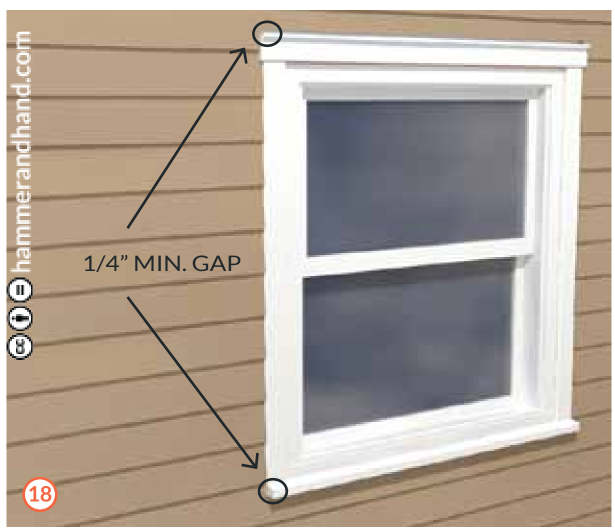
- Install trim.

Note: See alternate rain screen head flashing detail in section 4.2 Top of Window.

- Cut a slit in the WRB, fold up, and use tape to hold the flap out of the way while the head flashing is installed.
- Attach head flashing.

- Apply Joint & Seam Filler to the top of the back leg of the head flashing.
- Tool Joint & Seam Filler into place.

- Fold WRB flap back down and tape the slit to prevent water intrusion.



- Attach siding.
- There should be a 1/4" gap between the bottom of the sill trim and the siding underneath for expansion and contraction.

3.2 WINDOW RETROFIT

- Existing conditions to be retrofitted.

- Carefully remove existing trim and try to salvage for use after new window is installed.

- Remove existing window.
- Adjust framing as necessary to make opening square and allow for 1/2" of space around window frame.
- If adding a sloped sill, be sure to account for the height of the sloped sill in addition to the 1/2" of space on each side of the window casing.

- Apply Joint & Seam Filler to corners, intersections, and edges of opening.
- Tool into place.

- Apply FastFlash around inside of opening and extend out as far as possible from opening on face of sheathing.

- Lift up any existing building paper and continue FastFlash out as far as possible.

- When possible, bring FastFlash out over the top of siding for continuous lapping (shown with window installed).

- Use shims to leave a space between the bottom flange and building frame to allow drainage in case of window failure.
- 1/16” to 1/8” horseshoe shims are recommended.

- Install window in RO and fasten per manufacturer specifications.

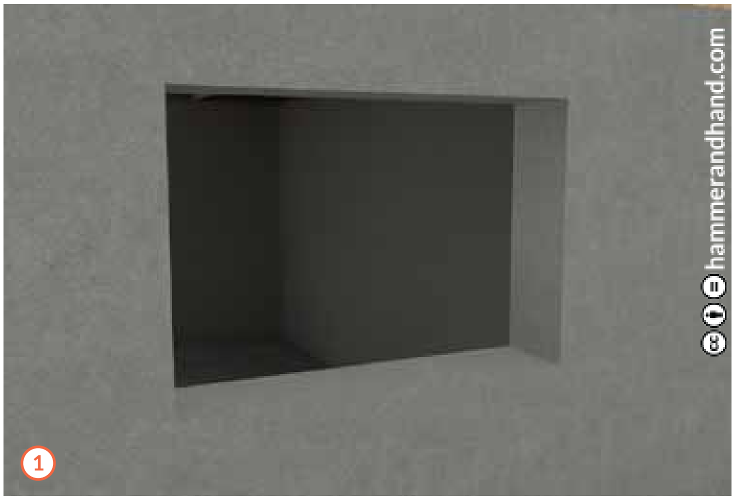
- Bead and tool Joint & Seam Filler along top window flange to prevent water intrusion.
- Optional (pictured): Apply Joint & Seam Filler to jambs as well, but NEVER to sill.

- Install head flashing to protect the trim.

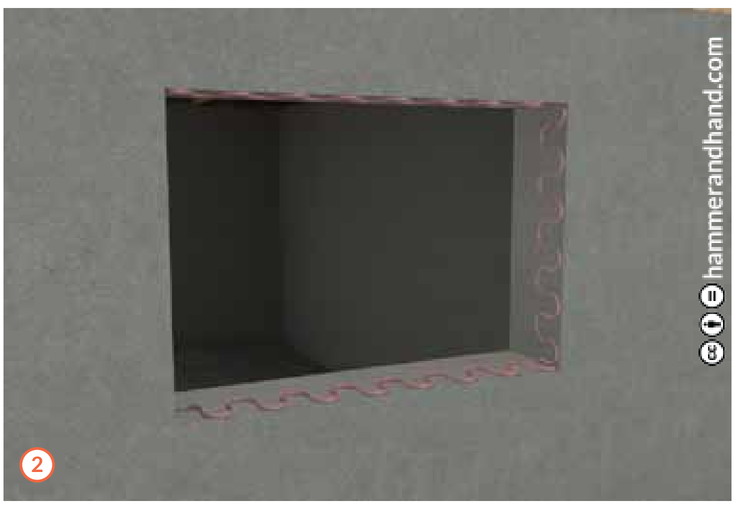
- Complete the window retrofit by fitting trim and caulking around edges where the trim meets the siding on the sides, but NEVER the bottom.
- Kerf bottom of sill trim with a 3/16" drip edge.

3

3.3 WINDOW BUCK IN A MASONRY WALL



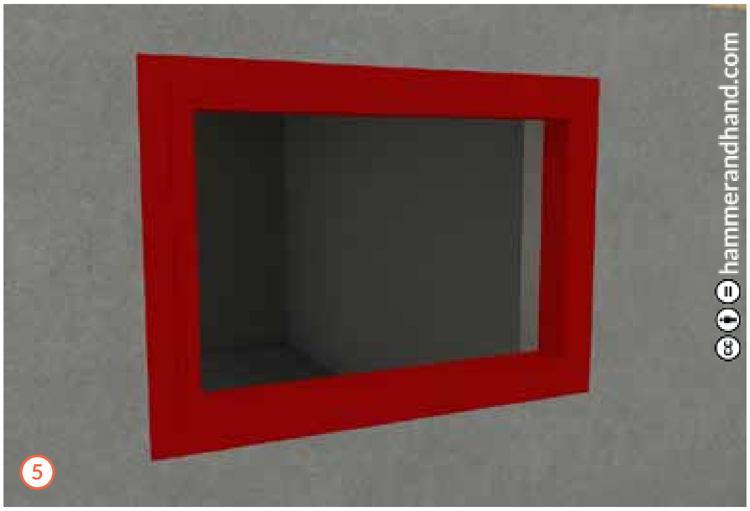
- Rough opening.



- Apply Joint & Seam Filler to the opening where the buck will be installed.

- Screw window buck into masonry opening.

- Use Joint & Seam Filler to seal around the installed window buck.
- Also apply to corners and seams where the pieces of the buck come together.



- FastFlash the buck from the inside edge of the sill to the building face.
- Extend FastFlash out from opening as wide as the trim to be installed.

- Install window in FastFlashed RO.

3

Interior View

- Insert properly sized backer rod, taking care not to puncture or damage it.

- AirDam over the backer rod and tool the joint.

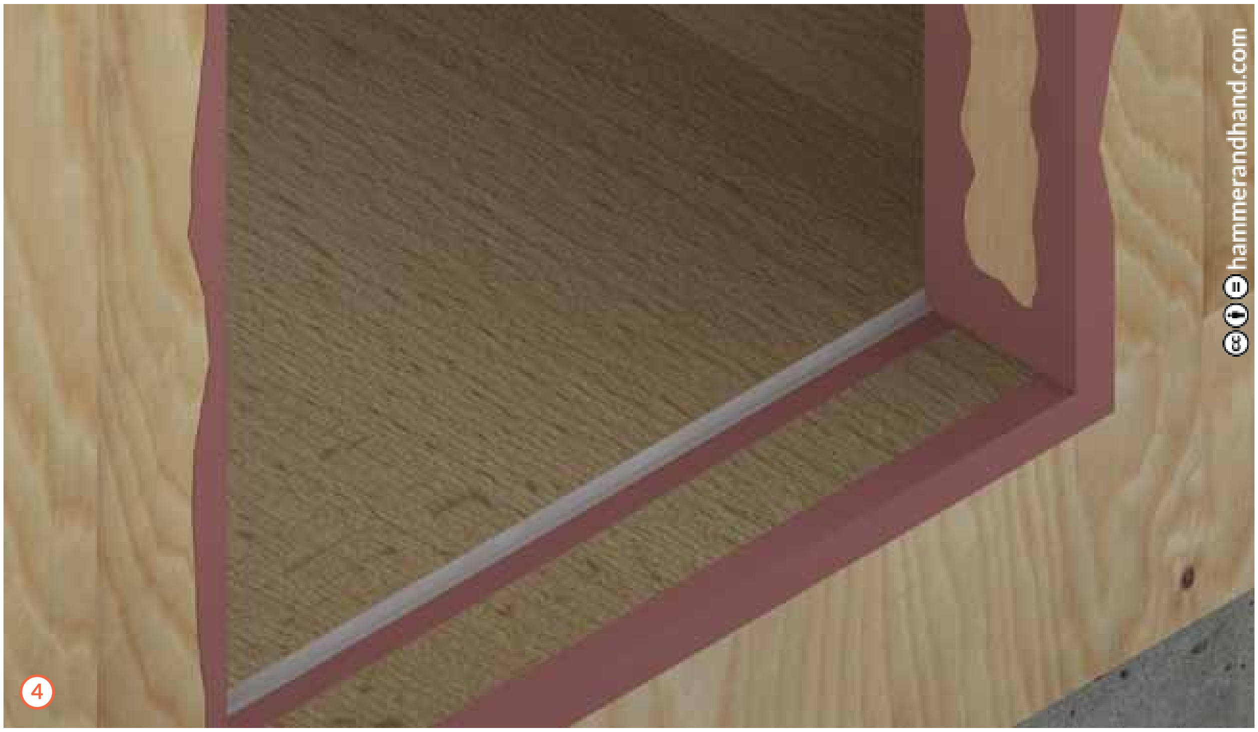
3.4 DOOR INSTALLATION

- Router the RO to make clean edges for applying fluid flashing.
- Pass over outer edges with sand paper to get rid of any inconsistencies.
- ROs should be 1” larger than door width dimensions and 1/2” larger than height.
- Make sure sill is flat and level.
- Make sure opening is square and plumb.

- Apply Joint & Seam Filler to all joints to be covered in FastFlash.
- Ensure that all nails are set, apply Joint & Seam Filler and tool into place.

- Tool Joint & Seam Filler.

L-Metal Installation

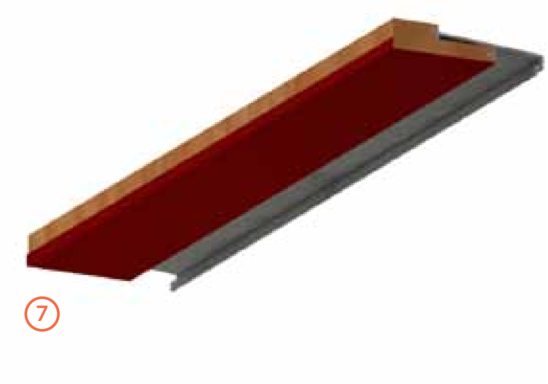


- Set L-Metal into bed of Joint & Seam Filler.

- Apply another bed of Joint & Seam Filler over L-Metal to form a continuous barrier.

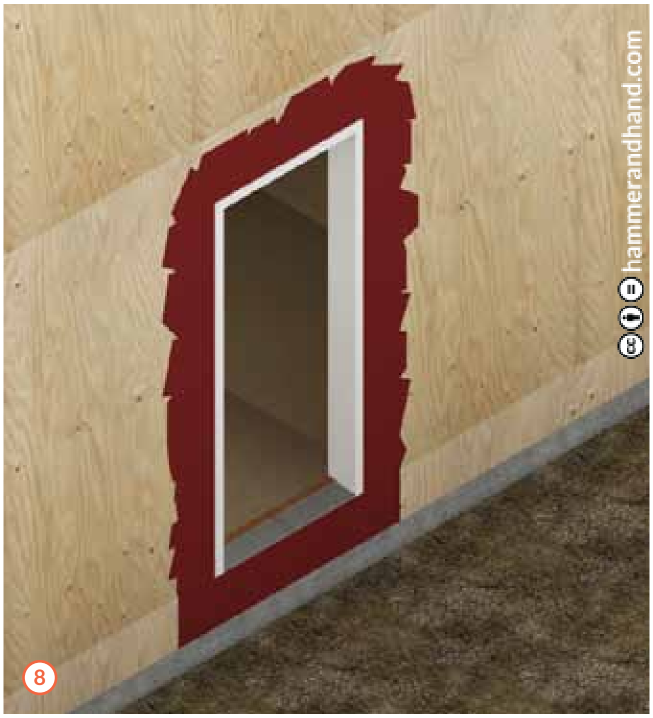
3

Applying FastFlash



- When installing a wood door threshold, coat the bottom of the threshold with FastFlash. Alternatively, the height of the rough opening can be sized slightly larger and composite shims can be used to elevate the wood threshold off of the sill.

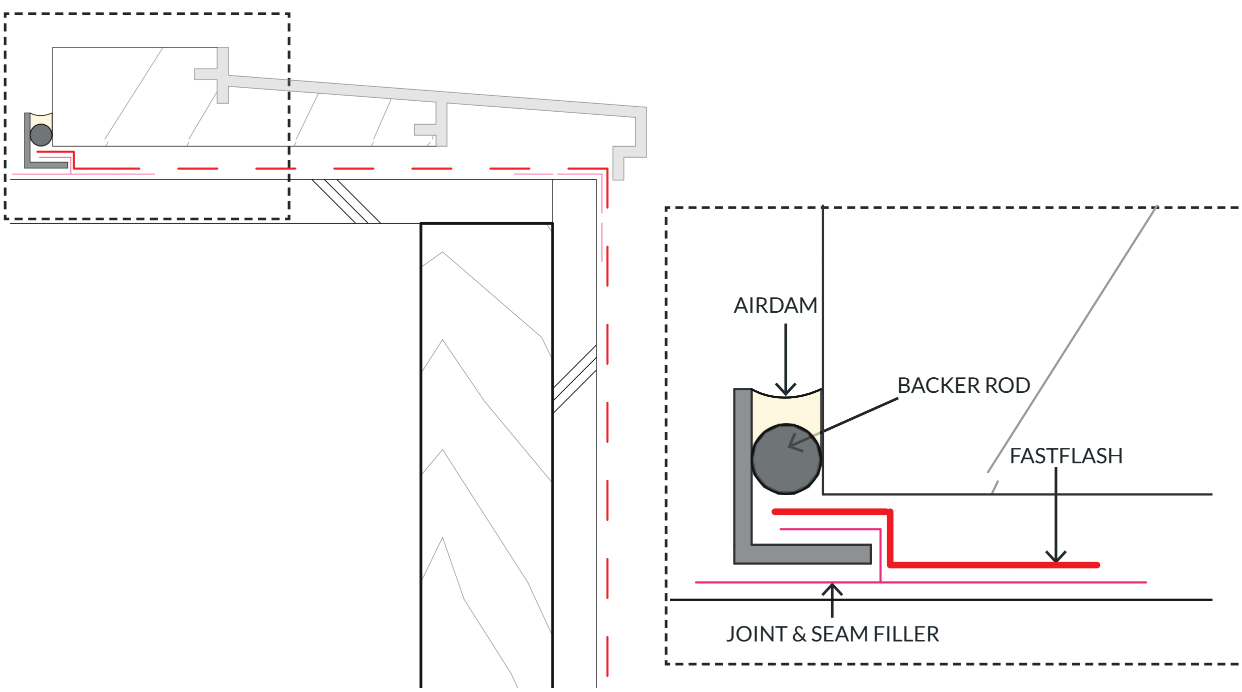
- Apply FastFlash to sill, extending 9” out from the RO to either side.



- Install door threshold and sill.
- Fasten accordingly to manufacturer’s specifications.

Interior View

- Insert backer rod and sealant between L-Metal and door sill and tool into place.



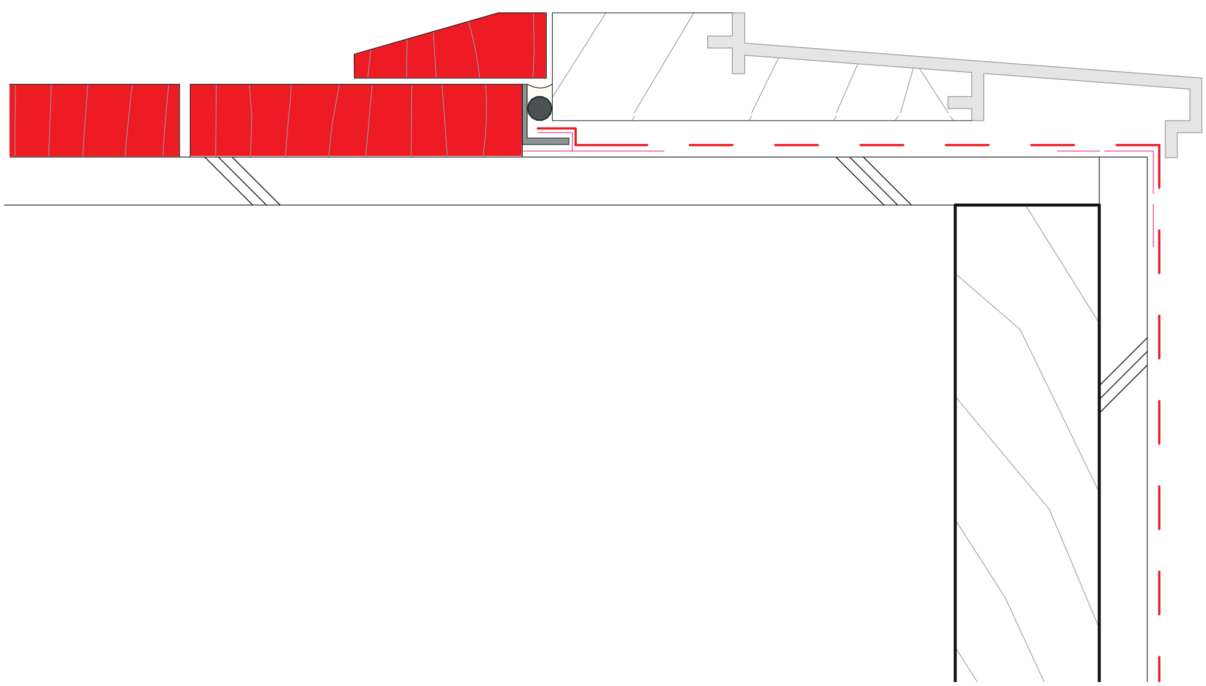
Note: If the threshold is subject to moisture, the door needs to sit on a resilient shim material.

Interior View

- Insert properly sized backer rod, taking care not to puncture or damage it.
- Make continuous around door frame.

- AirDam over the backer rod and tool the joint.

- After interior flooring is installed, finish door with trim piece to hide sealant.



BEST PRACTICE DETAILS STEP-BY-STEP

RAIN SCREENS

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INTRODUCTION TO RAIN SCREENS

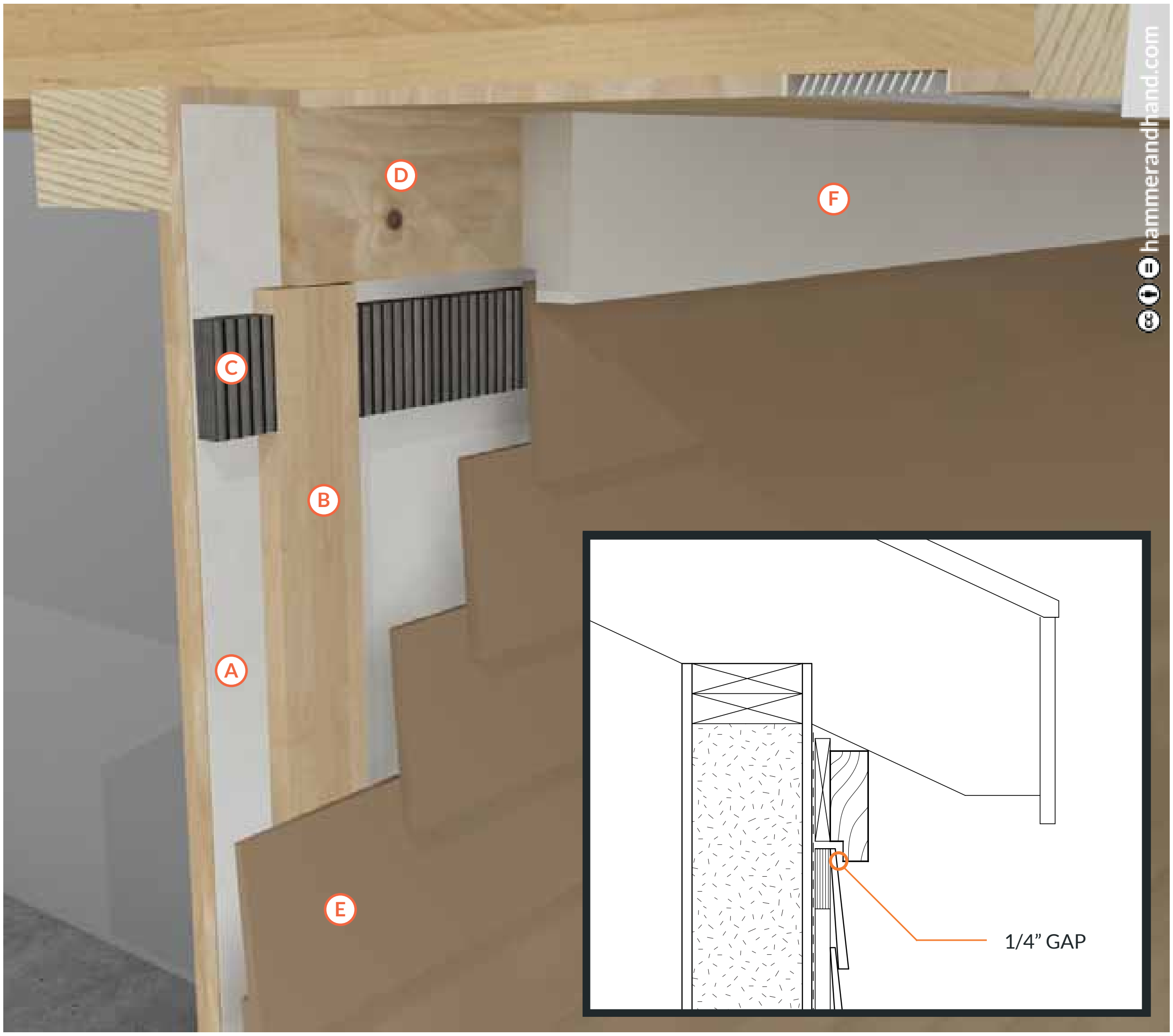
Built right, rain screens are vital to modern construction in our Pacific NW climate. They are also poorly named with multiple definitions. At Hammer & Hand, when we say "rain screen" we are referring to the ventilated rain screen, with that all-important ventilated cavity between cladding and the rest of the wall assembly. That cavity serves two functions for the exterior wall assembly:

1. **The cavity helps protect the wall from water intrusion.** By separating the cladding from the face of the wall assembly, the rain screen cavity interrupts capillary action into the assembly and provides a drainage plane for bulk water to drain away harmlessly.

Note: we also include a WRB (water-resistive barrier) inboard of the cavity to provide a final line of defense against bulk water intrusion.

2. **The cavity helps wall assemblies dry out.** When ventilated properly, with a minimum 1/4" gap to the exterior at bottom and top of the rain screen and a minimum 3/8" deep vertical cavity in between, the volume of air passing through the rain screen cavity can be measured in the 10s, even 100s, of air changes per hour. This dramatically increases the assembly's drying potential and resiliency. This is good, particularly for highly insulated walls which by design decrease airflow and thermal transfer across the assembly, reducing the assembly's capacity to dry. The drying action of the ventilated cavity behind the rain screen helps to counteract this limitation, promoting building durability.

4.1 TOP OF WALL



A. WRB (WATER-RESISTIVE BARRIER)
B. FURRING
C. COR-A-VENT SV-5
D. TRIM BLOCKING
E. CLADDING
F. TRIM

- When the WRB is complete and lapped correctly, the rain screen installation begins.

- Install vertical furring to correspond with the framing method (aligned with vertical framing members).
- Use untreated 1x4 furring.

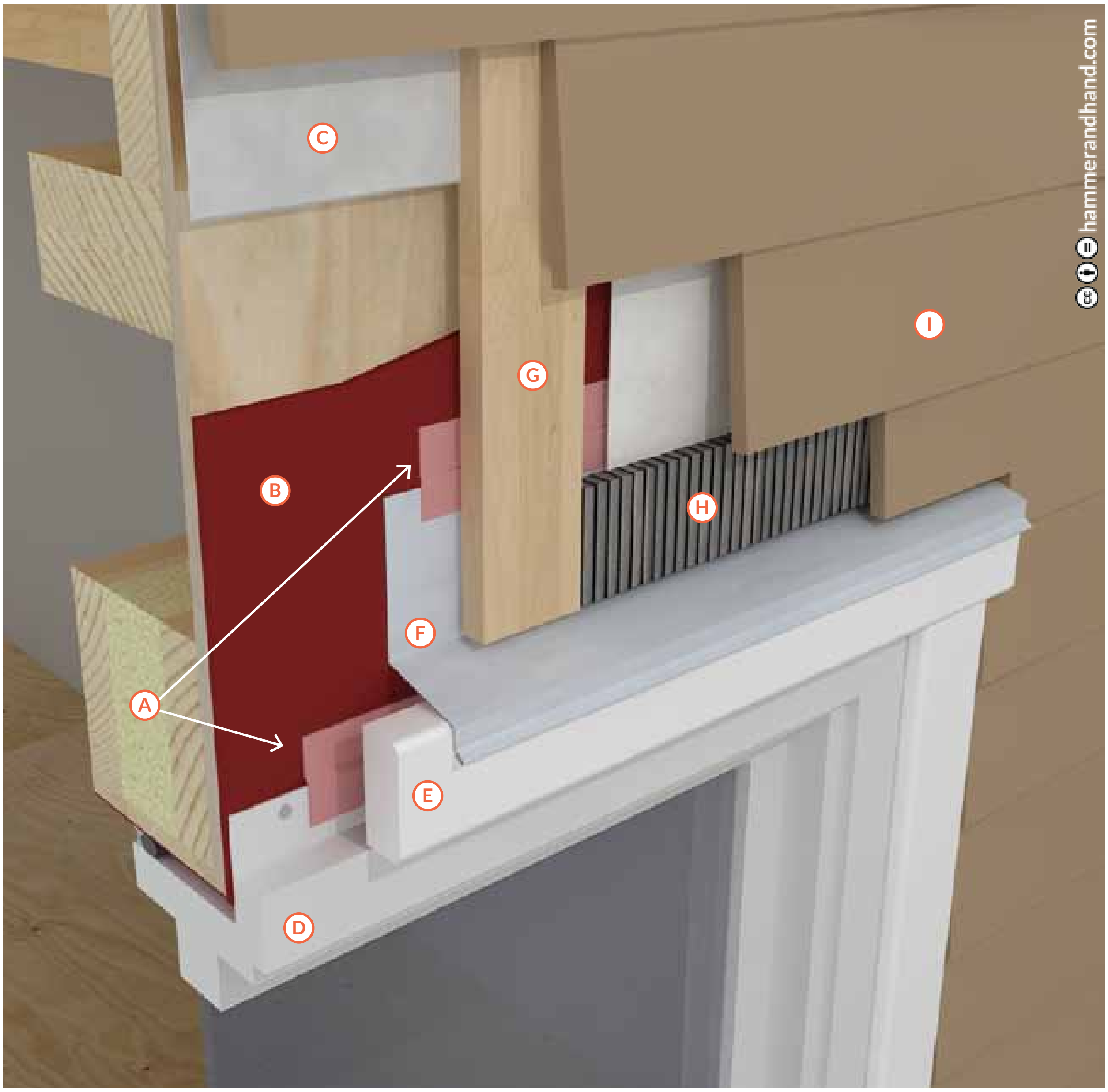
- Attach Cor-A-Vent SV-5 insect blocker strip between furring.

- Attach siding.

- Install blocking to attach the rabbeted trim to.

4

4.2 TOP OF WINDOW



A. JOINT & SEAM FILLER
B. FASTFLASH
C. WRB (WATER-RESISTIVE BARRIER)
D. INSTALLED WINDOW
E. TRIM
F. HEAD FLASHING
G. FURRING
H. COR-A-VENT SV-5
I. CLADDING

- Layer on WRB. Layer in a shingle method starting at the bottom and lapping top over bottom piece.

- Install vertical furring to correspond with the framing method (aligned with vertical framing members).
- Use untreated 1x4 furring.

- Install trim.

- Cut a slit in the WRB, fold up, and use tape to hold the flap out of the way while the head flashing is installed.
- Attach head flashing.

- Apply Joint & Seam Filler to the top of the back leg of the head flashing.
- Tool Joint & Seam Filler into place.

- Fold WRB flap back down and tape the slit to prevent water intrusion.

- Attach remaining rain screen furring above head flashing.

- Install Cor-A-Vent above the window.

- Complete rain screen by installing siding.

4.3 BOTTOM OF WINDOW

A. WRB (WATER-RESISTIVE BARRIER)
B. TRANSITION STRIP
C. SHIMS SUPPORTING WINDOW
D. INSTALLED WINDOW
E. FURRING
F. COR-A-VENT SV-5
G. TRIM
H. CLADDING

- Layer on WRB. Layer in a shingle method starting at the bottom and lapping top over bottom.

- Install vertical furring to correspond with the framing method (aligned with vertical framing members).
- Use untreated 1x4 furring.

- Cut pieces of Cor-A-Vent SV-5 to fit flush in between furring below window.

- Attach trim.
- Can be nailed to furring.

- Install siding to complete the rain screen.

4.4 BOTTOM OF WALL

A. WRB (WATER-RESISTIVE BARRIER)
B. FURRING
C. COR-A-VENT SV-5
D. WATER TABLE
E. FLASHING
F. CLADDING

- Layer on WRB.

- Seal sheathing to stem wall with Joint & Seam Filler.

- Install vertical furring to correspond with the framing method (aligned with vertical framing members).
- Use untreated 1x4 furring.

- Attach a continuous strip of Cor-A-Vent SV-5 insect blocker at bottom of furring.

- Attach water table to furring.

- Install flashing above water table.

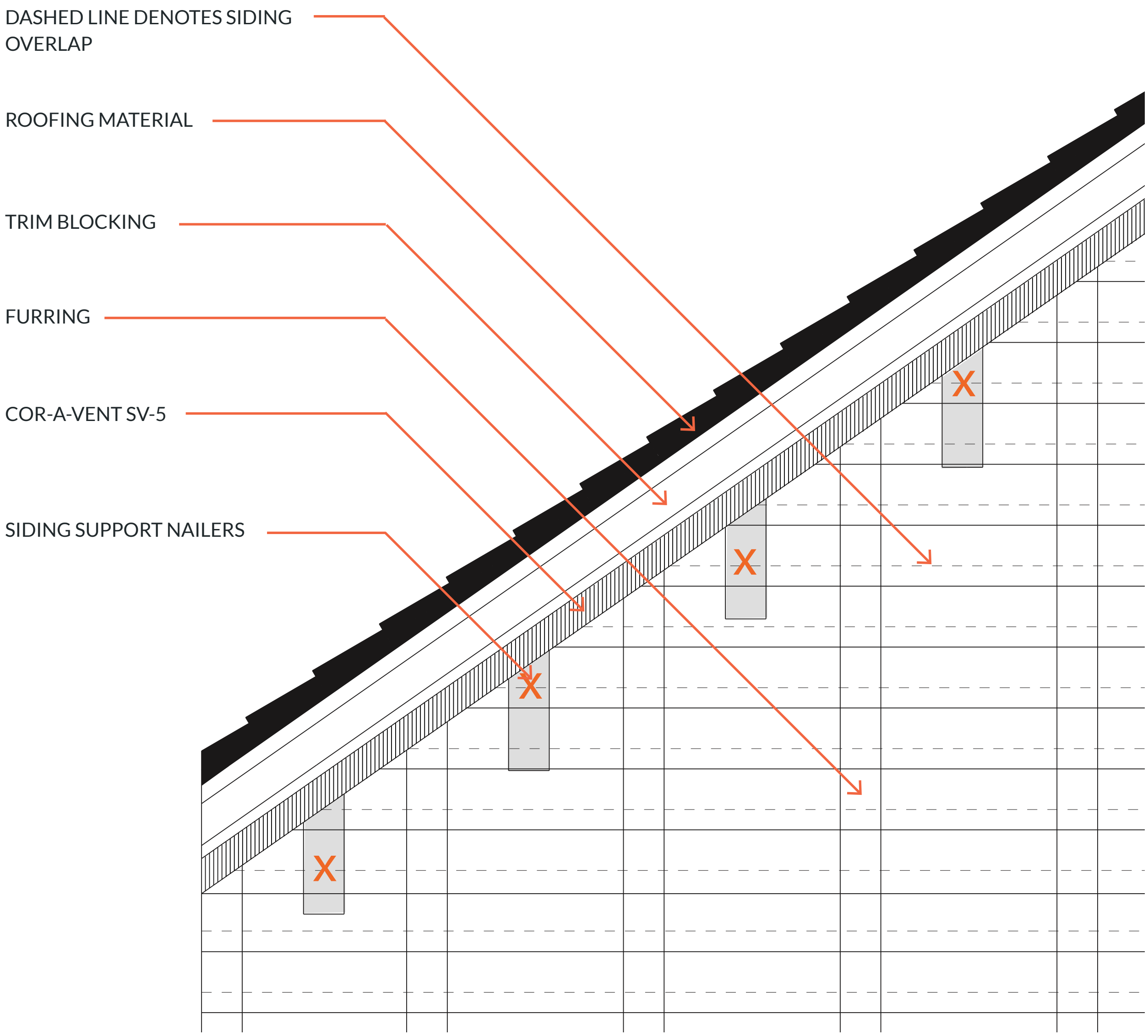
- Install siding to complete the rain screen.

4.5 GABLE END

A. ROOFING MATERIAL
B. FLASHING
C. WRB (WATER-RESISTIVE BARRIER)
D. FURRING
E. BLOCKING FOR RABBETED TRIM
F. COR-A-VENT SV-5
G. CLADDING

On Gable Ends

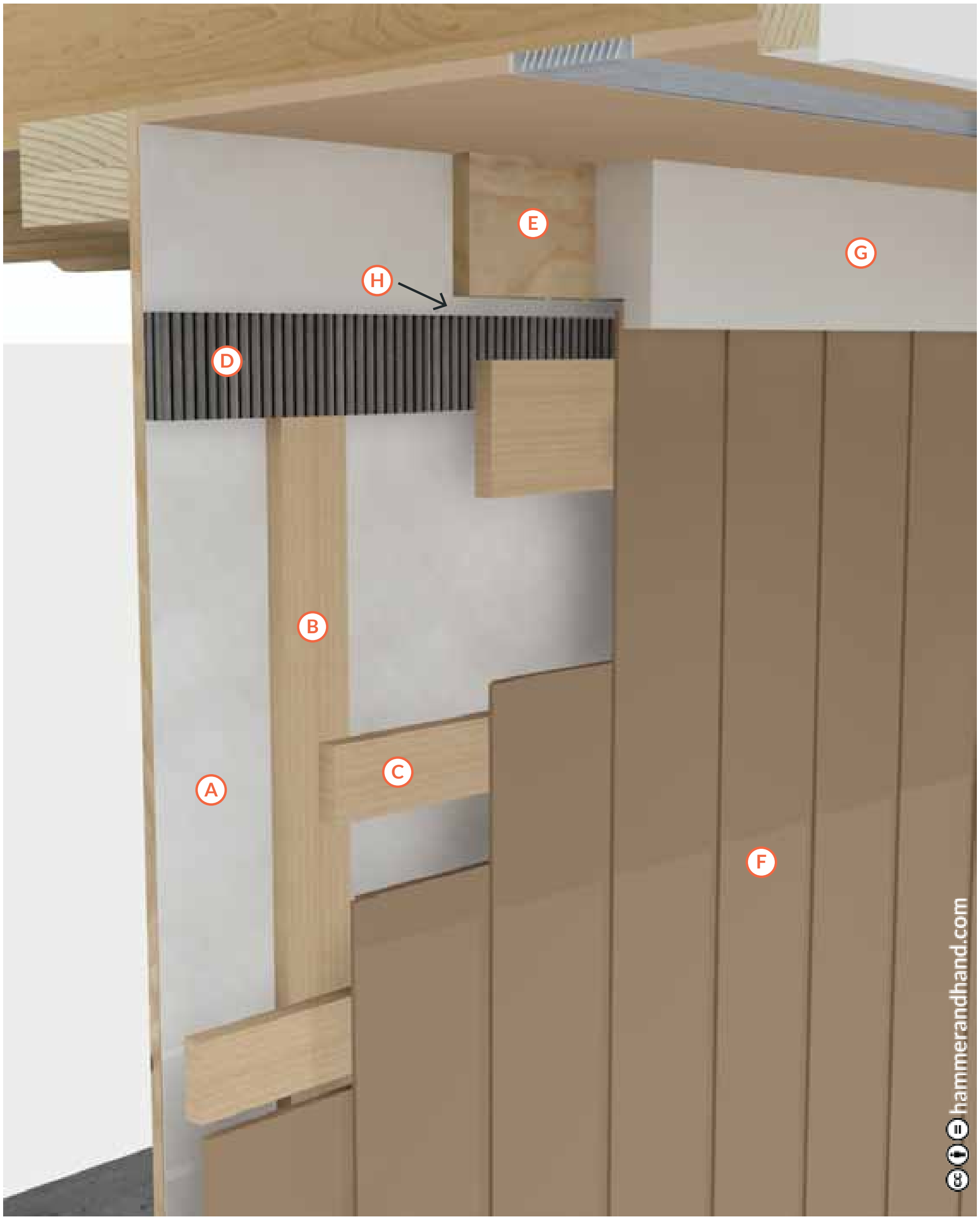
At the sloped angle of the roof where the siding will terminate, attach small segments of furring in between full pieces. This provides support for the ends of the lap siding where it does not meet regular furring.



X'S SHOW SOME INSTANCES IN THE DIAGRAM WHERE LAPPED SIDING IS ATTACHED TO NAILER.

4.6 HORIZONTAL RAIN SCREEN FURRING FOR VERTICAL SIDING

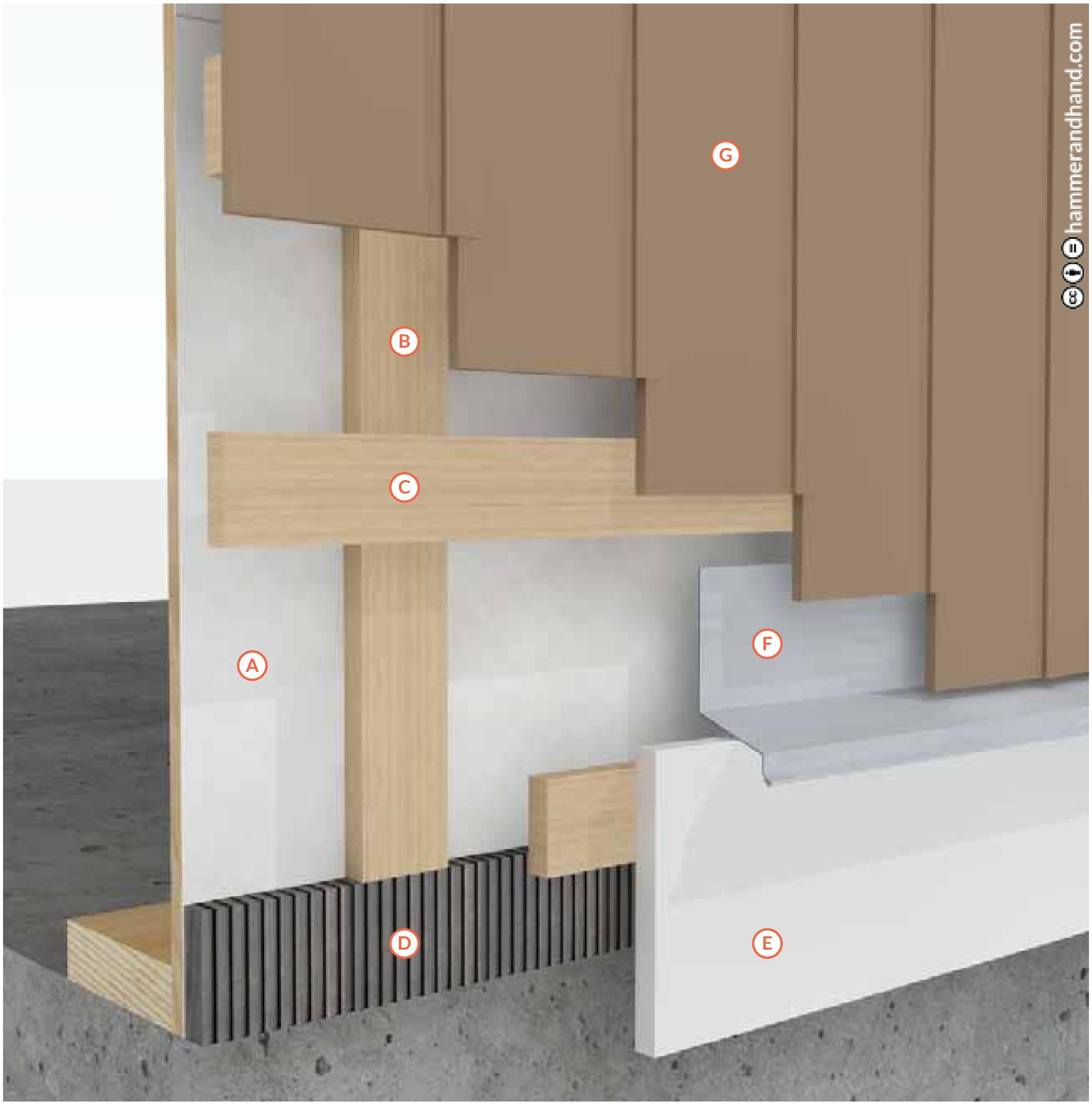
Top of Wall Reveal



A. WRB (WATER-RESISTIVE BARRIER)
B. VERTICAL FURRING
C. HORIZONTAL FURRING
D. COR-A-VENT SV-5

E. BLOCKING FOR RABBETED TRIM
F. CLADDING
G. TRIM
H. MAINTAIN QUARTER INCH GAP

Bottom of Wall Reveal



A. WRB (WATER-RESISTIVE BARRIER)
B. VERTICAL FURRING
C. HORIZONTAL FURRING
D. COR-A-VENT SV-5
E. WATER TABLE ATTACHED TO HORIZONTAL FURRING
F. FLASHING FOR WATER TABLE
G. CLADDING

- Rain screen installation begins after the WRB is properly lapped and in place.

- Install vertical furring to correspond with the framing method (aligned with vertical framing members).
- Use untreated 1x4 furring.

- Install horizontal furring to allow attachment of vertical siding.
- Use 1x4 furring.
- Nail on blocking for rabbeted trim, leaving space for Cor-A-Vent SV-5.

- Install a continuous strip of Cor-A-Vent SV-5 at top and bottom of the rain screen to prevent bug entry.

- Attach water table.

4

- Install flashing for water table.

- Attach vertical siding and then trim.

BEST PRACTICE DETAILS STEP-BY-STEP

ENVELOPES

Note to Hammer & Hand field staff:

High risk projects such as basement remodels, parapet walls, pool rooms, etc. require further analysis.

Manufacturer's installation instructions and architect's construction drawings and specifications always take precedence over the details in this Best Practices Manual. Any discrepancies with this manual should trigger discussion with the architect about alternative approaches to their detailing. However, any alterations to architect's plans must be approved by the architect and such approval memorialized in an SK, ASI, RFI or other contractual method.

INTRODUCTION TO BUILDING ENVELOPES

The building envelope is arguably the single most important determinant of building durability, energy efficiency, and occupant comfort and health. We deliver these qualities to our buildings by carefully managing heat, air, and moisture through envelope assemblies. Put simply, we want to limit the movement of air and heat through our assemblies, limit the intrusion of moisture, and promote drying of any moisture that does intrude. The interplay between heat, air, and moisture is extremely dynamic, however, and a full understanding of that interplay in any given assembly can require extensive analysis. Nonetheless, a couple core principles can guide much of our work:

1. Start by making it airtight. If you control for air, you also make major strides in controlling for heat and moisture. This is because much of the movement of heat and moisture into and through building assemblies is carried by air. When we stop air movement through our assemblies we also stop this air-borne problem.

2. Avoid condensation where it hurts. Condensation forms where relative humidity – a function of moisture concentration and air temperature – hits 100%, aka the "dew point." Relative humidity can reach the dew point when (1) moisture concentration increases in a given volume of air to the point where it surpasses the air's capacity to hold that moisture in suspension, or (2) when air temperature decreases, reducing the air's capacity to hold moisture in suspension. Major problems, including building failure, arise when the dew point occurs inside building envelope assemblies where moisture can accumulate. The most likely place for this to occur is on the surface of a building component in an assembly. Warm concentrations of moisture, carried by air or moved via vapor drive (the diffusion of moisture from areas of higher concentration to areas of lower concentration), hit a cold surface and the moisture drops out of suspension and condenses on the surface. Therefore, our assemblies must be designed and built to prevent concentrations of moisture from hitting surfaces that are cold enough to cause this condensation inside our assemblies. Furthermore, when working with materials that are subject to mold growth we need to include an additional safety factor in assembly design, as mold grows at relative humidity levels even lower than 100%.

5.1 WALL PENETRATIONS

Built right, a building's exterior wall is a comprehensive system for protecting the building from the elements and for managing heat, air, and moisture. So when we punch a hole through this system we must proceed with caution, ensuring that we maintain the integrity of the building envelope. A moisture management system is only as strong as its weakest link.

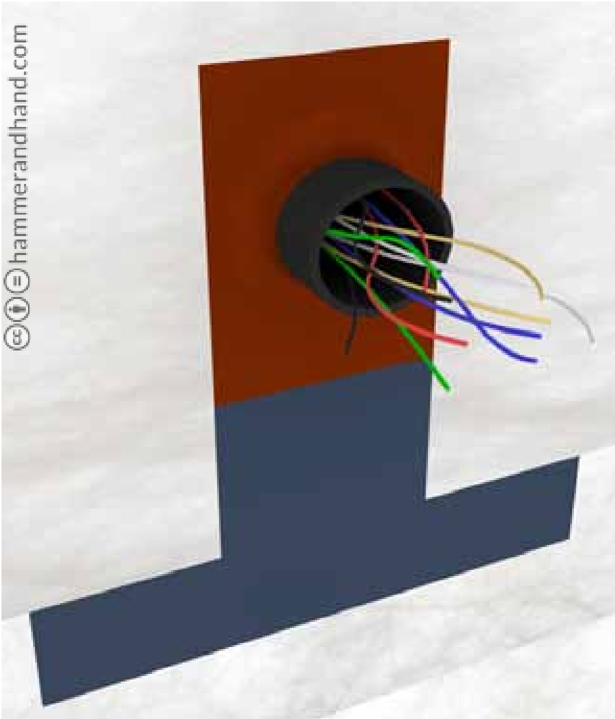
A. It is Critical That No Wall Penetrations are Overlooked

Proper planning and sequencing will ensure that every penetration is correctly detailed. The following is a list of various wall enclosure penetrations that are frequently encountered on a project:

- Electrical service and meter.
- Exterior electrical outlets and lighting.
- Telecommunications and miscellaneous low voltage (cable, phone, satellite dish mounts, etc.).
- HVAC (electrical, refrigerant lines, combustion piping/flues, exhaust and intake ports, condensate drain lines, dryer exhaust vents).
- Natural gas line and meter.
- Hose bibs.

B. Consolidate Wires

Wires should be consolidated into as few penetrations as possible and routed through a plastic pipe that can easily be sealed (shown below). Allow space for future wiring changes to prevent the creation of future wall penetrations.



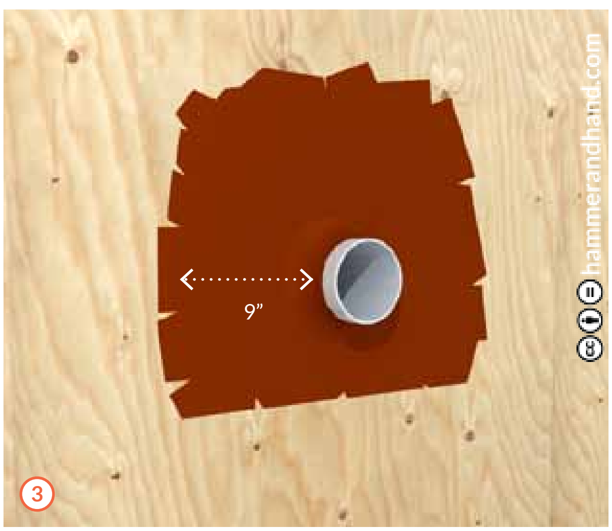
Note:

One of the best methods for sealing around wires inside pipes and conduits is to use a non-hardening duct seal electrical putty. This is especially critical at the electrical panel where the main conduit enters the building.

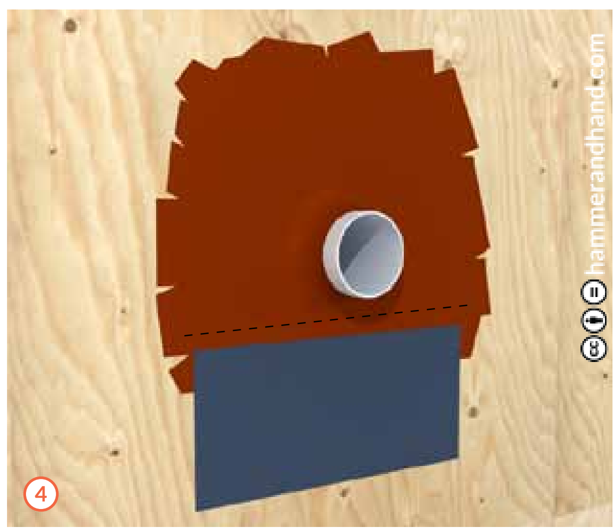
Duct Flashing with a Rain Screen

- Cut hole for duct as tight as possible.
- Space between duct and wall sheathing to be 1/4” or less.

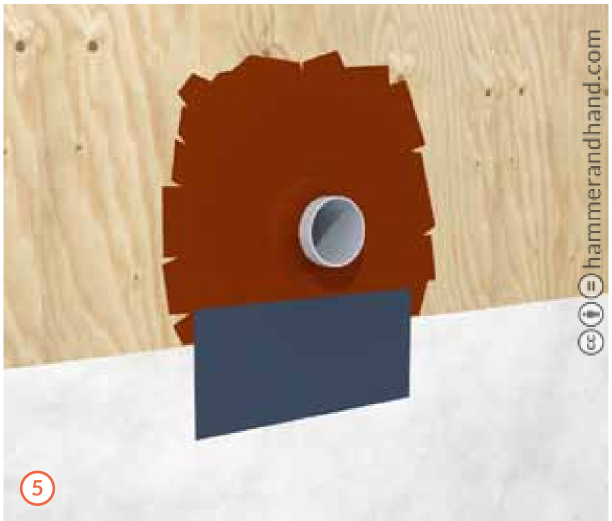
- Apply Joint & Seam Filler.



- Apply FastFlash to a distance of 9” from outer edge of pipe and 2” up the sides.
- Only extend downward slightly so FastFlash does not adhere to the back side of the transition strip.



- Stick top edge of transition strip membrane to FastFlash.
- Bead and tool FastFlash to the top edge of transition strip.



- Slip WRB under transition strip for correct lapping.

- Attach furring for rain screen.
- Include strips for vent hood blocking.

- Secure vent hood trim block.

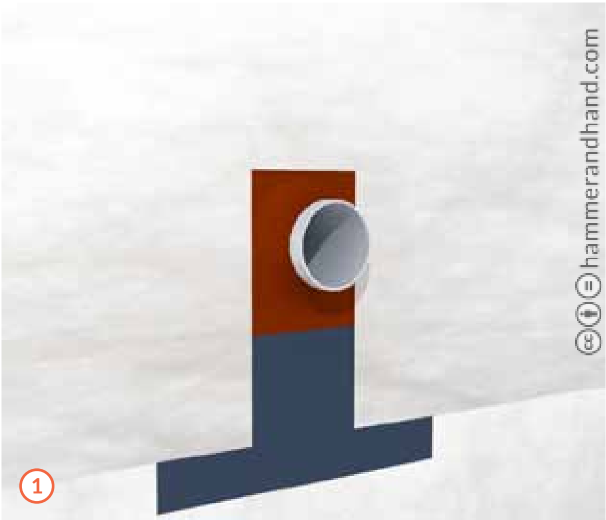
- Install metal flashing at top of block.
- Apply fluid flashing at top of flashing back leg.

- Attach flashing to vent hood blocking strips.

- Attach vent hood.

- Complete rain screen by adding siding and caulking the sides of the duct blocking, not the top or bottom.

Duct Flashing, No Rain Screen



- Complete up to Step 5 from page 57.

- Secure vent hood trim block.

- Attach vent hood.

- Carefully cut back WRB to attach flashing for trim block.

- Apply Joint & Seam Filler at the top of the flashing and tool into place.

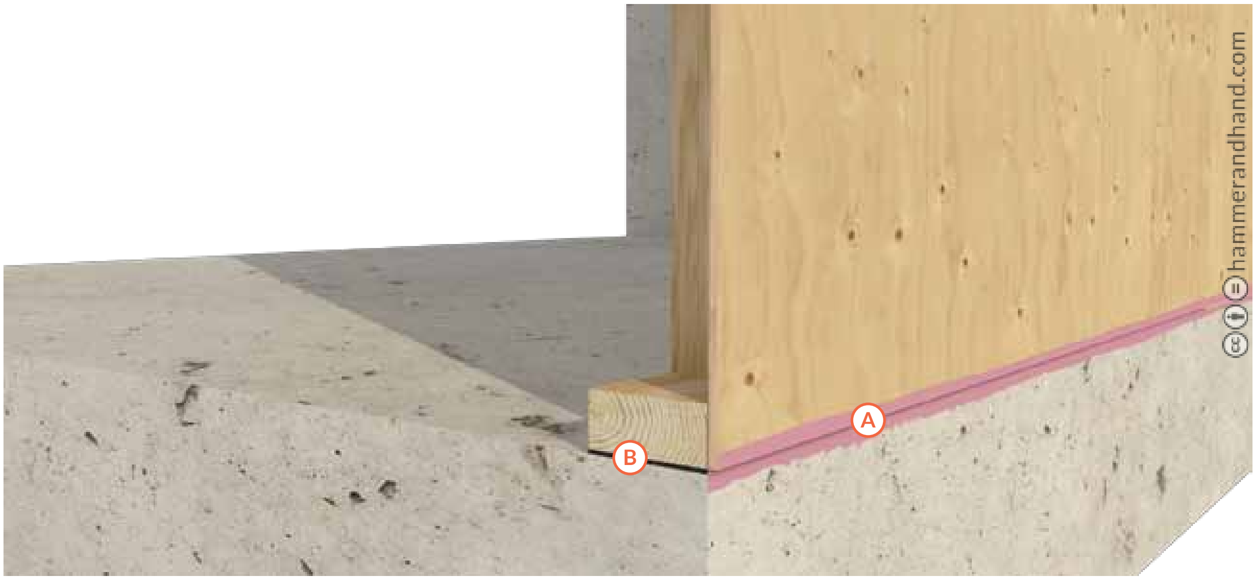
- Fold down WRB flap and tape slits closed.

- Complete rain screen by adding siding and caulking the sides of the duct blocking, not the top or bottom.

5.2 AIR SEALING

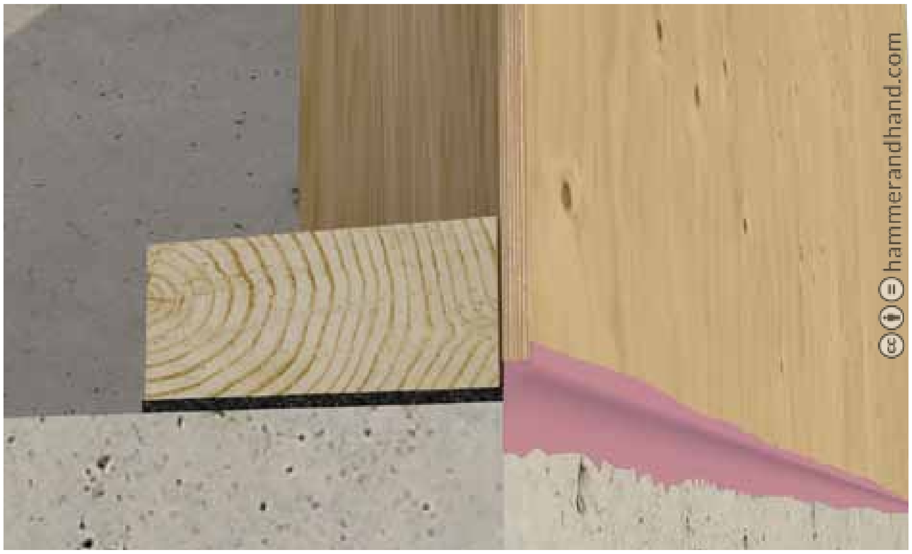
Airtight construction controls the flow of air and therefore the flow of airborne heat and moisture into and through the building envelope. It needs to be approached in a comprehensive manner on all sides of the envelope. The most difficult aspect of air sealing is where dissimilar materials intersect, especially in complex geometry. The details that follow illustrate strategies for tackling some of the most commonly encountered intersections.

Foundation to Sheathing

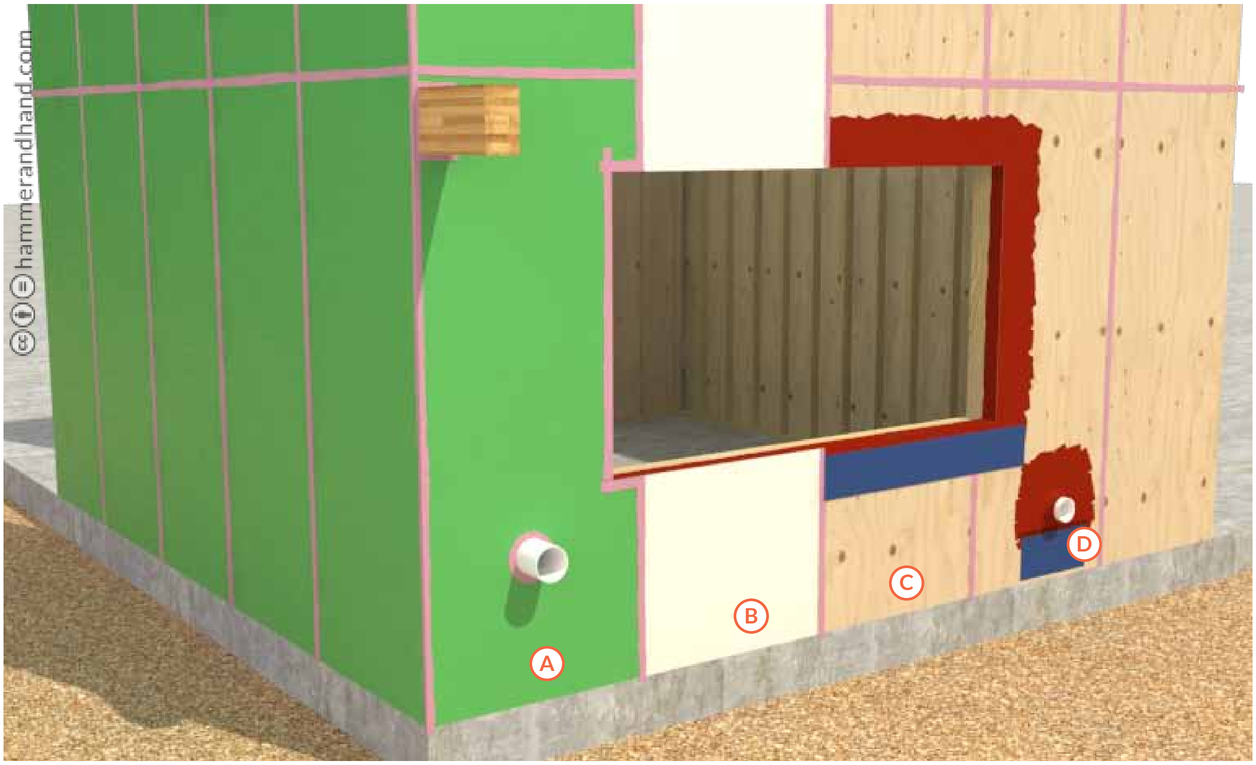


A. JOINT AND SEAM SEALANT OR APPROVED TAPE
B. SILL SEAL

1. To function as air barrier, foundation must be structural reinforced concrete.
2. Prevent sheathing-to-concrete contact.



At Sheathing



Materials

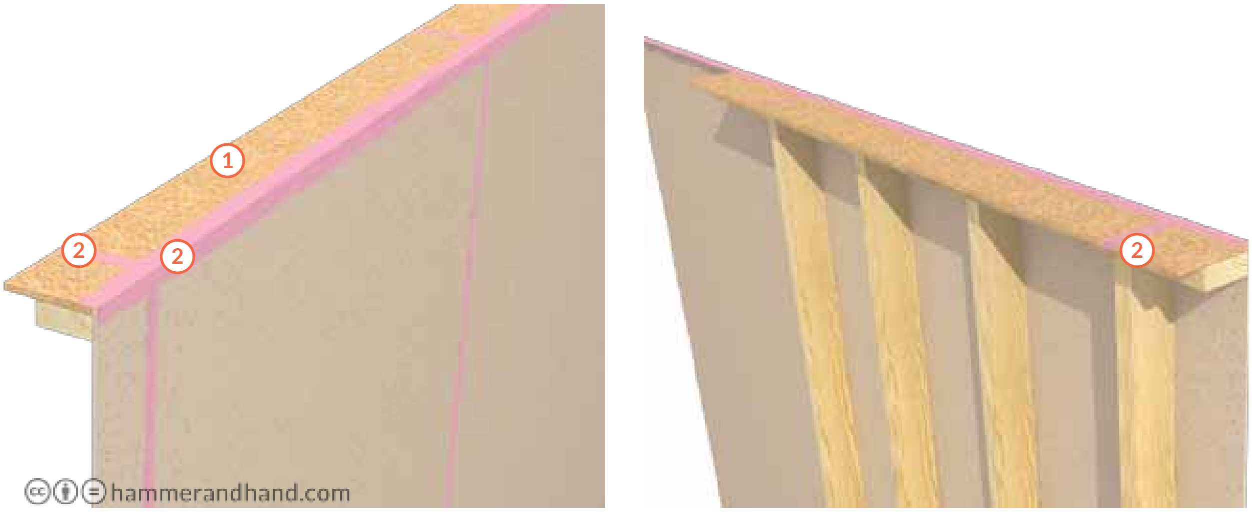
A. RIGID PANEL WITH INTEGRAL WRB (ZIP SHEATHING OR SIMILAR)
Apply approved sealant at all joints, seams, and penetrations.
Apply fluid applied membrane at interior of punched openings.

B. RIGID PANELS WITH FLUID APPLIED WRB
Apply fluid applied system at punched openings, seams, and penetrations.
Cover entire exterior plane of envelope with fluid applied WRB.

C. RAW RIGID PANEL READY FOR FABRIC WRB
Apply fluid applied system at punched openings, joints, and penetrations.
Tile-in fabric WRB product into wet set transition sheets.

D. SEE SECTION 5.1 DUCT FLASHING WITH A RAIN SCREEN

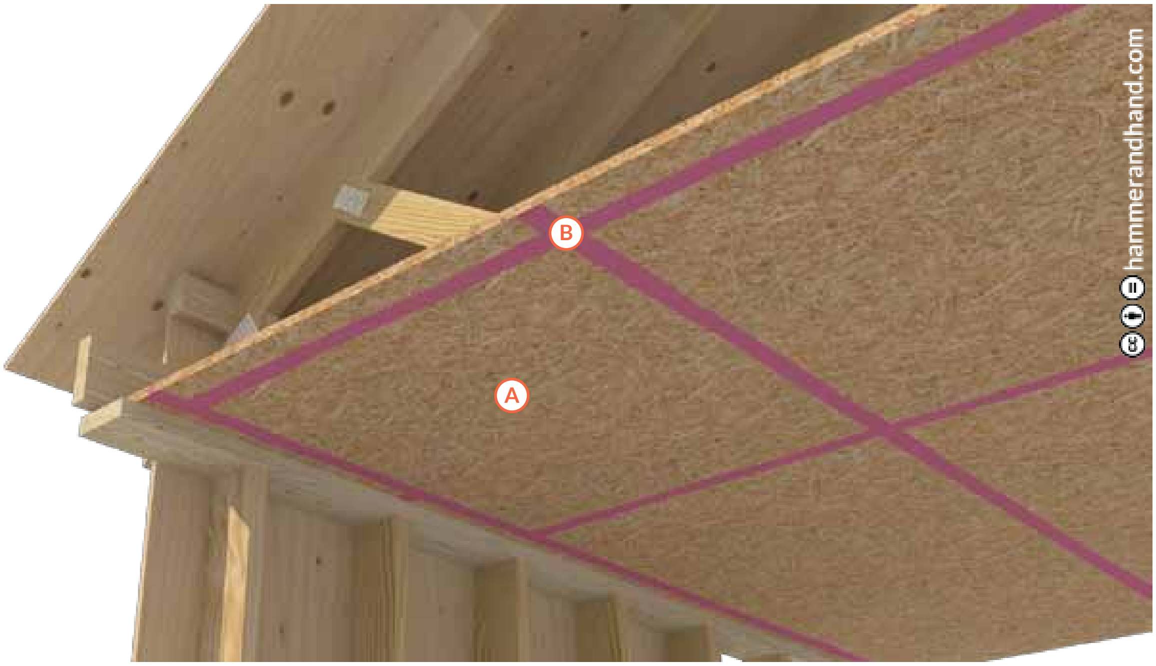
Air Barrier: Exterior Wall Sheathing to Interior Ceiling Transition



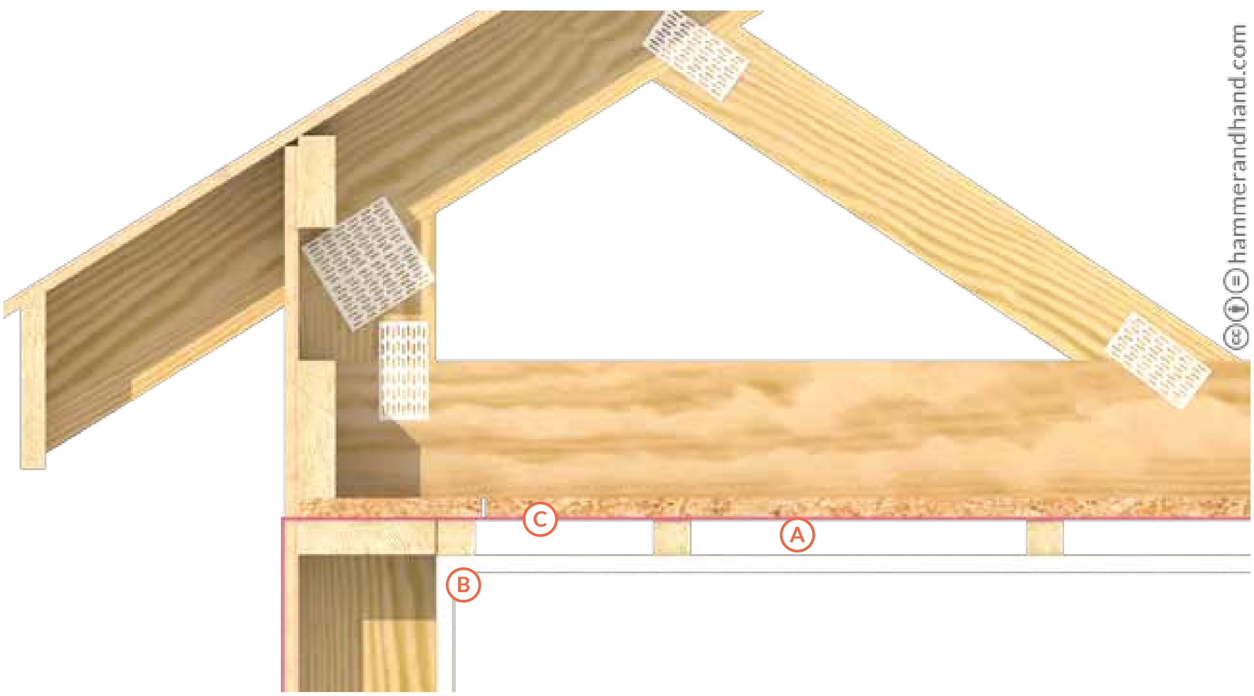
1. Install perimeter rip of rigid panel before ceiling framing/trusses are set, extend past interior edge of top plate a minimum of 1" for flat ceiling over top plate.
2. Seal perimeter rip panel edges prior to setting trusses.
3. For vaulted ceilings extend rigid panel 1/2" past inside of top plate.

5

Wall to Ceiling/Roof

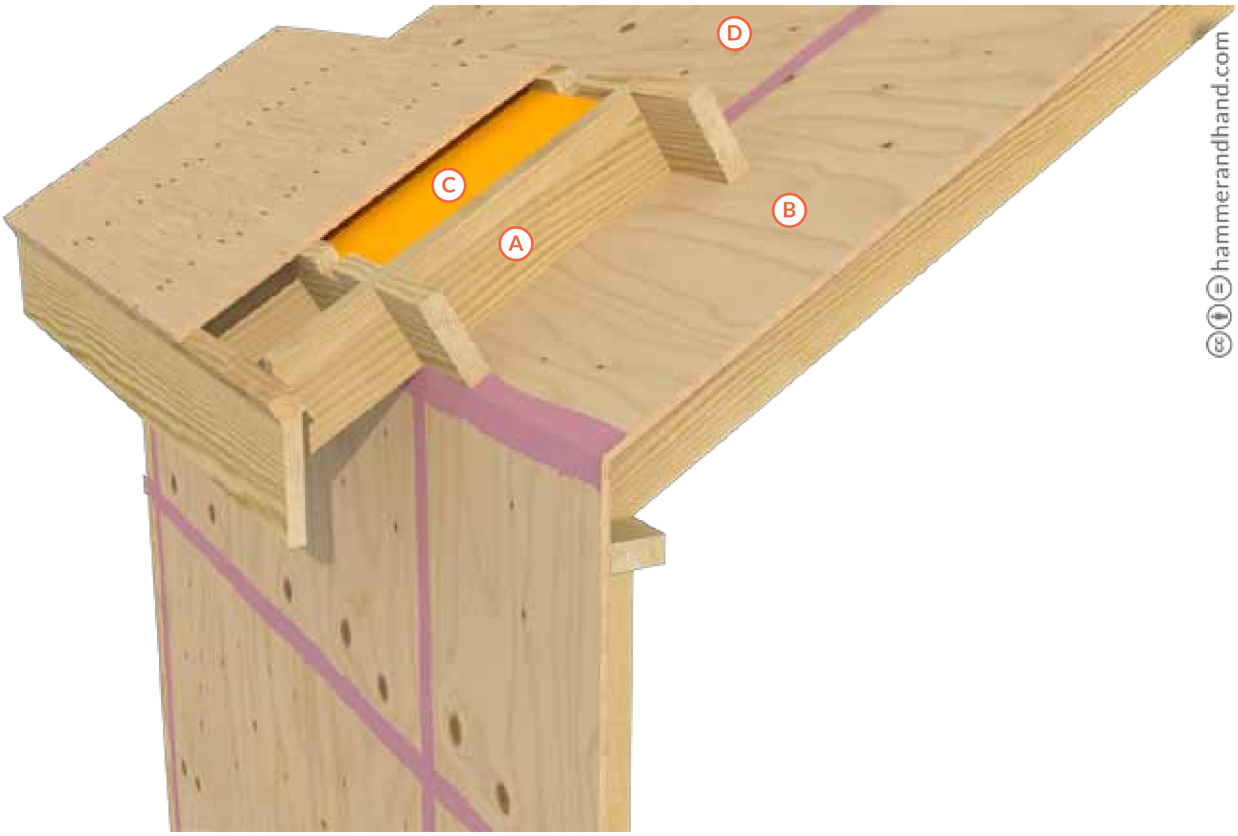


A. AIR BARRIER AT CEILING
B. JOINT AND SEAM SEALANT OR APPROVED TAPE



A. 1.5" SERVICE CAVITY
B. DRYWALL
C. RIGID PANEL WITH SEALANT OR TAPE

If Vaulted Ceiling with Exterior Air Barrier, Seal Wall to Roof Sheathing



A. IF VAULTED CEILING, INSTALL OVERHANGS AS ADDITIONAL FRAMING SYSTEM ABOVE STRUCTURAL SHEATHING.
B. THIS SHEATHING LAYER IS ALSO THE AIR BARRIER AND WILL BE SEALED AT ALL PANEL EDGES.
C. RIGID INSULATION OR MINERAL WOOL BETWEEN FRAMING. INSULATION TO BE 1" SHALLOWER THAN FRAMING TO ALLOW FOR VENTILATION CHANNEL.
D. INSULATION ABOVE OVERHANG FRAMING TO BE PROVIDED WITH VENTED NAIL BASE OR SIMILAR.

5.3 INSULATION

By limiting the flow of heat through the building envelope, insulation plays a fundamental role in delivering occupant comfort and energy efficiency. To maximize the effectiveness of the insulative layer, we need to build the structure to accept the insulation and then need to install the insulation properly. The details that follow describe a handful of critical standard insulation applications.

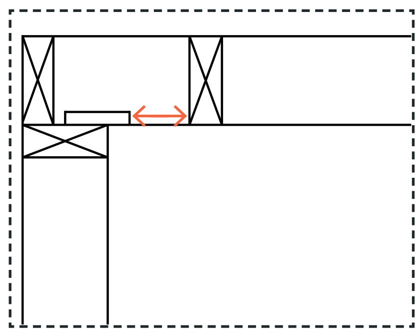
Note: By reducing the flow of energy through the envelope, affecting the movement of moisture, and altering airflows, adding insulation can cause unintended consequences on building durability. The design of insulated assemblies must therefore be guided by an understanding of building physics and hygrothermal performance, and installation must be completed as designed.

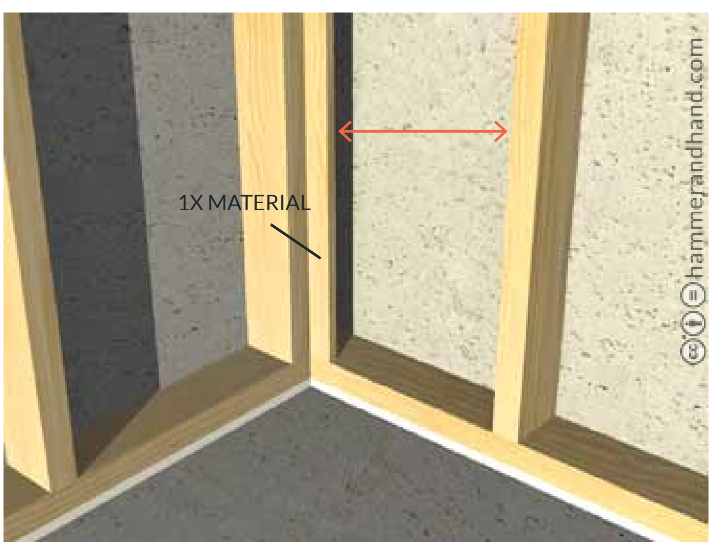
Cavity Fill

Allow for proper access in all areas to facilitate complete and thorough filling of cavity.

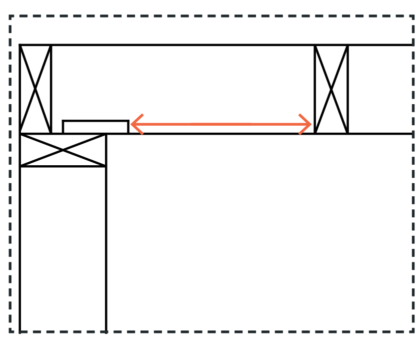
Framing Example at an Inside Corner:

Poor Spacing at Corner with Insufficient Clearance





Proper Spacing at Corner



Dense Pack Blown-In Cellulose

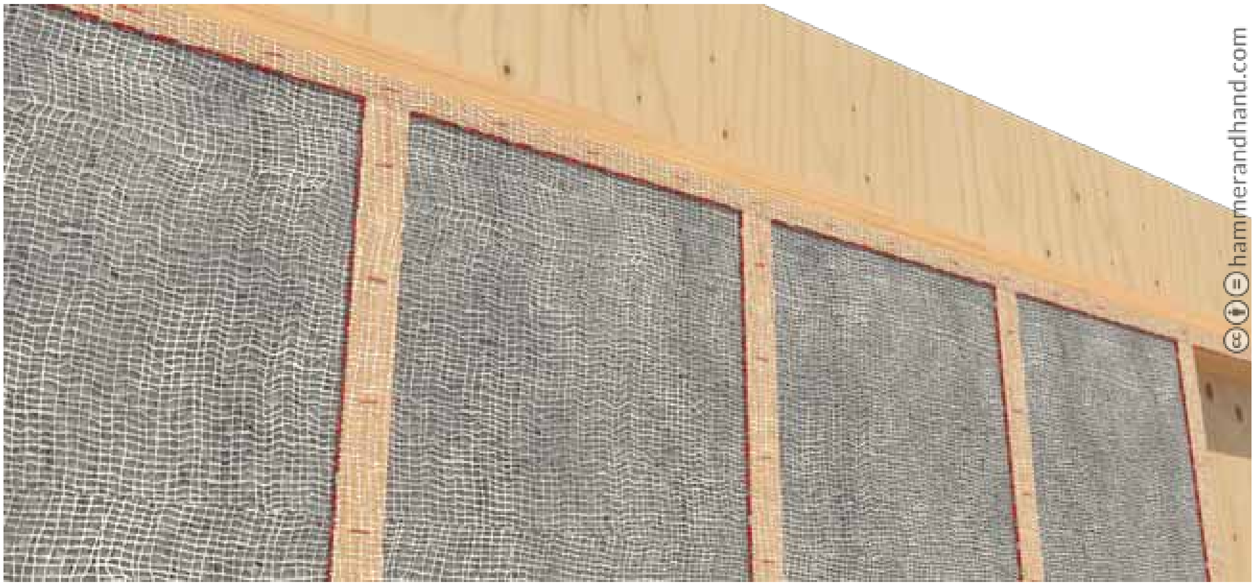
- At completion of project, insulation is to be enclosed on all 6 sides with rigid material to prevent wind washing/convection losses and settling. The specific quantity of material to be installed should always be calculated and confirmed by site superintendent. *See bag count at bottom of next page.
- Ensure good access to all areas for proper fill.

Netting

- Inset stapling at corner of stud to prevent intrusion of insulation to front of stud.
- Use dense pack specific netting material.

Netting is to be taut prior to fill. Check density after 10% of work is complete to confirm proper installation. At initial completion, review integrity of installation and remedy any under-filled areas.

Material density determined by manufacturer, should feel like solid felt. Keep dry with NO exposure to bulk water during construction.



Fiberglass

- At completion of project, insulation is to be enclosed on all 6 sides with rigid material to prevent wind washing/convection losses and settling. The specific quantity of material to be installed should always be calculated and confirmed by site superintendent. *See bag count below.
- Ensure good access to all areas for proper fill.

Netting

- Inset stapling of netting at corner of stud to prevent intrusion of insulation to front of stud.
- Utilize netting per fiber glass manufacturer's specifications.

Netting is to be taut prior to fill. Check density after 10% of work is complete to confirm proper installation.
At initial completion, review integrity of installation and communicate any under-filled areas to insulation contractor.

Check building specifications for desired density. Keep dry during construction.

1. 'Dense-Pack' feels like a firm mattress. See manufacturer's documentation for lbs/ft^3 specifications.
2. 'Standard Fill' feels like a firm pillow. See manufacturer's documentation for lbs/ft^3 specifications.

** Bag Count Example:*
435 SF of 2 x 6 wall
Framing factor of 18% (area taken up by wall framing)
(435 ft^2 x 5.5/12 ft) x (100% - 18%)
(435 ft^2 x .458 ft) x .82
199.375 ft^3 x .82 = 163.5 ft^3

Example: Fiberglass might be 1.8 lbs/ft^3.
The 435 ft^2 area needs 294.3 lbs of material.
Bags are 28 lbs/each, this wall needs 10.5 bags of material.

Attic Insulation

Loose Fill in Attics

- Protect from wind-washing at perimeter, especially where close to roof venting.
- Roof baffles for soffit venting to terminate no less than 12 inches above cellulose to prevent wind from displacing material.
- Baffles between rafters to be continuous from rafter to rafter (do not use baffles which are fastened to roof sheathing). Must fill full width of cavity.
- Maximum slope of ceiling below loose fill: 5/12.
- Do not use blown-fiberglass due to light density/wind washing.
- Insulation depth markers to be installed per manufacturer's specification.

Note: These areas are outside the thermal envelope and air barrier and are not suitable for mechanical systems or ductwork.

Attic Walls

- Where vertical walls are encountered in attic spaces (this condition occurs where ceiling heights change) install rigid material on attic side of framing and insulate from interior so area can be readily inspected post-installation of insulation material.

Attic Hatch

- Ensure proper clearance is present from ceiling to bottom of rafters to allow for access, post-installation of insulation; if current location does not allow for needed clearance, relocate hatch.
- Construct “dam” of plywood or other durable rigid panel (cardboard is not sufficient) to a height of final insulation depth plus 2.” Minimum height above dam to be 30” to allow for access to attic. Minimum rough framed opening of hatch per code to be 22” x 30.”
- Insulate hatch area with rigid insulation to the minimum R-value of general attic area. Allowable gap at perimeter of insulation panel to be a maximum of 1/4” per side. Hatch to be integrated into air barrier necessary to maintain airtightness.

5.4 EXTERIOR CONTINUOUS INSULATION (CI) AT WALLS

Continuous exterior insulation is like a winter sweater wrapping a building. It is also a key component in establishing a thermal bridge-free building envelope. Thermal bridges are penetrations in a building's insulation layer, like the wood studs of a stud wall for example, that allow heat to escape and cold to intrude through the building envelope.
In otherwise high performance assemblies, thermal bridges can be a source of tremendous energy loss and condensation risk. By insulating around would-be thermal bridges, continuous exterior insulation establishes a thermal break between these building components and the exterior environment. As with insulation in general, as we introduce exterior insulation we need to understand and detail for the effects this insulation will have on moisture movement through the overall assembly.

Types of Exterior Rigid Foam and Installation Instructions

Foil-Faced Polyisocyanurate (Polyiso)

- Exterior surface may be used as a WRB, with manufacturer approval.
- Install tape at seams per manufacturer specification.
    1. Must use J-Roller on tape with good detailing to eliminate 'Fish-Mouthing.'

Expanded Polystyrene (EPS)

- Multiple layers with staggered seams recommended to accomodate product shrinkage.
- While exterior surface may be used as a WRB, we do not recommend it.
    1. Install tape at seams per manufacturer specification.
    2. Must use J-Roller on tape with good detailing to eliminate 'Fish-Mouthing.'

Extruded Polystyrene (XPS)

- Limit use of this product as the material has a high Global Warming Potential.
- Exterior surface may be used as a WRB.
    1. Install tape at seams per manufacturer specification.
    2. Must use J-Roller on tape with good detailing to eliminate 'Fish-Mouthing.'

Rigid Foam Installation

- For cutting, use knives and (for EPS and XPS) "hot wire" devices; minimize use of saws to limit dust for site cleanliness, carpenter health, and to prevent tool damage.
- If thicker than 2," install in multiple layers with staggered seams to prevent thermal bypass.
- Fastening: consult manufacturer specifications or structural architectural drawings.

When Rain Screen Furring is to be Installed 0ver Rigid Insulation

Steps:

1. Install first layer of rigid insulation with limited number of nails or screws with washers.
2. Install second layer of rigid insulation with limited number of nails or screws with washers.
3. Fasten furring with screws; spacing and fastener size to be decided by weight of siding material and spacing of furring.

Mineral Wool AKA 'Rockwool' and Installation Instructions

- WRB to be placed and fully integrated at wall structure.
- Exterior flashings should be installed to minimize thermal bridging (locate back dam on outer face of first layer of insulation).
- Minimize cutting of product; when needed use specific mineral wool knives.

Steps for installing furring over mineral wool:

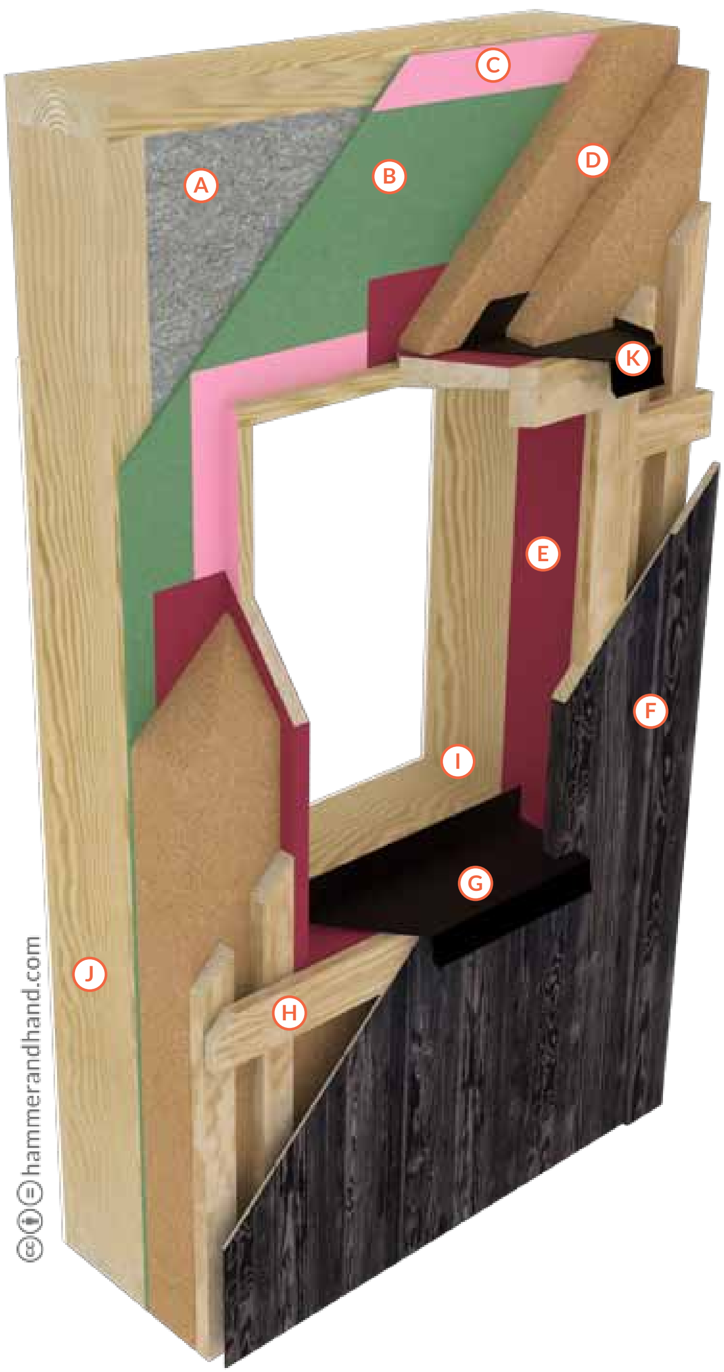
1. Install first layer of mineral wool with limited number of nails or screws with washers.
2. Install second layer of mineral wool with limited number of nails or screws with washers.
3. Align vertical edges of exterior layer to ensure coverage by furring and prevent puckering.
4. Fasten furring with screws: spacing and fastener size to be decided by weight of siding material and spacing of furring. Consult manufacturer, architectural, or structural specifications.

Examples:
(Black) Fastenmaster Hedlock
(Silver) GRK

For reference only (with all CI):

- Fastenmaster Technical Evaluation Report TER No. 1009-01
- Building Science Corp Report January 2014 *Cladding Attachment Over Thick Exterior Insulating Sheathing*

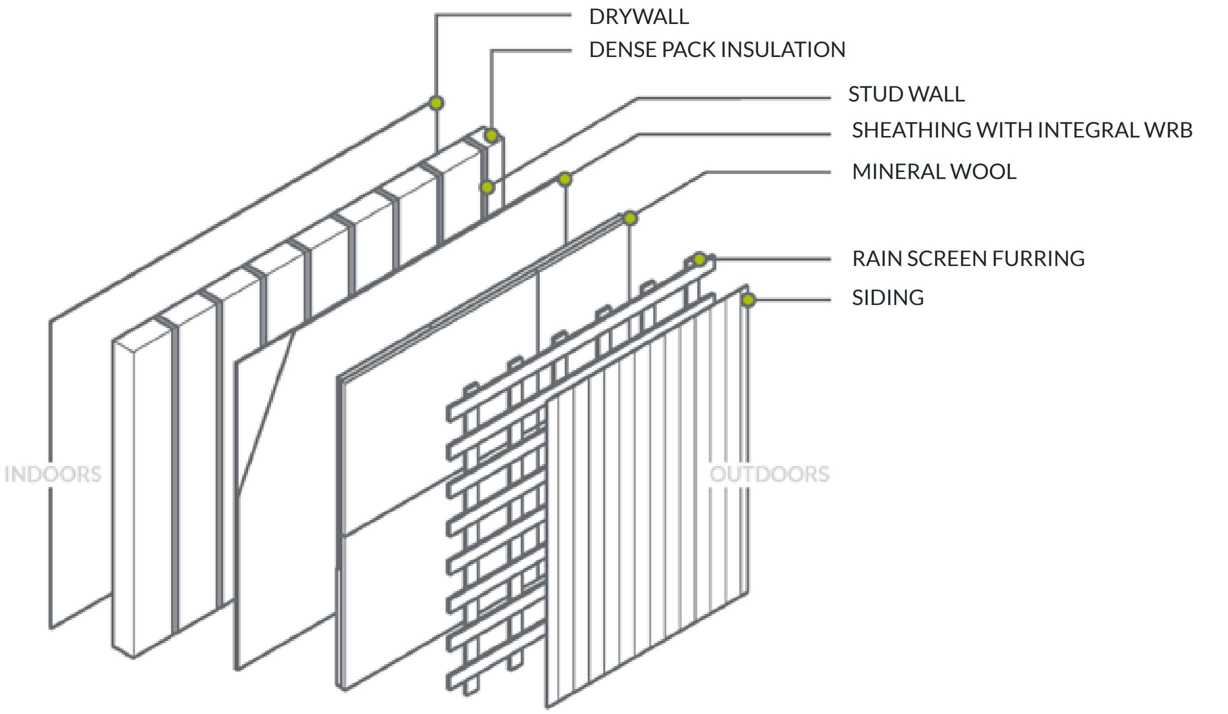
5.5 WALL ASSEMBLY EXAMPLE



A. DENSE PACK INSULATION
B. SHEATHING WITH INTEGRAL WRB
C. JOINT & SEAM FILLER
D. MINERAL WOOL INSULATION
E. FLUID APPLIED SYSTEM AT PUNCHED OPENING
F. CEDAR SIDING (VERTICAL)
G. SILL PAN FLASHING
H. 2-WAY RAIN SCREEN FURRING
I. WINDOW BUCK
J. FRAMED STUD WALL
K. HEAD FLASHING

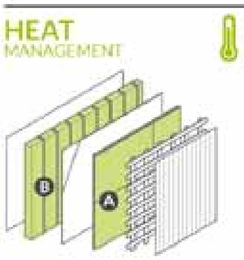
Note: Metal flashings not to return back to sheathing.

The example on page 74 combines an exterior layer of mineral wool insulation, ZIP Sheathing as air barrier and water-resistive barrier, fluid-applied flashing at rough openings, and dense pack insulation (cellulose or fiberglass) in an interior stud wall for a super insulated, vapor open, and resilient high performance wall assembly. The diagrams below show how the assembly manages air, heat, water, and vapor.



A. SHEATHING WITH INTEGRAL WRB

A.PRIMARY BARRIER: SIDING
B. SECONDARY BARRIER: MINERAL WOOL
C. FINAL BARRIER: SHEATHING WITH INTEGRAL WRB
D. RAIN SCREEN ALLOWS BULK WATER TO DRAIN AWAY



A. EXTERIOR MINERAL WOOL INSULATION
B. DENSE PACK INSULATION

A. RAIN SCREEN DRIES CLADDING AND ASSEMBLY
B. ASSEMBLY IS VAPOR OPEN IN BOTH DIRECTIONS, THOUGH THE SHEATHING WITH INTEGRAL WRB SLOWS VAPOR MOVEMENT FROM INTERIOR. MINERAL WOOL ALSO WARMS SHEATHING, WHICH ENCOURAGES VAPOR DIFFUSION.

BEST PRACTICE DETAILS STEP-BY-STEP

ROOFS

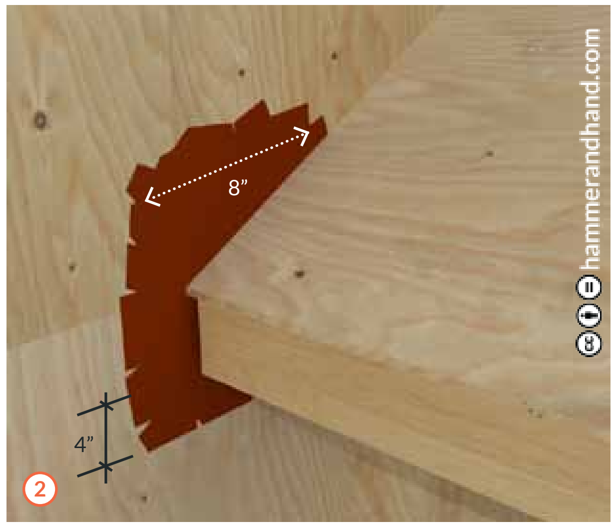
Note to Hammer & Hand field staff:

Manufacturer's installation instructions and architect's construction drawings and specifications always take precedence over the details in this Best Practices Manual. Any discrepancies with this manual should trigger discussion with the architect about alternative approaches to their detailing. However, any alterations to architect's plans must be approved by the architect and such approval memorialized in an SK, ASI, RFI or other contractual method.

6.1 KICK-OUT FLASHING

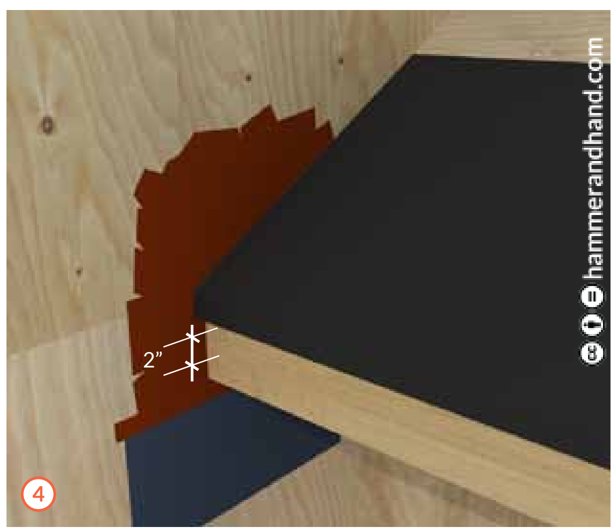
Whenever a roof surface abuts a vertical wall surface, moisture intrusion and rot become a risk at the connection between the two planes. Kick-out flashing, a somewhat forgotten practice except by the best roofers, addresses this risk at the most vulnerable intersection between sloped roofs and walls: the drip edge.

- Be sure to leave space between the end of the fascia and the wall where FastFlash, WRB, and siding can slide up.

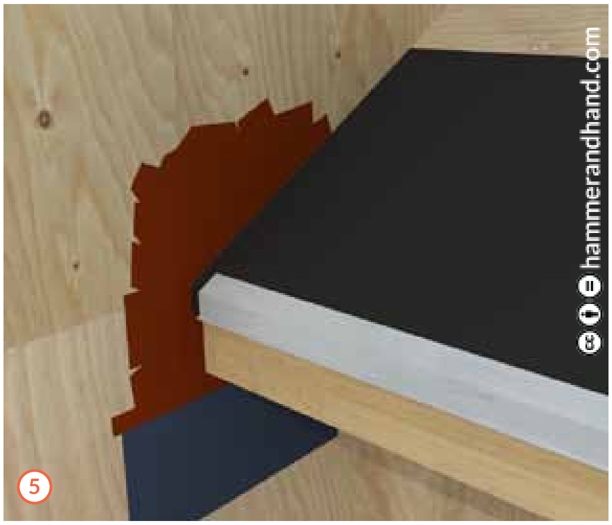


- Install FastFlash along the wall at the roof edge.

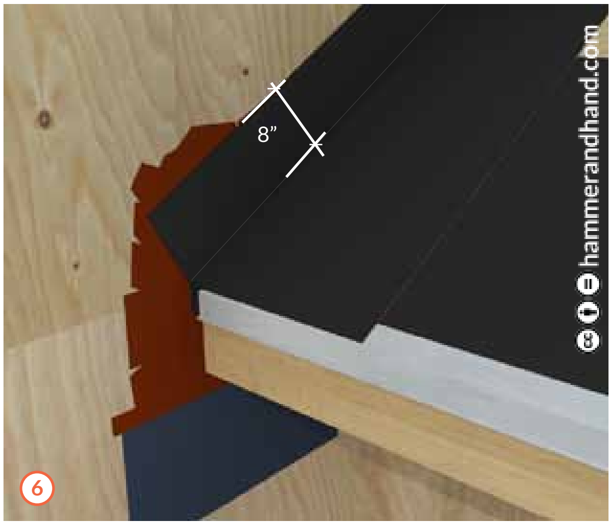
- Stick top edge of transition strip membrane to FastFlash.
- Bead and tool FastFlash to the top edge of transition strip.



- Peel and Stick along the edge of the roof and lap over top of fascia.



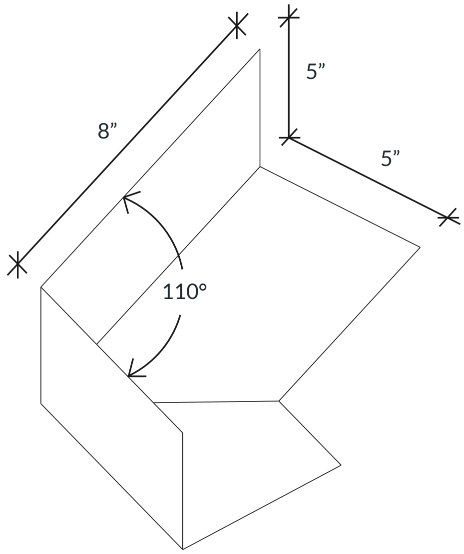
- Attach drip edge.



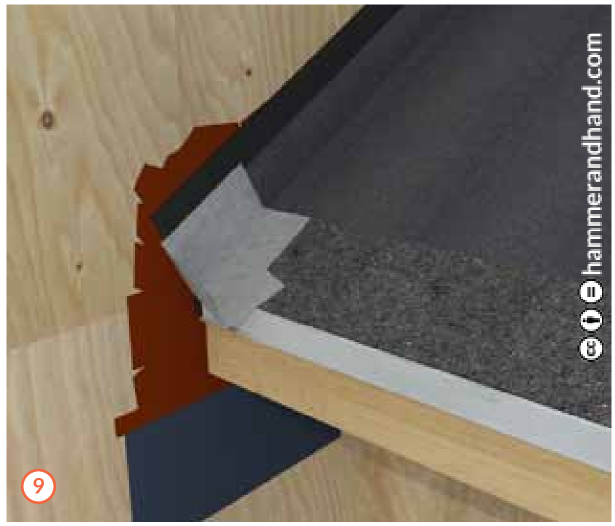
- Install Peel and Stick the entire length of the roof-to-wall intersection.

- Attach roofing felt. Extend 4” up the wall.

- Nail on starter strip of roofing material.

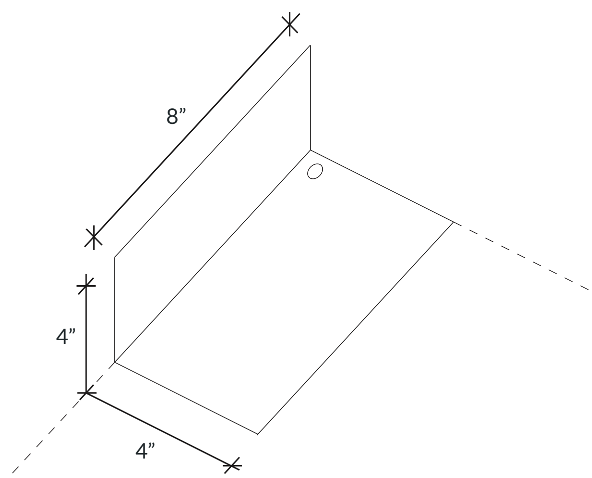


Kick Flashing Guide
Note: All kick-out flashing fabricated on site must have welded seams.



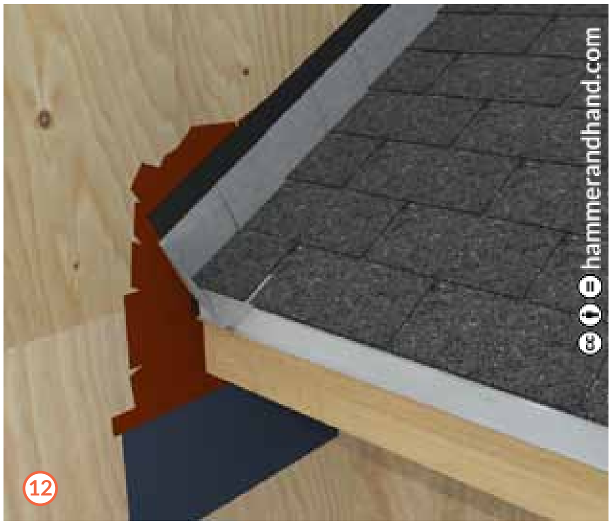
- Fasten kick flashing in upper right corner.

- Install first course of shingles.

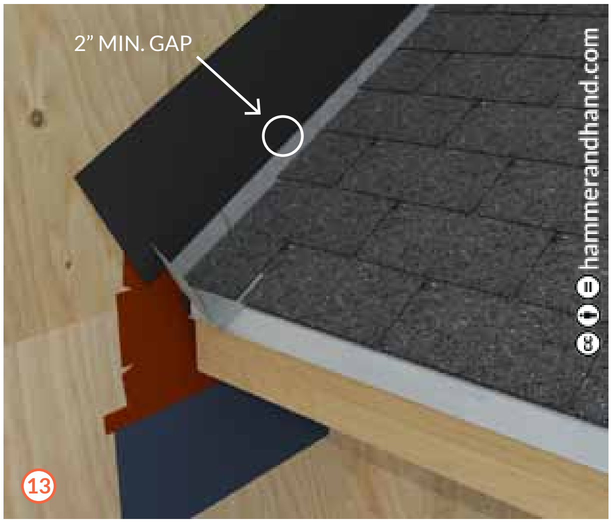


Step Flashing Guide
Note: Align with top edge of shingle course.

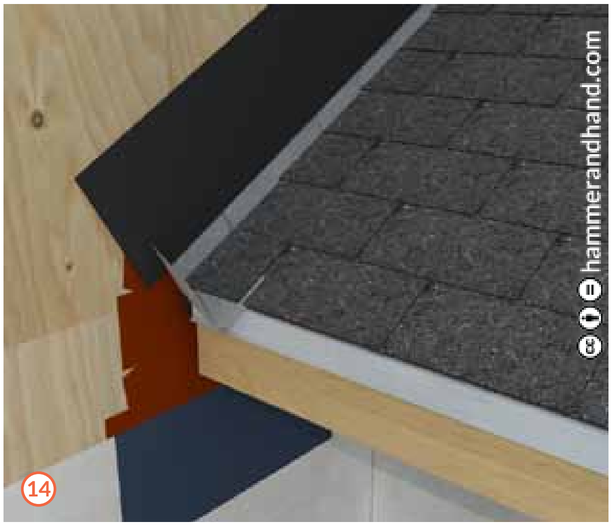
- Fasten stepped flashing.
- 2" minimum overlap with preceding piece of flashing. Top of flashing piece should align with top of shingle course.



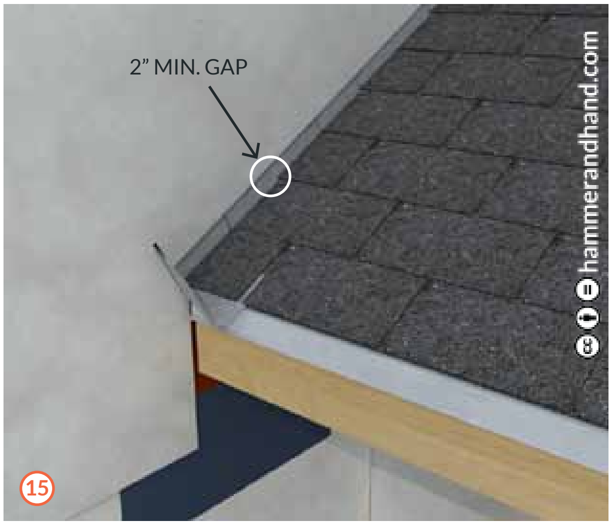
- Continue alternating shingle course and stepped flashing until the roof is complete.



- Install Peel and Stick over the stepped flashing.



- Slip WRB as high and tight as possible under the transition strip membrane.



- Continue layering WRB up to the top of the wall.
- 4" minimum overlap between sheets.

- Install siding.
- Allow for a 2" clearance between bottom of siding and roofing material to avoid water damage.

- Install gutter under drip edge.

6.2 VENTED AND UNVENTED ROOF ASSEMBLIES

Vented Roofs (For Pitches of 3:12 or Above)

When detailed correctly, vented roofs have a long, successful track record in the Pacific Northwest. Vented roofs provide the capacity for moisture to be removed from the underside of roof sheathing via convection currents in the vent cavity. Because today we as an industry are insulating below the vented cavity as standard practice, the building itself is no longer heating the cavity. So, convection currents need to be carefully designed.

To establish sufficient stack effect for these convection currents:

- Install exterior air inlets at a location lower than outlets. Opposing vents with no or minimal elevation change will not generally provide sufficient airflow.
- Maintain a free-flowing channel between vents the full width of the rafter bay and with a minimum of 1" depth.

Note that the drying capacity of vented roofs can easily be short-circuited by bad workmanship or flawed design. Be sure to avoid these four pitfalls:

- Bulk water intrusion via water leaks from outside (poor workmanship).
- Air-borne vapor intrusion via air leaks from inside (poor workmanship).
- Constricted airflow due to insulation baffles not fully spanning from rafter to rafter (poor workmanship).
- Vapor drive from inside (poor design).

Net Free Area (NFA) of exterior venting is to be a minimum of 1/300ths of the horizontal plane below the roof with equal parts at top and bottom. When in doubt, follow local code.

Unvented Roofs

Unvented roofs are increasingly common due to design priorities. An understanding of heat, air, and moisture as well as the causes of condensation is critical in detailing unvented roof assemblies. Potential pitfalls to avoid include:

- Incorrect ratio of vapor impermeable insulation (directly under the roofing and substrate, if present) to the vapor open insulation beneath it. If the vapor impermeable insulation is too thin then its bottom surface can be cold enough to allow condensation where it meets the vapor open insulation.
- Poor air sealing. If the assembly is not airtight then air movement through the assembly can carry moisture concentrations into the assembly, with significant risk of condensation.
- Careless detailing of partial penetrations. If not properly detailed, partial penetrations into the unvented roof assembly (for things like can lights or ceiling fans) can undermine the insulation and/or air tightness strategies alluded to above.
- Insufficient fill below the impermeable insulation layer. If air gaps are present between insulation layers, convection currents can significantly reduce the performance of the assembly and compromise durability.

Two potential unvented roof assemblies:

1. Preferred: Monolithic continuous exterior insulation (CI) above structural sheathing.
    - 40% of insulation R-value to be above sheathing. If not feasible, additional analysis required.
    - Roof sheathing to be air-sealed.
    - CI to be installed in multiple layers to limit insulation by-pass from gapping of insulation.

2. Acceptable if above is not feasible: Closed-Cell Spray-Polyurethane Foam (ccSPF) at bottom of roof sheathing.
    - R-value of ccSPF to be 40% of total assembly. If less, analysis is required.
    - NO mechanical systems (electrical, plumbing, HVAC, fire suppression, etc.) can intrude into ccSPF layer.
    - Insulation below ccSPF is to be blown-in fiberglass, blown-in cellulose, or open-cell Spray-Polyurethane Foam (ocSPF). No batt materials.

Because the drying capacity of unvented roof assemblies is inherently lower than vented ones, it is especially critical to control built-in moisture during construction. Control construction moisture content with tenting or temporary roofing when necessary. Moisture content in roof structure must be less than 18% prior to covering. Rigid insulation (if present) must be kept dry.

Roof assemblies must control for exterior moisture in a monolithic and complete fashion. Test roofing membranes for integrity prior to covering from below. In unvented 'flat' or low-slope roofs with parapets, perform a full 'flood' test to ensure leak-free installation of roofing membrane.

Drying of unvented roofing assemblies is, by definition, only provided to the interior. Therefore, moisture analysis of interior conditions and long-term management strategy is required at all wet locations or areas of high humidity generation such as steam showers, kitchens, baths, laundry, and pools. Special guidance and attention is required when selecting and installing roofing systems over these high humidity areas.

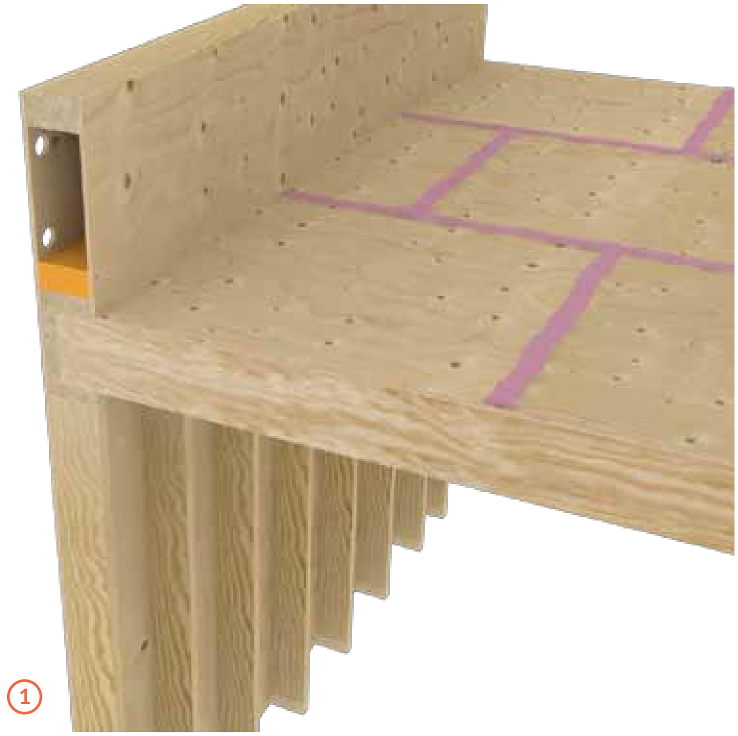
Note: For info about attics, see pg. 69: Attic Insulation

6.3 PARAPET WALLS

Parapet walls are a difficult detail with a long history of failure. Unlike standard exterior walls, parapet walls are exposed to the elements on three sides. Furthermore, parapets are often inadvertently connected to interior space via balloon framing, gaps in structure, or penetrations for wiring and mechanicals, introducing warm, moist interior air into the assembly and potential condensation. To address these conditions, detailing must provide excellent bulk water management of roofing, parapet wall, and parapet cap, venting to promote drying, and careful attention to separating the parapet from interior spaces.

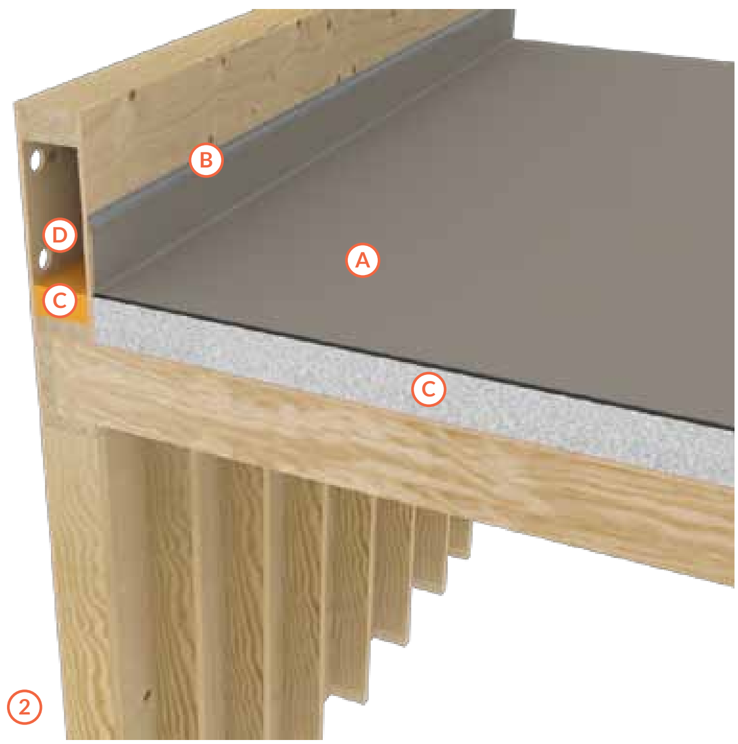
1. Height of roofing at wall: minimum of 12” to top of parapet.
    - Do not lap TPO over top of parapet unless required by unique construction conditions.
2. Top of parapet, below cap, to be sealed with fluid applied flashing.
3. Venting in wood framed parapets:
    - Provide venting to each wall cavity.
    - If cavity is greater than 12” above roof insulation, provide high/low venting in each wall cavity.
    - Can use round/louvered ‘soffit vents’ to limit bulk water intrusion if venting holes are in exposed locations.
    - For areas which do not need above, cover hole with bug screen.
    - Ensure ventilated siding cavity is correctly vented yet covered against bulk water intrusion at top.
4. Railing Attachments
    - Side wall: see Section 6.4: Flat Roof Assemblies.
5. Special Considerations
    - Strive to avoid penetrations through top of the parapet wall. If unavoidable, get further direction from design team before proceeding.
    - Likewise, strive to avoid balloon framing of the parapet wall. If unavoidable, get further direction from the design team before proceeding.

Venting and Roofing for Parapet Walls



Venting in wood framed parapets:

- Provide venting to each wall cavity.
- If cavity is greater than 12," provide high/low venting in each wall cavity.
- Can use round/louvered 'soffit vents' to limit bulk water intrusion if venting holes are in exposed location.
- For areas which do not need above, cover hole with bug screen.
- Insulate within parapet wall cavity to depth of roof insulation (if present).



- Roof membrane must lap up wall to minimum of 12" above roof plane or per specifications, whichever is greater.
- Terminate roofing on parapet wall with mechanically fastened termination bar.

A. ROOF MEMBRANE
B. TERMINATION BAR
C. INSULATION
D. VENTILATION HOLES

3

- Counterflash termination bar with fluid applied flashing (FAF) to be encapsulated at both top and face, covering fasteners.

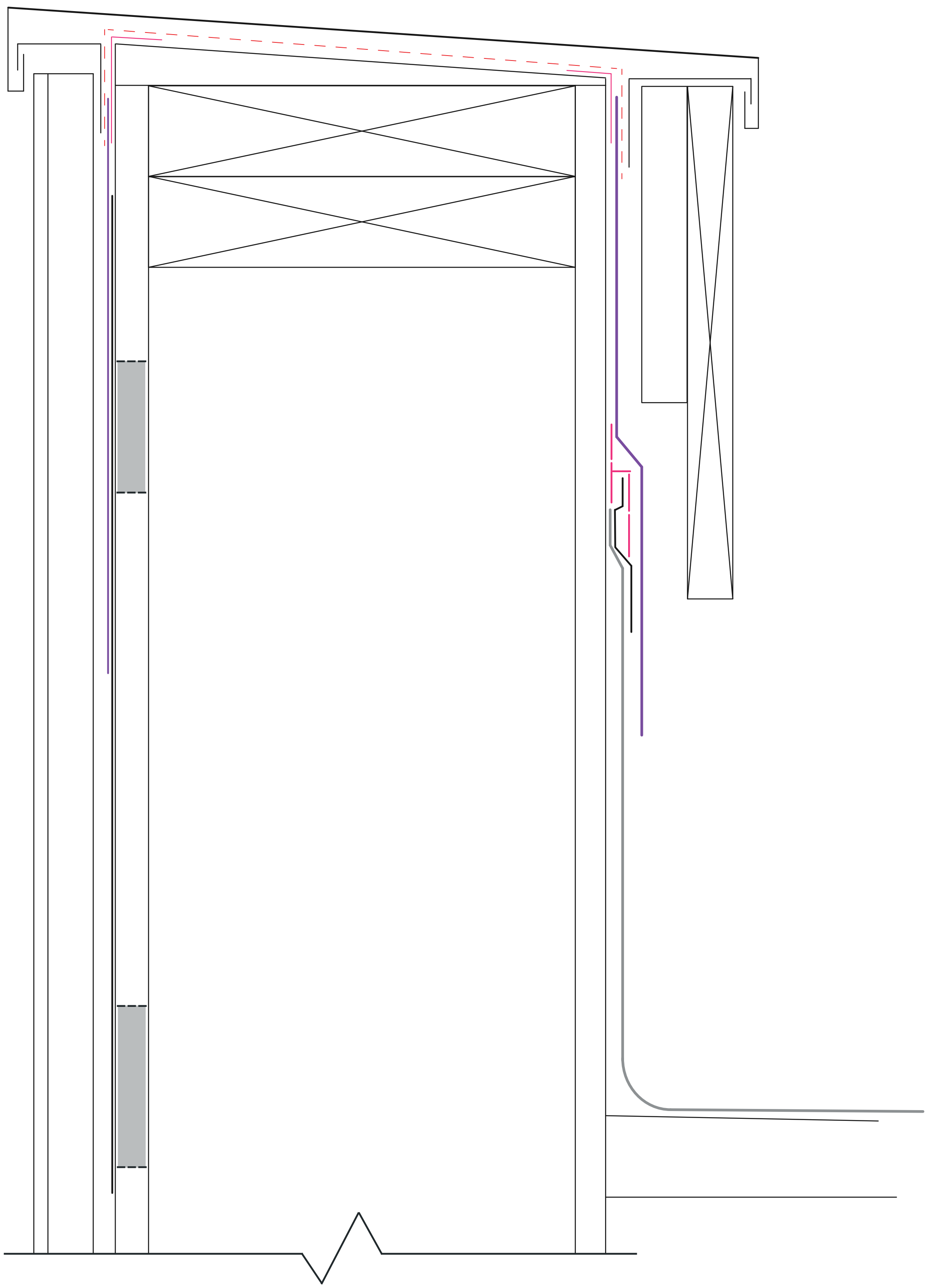
A. APPROPRIATE FAF

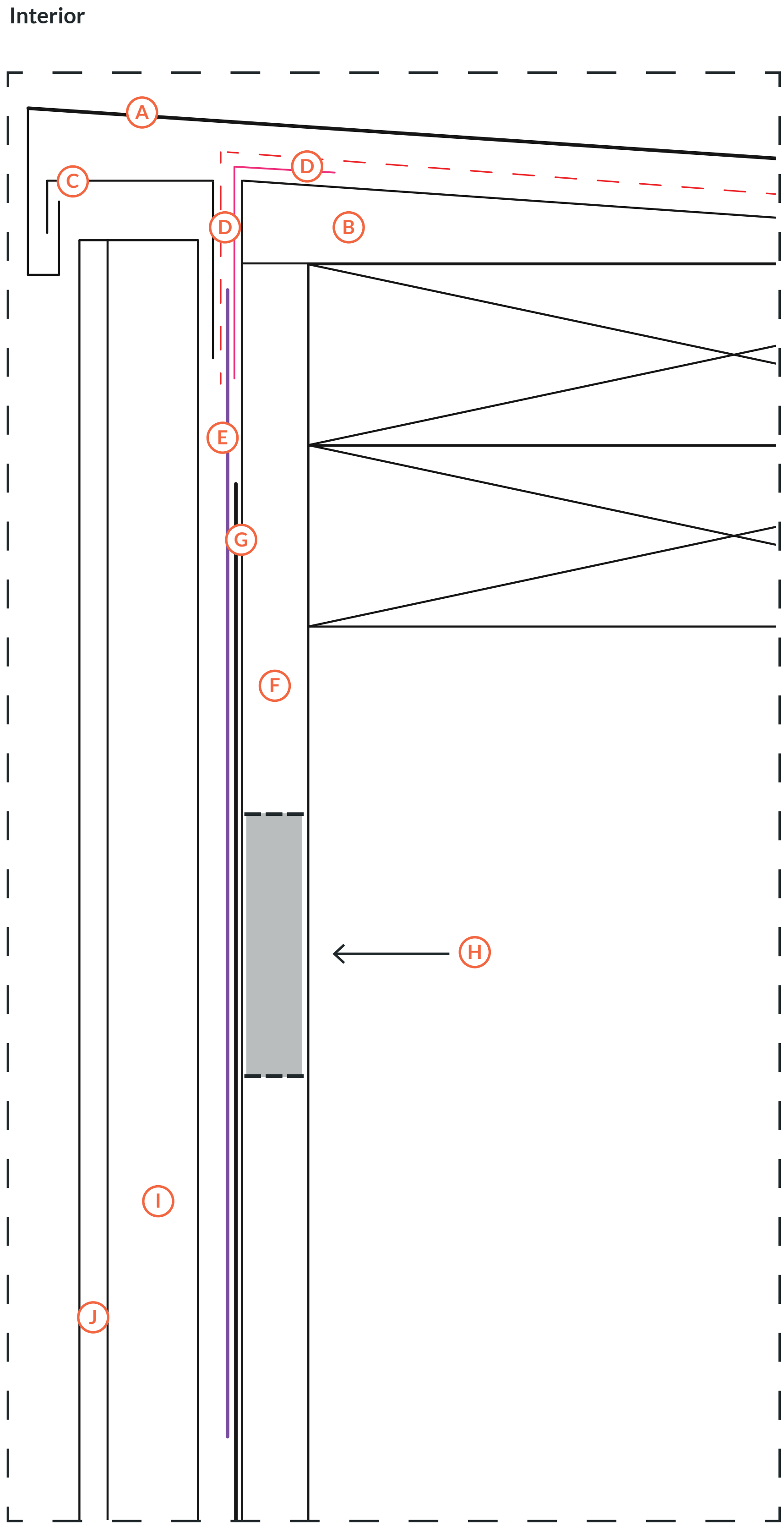
4

- Top of parapet below cap to be sealed with vapor permeable FAF.
- Install either fluid applied WRB from termination bar up and over parapet top or cover transition with transition strip.

6

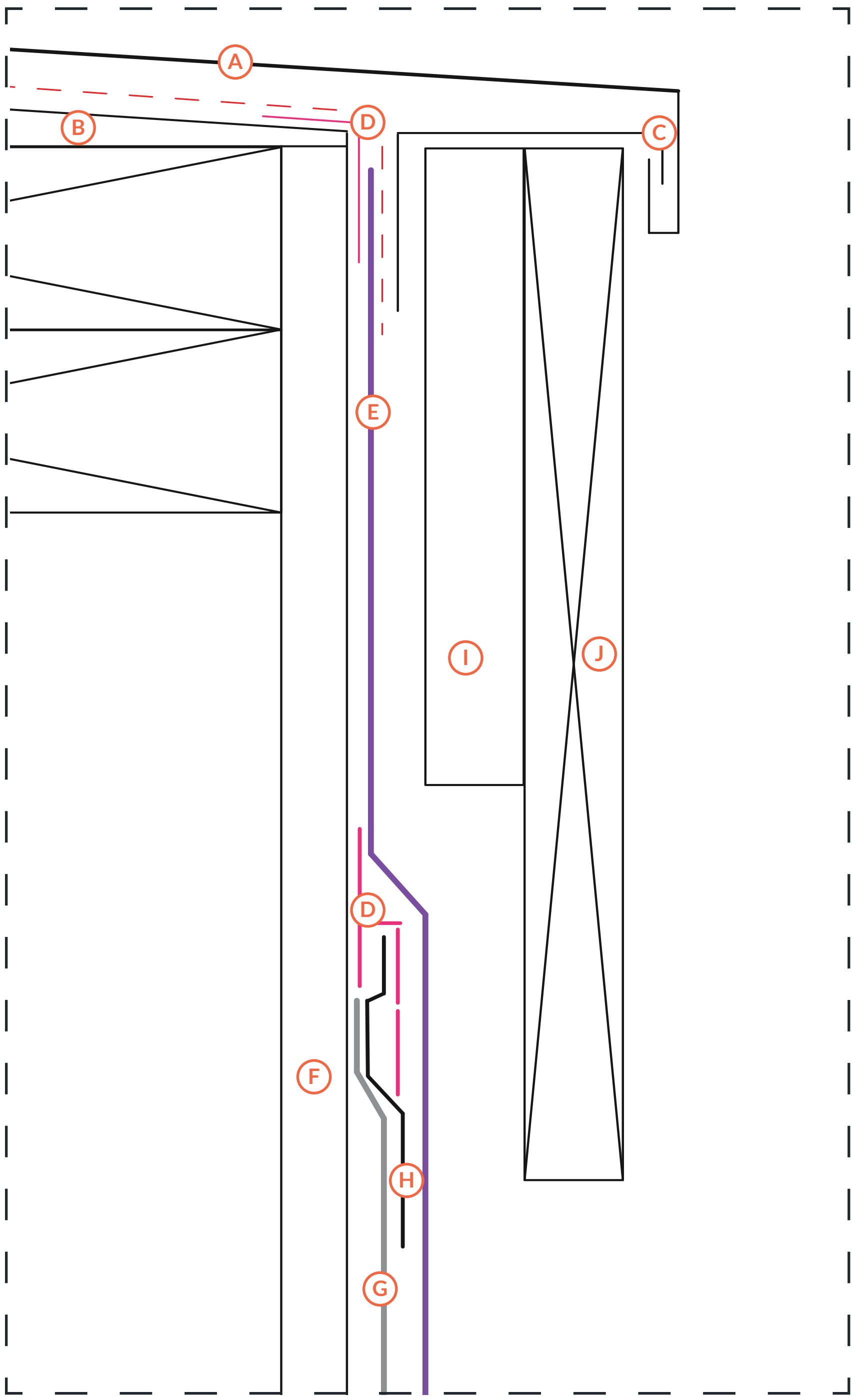
Complete Parapet Wall





A. 24 GAUGE MINIMUM PARAPET CAP
B. WEDGE
C. C-CLIP
D. FLUID APPLIED FLASHING
E. VAPOR PERMEABLE TRANSITION STRIP
F. 1/2" SHEATHING
G. WRB
H. VENT HOLES
I. 1X4 FURRING
J. SIDING

Exterior

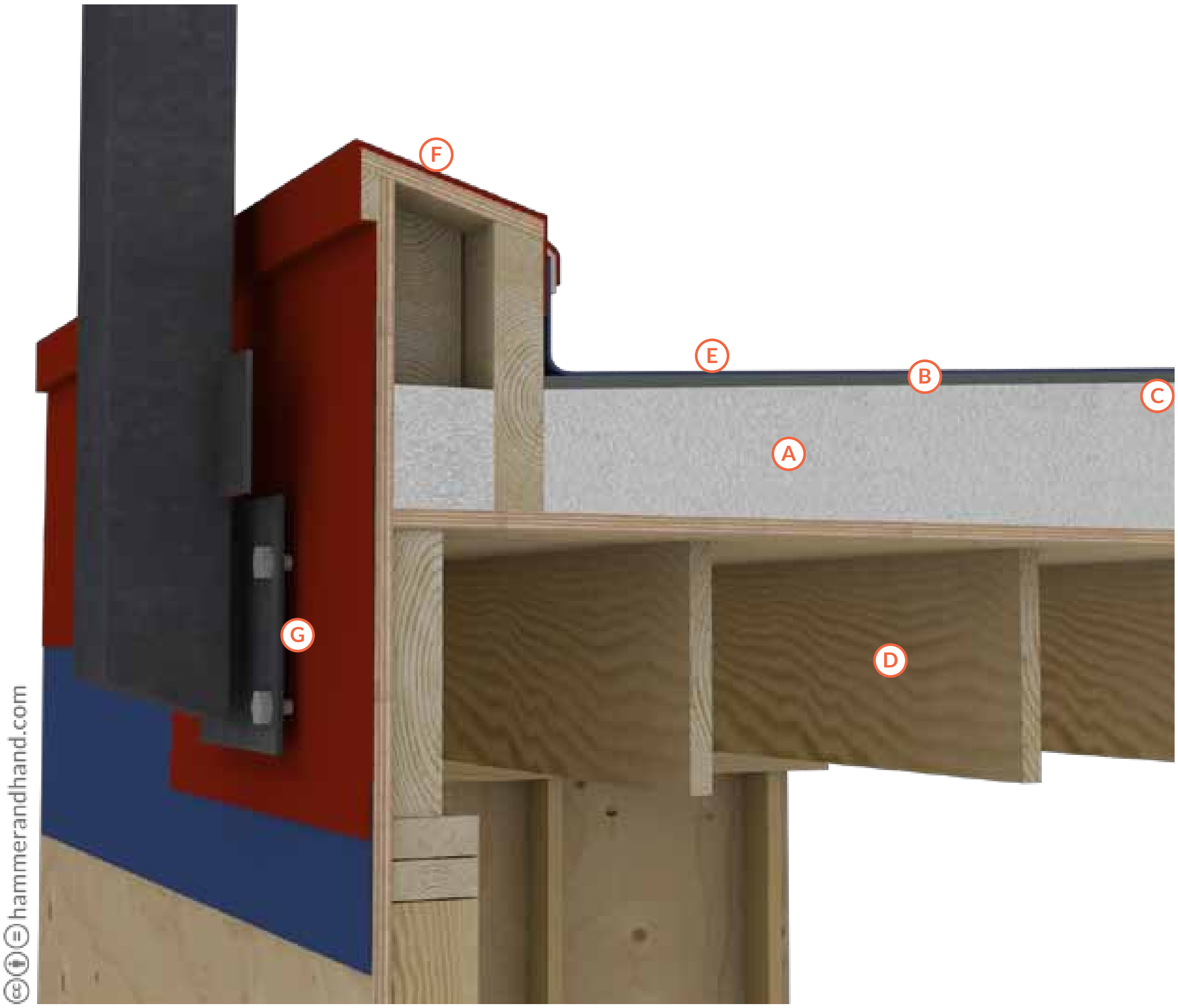


A. 24 GAUGE MINIMUM PARAPET CAP
B. WEDGE
C. C-CLIP
D. FLUID APPLIED FLASHING
E. VAPOR PERMEABLE TRANSITION STRIP
F. 1/2" SHEATHING
G. ROOFING
H. TERMINATION BAR
I. FURRING
J. SIDING/TRIM

6.4 FLAT ROOF ASSEMBLIES

Before constructing a flat roof assembly, please refer to the unvented roof assembly comments under 6.2 Vented and Unvented Roof Assemblies and, if applicable, 6.3 Parapet Walls. There is absolutely no room for error in the detailing and installation of roofing and air sealing in these assemblies. This step should be closely monitored and tested prior to acceptance of work. Do not rush this.

Continuous Insulation on Top of Sheathing (Exterior CI) with Fiber-Fill in Joist Cavity
This is how to detail an unvented roof assembly for flat and low slope roofs.

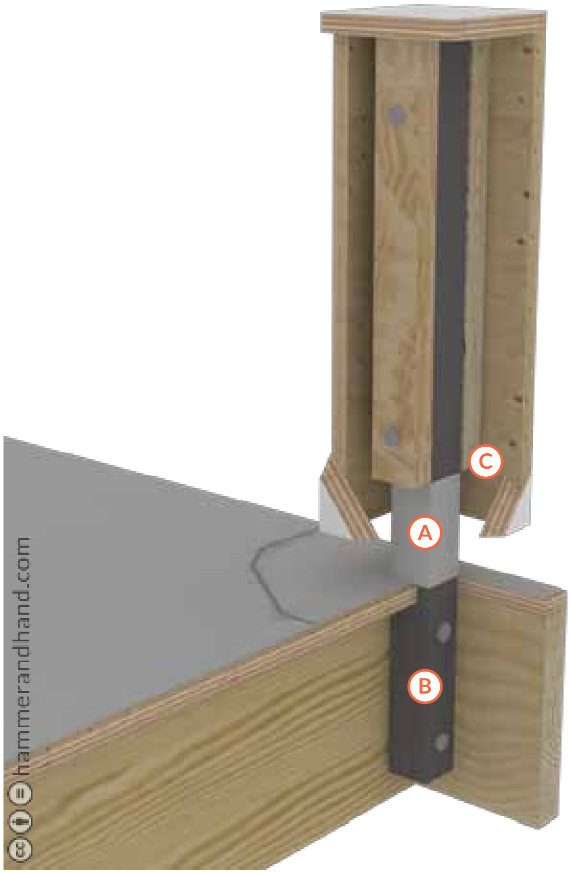


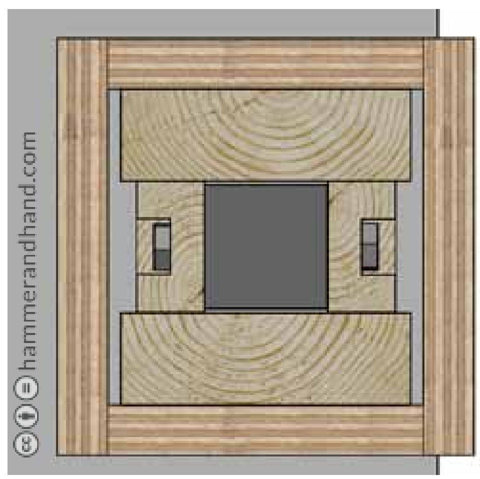
A. MINIMUM R-VALUE OF EXTERIOR CI DETERMINED BY TOTAL R-VALUE OF INSULATED ASSEMBLY (SEE ALSO: UNVENTED ROOF SECTION).
B. COVER BOARD IN HIGH IMPACT AREAS
C. ROOFING SUBSTRATE TO HAVE MINIMUM SLOPE OF 1/4"
D. FIBER FILL: BLOWN-IN ONLY, ENSURE COMPLETE CONTACT TO BOTTOM OF SHEATHING
E. RECOMMENDED ROOFING IS TPO
F. NEVER PENETRATE PARAPET ASSEMBLY THROUGH THE TOP
G. HOLD OFF WALL BY A 1/8" GALVANIZED OR STAINLESS STEEL WASHER FOR DRAINAGE GAP

Penetrating Post

Use this option when it's necessary for the rail to penetrate a low slope roofing membrane.

Vented Post Detail with Low Slope Roof Penetration





A. TPO BOOT
B. TUBE STEEL OR EQUAL
C. SEAL TOP OF BOOT TO POST WITH COMPATIBLE SEALANT

Note: If post (B) penetrates into thermal envelope, encapsulate with closed cell spray foam to mitigate condensation.

BEST PRACTICE DETAILS STEP-BY-STEP

BASEMENTS

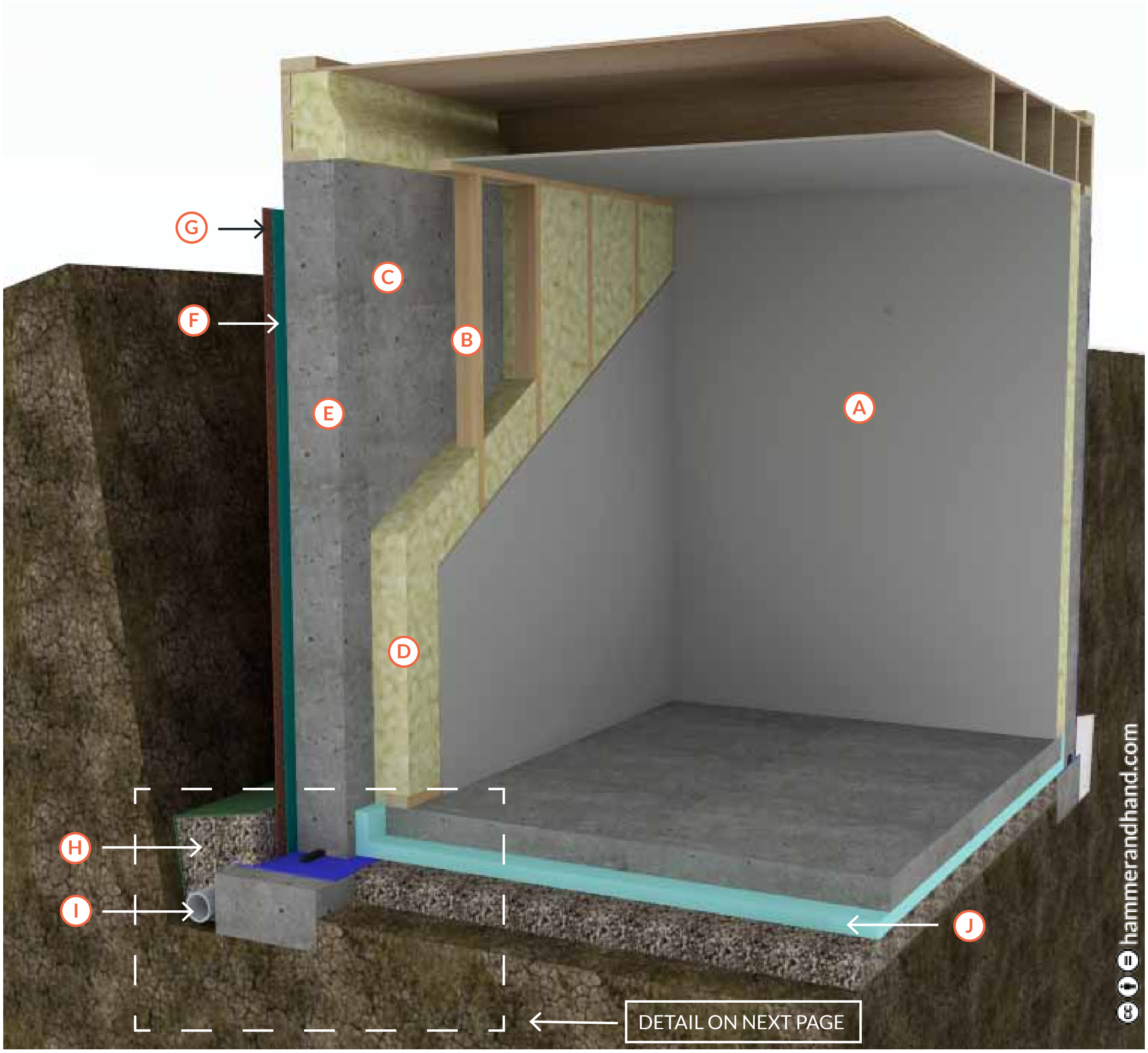
Note to Hammer & Hand field staff:

Manufacturer's installation instructions and architect's construction drawings and specifications always take precedence over the details in this Best Practices Manual. Any discrepancies with this manual should trigger discussion with the architect about alternative approaches to their detailing. However, any alterations to architect's plans must be approved by the architect and such approval memorialized in an SK, ASI, RFI or other contractual method.

7.1 BASEMENT, NEW CONSTRUCTION

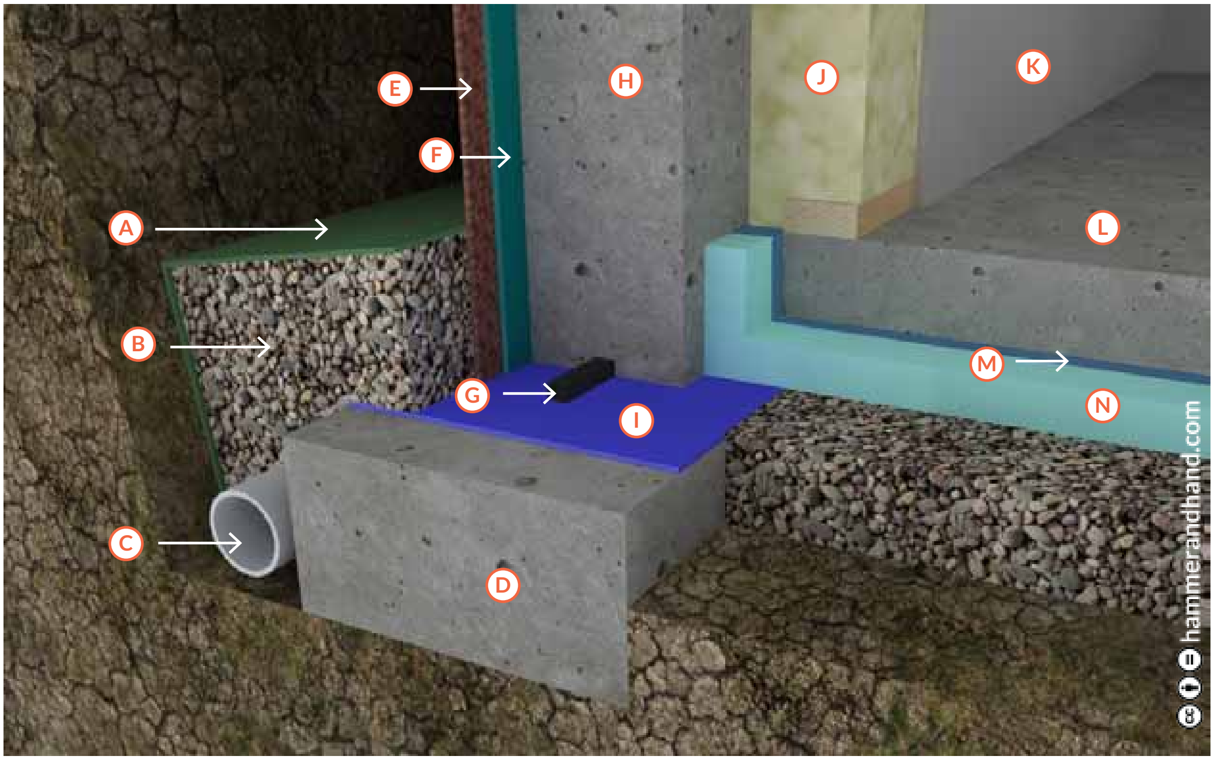
In addition to structural integrity, we need to address two priorities when constructing new basements: moisture protection and thermal control. With new construction, we have the luxury of installing our moisture management layers outboard of the foundation wall. Our preferred method uses a fluid-applied elastomeric membrane applied directly to the exterior face of concrete followed by a drainage mat with integrated filter fabric. Water in the soils adjacent to the foundation wall can then drain down to a drainage pipe installed in a bed of gravel next to the foundation wall footing. A bentonite waterstop laid atop a capillary break on the footing inhibits moisture movement through the cold joint between foundation footing and foundation wall. To limit heat, air, and moisture transmission we use low or medium density spray foam insulation in a stud wall (or, alternatively, a continuous layer of EPS against the concrete wall combined with blown-in insulation in a stud wall immediately inboard of that EPS). The concrete slab sits on 2-6” of rigid insulation with a perimeter thermal break and is then topped with a soil barrier membrane, completing the basement’s thermal and moisture isolation from the earth.

New Construction



A. DRYWALL
B. 2X4 STUD WALL
C. 1- 2 1/2" GAP BETWEEN STUD WALL AND FOUNDATION WALL
D. LOW OR MEDIUM DENSITY SPRAY FOAM INSIDE AND BEHIND STUD WALL
E. FOUNDATION WALL
F. FLUID APPLIED ELASTOMERIC MEMBRANE
G. DIMPLED DRAINAGE MEMBRANE WITH GEOTEXTILE FABRIC
H. MINIMUM 4" LAYER WASHED AND CLEANED (NO FINES) CRUSHED STONE OR GRAVEL
I. 4" DRAINAGE PIPE, HOLES DOWN
J. 2-4" RIGID INSULATION
K. NOT SHOWN: IF RIGID FOAM INSULATION IS USED ON AN EXTERIOR WALL, PROTECT THE TOP WITH A COATING OR PROTECTION BOARD. BELOW GRADE, PLACE INSULATION BETWEEN DIMPLE DRAINAGE MAT AND ELASTOMERIC WATERPROOF MEMBRANE. FOAM MUST BE PROTECTED WITH DURABLE FINISH WHEN EXTENDED ABOVE GRADE.

New Construction Close Up



A. HEAVY DUTY GEOTEXTILE FILTER FABRIC
B. WASHED GRAVEL FILL
C. 4" DRAINAGE PIPE, HOLES DOWN. ALWAYS LOCATE BELOW BOTTOM OF SLAB.
D. FOOTING
E. DIMPLED DRAINAGE MEMBRANE WITH GEOTEXTILE FABRIC
F. FLUID APPLIED ELASTOMERIC WATERPROOF MEMBRANE
G. EXPANDING JOINT WATERSTOP*
H. FOUNDATION WALL
I. FLUID APPLIED CAPILLARY BREAK (SEE SECTION 7.2)
J. LOW OR MEDIUM DENSITY FOAM
K. DRYWALL
L. FLOOR SLAB
M. 12 MIL REINFORCED SOIL BARRIER WITH SEALED SEAMS (SEE SECTION 7.3)
N. 2-4" RIGID INSULATION

*Waterstops should be installed at all joints below grade. Place water stop a minimum of 3" to the exterior surface of the wall.

Note: Utilize pipe cast into footings to interconnect sub-slab drainage zone.

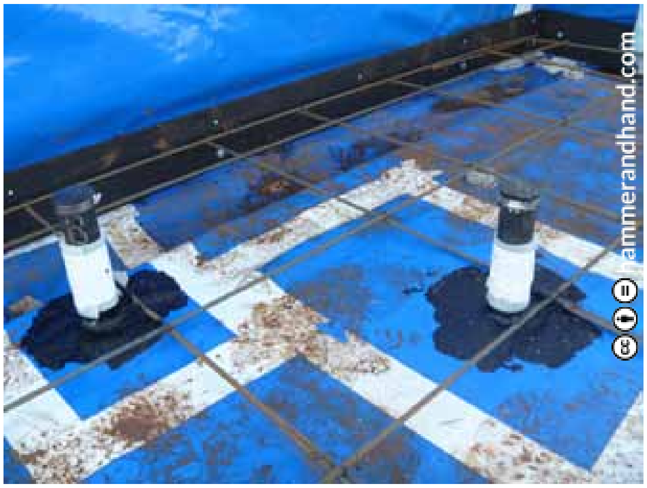
7.2 CAPILLARY BREAK

FOOTINGS AND STEM WALL COATED WITH CAPILLARY BREAK/FLUID APPLIED WATERPROOFING.

FLUID-APPLIED ELASTOMERIC WATERPROOF MEMBRANE.

FLUID-APPLIED CAPILLARY BREAK.

7.3 SUB SLAB VAPOR/SOIL BARRIER



TAPED SEAMS AND SEALED PENETRATIONS IN THE SUB SLAB VAPOR AND SOIL BARRIER.

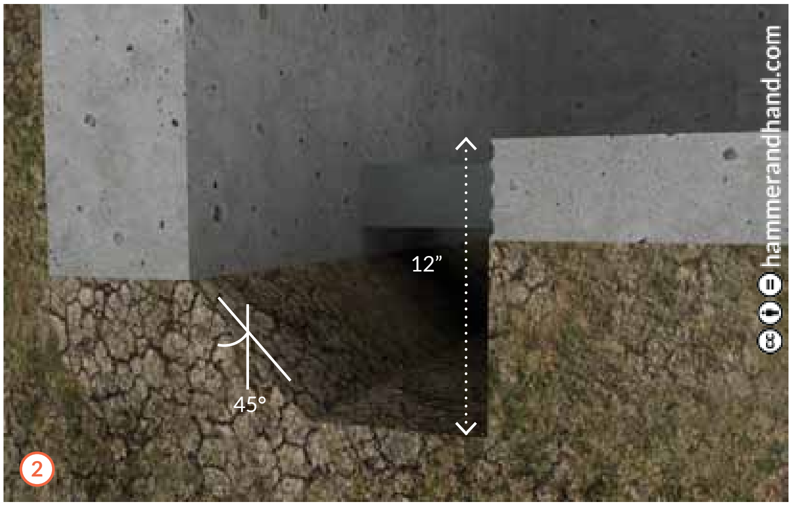
7.4 BASEMENT RETROFIT

Basement retrofits require special care and attention to moisture management, but with a unique constraint in most cases: all our efforts are limited to the inside of the structure. Our experience with basement retrofits is that there are two types of existing basements: ones that leak now and ones that will leak in the future. Therefore, our retrofit strategy is to establish a robust behind-the-wall drainage system interconnected to an active dewatering system. First, we create an interior French Drain to capture any water that leaks through foundation walls. Second, we install a dimple drainage mat on the inside face of the foundation wall to ensure that water is directed down to that French Drain. Third, we seal up and insulate the assembly to control for vapor and thermal transfer.

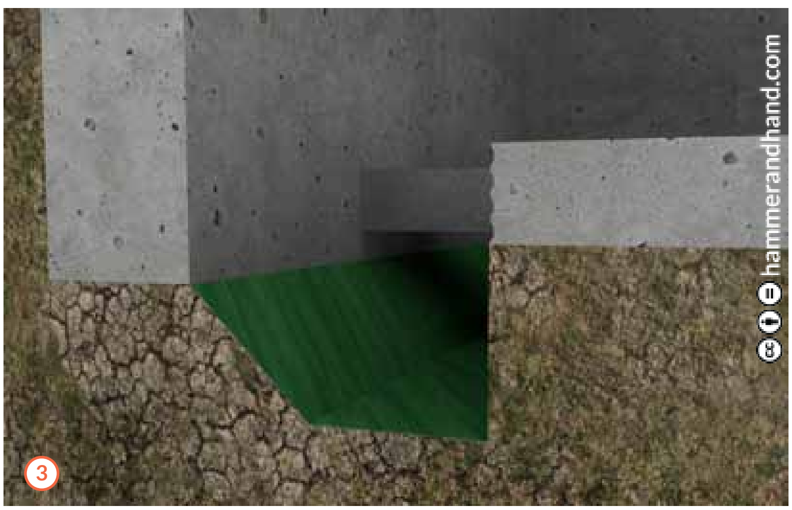
Interior French Drain Installation Step-by-Step

EXISTING CONDITIONS

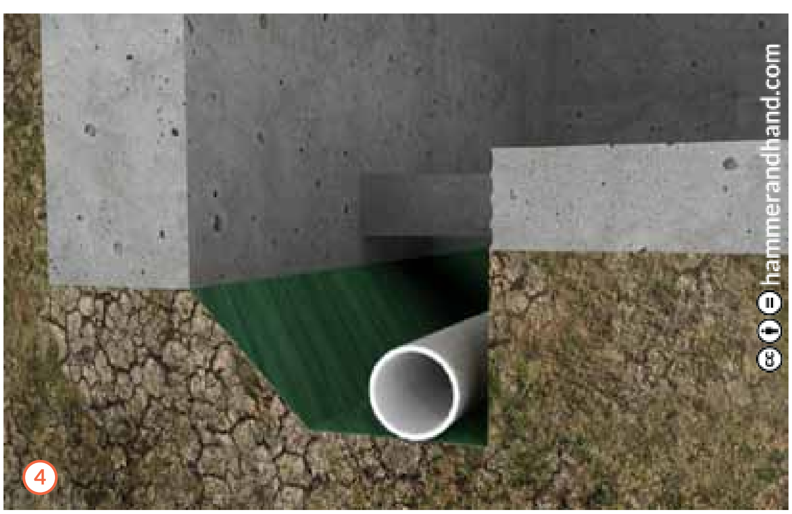
- Remove existing concrete basement floor with concrete saw or a 75lb+ jackhammer.
- Cut concrete floor at least 14” away from foundation wall (wider if footing is in the way).
- Leave 16” sections of the concrete floor (contact points) every 15’-20’ to keep foundation wall stable.



- After concrete has been removed, dig a trench 12" from top of concrete floor.
- Use a sump pump to manage water during digging.
- Always use a sump pump basin with air/vapor tight lid.
- The sump basin should be surrounded by at least 6 to 8 inches of 3/4" washed gravel.
- DO NOT undermine footing or foundation wall, maintain a 45 degree angle.



- Install heavy duty geotextile fabric in trench.

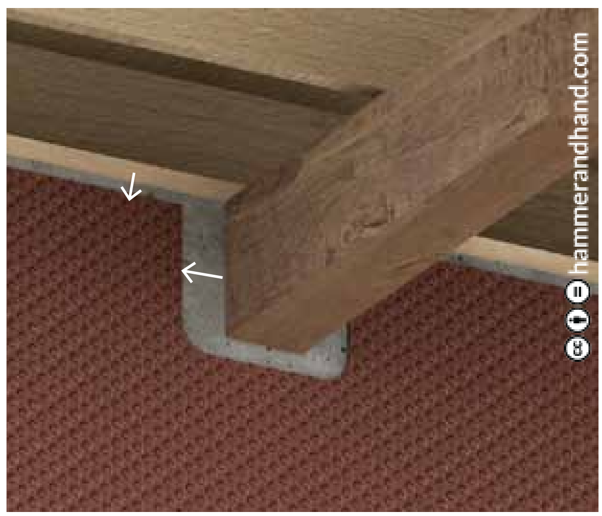


- Start from sump and lay perforated plastic pipe (holes down).
- Typical pipe slope/pitch is 1/4" per 5ft.
- This discharge line is typically a 1-1/2" inch PVC schedule 40 (solid) pipe.
- Always place in-line check valve directly above pump.

- Fill trench with clean, crushed stone (3/4” to 1-1/2”).

- Run dimple drainage mat at foundation wall to trench for weep.

- The cut concrete edge must be sprayed down and brushed so the new concrete has a clean surface to bond to.
- Pour new concrete flush with existing floor.



Note: It is critical that dimple drainage mat is terminated before intersecting embedded wood beams and the top of the foundation wall. This prevents the wood from coming into contact with the humid air between the foundation wall and dimple mat.

- Frame basement wall 1” off wall with a capillary break under bottom plate.
- Install vertical floor to ceiling fire blocking per code.

- Spray foam rim joist and foundation wall.

- Install Drywall.

Additional Information

Note: Warn clients against using carpet and vapor impermeable flooring on existing uninsulated slabs.

Flooring Options Going Forward:

1. Leave as is (highest risk).
2. Add vapor-tight dimple mat over existing slab and install new flooring.
3. Add rigid insulation over existing slab and install new flooring.
4. Remove existing slab and install rigid insulation, heavy duty sealed soil barrier, and new slab.

Always Provide Radon System Option:
Provide electrical near the sump pump to allow for easy addition of a radon system if necessary.

BEST PRACTICE DETAILS STEP-BY-STEP

CRAWLSPACES

Note to Hammer & Hand field staff:

Manufacturer's installation instructions and architect's construction drawings and specifications always take precedence over the details in this Best Practices Manual. Any discrepancies with this manual should trigger discussion with the architect about alternative approaches to their detailing. However, any alterations to architect's plans must be approved by the architect and such approval memorialized in an SK, ASI, RFI or other contractual method.

8.1 GENERAL GUIDELINES

Options:

1. New Construction: Conditioned Crawlspace with Insulated Slab (8.2)

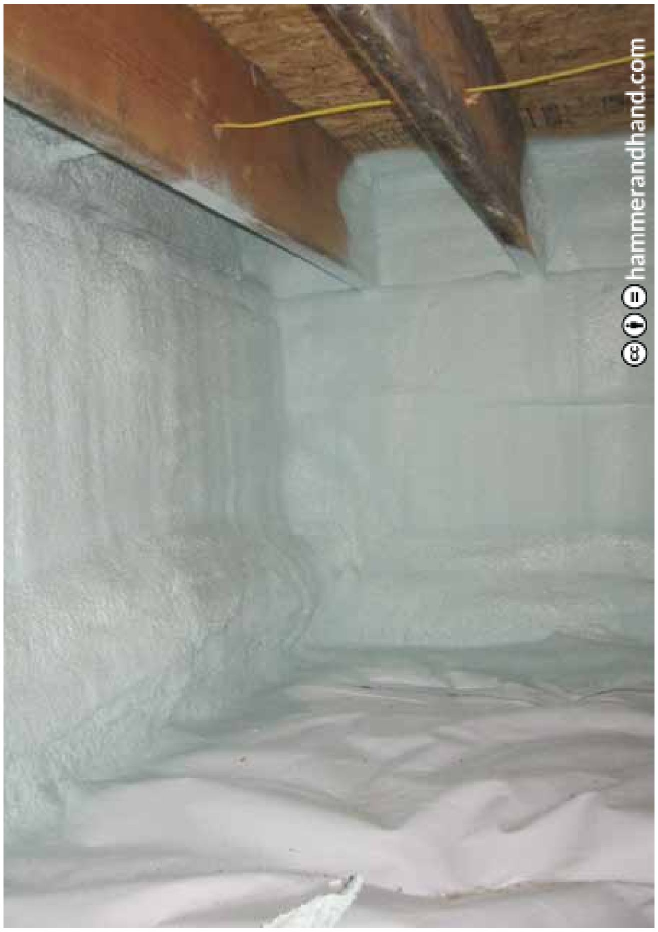
- Treating the crawlspace like a mini-basement with an insulated wall and slab is the highest performance crawlspace option.

2. Retrofit: Conditioned Crawlspace with Soil Barrier (8.3)

- This is the best retrofit option in crawlspaces that contain mechanicals or ductwork, or are interconnected with a conditioned basement.
- Install a Sealed Seam heavy duty (12 mil) soil barrier to seal the space from water vapor and soil gasses.

3. Retrofit: Vented Crawlspace with Floor Encapsulation (8.4)

- Acceptable option for crawlspaces without mechanicals or ductwork.
- Install new plastic soil barrier with lapped seams. Heavy duty soil barrier with sealed seams optional.
- Air space should be maintained between floor and spray foam if underfloor hydronic tubing is being used for radiant heat.



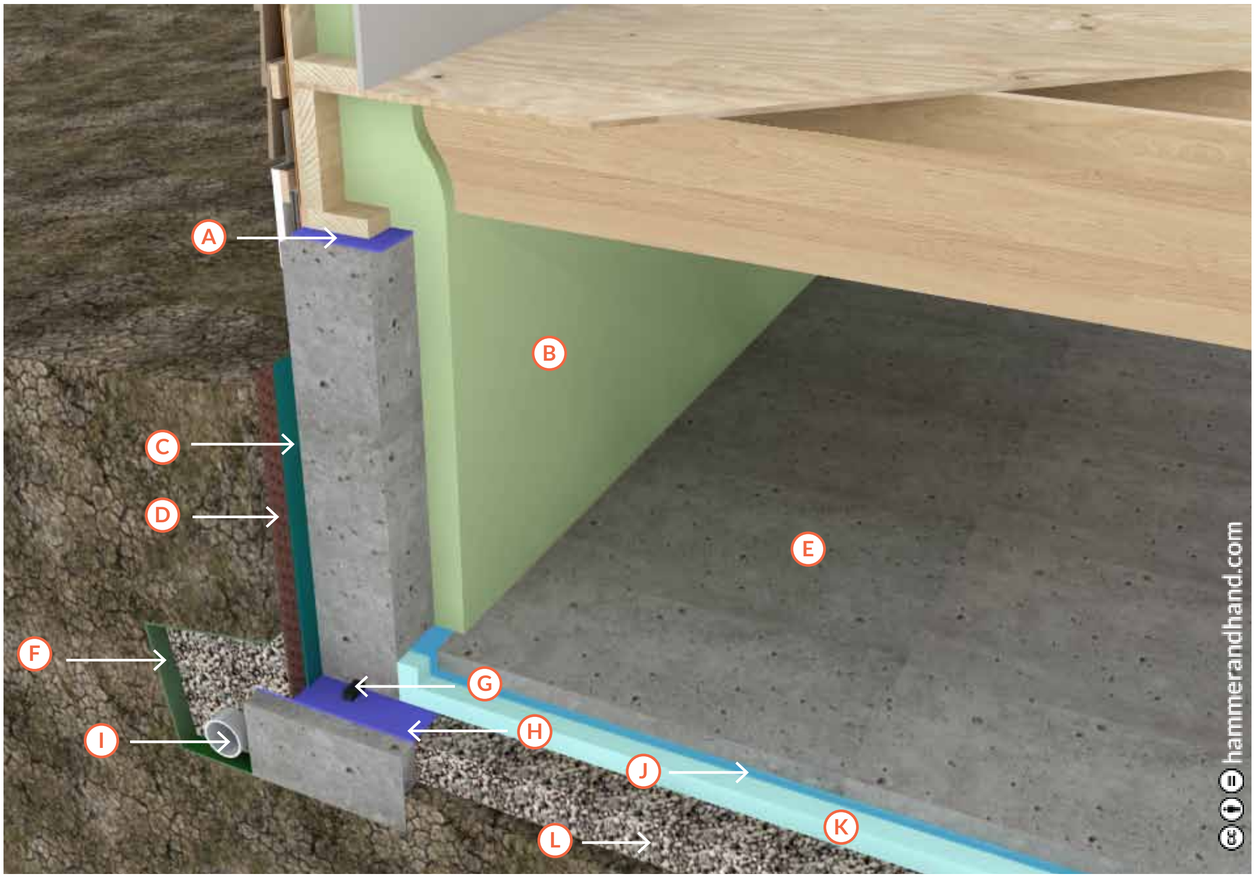
To Know Before Building or Retrofitting a Crawlspace:

- Moisture management: all surface and ground water must be properly managed prior to sealing and insulating a crawlspace.
- DO NOT route ductwork through unconditioned attics or crawlspaces. All water supply lines must be insulated even in a conditioned crawlspace.
- Cleanup: crawl must be thoroughly cleaned of all dust and debris after construction is complete and any damage to the soil barrier must be repaired.

8.2 NEW CONSTRUCTION: CONDITIONED CRAWLSPACE WITH INSULATED SLAB

We treat conditioned crawlspaces just like a very shallow basement. Please refer to 7.1 Basement, New Construction for a narrative of our approach.

Note: With appropriate detailing and maintenance, vented crawlspaces in new construction are also okay in many Pacific Northwest locations. For guidance, refer to 8.4 Retrofit Option 2: Vented with Floor Encapsulation.



A. CAPILLARY BREAK
B. MEDIUM DENSITY SPRAY FOAM (MDSPF)
C. FLUID APPLIED ELASTOMERIC MEMBRANE
D. DIMPLED DRAINAGE MEMBRANE WITH GEOTEXTILE FABRIC
E. 2" CONCRETE SLAB, "RAT SLAB"
F. HEAVY DUTY GEOTEXTILE FILTER FABRIC
G. WATERSTOP
H. CAPILLARY BREAK
I. 4" DRAINAGE PIPE, HOLES DOWN
J. 12 MIL REINFORCED SOIL BARRIER WITH JOINTS LAPPED, TAPED, AND SEALED
K. 2"-4" RIGID SUB-SLAB INSULATION (XPS OR EPS)
L. MINIMUM 4" LAYER WASHED AND CLEANED (NO FINES) CRUSHED STONE OR GRAVEL ALSO CONNECTED TO FOOTING DRAIN WITH PIPE/SLEEVES CAST INTO FOOTING
M. NOT SHOWN: IF RIGID FOAM INSULATION IS USED ON AN EXTERIOR WALL, PROTECT THE TOP WITH A COATING OR PROTECTION BOARD. BELOW GRADE, PLACE INSULATION BETWEEN DIMPLE DRAINAGE MAT AND ELASTOMERIC WATERPROOF MEMBRANE. FOAM MUST BE PROTECTED WITH DURABLE FINISH WHEN EXTENDED ABOVE GRADE.

Ventilation: Code requires 1.0 CFM of continuous mechanical exhaust for each 50 square feet. For example, a 1000sf crawlspace will need 20cfm of ventilation. Ideally this is provided by a Heat Recovery Ventilator (HRV).

8.3 RETROFIT OPTION 1: CONDITIONED CRAWLSPACE WITH SOIL BARRIER

Note: As an option, insulation can be added below the soil barrier. Insulation cannot, however, be added in/below the floor system because this thermal barrier defeats the purpose of a conditioned crawlspace and can set up a dangerous condition where the mechanically vented crawlspace becomes cold enough to produce condensation.

A. MEDIUM DENSITY SPRAY FOAM (MDSPF)
B. STEM WALL
C. 12 MIL REINFORCED SOIL BARRIER WITH JOINTS LAPPED, TAPED, AND SEALED

Ventilation: Code requires 1.0 CFM of continuous mechanical exhaust for each 50 square feet. For example, a 1000sf crawlspace will need 20cfm of ventilation. Ideally this is provided by a Heat Recovery Ventilator (HRV).

8.4 RETROFIT OPTION 2: VENTED CRAWLSPACE WITH FLOOR ENCAPSULATION

Vented crawlspaces are a great option provided that:
1. They are kept clean and dry (with proper site drainage)
2. Ventilation is kept open and free flowing.

By enveloping the bottom of the floor joists with the floor insulation/encapsulation the joists become thermally broken from the unconditioned crawlspace and protected from the risk of condensation and rot. Do not install high density/closed cell spray foam in the joists as that would establish a vapor barrier in a dangerous location.

A. ENCAPSULATE FLOOR WITH LOW DENSITY SPRAY FOAM (LDSPF)
B. STEM WALL
C. 6 MIL POLYETHYLENE BARRIER WITH 12” LAPPED SEAMS

R408.1 Ventilation

- Minimum Net Area: 1 square foot for each 150 square feet of under-floor space area.
- Minimum Net Area when soil barrier is installed with 12” lapped seams: 1 square foot for each 1,500.
- Install vents within 3 feet of each corner of the building to encourage cross flow ventilation.

BEST PRACTICE DETAILS STEP-BY-STEP

STRUCTURE

Note to Hammer & Hand field staff:

The details provided in this section are not meant to indicate or imply structural engineering requirements or code compliance.

Manufacturer's installation instructions and architect's construction drawings and specifications always take precedence over the details in this Best Practices Manual. Any discrepancies with this manual should trigger discussion with the architect about alternative approaches to their detailing. However, any alterations to architect's plans must be approved by the architect and such approval memorialized in an SK, ASI, RFI or other contractual method.

9.1 DECK LEDGERS

The conventional approach to deck construction creates a dangerous condition: a wood-to-wood connection between deck ledger and building structure in which the ledger wood gets wet regularly, transfers moisture into the building structure, and does not dry well. The result can be rot and deck collapse. Our approach solves this by properly flashing the building at the point of connection with the ledger, and then holding the ledger off the face of the building with simple spacers.

- Remove siding where ledger is to be attached and fold up and pin existing building membrane above install zone.
- Cut away lower piece to align with top of remaining siding below the ledger install space.

- FastFlash exposed sheathing.
- Be sure to lap over lower section of building membrane and as far as possible up under the folded up piece.

- Embed top of sheet metal flashing into a bead of FastFlash or Joint & Seam Filler.
- Bead and tool Joint & Seam Filler over top of flashing leg for a continuous drainage plane.

- Drill pilot holes for attaching ledger board through structural sheathing and rim joist.
- When using lags instead of bolts, be sure pilot holes are slightly smaller than lag diameter.

- Drill pilot holes in the PT ledger board according to plans from the designer. Make sure pilot holes are slightly smaller than the lag (if bolts are not being used).
- *Note:* Ledger can be temporarily tacked in place to pre-drill through ledger and rim in one step. Ex. 3/8” pilot hole for a 1/2” screw.

- Center spacers over bolt holes.
- Deck2Wall brand spacers are recommended.

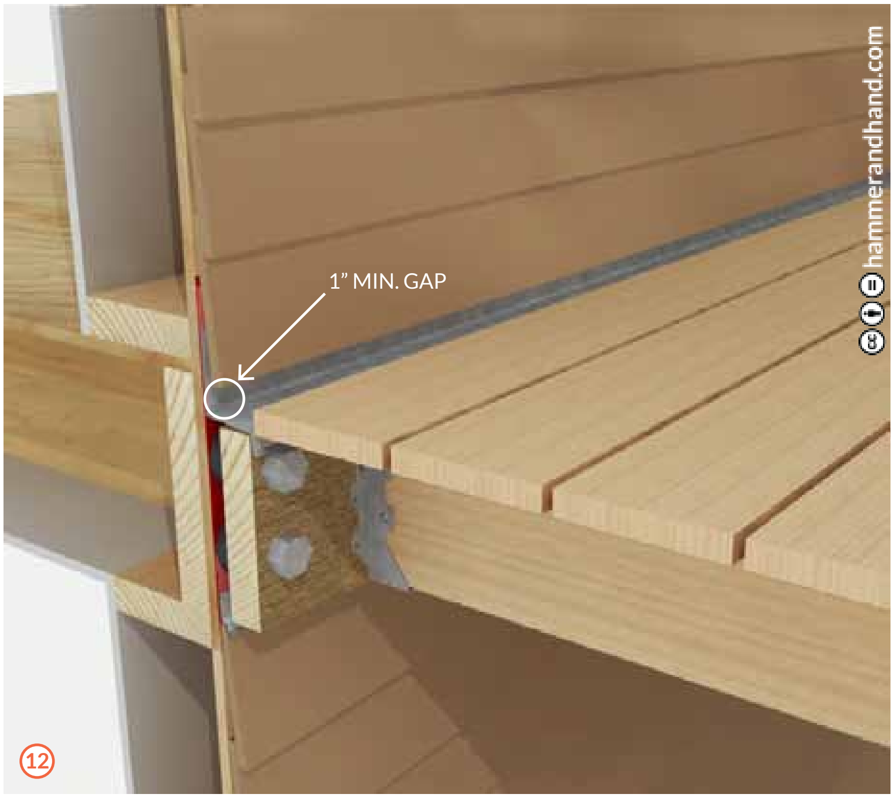
- Attach spacers with corrosion-resistant nails or screws.

- Dab a generous amount of FastFlash in and over the pilot holes in the sheathing and rim joist before attaching ledger board to prevent moisture intrusion.
- Bolt on PT ledger board.

- Attach joist hangers over top of FastFlashed ledger board.

- FastFlash around the ends of the joists before setting into joist hangers.

- Install flashing above ledger board. Cut slots where joists intersect with flashing and bend the leg straight along the top of the joist. Hammer flat.
- Bead and tool Joint & Seam Filler over top of sheet metal flashing leg for a continuous drainage plane.



- Attach decking.
- Replace necessary siding, allowing for a 1 - 2" gap above flashing to prevent water damage to cladding.

9.2 POCKET DOOR FRAMING

A. Studs at pocket to be engineered lumber or heavy gauge steel studs to provide rigidity to wall panel.
B. Create rabbet in door jamb by installing additional trim to receive the door and provide complete closure.

Hardware

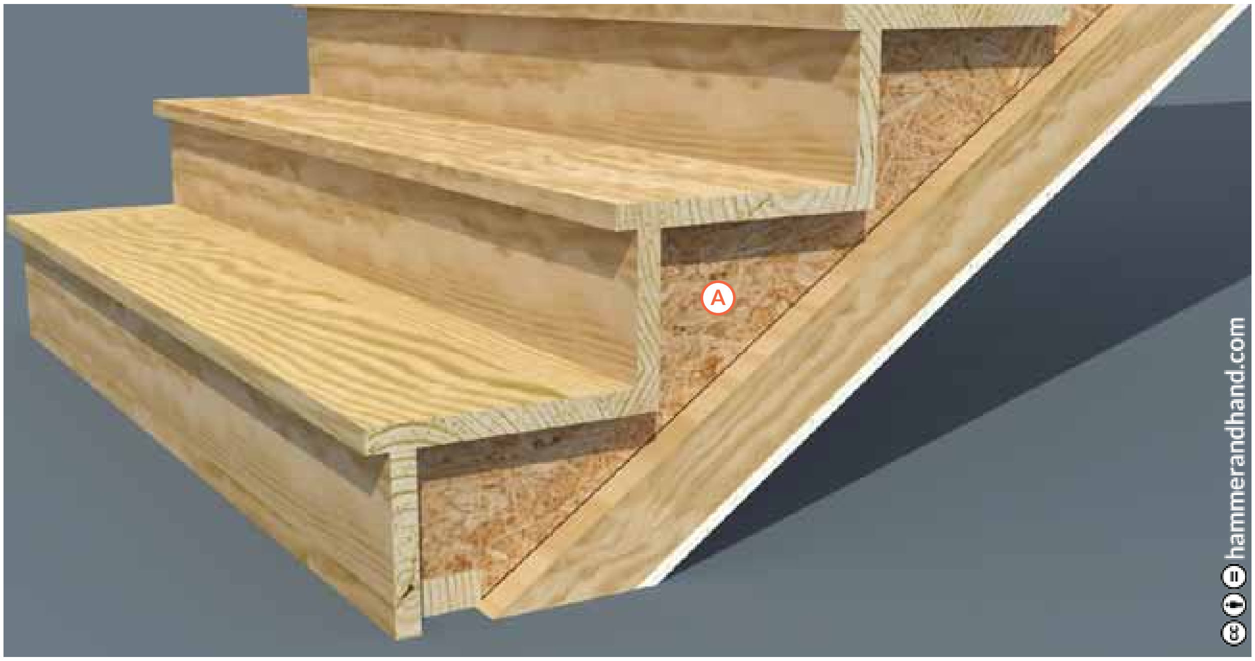
Options

- Johnson hardware: 200sd commercial grade with 200 series door hanger and hanger plate.
- Ducasse: Many options.
- Sugatsume: Many options.
- Hafele: Many options.

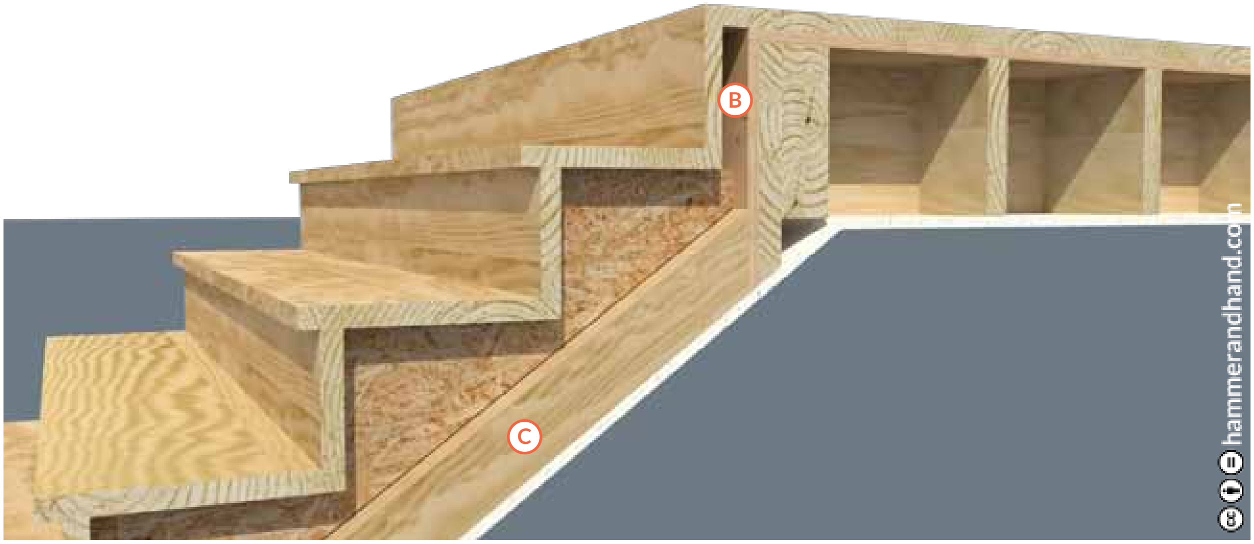
For situations where wall framing is limited to 3 1/2” (not recommended) the Johnson Pocket Door Kit can be used (2700 Pre-Assembled Pocket Door Frame). Do not use the assembly required steel stud Pocket Door Kit.

9.3 STAIR FRAMING

Bottom of Stairs



Top of Stairs



A. STRINGERS ARE FROM ENGINEERED MATERIAL (LVL PREFERRED)
B. 3/4 PLYWOOD HANGER PLATE
C. STRONGBACK (2 X 4 OR SIMILAR)

Note: This is for hemmed in stairs. If the staircase is floating, the strongback would be against the inside wall.

ABBREVIATION	MEANING
AC	Air Conditioning
DHW	Domestic Hot Water
ECM	Electrically Commutated Motor
EPDM	Ethylene Propylene Diene Monomer
EPS	Expanded Polystyrene
FAF	Fluid Applied Flashing
H&H	Hammer And Hand
HPA	Health Protection Agency
HRV	Heat Recovery Agency
HSPF	Heating Seasonal Performance Factor
HVA	Heating Ventilation And Air Conditioning
IC-RATING	Insulation Contact Rating
ICAT	High Performance Insulation Contact Rating
KD	Kiln Dried
MDF	Medium-Density Fiberboard
OC	On Center
OSHA	Occupational Safety And Health Administration
PT	Pressure Treated
POLYISO	Polyisocyanurate Insulation
QAP	Quality Assurance Program
RO	Rough Opening
RRP	Renovation, Repair, And Painting
S-DRIED	Standing Dried
SEER	Seasonal Energy Efficiency Ratio
RIGID PANEL	Rigid Material Layer
STD-BTR	Standard Or Better
TPO	Single Ply Roofing Material
WRB	Water-Resistive Barrier
XPS	Extruded Polystyrene

THANK YOU

Many hands were involved in the production of this manual. From the building experts penning the pages to the illustrators creating the details, each person involved helped bring this manual from conversations in hallways to the detailed manual you are reading now.

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