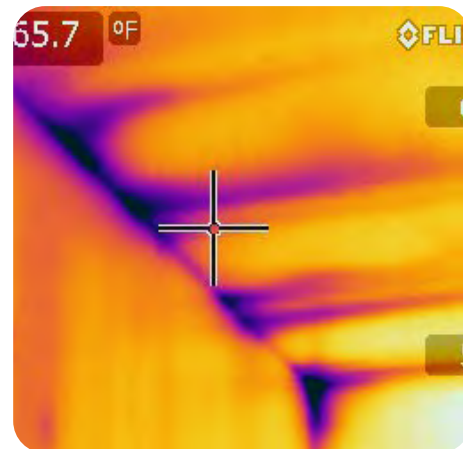
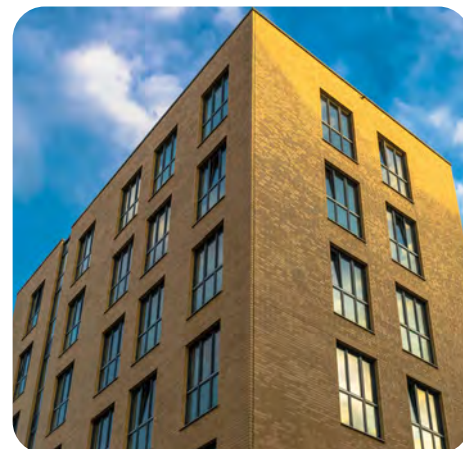


RETROFITTING MINNESOTA

STANDARD WORK SPECIFICATION-ALIGNED FIELD GUIDE



**COMMERCE
DEPARTMENT**

DIVISION OF ENERGY RESOURCES

Last updated 19 November 2021
Created by the Energy Smart Academy at Santa Fe Community College
For the Weatherization Collaborative
In alignment with the Standard Work Specifications
Created by the National Renewable Energy Laboratory,
found at <https://sws.nrel.gov>

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PERSONAL PROTECTIVE EQUIPMENT (PPE) GUIDE



Safety Glasses



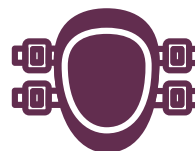
Hearing
Protection



Hard Hat



Bump Cap



Knee Pads



Gloves – Leather
or Heavy Cloth



Gloves – Nitrile



Tyvek Suit



Boot/Shoe
Covering



95

N-95 Mask
without Exhale
Valve



95

N-95 Mask with
Exhale Valve



Half-Face
P-100 Respirator



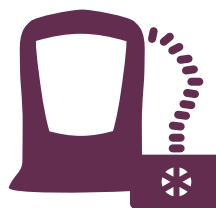
Half-Face
P-100 Respirator
with OV Valve



Full-Face
P-100
Respirator



Full-Face
P-100 Respirator
with OV Valve



Powered Air
Purifying
Respirator



Cooling Vest

1-1 INTERIOR LEAD-SAFE WEATHERIZATION

Aligns with Lead RRP



BEFORE

- ✗ Homes built before 1978 have the potential for lead paint and require special considerations during retrofitting



AFTER

- ✓ No lead dust or debris remains inside the home
- ✓ Contaminated materials have been disposed of or cleaned properly
- ✓ Disposal containment is securely closed

TOOLS

- Zip Walls
- HEPA Vacuum
- Hand Tools or Shrouded Power Tools
- Half or Full-face Respirator (Fit-Tested)

MATERIALS

- 6-Mil Plastic Sheeting
- Signage
- Tack Pads
- Painters Tape
- Trash Bags
- Disposable Tyvek Suits
- Booties
- P or N 100-Rated Filters

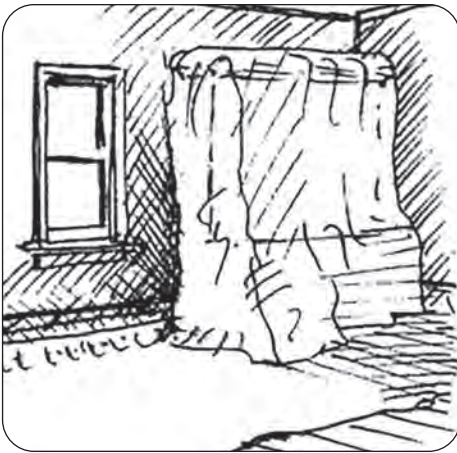
PPE



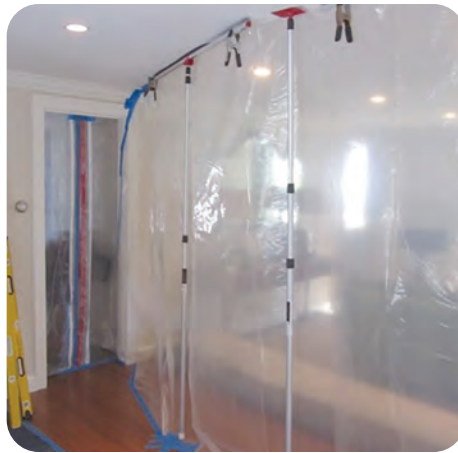
* weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

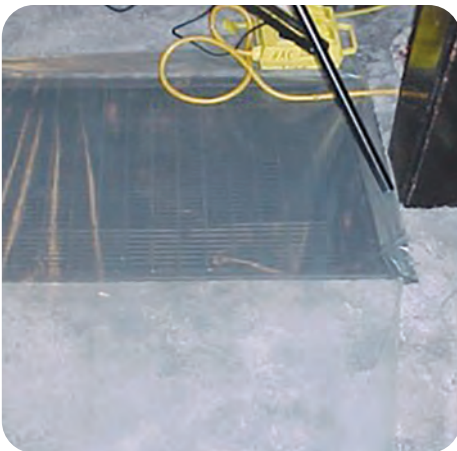
1-1 INTERIOR LEAD-SAFE WEATHERIZATION



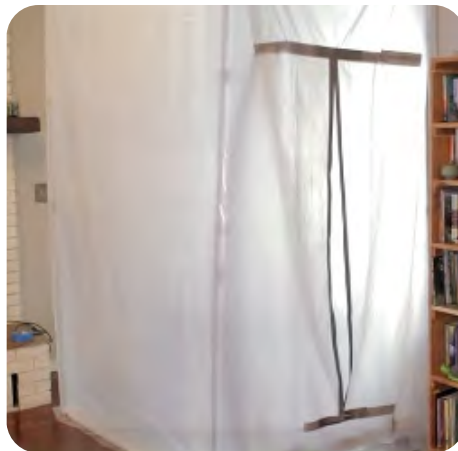
1. Move furniture out of work area and, if it cannot be removed, securely cover horizontal with plastic sheeting



2. Use disposable physical barriers to mark out and contain work area dust and debris



3. Six feet in any direction from the work area, cover surfaces with plastic sheeting, taped in place, including HVAC access points



4. Block off access doorways and install zippers to contain debris in work area

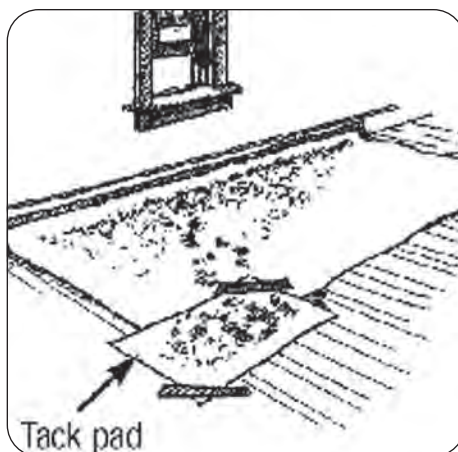
NOTES

Half and Full-face respirators, required for Lead Renovation work, must be fit-tested on all workers at least once a year. The respirator must form a tight seal at the face and neck. Workers who have a beard cannot wear a half- or full-face respirator, since they will not form a tight seal and contaminants can bypass the respirator. Bearded workers need to wear a PAPR, or powered air-purifying respirator.

1-1 INTERIOR LEAD-SAFE WEATHERIZATION

CAUTION

**RENOVATION WORK
DO NOT ENTER WORK AREA
UNLESS AUTHORIZED
NO SMOKING, EATING, OR
DRINKING**



- 5.** Post signs outside work area to prevent anyone from entering work area unintentionally

- 6.** Use tack pads at access points to containment area to minimize dust and debris being tracked outside area



- 7.** Wear appropriate PPE, including Tyvek suit, gloves and 100-Rated HEPA Disposable or Fit-Tested Respirator



- 8.** Utilize hand tools and/or shrouded tools that minimize dispersion of dust and debris

NOTES

1-1 INTERIOR LEAD-SAFE WEATHERIZATION



- 9.** Wipe down surfaces and vacuum work area, taking special care and attention of cracks and crevices where dust and debris might collect



- 10.** Carefully roll up and dispose of any plastic sheeting or other disposable materials in the work area



- 11.** Doff PPE outside, avoiding contact with contaminated surfaces of suit, gloves, etc., and dispose immediately

NOTES

1-2 EXTERIOR LEAD-SAFE WEATHERIZATION

Aligns with Lead RRP



BEFORE

- ✗ Homes built before 1978 have the potential for lead paint and require special considerations during retrofitting



AFTER

- ✓ Detailed attention needs to be paid to every aspect of work with lead-based paint, from start to finish

TOOLS

- HEPA Vacuum
- Hand Tools or Shrouded Power Tools
- Half or Full-face Respirator (Fit-Tested)

MATERIALS

- 6-Mil Plastic Sheeting
- Catchment Poly Bags
- Signage
- Tack Pads
- Painters Tape
- Trash Bags
- Scaffolding
- Disposable Tyvek Suits
- Booties
- P or N 100-Rated Filters

PPE



* situation dependent ** weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

1-2 EXTERIOR LEAD-SAFE WEATHERIZATION



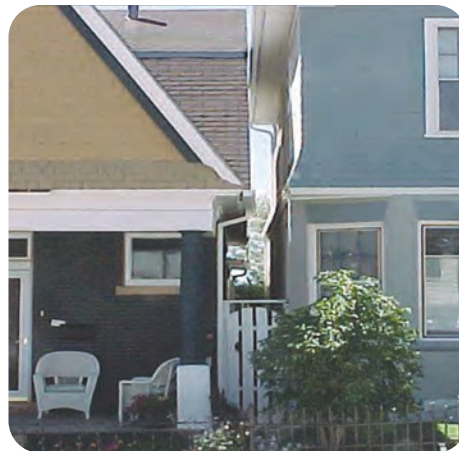
1. Create containment area with plastic sheeting 10 feet in any direction from work area



2. Post signs at least 20 feet from work area to prevent anyone from entering work area unintentionally



3. Seal off all exterior access points to home within containment area, including windows, doors, mail slots and vents



4. Where houses are located close together, vertical containment will be necessary

NOTES

Half and Full-face respirators, required for Lead Renovation work, must be fit-tested on all workers at least once a year. The respirator must form a tight seal at the face and neck. Workers who have a beard cannot wear a half- or full-face respirator, since they will not form a tight seal and contaminants can bypass the respirator. Bearded workers need to wear a PAPR, or powered air-purifying respirator.

1-2 EXTERIOR LEAD-SAFE WEATHERIZATION



- 5.** Tape plastic up onto work surface and utilize systems to catch debris while limiting damage to exterior plantings



- 6.** Don proper PPE, including tyvek suit with hood, gloves, booties and half- or full-face respirator (see notes). Be aware of potential for thermal stress when working in full PPE



- 7.** Use hand tools or shrouded power tools to limit dispersal of contaminated dust and debris



- 8.** Clean work area and carefully fold and dispose of plastic sheeting



- 9.** Doff PPE outside, avoiding contact with contaminated surfaces of suit, gloves, etc., and dispose immediately

NOTES

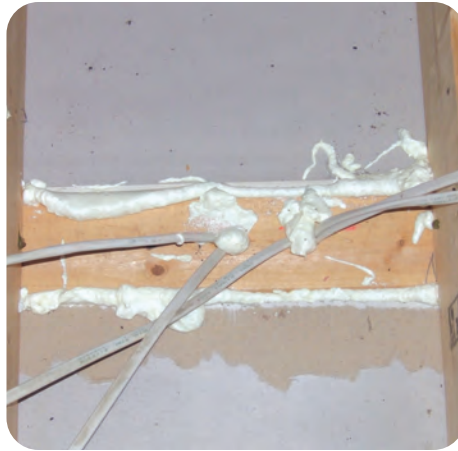
2-1 AIR SEAL TOP PLATES IN ATTIC

Aligns with SWS [3.0101.1](#), [3.0102.11](#)



BEFORE

✗ Air can move around unsealed top plates in attic, making new insulation less effective



AFTER

✓ Seal perimeter at all gaps and extend sealant up onto adjacent materials

TOOLS

- Caulk Gun
- Spray Foam Dispensing Gun

MATERIALS

- Caulk
- 1-part Polyurethane Spray Foam
- Mastic

PPE



* weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

2-1 AIR SEAL TOP PLATES IN ATTIC



Apply caulk to areas with
gap 1/4 inch or smaller



Apply sprayfoam or
mastic to gaps 1/4 inch to
2 inches wide

NOTES

2-2 AIR SEAL AN ATTIC SOFFIT OR LARGE OPENING

Aligns with SWS [3.0101.1](#), [3.0102.9](#)



OPTION A SEAL SOFFIT INTO CONDITIONED SPACE

Soffits, coffered ceilings and other design details can create lower sections in the ceiling line and often are not sealed or insulated properly



OPTION B SEAL SOFFIT OUT OF CONDITIONED SPACE

From the attic side, it is best to determine if it's better to leave the soffit connected to the conditioned space (inside the house) or seal it off as part of the unconditioned space

TOOLS

- Caulk Gun
- Utility Knife
- Measuring Tape
- Drill
- Spray Foam Nozzle

MATERIALS

- Spray Foam
- Lumber for Support
- Extruded Polystyrene (XPS)
- Gypsum Board
- Plywood
- Caulk
- Mechanical Fasteners

PPE



* situation dependent ** if cutting lumber

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

2-2 AIR SEAL AN ATTIC SOFFIT OR LARGE OPENING

OPTION A - SEAL SOFFIT INTO CONDITIONED SPACE



A-1. For openings larger than 24 inches, support braces will be necessary



A-2. Attach bracing across joists securely, spacing no more than 24 inches apart



A-3. Apply sealant along top plates, bracing, and framing members adjacent to opening more than 24 inches apart



A-4. Place Infill material over opening and secure in place with mechanical fasteners

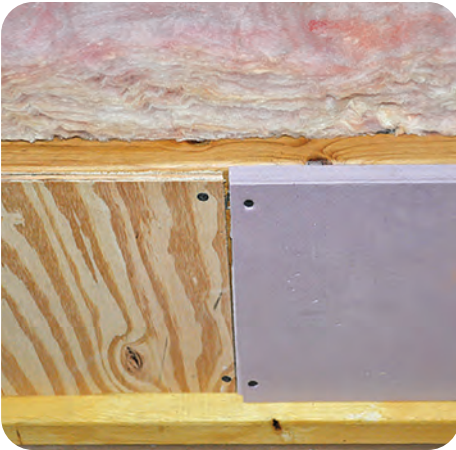


A-5. When support bracing has been used, screw infill material to bracing as well

NOTES

2-2 AIR SEAL AN ATTIC SOFFIT OR LARGE OPENING

OPTION B - SEAL SOFFIT OUT OF CONDITIONED SPACE



B-1. Seal off framed openings with rigid material, such as gypsum board, XPS, or OSB



B-2. Seal around infill materials

NOTES

2-3 AIR SEAL AN ATTIC CHASE OR SMALL OPENING

Aligns with SWS 3.0102.1



BEFORE

✗ Open chases for electrical and plumbing allow air movement from subspace and/or conditioned space



AFTER

✓ When properly sealed, air movement will cease through these spaces

TOOLS

- Measuring Tape
- Drill
- Utility Knife
- Caulk Gun
- Spray Foam Gun

MATERIALS

- Extruded Polystyrene (XPS)
- Gypsum Board
- Plywood
- Spray Foam
- Mechanical Fasteners

PPE



* weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

2-3 AIR SEAL AN ATTIC CHASE OR SMALL OPENING



- 1.** Measure the opening of the chase in a location that will maintain the pressure plane



- 2.** Cut material to fit for each space where it is needed, paying attention to locations of wires and pipes



- 3.** Rigid material to cover the span can be XPS, gypsum board or plywood, as appropriate for the location



- 4.** Seal rigid material into place securely and air seal with caulk, spray foam or mastic



- 5.** Extend sealing to adjacent materials to ensure a complete air seal

NOTES

2-4 AIR SEAL BALLOON FRAMING FROM ATTIC

Aligns with SWS 3.0101.1, 3.0102.4



BEFORE

- ✗ Balloon framing leaves cavities open from the basement to the attic, allowing for large amounts of air movement



AFTER

- ✓ By sealing at the top of the cavity, air flow is stopped and the cavity below is another step closer to being ready to insulate

TOOLS

- Measuring Tape
- Drill
- Utility Knife
- Saw
- Sprayfoam Gun
- Caulk Gun

MATERIALS

- Extruded Polystyrene (XPS)
- Gypsum Board
- Plywood
- Plastic-wrapped/ Bagged Fiberglass Batts
- 1-part Sprayfoam
- Caulk
- Mastic
- Mechanical Fasteners

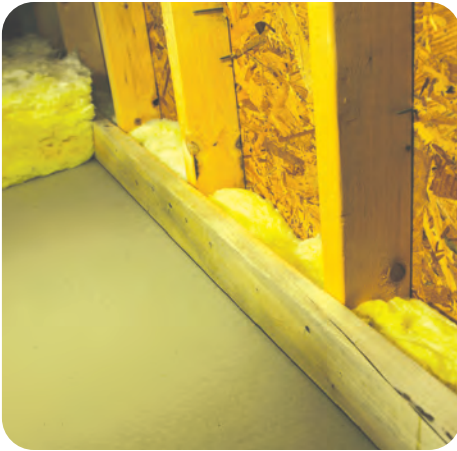
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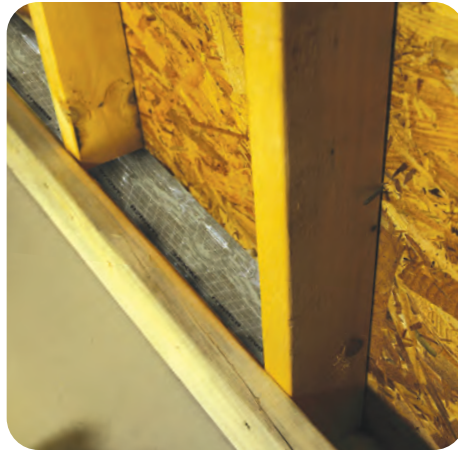
* weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

2-4 AIR SEAL BALLOON FRAMING FROM ATTIC



- 1.** Block the opening of balloon framed sidewalls in alignment with the pressure boundary



- 2.** Blocking material options include lumber, gypsum board, XPS, or bagged fiberglass batts



- 3.** Blocking material needs to be appropriate for potential weight load



- 4.** And securely fastened rigid material to withstand pressure of dense-packing beneath



- 5.** Seal any remaining gaps with caulk or 1-part spray foam, extending sealing to adjacent materials

NOTES

2-5 SEAL INSULATION-CONTACT RATED CAN LIGHTS

Aligns with SWS [3.0101.1](#)



BEFORE

✗ Insulation-Contact rated Can lights are commonly installed in the ceiling between the upper story and the attic, meaning gaps around them allow for significant air leakage



AFTER

✓ By sealing around an IC-rated can light, a continuous thermal boundary is maintained

TOOLS

• Caulk Gun

MATERIALS

• Caulk

NOTES

PPE



* weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

2-6 SEAL ELECTRICAL AND OTHER PENETRATIONS IN ATTIC

Aligns with SWS [3.0101.1](#), [6.0201.1](#), [6.0201.2](#)



1. Electrical, plumbing and HVAC penetrations are often oversized



2. For smaller gaps, caulk is enough to seal the hole

TOOLS

- Caulk Gun
- Spray Foam Gun
- Utility Knife

MATERIALS

- Caulk
- Spray Foam
- Backer Rod

PPE



* weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

2-6 SEAL ELECTRICAL AND OTHER PENETRATIONS IN ATTIC



3. Holes larger than 1/4 inch may require support for the sealant



4. Inserting backer rod provides infill to support the sealant



5. Seal to cover entire opening, including all backer rod

NOTES

For gaps larger than 3 inches, see 2-3 Air Seal an Attic Chase or Small Opening

2-7 AIR SEAL A FLOORED ATTIC

Aligns with SWS 3.0101.1



BEFORE

✗ Check floor joist cavities for blocking material and penetrations



AFTER

✓ Air seal cracks and penetrations in floored attic spaces

TOOLS

- Saw
- Drill
- Measuring Tape
- Utility Knife
- Caulk Gun
- Spray Foam Gun

MATERIALS

- Caulk
- Extruded Polystyrene (XPS)
- Lumber
- Gypsum Board
- 1-part Spray Foam
- Mechanical Fasteners
- Backer Rod

NOTES

Spray foam will not be used in spaces that will be exposed to habitable living spaces.

PPE



* situation dependent ** if cutting lumber

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

2-7 AIR SEAL A FLOORED ATTIC



1. With property owner permission, remove flooring material to access cavities



2. Remove only as much flooring as necessary to gain access to every cavity and any large air sealing areas



3. Place blocking material to align with thermal boundary, as needed, and air seal to hold insulation in place



4. In rare cases it may be easier to install air sealing materials from below floored attic spaces



5. Air seal gaps and seams in joist cavities as accessible



6. Check for and air seal electrical, plumbing, and HVAC penetrations properly

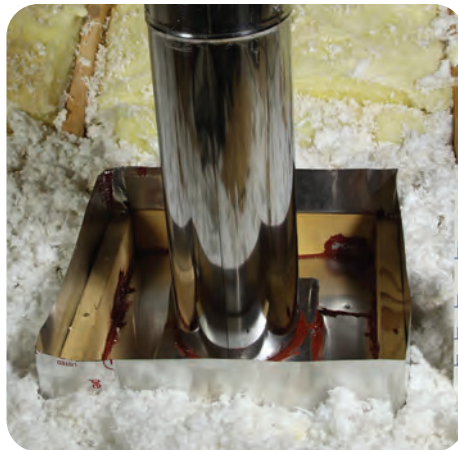
3-1 SEAL AROUND CHIMNEYS AND FLUES

Aligns with SWS 3.0102.2



BEFORE

✗ Even high-temperature sites need air sealing



AFTER

✓ Maintain 3-inch clearance from flue for all combustible materials

TOOLS

- Caulk Gun
- Metal Snips or Nibbler
- Drill
- Tape Measure

MATERIALS

- Sheet Metal
- Mechanical Fasteners
- Lumber

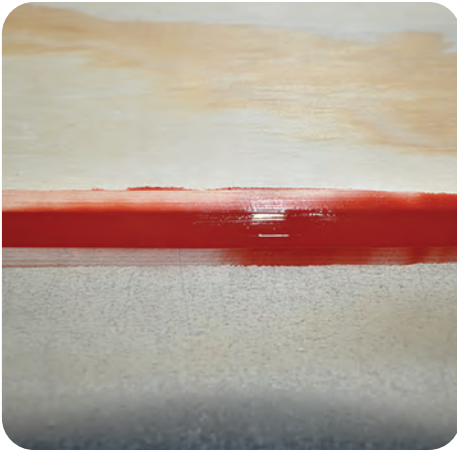
PPE



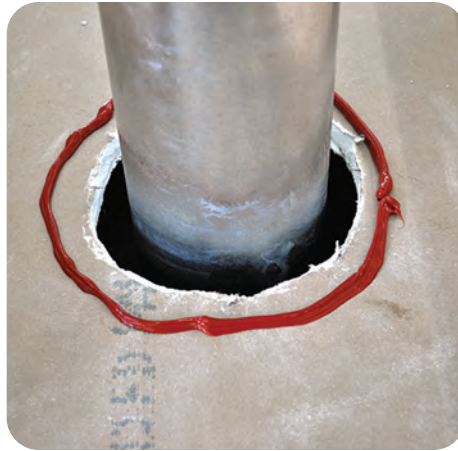
* situation dependent ** if cutting lumber

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

3-1 SEAL AROUND CHIMNEYS AND FLUES



1. Select high-temperature caulk sealant that will adjust to temperature differences between materials

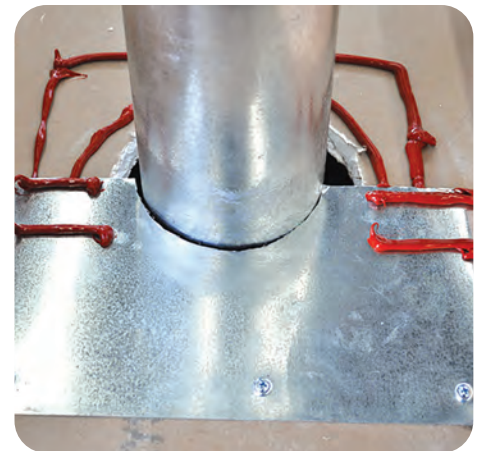


2. Apply unbroken ring of caulk directly to clean decking around entire perimeter of flue or chimney



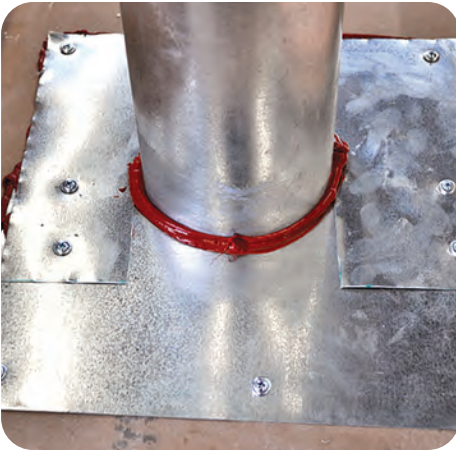
3. Apply unbroken ring of caulk directly to clean decking to match perimeter of sheet metal backing

NOTES

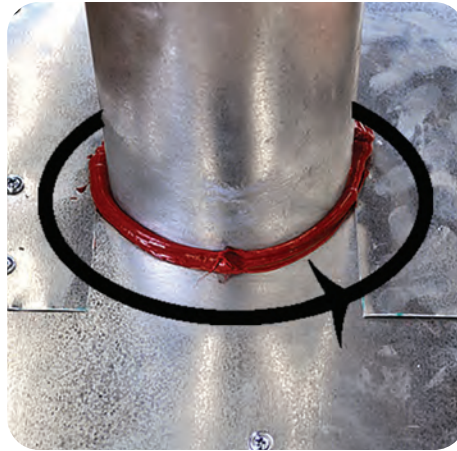


4. Install first layer of metal sheeting and apply additional caulk to complete new perimeter for second layer of sheeting

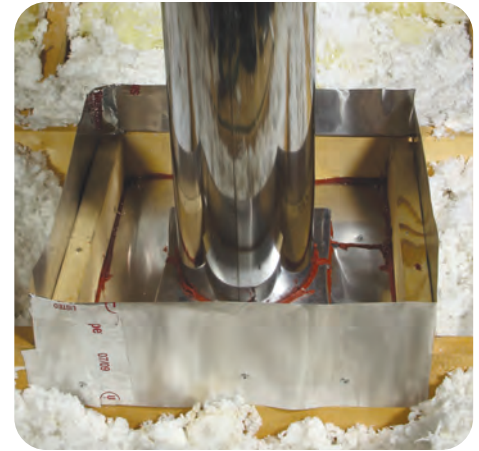
3-1 SEAL AROUND CHIMNEYS AND FLUES



5. Set second layer of sheeting to complete ring around flue or chimney. Fasten sheeting mechanically



6. Run bead of high-temperature caulk around flue at backing to seal remaining gaps $< 1/4$ inch



7. Create a durable, fixed dam, at least 2 inches higher than final insulation level, keeping all combustible materials at least 3 inches away from flue or chimney

NOTES

3-2 SEAL AROUND NON-INSULATION CONTACT-RATED (NON-IC) CAN LIGHTS

Aligns with SWS [3.0102.1](#)



BEFORE

- ✗ Non-Insulation
Contact-rated can lights
create a fire hazard in
well-insulated attics



AFTER

- ✓ When boxed with
appropriate clearances
and fire-rated materials,
fire risk is mitigated

TOOLS

- Measuring Tape
- Utility Knife
- Caulk Gun

MATERIALS

- 5/8 Inch
Gypsum Board
- High-Temperature
Caulk
- 100% Silicone Sealant

PPE



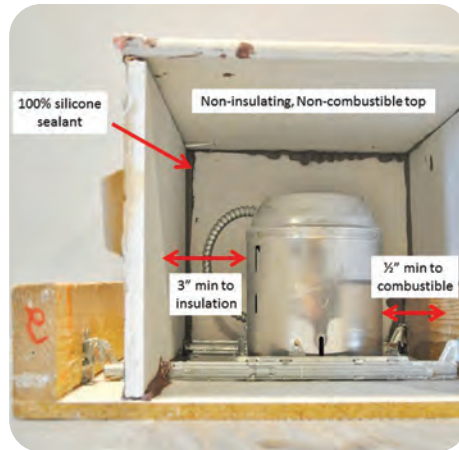
* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

3-2 SEAL AROUND NON-INSULATION CONTACT- RATED (NON-IC) CAN LIGHTS



1. Clear any debris from around non-IC-rated can light



2. Enclosure has 3 inches of clearance from lamp to insulation on all sides, at least 1/2 inch from any combustible material, such as wood



3. Premade boxes can make installation easier when installation site is clear of framing members

NOTES

Non "Insulation Contact" Can Lights are designed to vent heat from the lamp into the cavity around them. They are safe to use in non-insulated cavities, such as the ceiling/floors between different stories in a home. IC-rated Can Lights have a secondary housing to keep the heat of the lamp from contacting the insulation. They are also recommended for use with lower wattage lamps.

3-2 SEAL AROUND NON-INSULATION CONTACT- RATED (NON-IC) CAN LIGHTS



- 4.** Seal box on all sides and edges to make continuous barrier from attic, using high temp caulk where appropriate



- 5.** Top of box must be R-1 or less and left free of insulation. Flag enclosure for added visibility

NOTES

With the help of a licensed electrician, there is also the option of replacing old can lights with air-tight units, LED retrofit inserts or surface-mounted LED fixtures. Check program requirements.

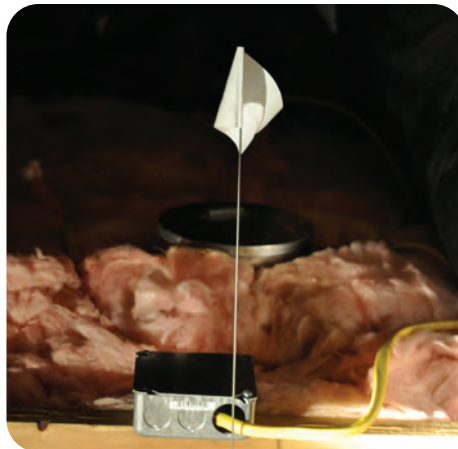
4-1 PREPARE ATTIC FLOOR FOR INSULATION

Aligns with SWS [4.0103.1](#), [4.0103.2](#), [4.0103.3](#), [4.0103.4](#), [4.0103.5](#), [4.0103.6](#), and [4.0103.8](#)

BEFORE YOU BEGIN



- ✓ Check for live knob & tube wiring. Replace with modern wiring.



- ✓ Cover junction boxes and attach flag for visibility

TOOLS

- Non-Contact Tester
- Utility Knife
- Drill
- Hole Saw
- Caulk Gun
- Staple Gun
- Metal Snips
- Nibbler

PPE



* if cutting lumber or sheet metal ** situation dependent *** if cutting lumber

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

4-1 PREPARE ATTIC FLOOR FOR INSULATION



1. Remove stored materials



2. Run exhaust fan ducts
to outside, insulate to R-8



3. Ensure air sealing, if any,
is completed



4. Install baffles, if needed.
Ensure 2 inches of gap
for airflow

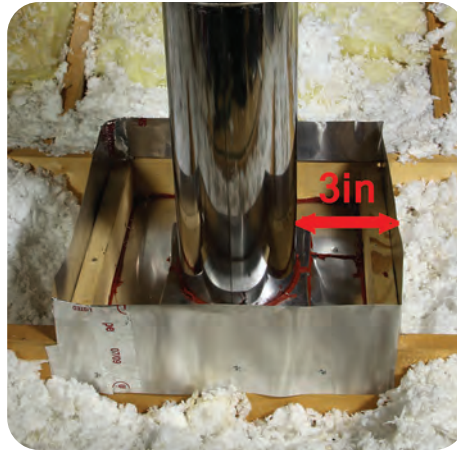
MATERIALS

- Plywood
- Drywall
- XPS
- Junction Box Covers
- Flags
- Vent Caps
- Rigid Duct
- Mechanical Fasteners
- Foil Tape
- R-8 Duct Insulation
- Soffit Baffles
- Depth Rulers
- Metal Sheeting
- High-Temperature Caulk

4-1 PREPARE ATTIC FLOOR FOR INSULATION



- 5.** Depth rulers installed,
1 per 300 square feet



- 6.** All dams are built,
as needed

NOTES

Knob-and-tube can
be replaced by a
qualified professional.

5-1 DAM, SEAL & INSULATE AN ATTIC HATCH

Aligns with SWS 3.0103.1



BEFORE

✗ Uninsulated attic access points allow conditioned air to escape the home in all seasons



AFTER

✓ Safely and durably sealing and insulating attic access doors prevent air movement and reduces heating and cooling loads

TOOLS

- Measuring Tape
- Saw
- Drill
- T-Square
- Utility Knife
- Caulk Gun

MATERIALS

- Lumber
- Mechanical Fasteners
- Extruded Polystyrene (XPS) or Other Rigid Foam Insulation Board
- Foam Tape
- Weatherstripping
- Adhesive
- Latch (optional)

PPE



* if cutting lumber ** situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

5-1 DAM, SEAL & INSULATE AN ATTIC HATCH



1. Rigid, durable attic hatch blocking/dam is installed in a permanent way



2. Dam is at least 2 inches taller than the final attic insulation depth



3. Cut gypsum board to hatch size for "friction fit" and air seal bottom of hatch with unbroken ring of foam tape or weatherstripping

NOTES



4. Cut and stack rigid foam insulation, gluing with appropriate adhesive, to build up R-value

5-1 DAM, SEAL & INSULATE AN ATTIC HATCH



5. Hatch is insulated to proper R-value (the maximum R-value structurally allowable, up to the final insulation level of surrounding attic)



6. Trim is air-sealed with appropriate material



7. For vertical accesses, run weatherstripping or foam tape to air seal at these doorways too. Hold vertical accesses closed with latch if necessary

NOTES

5-2 DAM, SEAL & INSULATE A PULL-DOWN ATTIC STAIRWAY

Aligns with SWS 3.0103.1



BEFORE

✗ Pull-down stairs can be a weak point in thermal/pressure boundaries, as well as creating a place where insulation can fall down into the home



AFTER

✓ Attic pull-down stairs are safely and durably sealed and insulated to prevent air movement

MATERIALS

- Foil Faced Polyiso (such as Thermax)
- Polyiso
- Plywood
- 1-Part Spray Foam
- Spray Adhesive
- Caulk Adhesive
- Foil Tape
- Mechanical Fasteners
- Foam Tape
- Weatherstripping
- Latches

TOOLS

- | | |
|------------------|------------------|
| • Measuring Tape | • Caulk Gun |
| • Utility Knife | • Spray Foam Gun |
| • Saw | • Drill |

PPE



* if cutting lumber ** situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

5-2 DAM, SEAL & INSULATE A PULL-DOWN ATTIC STAIRWAY



- 1.** Build cover above and around pull-down stair, taller than final insulation height



- 2.** Insulate top and sides of dam cover, to appropriate R-value



- 3.** Air seal all edges of trim



- 4.** Air seal with foam tape or weatherstripping



- 5.** Install latches to ensure hatch remains closed and air sealed if it does not remain closed with a 'friction fit'

NOTES

6-1 INSULATE AN UNFLOORED ATTIC

Aligns with SWS [4.0103.2](#), [4.0103.4](#), [4.0103.6](#)



BEFORE

Ensure that attic prep work has been completed before starting installation (See 4-1 Prep Attic Floor for Insulation)



AFTER

FINAL CHECKLIST

- ✓ Appropriate insulation material used
- ✓ Correct depth, as specified in work order
- ✓ Insulation level is even

TOOLS

- Measuring Tape
- Insulation Machine
- Staple Gun

MATERIALS

- Loose fill fiberglass or cellulose (as per work order)
- Staples

PPE



* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

6-1 INSULATE AN UNFLOORED ATTIC

Measure 2 User-Spec Ceiling R

Comment

#	Material / Labor	Description /Comment
1	Insulation	Attic Insulation - Blown Cellulose - R-38
2	Labor	Attic Insulation - Blown Cellulose - R-38

Other Detail

R13 to R60

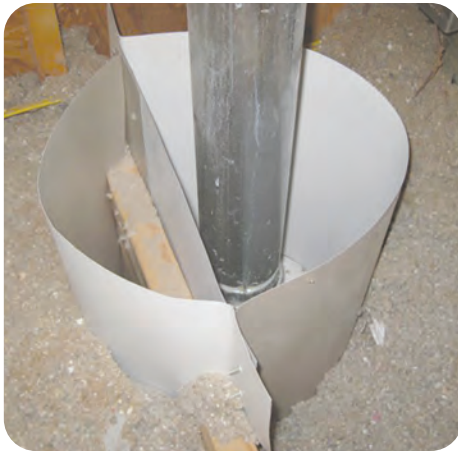
Nature Blend™ Loose Fill Formula

Coverage Chart for Thermal Acoustical Application

R-Value @ 75°F	Initial Insulation Thickness (inches)	Minimum Settling Thickness (inches)	No. Joists (don't adjust for arched)			2" x 8", 10" O.C.		
			Bags Per 1000 Sq. Ft.	Net Coverage Sq. Ft. Per Bag	Minimum Weight Per Sq. Ft.	Bags Per 1000 Sq. Ft.	Net Coverage Sq. Ft. Per Bag	Minimum Weight Per Sq. Ft.
13	4.4	4.0	17.4	57.5	0.38	15.8	63.5	0.35
19	6.1	5.5	27.9	35.8	0.61	25.3	39.6	0.56
22	6.9	6.2	33.2	30.1	0.73	30.5	32.8	0.67
25	7.8	7.0	38.6	25.9	0.85	35.8	28.0	0.79
30	9.2	8.3	47.6	21.0	1.00	44.6	22.4	0.98
36	11.4	10.3	62.0	16.1	1.30	58.9	17.0	1.30
48	14.6	13.1	82.0	12.2	1.80	76.7	12.7	1.73
60	17.7	15.9	101.9	9.8	2.24	96.6	10.1	2.17



1. Verify against work order that correct insulation material is being installed
2. Verify insulation depth/density against manufacturer's density chart
3. While installing, regularly check depth of insulation for even coverage and to meet required depth



4. Ensure that insulation does not get into dammed-off areas, such as around chimneys and flues and inside soffit baffles
5. When complete, post insulation certificate by attic entrance

NOTES

6-2 INSULATE UNDER A FLOORED ATTIC

Aligns with SWS 4.0103.6



BEFORE

✗ Attics with flooring often hide uninsulated cavities



AFTER

✓ An insulated attic floor provides a continuous, contiguous, safe, and compliant thermal boundary that prevents air movement

TOOLS

- Measuring Tape
- Utility Knife
- Insulation Machine
- Drill
- Hole Saw
- Prybar
- Caulk Gun

MATERIALS

- Loose Fiberglass or Cellulose Insulation
- Extruded Polystyrene (XPS)
- Caulk
- Mechanical Fasteners
- Gypsum Board
- Plugs

PPE



* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

6-2 INSULATE UNDER A FLOORED ATTIC



1. Ensure that floor cavities are blocked securely at both ends



2. If boards can be loosened, pry up as few boards as possible to access all cavities. If flooring is in solid sheets, access holes may need to be drilled



3. Fill entire cavity with insulation to prescribed density

NOTES



4. Occasionally a homeowner may not want the attic floor to be disturbed. The cavities can also be accessed from below through the ceiling, particularly in garage spaces

6-2 INSULATE UNDER A FLOORED ATTIC



- 5.** Blocking still needs to be put into place



- 6.** Blow insulation to completely fill cavities to prescribed density



- 7.** Fill and reseal access holes to prevent air movement

NOTES

6-3 INSULATE AN ATTIC STAIRWAY

Aligns with SWS [4.0104.1](#), [4.0104.2](#), [4.0104.3](#), [4.0104.4](#),
[4.0104.5](#), [4.0104.6](#), [4.0201.2](#), [4.0201.3](#), [4.0202.1](#)



BEFORE

✗ Attic stairways can offer a unique set of insulation challenges. Clearly define where the thermal and pressure boundary are going to be located before starting insulation



AFTER

✓ Insulation provides a continuous, contiguous, safe, and compliant thermal boundary that prevents air movement between the attic and the remainder of the home

TOOLS

- Measuring Tape
- Drill
- Utility Knife
- Hole Saw
- Insulation Machine
- Spray Foam Gun

MATERIALS

- Kraft-Faced Fiberglass Batts
- Loose Cellulose or Fiberglass Insulation
- Netting
- Furring Strips
- Staples
- Mechanical Fasteners
- Extruded Polystyrene (XPS)
- 2-Part Spray Foam
- 1-Part Spray Foam
- Plywood
- Gypsum Board
- House Wrap

PPE



* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

6-3 INSULATE AN ATTIC STAIRWAY



- 1.** If walls are accessible from the attic side, choose between batt or blown-in insulation



- 2.** Block off open cavities along the line of the thermal/pressure boundary



- 3.** Air seal around blocking material



- 4.** Cut batts to size for each individual cavity, ensuring no gaps remain, locating kraft-paper toward conditioned space



- 5.** For batt insulation, cover installed batts with backing. For blown-in, attach netting to framing members, cut holes in netting and blow in insulation to 3.5 pounds per cubic inch



- 6.** If walls are enclosed from attic side, drill holes in stairways walls

6-3 INSULATE AN ATTIC STAIRWAY



7. Dense pack stairway walls



8. Weatherstrip and insulate door



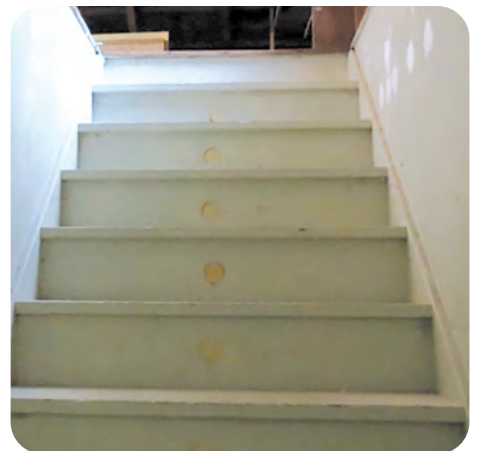
9. Insulate under stairway using insulation indicated by work order



10. Seal off insulation from conditioned space in home



11. If backside of stairs is already sealed, blow insulation into cavity behind stairs



12. Plug access holes for blown insulation

NOTES

7-1 PREPARE A MANUFACTURED HOME CEILING FOR INSULATION

Aligns with SWS [4.0103.6](#), [4.0103.9](#), [4.0103.10](#), [4.0103.11](#), [4.0103.12](#)



BEFORE YOU BEGIN

Make any repairs and preparation as noted from assessment, as well as fixing any new issues that could cause the ceiling to be compromised with the additional weight of insulation



AFTER

FINAL CHECKLIST

- ✓ Vents all terminate to outside and are properly sealed
- ✓ Flues are dammed properly
- ✓ Ceiling is in good condition to hold weight

TOOLS

- Measuring Tape
- Utility Knife
- Zip Tie Tensioner

MATERIALS

- R-8 minimum Flex Duct insulation
- Duct Insulation with Vapor Retarder
- Water Heater Blanket with Vapor Retarder
- Zip Ties
- Twine
- Spray Adhesive
- Mastic
- UL 181 Fiberglass Mesh Tape

PPE



*if working with mold **weather dependent ***if cutting lumber

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

7-1 PREPARE A MANUFACTURED HOME CEILING FOR INSULATION



1. Ensure plumbing and exhaust vents terminate outside



2. Dam around high temperature flues (note: flue in image is in need of work)



3. Replace non-IC rated can lights with IC-rated cans



4. Repair roof leaks or other damage, as possible, or defer job if necessary

NOTES

Check with your state
program to find out
deferral thresholds
and procedures

7-2 MH INSULATION: GABLE END BLOW METHOD

Aligns with SWS 4.0103.9



BEFORE

✗ Manufactured housing often does not meet regional standards for insulation



AFTER

✓ Fill entire cavity and reseal gable ends

TOOLS

- Drill
- Utility Knife
- Hole Saw or Saws-All
- Caulk Gun

MATERIALS

- Fiberglass Loose Insulation
- Mechanical Fasteners
- Caulk/Sealant

NOTES

PPE



* if cutting lumber

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

7-2 MH INSULATION: GABLE END BLOW METHOD



1. Verify integrity of ceiling to hold weight of insulation



2. Ground blower hose to reduce chance of electrical build-up



3. Remove or fold up gable end to access attic



4. Insert blower hose as far as possible and then retract slowly to fill cavity entirely, on each side of marriage wall



5. Fill cavity and leave appropriate documentation



6. Reseal gable end or install gable vent at peak that has no more than 1/2 inch mesh screen. Repeat all steps from other end, if needed.

7-3 MH INSULATION: EDGE BLOW METHOD

Aligns with SWS 4.0103.10



BEFORE

- ✗ Manufactured housing often does not meet regional standards for insulation



AFTER

- ✓ Verify reinstallation and proper sealing of edge of roof to ensure no water or pest intrusion

TOOLS

- Drill
- Utility Knife
- Insulation Machine

MATERIALS

- Fiberglass Loose Insulation
- Blocking Material
- Butyl Tape

NOTES

PPE



* if cutting lumber ** situation dependent *** if cutting lumber

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

7-3 MH INSULATION: EDGE BLOW METHOD



1. Verify integrity of ceiling to hold weight of insulation



2. Prepare stable work area to access roof edge



3. Unfasten and remove J channel from edge of roof



4. Clean old butyl tape or putty from J channel and store J channel somewhere safe until it can be reinstalled



5. Remove staples holding down edge of roof



6. Insert blocks to hold roof edge up approximately 6 inches

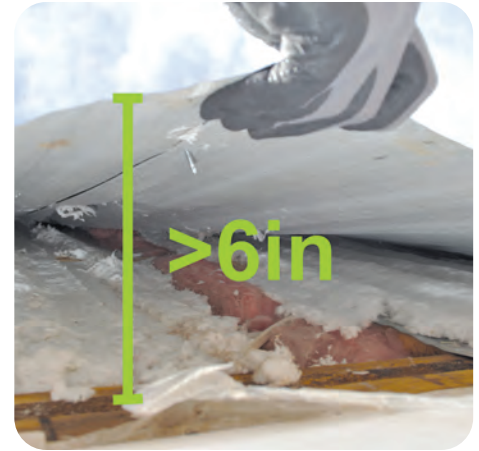
7-3 MH INSULATION: EDGE BLOW METHOD



- 7.** Ground the fill hose to reduce chance of electrical build-up



- 8.** Insert blower hose as far as possible into cavity and retract slowly while filling space between trusses



- 9.** Work down the edge of the roof until entire cavity is full



- 10.** Remove blocks and reattach edge of roofing over exterior sidewall paneling



- 11.** Replace butyl tape on J channel



- 12.** Reattach J channel, lapping over edge of roof. Repeat entire process for other side, if necessary

7-4 MH INSULATION: RIDGE BLOW METHOD

Aligns with SWS 4.0103.11



BEFORE

✗ Manufactured housing commonly is underinsulated, particularly older models



AFTER

✓ After accessing from ridge, ridge cap can be installed or a series of vent caps

TOOLS

- Drill
- Saw
- Insulation Machine
- Caulk Gun
- Metal Sheers

MATERIALS

- Loose Fiberglass Insulation
- Sealant
- 26-Gauge Metal Sheeting
- Vent Caps
- Mechanical Fasteners
- Elastomeric Coating

PPE



7-4 MH INSULATION: RIDGE BLOW METHOD



1. Remove ridge cap or cut access holes at ridge, leaving one side attached to put back in place



2. Insert blower hose



3. Fill all accessible areas



4. If not installing ridge or cap vents, replace flaps, patch over with metal, and seal with elastomeric

NOTES

7-5 MH INSULATION: INTERIOR BLOW METHOD

Aligns with SWS 4.0103.12



1. Drill holes in ceiling to fill each ceiling joist cavity



2. Blow insulation into ceiling cavity to appropriate R-value for region

TOOLS

- Hole Saw
- Vacuum
- Insulation Machine
- Caulk Gun

MATERIALS

- Fiberglass Loose Insulation
- Plugs
- Sealant

PPE



7-5 MH INSULATION: INTERIOR BLOW METHOD



3. Continue throughout house to ensure even coverage and no gaps



4. Seal all holes securely

NOTES

7-6 MH INSULATION: TOP FILL BLOW METHOD

Aligns with SWS 4.0103.11



BEFORE

X Attics in older manufactured housing are often underinsulated or poorly insulated



AFTER

FINAL CHECKLIST

- ✓ Provide a continuous and safe thermal barrier
- ✓ Protect integrity of roof

TOOLS

- Saw
- Insulation Machine
- Caulk Gun
- Paint Brush
- Drill

MATERIALS

- Fiberglass Loose Insulation
- All-Weather Adhesive
- Sheet Metal
- Mechanical Fasteners
- Elastomeric Paint

PPE



7-6 MH INSULATION: TOP FILL BLOW METHOD



- 1.** Drill or cut uniform access holes in the roof adequately spaced to access the entire roof cavity



- 2.** Blow insulation into attic cavity to capacity



- 3.** Run a continuous bead of flexible and durable all-weather adhesive around the access hole



- 4.** Install a durable metal patch of equal or greater gauge than the roof material that overlaps the opening at least 2 inches on all sides, and fastening in place every 2 inches along perimeter



- 5.** Apply elastomeric paint over patch that laps at least 6 inches on all sides to create a continuous seal

NOTES

8-1 AIR SEAL ABOVE THE KNEE WALL

Aligns with SWS [3.0101.1](#), [3.0102.11](#)



BEFORE

✗ Knee walls are part of the thermal and pressure boundary



AFTER

✓ Air sealing from above continues the pressure boundary while supporting future insulation

NOTES

TOOLS

- Measuring Tape
- Utility Knife
- Saw
- Drill
- Caulk Gun
- Spray Foam Gun

MATERIALS

- Extruded Polystyrene (XPS)
- Plywood
- Gypsum Board
- Lumber
- Mechanical Fasteners
- Caulk
- Spray Foam
- Mastic

PPE



* if cutting lumber ** situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

8-1 AIR SEAL ABOVE THE KNEE WALL



1. After clearing away debris, measure gap above knee wall in line with pressure boundary



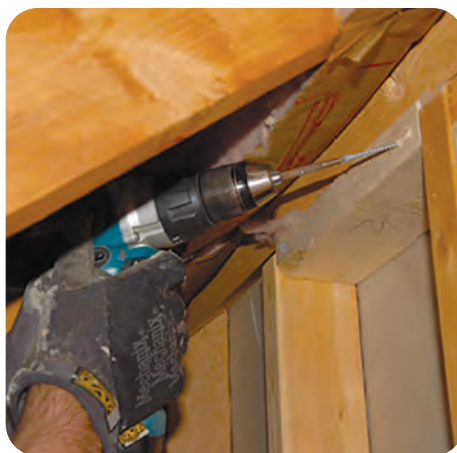
2. Cut blocking material (XPS, wood, gypsum board) to fit gap



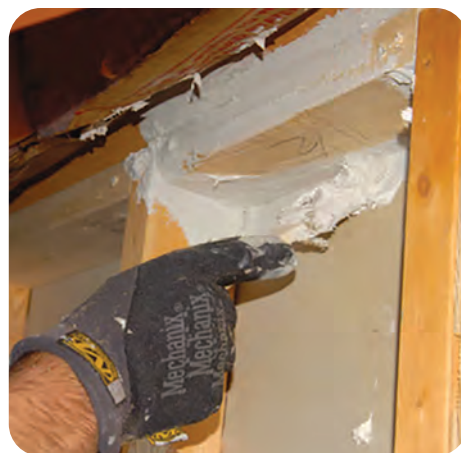
3. Securely fit infill or blocking material in place



4. Ensure blocking material is located in line with preferred pressure boundary



5. Secure in place with mechanical fasteners or adhesive as necessary to prevent movement when insulation is installed



6. Seal continuously around blocking material to preserve pressure boundary

8-2 AIR SEAL BENEATH THE KNEE WALL

Aligns with SWS 3.0101.1



BEFORE

- ✗ Knee walls are part of the thermal and pressure boundary



AFTER

- ✓ Air sealing from below allows areas of the attic floor to be treated separately according to whether they fall in or out of the pressure boundary

TOOLS

- Measuring Tape
- Utility Knife
- Saw
- Drill
- Caulk Gun
- Spray Foam Gun

MATERIALS

- Extruded Polystyrene (XPS)
- Foam-Faced Polyiso
- Plywood
- Gypsum Board
- Lumber
- Mechanical Fasteners
- Caulk
- Spray Foam
- Mastic



* if cutting lumber ** situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

8-2 AIR SEAL BENEATH THE KNEE WALL



1. After clearing away debris, measure gap below knee wall in line with pressure boundary



2. Cut blocking material (XPS, wood, gypsum board) to fit gap



3. Securely fit infill or blocking material in place



4. Ensure blocking material is located in line with preferred pressure boundary



5. Seal continuously around blocking material to preserve pressure boundary

NOTES

8-3 INSULATE AN ATTIC KNEE WALL WITH BATTS

Aligns with SWS [4.0104.2](#), [4.0104.3](#)



BEFORE

✗ Air sealed knee walls are ready for insulation



AFTER

✓ Once insulated, this knee wall provides a continuous, contiguous, safe, and compliant thermal boundary that prevents air movement

TOOLS

- Measuring Tape
- Utility Knife
- Staple Gun

MATERIALS

- Fiberglass Batts
- Staples
- Nylon Strap
- Mechanical Fasteners
- House Wrap
- Radiant Barrier

PPE



* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

8-3 INSULATE AN ATTIC KNEE WALL WITH BATTS



1. Measure cavities



2. Cut batts for exact fit



3. Install batts with minimal compression



4. Install backing material

NOTES

8-4 INSULATE AN ATTIC KNEE WALL WITH 2-PART SPRAY FOAM

Aligns with SWS [4.0104.5](#), [4.0104.6](#)



BEFORE

- ✗ Air seal before applying spray foam to prevent foam from leaking into conditioned space



AFTER

- ✓ Spray walls as evenly as possible

TOOLS

- Spray Foam Gun
- Fit-Tested Respirator or PAPR
- Measuring Tape
- Utility Knife
- Drill

MATERIALS

- 2-Part Spray Foam
- Low-Perm Paint
- Polyisocyanurate
- Gypsum Board
- Mechanical Fasteners
- Joint Tape
- Joint Compound

PPE



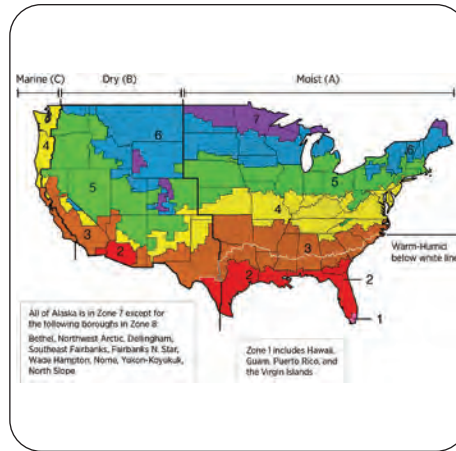
* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

8-4 INSULATE AN ATTIC KNEE WALL WITH 2-PART SPRAY FOAM



Ensure proper PPE when installing 2-Part Spray Foam



For climate zones 5-8, install foam to a thickness of at least a class II vapor retarder or install a class II vapor retarder, such as fiber-faced polyiso, unfaced EPS or low-perm paint



If space is used for utility access, storage, or permanently habitable, separate foam from the subspace with a suitable thermal barrier covering, such as 1/2-inch gypsum board

NOTES

8-5 INSULATE AN ATTIC KNEE WALL WITH BLOWN INSULATION

Aligns with SWS 4.0104.1



BEFORE

✗ Air sealed knee walls are ready for insulation



AFTER

✓ Once insulated, this knee wall provides a continuous, contiguous, safe, and compliant thermal boundary that prevents air movement

TOOLS

- Measuring Tape
- Utility Knife
- Drill
- Staple Gun
- Hole Saw
- Insulation Machine

MATERIALS

- Extruded Polystyrene (XPS)
- Gypsum Board
- House Wrap
- Building Wrap
- Mechanical Fasteners
- Furring Strips
- Loose Fiberglass or Cellulose Insulation

PPE



* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.
"After" photo credit: Home Insulation of Syracuse

8-5 INSULATE AN ATTIC KNEE WALL WITH BLOWN INSULATION



1. Securely install backing material over entire knee wall



2. Cut holes in backing material to allow access to all cavities



3. Blow insulation into cavities to meet dense-pack standards



4. Fill all cavities



5. Replace access hole plugs in backing material, if possible

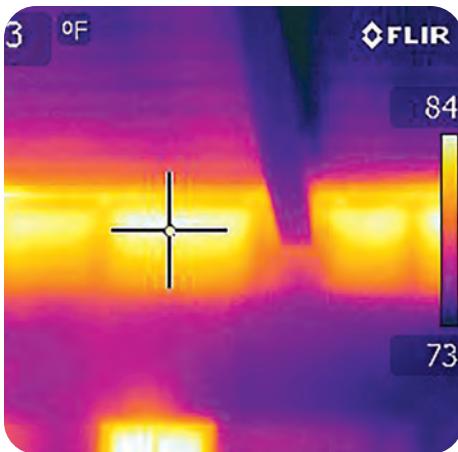


6. Seal access holes permanently and completely

NOTES

9-1 DENSE-PACK A SIDEWALL VIA EXTERIOR BLOW

Aligns with SWS 4.0202.1



BEFORE

✗ Walls that are missing insulation or underinsulated are an opportunity for energy savings



AFTER

✓ When properly insulated, walls will allow minimal heat and air transfer

TOOLS

- Measuring Tape
- Utility Knife
- Pry-Bar
- Siding Remover
- Hole Saw
- Drill
- Insulation Machine

MATERIALS

- Plastic Sheeting
- Painters Tape
- Loose Cellulose or Fiberglass Insulation
- Plugs
- Caulk
- Spray Foam
- Mechanical Fasteners

PPE



9-1 DENSE-PACK A SIDEWALL VIA EXTERIOR BLOW



- 1.** Protect work area from debris and dirt



- 2.** Ensure balloon-framed walls are blocked at top and bottom



- 3.** Ensure wall integrity is complete (no holes)



- 4.** Remove siding as needed



- 5.** Drill holes as required based on building frame design and exterior materials



- 6.** Fill cavities completely and to proper density

9-1 DENSE-PACK A SIDEWALL VIA EXTERIOR BLOW



7. If possible, ensure all cavities are filled before completing job



8. Patch holes

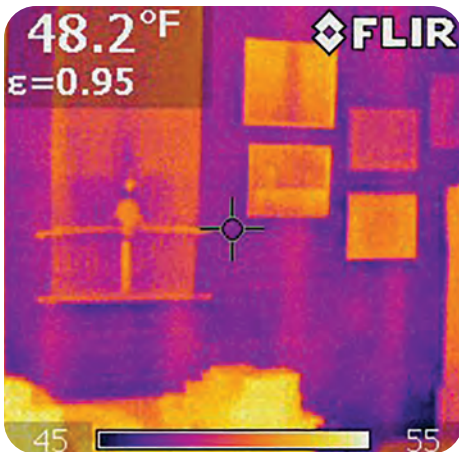


9. Replace and/or repair siding

NOTES

9-2 DENSE-PACK A SIDEWALL VIA INTERIOR BLOW

Aligns with SWS [4.0202.1](#)



BEFORE

✗ Older houses often are lacking in insulation



AFTER

✓ Inconspicuous capped, patched, or covered holes are the ideal

TOOLS

- Measuring Tape
- Utility Knife
- Hole Saw
- Drill
- Insulation Machine
- Infrared Camera

MATERIALS

- Plastic Sheeting
- Loose Cellulose or Fiberglass Insulation
- Gypsum Board
- Joint Compound
- Caulk
- Mechanical Fasteners
- Chair Rail
- Plugs
- Painters Tape

PPE



9-2 DENSE-PACK A SIDEWALL VIA INTERIOR BLOW



- 1.** Protect work area from debris and dust



- 2.** Ensure balloon-framed walls are blocked at top and bottom



- 3.** Ensure wall integrity is complete (no holes)

NOTES

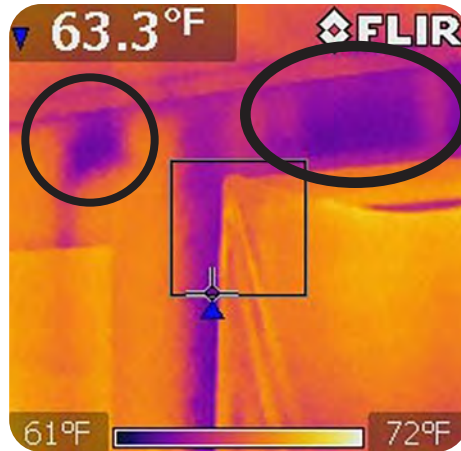


- 4.** Drill holes as required based on building design

9-2 DENSE-PACK A SIDEWALL VIA INTERIOR BLOW



5. Fill cavities completely and to proper density



6. If possible, ensure all cavities are filled before completing job (note: dark areas were missed)



7. Patch holes to standards

NOTES

10-1 INSULATE MANUFACTURED HOME SEWALLS WITH BATTS

Aligns with SWS 4.0202.3



BEFORE

✗ Manufactured housing sidewalls present a unique challenge when it comes to insulation



AFTER

✓ Properly installed insulation will have no gaps and compressed as little as possible

TOOLS

- Drill
- Measuring Tape
- Utility Knife
- Batt Stuffer

MATERIALS

- Wrapped Fiberglass Batts
- Mechanical Fasteners

PPE

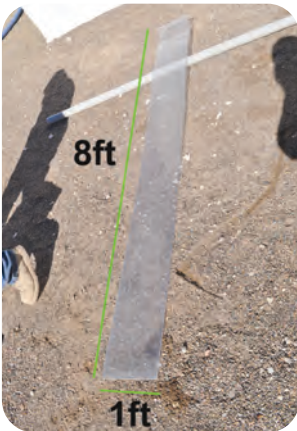


* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

10-1 INSULATE MANUFACTURED HOME SIDEWALLS WITH BATTS

BEFORE YOU BEGIN



Prepare insulation stuffer, if necessary



1. Remove siding as needed, starting from bottom and taking note of any obstacles that may compress insulation



2. Measure cavity size



3. Plastic-wrapped fiberglass batts provide both insulation value and vapor retarder for unsealed cavities



4. Cut batt to length for cavity

10-1 INSULATE MANUFACTURED HOME SIDEWALLS WITH BATTS



- 5.** Fold batt over end of insulation stuffer



- 6.** Insert batt into cavity, sliding under top belt rail to top of cavity, and ease stuffer back out to allow batt to fill in space



- 7.** Gently tug batt into place and tuck remaining batt under lower belt rail and fit down to bottom of cavity with minimal compression



- 8.** Reinstall siding



- 9.** Reattach mechanical fasteners

NOTES

10-2 INSULATE MANUFACTURED HOME SIDEWALLS WITH BLOWN INSULATION

Aligns with SWS 4.0202.4, 4.0202.5



BEFORE

- ✗ Older manufactured housing is often lacking insulation since it did not have to be built to a particular jurisdiction's codes



AFTER

- ✓ When properly insulated, siding will not bulge or be dented from installation

TOOLS

- Drill
- Insulation Machine

MATERIALS

- Loose Fiberglass Insulation
- Mechanical Fasteners

PPE



* situation dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

10-2 INSULATE MANUFACTURED HOME SIDEWALLS WITH BLOWN INSULATION



1. Ensure the integrity of the wall to be insulated, both from exterior and interior



2. Remove siding as needed, from the bottom



3. Fill cavity with blown insulation, ensuring to get past belt rails and electrical



4. Reinstall siding



5. Be prepared to adapt insulation strategy dependent upon exterior materials

NOTES

11-1 INSTALL WEATHERSTRIPPING ON AN EXTERIOR DOOR

Aligns with SWS 3.0202.1



BEFORE

- ✗ Daylight visible around an exterior door indicates air infiltration



AFTER

FINAL CHECKLIST

- ✓ Door closes and opens easily
- ✓ Weatherstrip makes a good seal with the door
- ✓ Weatherstrip does not get flattened in a way that will lead to damage when used

TOOLS

- Tape Measure
- Snips
- Drill with Appropriate Bits

MATERIALS

- Weatherstripping
- Mechanical Fasteners
- Caulk

PPE



11-1 INSTALL WEATHERSTRIPPING ON AN EXTERIOR DOOR



- 1.** Measure doorway for weatherstripping



- 2.** Measure door top or bottom as well for weatherstripping and potential door bottom or sweep



- 3.** Notch upper ends of side weatherstripping to allow for top piece



- 4.** Fit weatherstripping snugly into rabbet, if one exists, and against other pieces



- 5.** Fasten weatherstripping securely when no rabbet exists

NOTES

11-2 INSTALL A DOOR SWEEP OR DOOR BOTTOM ON AN EXTERIOR DOOR

Aligns with SWS [3.0202.1](#)



BEFORE

✗ Air and water can come in under doors when there is no door bottom or sweep



AFTER

FINAL CHECKLIST

- ✓ Ensure a good seal to prevent air infiltration
- ✓ Ensure unimpeded door operation

MATERIALS

- Mechanical Fasteners
- Caulk

PPE



TOOLS

- Measuring Tape
- Metal Snips
- Saw
- Drill
- Caulk Gun

NOTES

Door bottoms commonly are installed on new doors, those that have wooden thresholds, or to replace older existing door bottoms.

For houses with a rubber threshold, door sweeps are more common.

11-2 INSTALL A DOOR SWEEP OR DOOR BOTTOM ON AN EXTERIOR DOOR

STEPS 1-3: FOR DOOR SWEEP AND DOOR BOTTOM



1. Measure width of door and ensure that door sweep is appropriate length



2. Adjust threshold to ensure that it is seated tightly



3. Apply caulk to threshold at floor on interior, and exterior if possible, to minimize water intrusion

STEPS 4-6: FOR DOOR SWEEP



4. Install door sweep on interior face of door, centering on door face



5. Attach door sweep using mechanical fasteners



6. Evenly place mechanical fasteners along entire length of door sweep

11-2 INSTALL A DOOR SWEEP OR DOOR BOTTOM ON AN EXTERIOR DOOR

STEPS 4-8: FOR DOOR BOTTOM



- 4.** With threshold adjusted, measure door opening height



- 5.** Remove door from opening if height of door needs to be shortened to make room for door bottom



- 6.** Trim door, if possible, to ensure good fit of door bottom



- 7.** Trim sweep to match width of door



- 8.** Ensure that door bottom sits tight against the door and reinstall door

NOTES

12-1 AIR SEAL SILL PLATE AND RIM JOIST

Aligns with SWS 3.0104.1



BEFORE

✗ Air movement around sill plates and near rim joists needs to be addressed before insulating



AFTER

✓ Once air sealed, the cavity is ready for insulation

TOOLS

- Spray Foam Applicator
- Spray Foam Gun
- Caulk Gun

NOTES

MATERIALS

- 2-Part Spray Foam
- 1-Part Spray Foam
- Backer Rod
- Machine Mesh
- Steel Wool
- Caulk

PPE



12-1 AIR SEAL SILL PLATE AND RIM JOIST



- 1.** For exterior holes larger than 1/4 inch, steel wool or other pest blocking material before sealing



- 2.** Cut backing material to fill space



- 3.** Seal over to hold backing material in place and air seal



- 4.** Seal penetrations on subfloor as well, looking out not only for current electrical and plumbing, but also vacated holes



- 5.** Push sealant into seams where framing members meet



- 6.** Create a continuous seal on all seams

12-2 INSULATE RIM JOIST

Aligns with SWS [4.0401.1](#), [4.0401.2](#), [4.0401.3](#)



BEFORE

✗ Basement and crawlspace rim joists must be addressed when part of the thermal boundary



AFTER

✓ If using sprayfoam, make sure it is a consistent depth

TOOLS

- Measuring Tape
- Utility Knife
- Spray Foam Applicator
- Spray Foam Gun
- Drill
- Caulk Gun

MATERIALS

- Polyisocyanurate Foam Board
- 2-Part Spray Foam
- 1-Part Spray Foam
- Gypsum Board
- Mechanical Fasteners
- Caulk

PPE



* if using two-part

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

12-2 INSULATE RIM JOIST



1. Measure each individual cavity to be insulated and take note of obstacles for insulation



2. Cut insulation for each individual cavity, ensure no gaps or misalignment, and secure in place



3. 2-part sprayfoam can also be used as rim joist insulation

NOTES

As long as foam is not over 3.25 inches thick and space is not permanently habitable, insulation does not need to be covered by thermal barrier.

12-3 INSULATE BASEMENT WALLS IN CONDITIONED SPACE

Aligns with SWS 4.0402.4, 4.0402.5



BEFORE

✗ An uninsulated wall in a “conditioned” space allows the loss of conditioned air



AFTER

✓ A sealed continuous air barrier finishes off an insulated basement wall, providing air sealing and thermal comfort

TOOLS

- Caulk Gun
- Spray Foam Gun
- Metal Snips
- Measuring Tape
- Utility Knife
- Drill
- Taping Knife
- Mudding Trowel

MATERIALS

- | | | |
|--------------|------------------------|------------------|
| • Backer Rod | • Polyisocyanurate | • Joint Compound |
| • Metal Lath | • Mechanical Fasteners | • Joint Tape |
| • Spray Foam | • Gypsum Board | |
| • Caulk | • Luan | |

PPE



12-3 INSULATE BASEMENT WALLS IN CONDITIONED SPACE



1. Check wall for penetrations and seal as needed



2. Check wall for water intrusion that needs to be mitigated first. All bulk sources of moisture should be directed away from the foundation walls



3. Install insulation to prescribed R-value in full contact with the entire perimeter of foundation wall from ceiling to floor



4. Install a sealed air barrier on the conditioned side of the insulation. When using foam, gypsum board must be at least 1/2 inch to meet building codes for a thermal barrier

NOTES

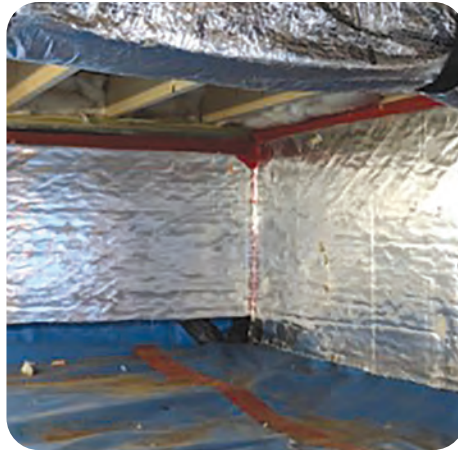
12-4 INSULATE CONDITIONED CRAWLSPACE WALL

Aligns with SWS 4.0402.2, 4.0402.3



BEFORE

X Unvented crawlspaces are sometimes considered to be part of the conditioned space, so the walls need insulation



AFTER

FINAL CHECKLIST

- ✓ Insulation is or has class II vapor retarder
- ✓ Vapor retarder faces conditioned space
- ✓ Insulation laps underneath ground vapor retarder at foundation wall

TOOLS

- Measuring Tape
- Utility Knife
- Drill
- Spray Foam Gun
- Half- or Full-Face Respirator
- Concrete Nail Gun

MATERIALS

- Polyisocyanurate Foam Board
- Nylon Fasteners
- 2-Part Spray Foam

PPE



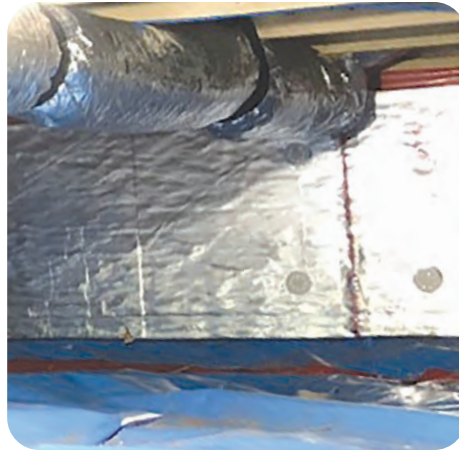
* if using two-part

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

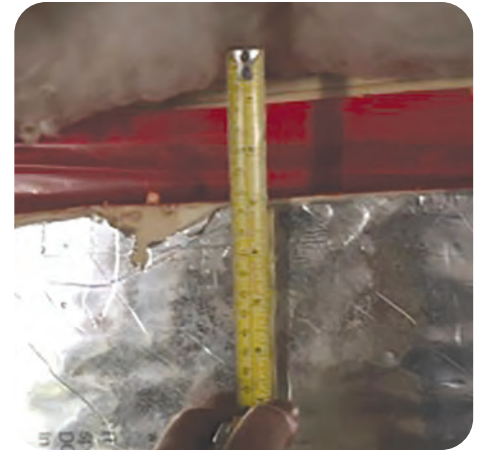
12-4 INSULATE CONDITIONED CRAWLSPACE WALL



1. Use a fire-rated material



2. Attach insulation in a durable manner



3. Leave a 3-inch termite inspection gap between the bottom of the sill plate at the top of the insulation, if needed

NOTES

13-1 AIR SEAL SMALL PENETRATIONS IN A SUBFLOOR

Aligns with SWS [3.0101.1](#), [3.0104.1](#)



Many types of caulks and sealants will easily span and seal a 1/4-inch gap



One-part spray foams can also span up to 3 inches to create an air seal

TOOLS

- Caulk Gun
- Spray Foam Gun
- Utility Knife

MATERIALS

- Caulk Sealant
- One-Part Spray Foam
- Backer Rod

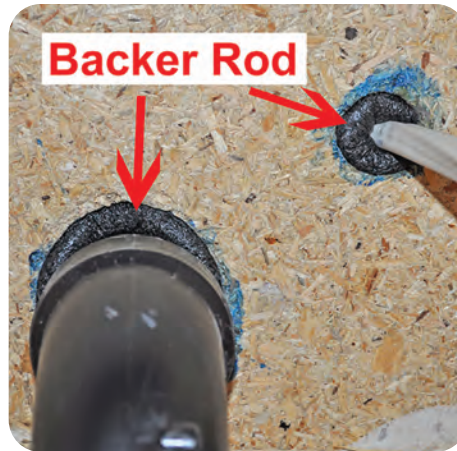
PPE



13-1 AIR SEAL SMALL PENETRATIONS IN A SUBFLOOR



- 1.** For small penetrations, caulk or sealant is often enough to seal the gap



- 2.** Use a backer rod or other infill material when sealing a gap larger than 1/4 inch with caulk



- 3.** Seal over the backer rod to establish the air seal



- 4.** Spray foam can also be used in areas with slightly larger penetrations

NOTES

13-2 AIR SEAL LARGE PENETRATIONS IN A SUBFLOOR

Aligns with SWS 3.0101.1, 3.0104.1



BEFORE

- ✗ Larger penetrations in the subfloor, especially plumbing chases, need to be air sealed



AFTER

- ✓ Depending on the size of the gap, one-part spray foam or a combination of infill material and foam or caulk can be used

TOOLS

- Measuring Tape
- Utility Knife
- Drill
- Spray Foam Gun
- Caulk Gun

MATERIALS

- One-Part Spray Foam
- Two-Part Spray Foam
- Caulk
- Extruded Polystyrene (XPS)
- Mechanical Fasteners

PPE



13-2 AIR SEAL LARGE PENETRATIONS IN A SUBFLOOR



1. One-part spray foam expands to fill large holes, but needs support for holes over 3 inches



2. For larger holes, rigid infill material is needed



3. Cut rigid infill with attention to locations of pipes and electrical



4. Secure rigid infill in place and seal smaller gaps around infill with appropriate materials



5. Use appropriate materials for high-temperature locations, such as around flues and chimneys

NOTES

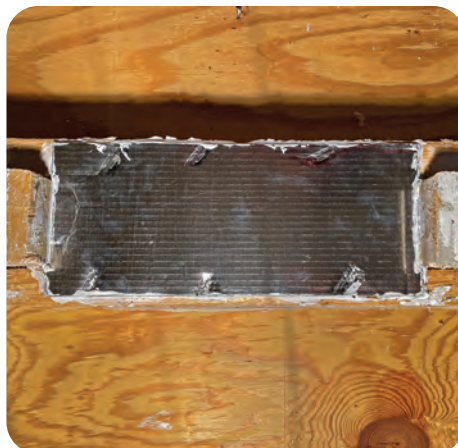
13-3 AIR SEAL BALLOON FRAMING AT SUBFLOOR

Aligns with SWS 3.0101.1, 3.0102.4



BEFORE

✗ Balloon-framed walls have an open cavity that runs from the basement to the attic, allowing for large amounts of air flow via stack effect



AFTER

✓ Securely sealing off these cavities prevents air movement, as well as providing a barrier to hold in insulation and providing fire blocking

TOOLS

- Measuring Tape
- Utility Knife
- Saw
- Drill
- Spray Foam Gun
- Caulk Gun
- Chip Brush

MATERIALS

- Extruded Polystyrene (XPS)
- Gypsum Board
- Lumber
- Mechanical Fasteners
- 1-Part Spray Foam
- 2-Part Spray Foam
- Caulk
- Mastic

PPE



13-3 AIR SEAL BALLOON FRAMING AT SUBFLOOR



1. Measure opening



2. Cut blocking material to fit



3. Seal all edges with caulk, foam or mastic

NOTES

Spray foam will not be used in spaces that will be exposed to habitable living space.

14-1 INSULATE A SUBFLOOR WITH BATTS ABOVE UNCONDITIONED SPACE

Aligns with SWS [4.0301.1](#), [4.0301.6](#), [4.0302.1](#)



BEFORE

✗ Uninsulated, unconditioned spaces drive down the energy efficiency of HVAC systems



AFTER

FINAL CHECKLIST

- ✓ Vapor retarder faces warm side of floor
- ✓ Consistent cover across subfloor

TOOLS

- Measuring Tape
- Utility Knife
- Drill

MATERIALS

- Kraft-Faced Fiberglass Batts
- Strapping
- Netting
- Rigid Barrier Such as Extruded Polystyrene (XPS)
- Mechanical Fasteners

PPE



14-1 INSULATE A SUBFLOOR WITH BATTS ABOVE UNCONDITIONED SPACE



- 1.** Ensure air sealing is complete



- 2.** Insulation R-value matches work order



- 3.** Batt vapor retarder faces warm side of floor



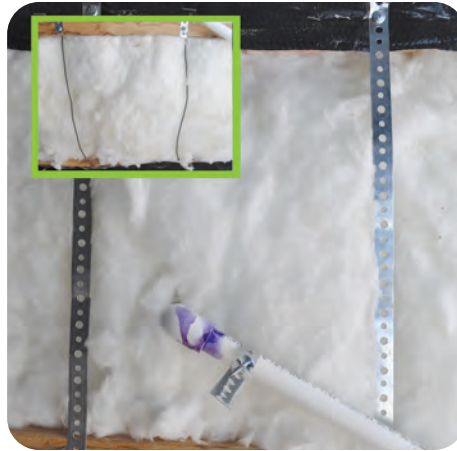
- 4.** Batts installed with no gaps

NOTES

14-1 INSULATE A SUBFLOOR WITH BATTS ABOVE UNCONDITIONED SPACE



- 5.** Batts are in good contact with subfloor



- 6.** Batts held in place with physical fasteners, with minimal compression



- 7.** In areas where exposure to outside elements may be a concern, such as cantilevered or exposed floors, a rigid barrier is an extra layer of protection

NOTES

14-2 INSULATE A SUBFLOOR WITH BLOWN INSULATION ABOVE UNCONDITIONED SPACE

Aligns with SWS [4.0301.2](#), [4.0301.3](#), [4.0301.4](#), [4.0302.2](#), [4.0302.3](#)

BEFORE YOU BEGIN



Uninsulated, unconditioned spaces drive down the energy efficiency of HVAC systems

Description /Comment

Floor Insulation - Loose-fill + Rigid Barrier - R-19

Floor Insulation - Loose-fill + Rigid Barrier - R-19

Floor Insulation - Loose-fill + Rigid Barrier - R-19

- ✓ Review work order to verify if dense-pack or loose fill is required. Netting a subfloor will mean loose fill, but a rigid barrier can mean either.

TOOLS

- Measuring Tape
- Utility Knife
- Scissors
- Caulk Gun
- Insulation Machine
- Pressure Gauge
- Hole Saw

MATERIALS

- Netting
- Rigid Barrier
Such as Extruded Polystyrene (XPS)
- Staples
- Mechanical Fasteners
- Caulk
- Cellulose or Fiberglass Loose Insulation

PPE



14-2 INSULATE A SUBFLOOR WITH BLOWN INSULATION ABOVE UNCONDITIONED SPACE



1. Verify all air sealing and prep work is complete



2. Attach rigid barrier to cover entire cavity



3. Seal seams between sheets of rigid material to prevent air movement and insulation leakage



4. Cut an access hole into each cavity of the floor, large enough for fill tube



5. Use appropriate fill tube to correspond with work order requirements



6. Fill cavity completely to density required by work order

14-2 INSULATE A SUBFLOOR WITH BLOWN INSULATION ABOVE UNCONDITIONED SPACE



- 7.** Plug access hole either with original material cut out or appropriate replacement



- 8.** Seal around plug to keep it secure and air tight



- 9.** For work orders that require netting, secure a smooth layer of netting across the bottom of floor joists

NOTES



- 10.** Keep staples close together

14-2 INSULATE A SUBFLOOR WITH BLOWN INSULATION ABOVE UNCONDITIONED SPACE



11. Cover the entire cavity to ensure continuous insulation coverage and prevent insulation from blowing out the ends



12. Cut access hole for fill tube



13. Loose fill netting to required density



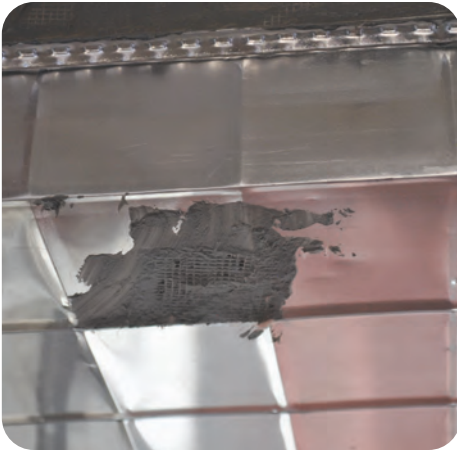
14. Ensure insulation coverage is even and continuous throughout floor cavities

NOTES

15-1 INSULATE A MANUFACTURED HOME BELLY

Aligns with SWS [4.0302.9](#), [4.0302.1](#), ([3.0102.5](#),
[3.0102.6](#), [3.0102.7](#))

BEFORE YOU BEGIN



CHECKLIST

- ✓ Air and duct sealing complete
- ✓ Electrical/plumbing issues fixed
- ✓ Belly board repaired/replaced

TOOLS

- Measuring Tape
- Utility Knife
- Drill
- Insulation Machine
- Pressure Gauge
- Saw
- Stitch Stapler

MATERIALS

- Belly Wrap
- Belly Board
- Caulk
- Mechanical Fasteners
- Mastic
- Spray Foam
- Extruded Polystyrene (XPS)

PPE



15-1 INSULATE A MANUFACTURED HOME BELLY



1. Remove old insulation and make repairs as needed



2. Attach new belly wrap



3. Seal seams of belly wrap

NOTES



4. Cut access holes to ensure entire cavity will receive continuous and consistent insulation

15-1 INSULATE A MANUFACTURED HOME BELLY



- 5.** Fill entire belly cavity to prescribed R-value



- 6.** Apply waterproof, permanent adhesive to patch for belly wrap, with patch sized at least 3 inches larger than hole in barrier



- 7.** Stitch staple patch to ensure permanent adhesion

NOTES

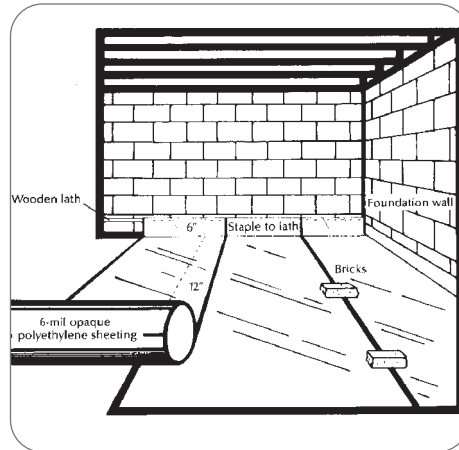
16-1 INSTALL A CRAWLSPACE VAPOR RETARDER

Aligns with SWS 2.0202.1, 2.0202.2, 2.0202.3, (3.0104.1)



BEFORE

- ✗ Moisture and resultant mold issues in crawlspaces can cause extensive damage to floor assemblies and foundations



AFTER

- ✓ A well-installed vapor retarder helps to minimize ground moisture vapor and soil gas, such as radon

TOOLS

- Utility Knife
- Measuring Tape
- Caulk Gun

MATERIALS

- 6 Mil Plastic Sheeting
- Durable Adhesive Tape
- Furring Strips
- Mechanical Fasteners
- Ballast
- Sealant

PPE



16-1 INSTALL A CRAWLSPACE VAPOR RETARDER



1. Clear out storage and debris



2. Select appropriate materials



3. Spread out plastic as flat as possible

NOTES



4. Extend plastic a minimum of 6 inches up walls, piers and columns

16-1 INSTALL A CRAWLSPACE VAPOR RETARDER



- 5.** Use a minimum 12" reverse shingle overlap and tape seams



- 6.** Plastic needs to be fastened in durable way: e.g. tape, sealant, screws



- 7.** Use ballast to hold down vapor retarder

NOTES

16-2 REPAIR AN EXISTING CRAWLSPACE VAPOR RETARDER

Aligns with SWS 2.0202.1, 2.0202.2, 2.0202.3, (3.0104.1)



BEFORE

✗ Improperly installed and damaged vapor retarders do not prevent moisture and resultant mold issues in crawlspace



AFTER

✓ A well-installed vapor retarder helps to minimize ground moisture vapor and soil gas, such as radon

TOOLS

- Utility Knife
- Measuring Tape
- Caulk Gun

MATERIALS

- 6-Mil Plastic Sheeting
- Durable Adhesive Tape
- Furring Strips
- Mechanical Fasteners
- Ballast
- Sealant

PPE



95

16-2 REPAIR AN EXISTING CRAWLSPACE VAPOR RETARDER



1. When repairing along the ground, ensure seams overlap uphill in a reverse shingle pattern



2. Overlap seams by at least 12 inches



3. Spread out plastic as flat as possible



4. Plastic needs to be fastened in durable way: e.g. tape, sealant



5. Ensure plastic extends a minimum of 6 inches up walls, piers and columns and is securely attached

NOTES

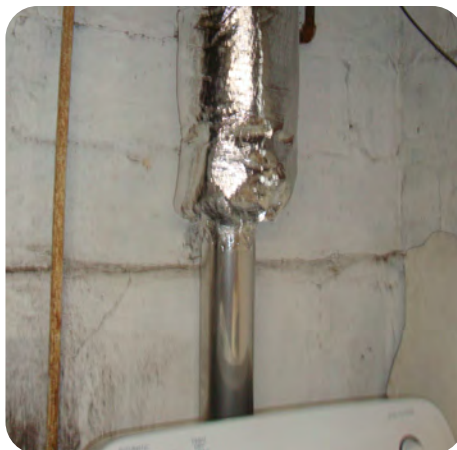
17-1 VENT A CLOTHES DRYER

Aligns with SWS 6.0202.1, (6.0101.1, 6.0101.2)



BEFORE

✗ Dryer vents with long bumpy runs create a fire hazard



AFTER

✓ When properly vented, dryers run more efficiently, are safer, and last longer

TOOLS

- Metal Snips or Grinder
- Flathead Screwdriver
- Utility Knife

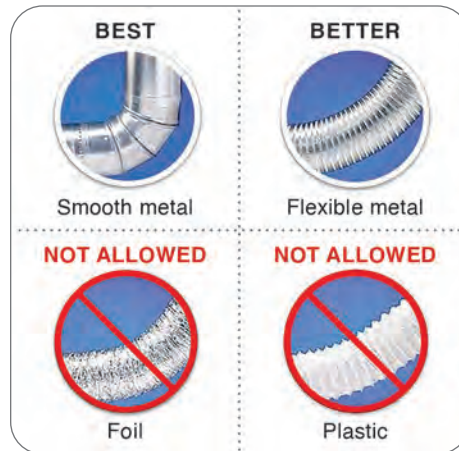
MATERIALS

- 28-Gauge Rigid or Semi-Rigid Metal Ducting
- Worm-Drive Clamps
- Backdraft Damper
- Duct Insulation
- Foil Tape

PPE



17-1 VENT A CLOTHES DRYER



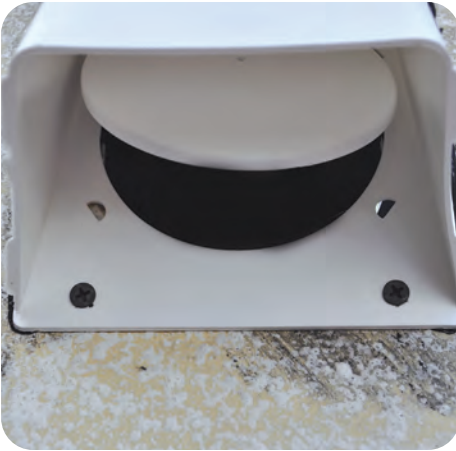
1. Keep duct run as short as possible to prevent backup of lint
2. Duct material is metal rigid or semi-rigid
3. Correct fasteners are used (no screws penetrating into duct)

NOTES



4. Duct terminates to outside, with last 3 feet of exhaust venting insulated to a minimum of R-8.

17-1 VENT A CLOTHES DRYER



5. Termination has backdraft damper and no cage



6. Duct in uninsulated space is insulated



7. If duct run must exceed 35 feet, install booster fan

NOTES

18-2 INSTALL A HARD-DUCTED EXHAUST VENT

Aligns with SWS [6.0101.1](#), [6.0101.2](#), [6.0201.1](#), [6.0201.2](#)



BEFORE

- ✗ Kitchens and bathrooms must be ventilated to control moisture, vapor, and combustion gases

TOOLS

- Measuring Tape
- Hole Saw
- Drill
- Caulk Gun

AFTER

KITCHEN CHECKLIST

- ✓ Located within 5 feet of primary cooking surface
- ✓ At least 100 cfm but not more than 3 sones
- ✓ Efficacy of 2.8 cfm/watt or more

BATHROOM CHECKLIST

- ✓ Located in center of room
- ✓ At least 50 cfm but not more than 2 sones
- ✓ Efficacy of 4 cfm/watt or more

MATERIALS

- Mastic
- Brush
- Foil Tape
- Duct Insulation
- 28-Gauge Ducting
- Vent Termination
- Caulk

PPE



* if going in attic **weather dependent if going in attic

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

18-2 INSTALL A HARD-DUCTED EXHAUST VENT



- 1.** Fasten rigid duct using three equally spaced screws



- 2.** Keep duct run as short as possible with few turns, and run to exterior – either via roof or sidewall



- 3.** Seal all joints with mesh and mastic or foil tape



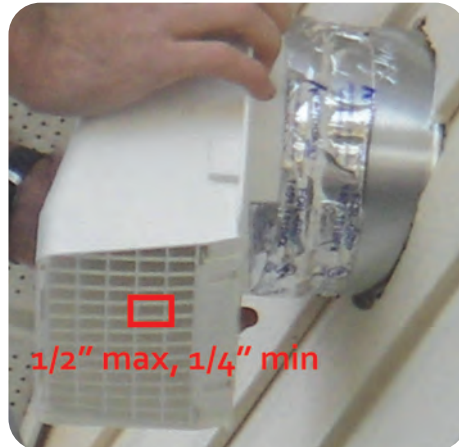
- 4.** Completely seal joints

NOTES

18-2 INSTALL A HARD-DUCTED EXHAUST VENT



5. Locate exterior vent based on duct run and size hole less than 1/2 inch larger than duct



6. Chose appropriate exterior termination to match size of duct while minimizing water intrusion and pest infestation. Seal around exterior termination as needed



7. Ducting that runs through unconditioned space will be insulated to R-8

NOTES

19-1 SEAL DUCTS WITH MASTIC

Aligns with SWS [5.0106.1](#), [6.0101.2](#), [6.0101.3](#), ([5.0105.1](#), [5.0105.2](#), [5.0105.3](#))



CHECKLIST

- ✓ Ensure ducts are properly connected
- ✓ Ensure ducts are properly supported

TOOLS

- Drill
- Zip Tie Tensioner
- Caulk Gun

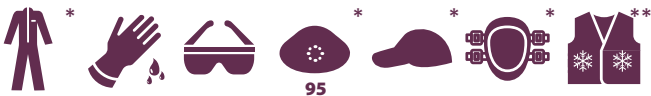
MATERIALS

- | | |
|----------------------------|---|
| • Mastic | • Duct or Electrical Tape (for temporary use) |
| • Fiberglass Mesh Tape | • Flexible Caulking |
| • Chip Brush | • Butyl Tape |
| • Mechanical Fasteners | • Foil Tape |
| • 26-Gauge Metal Sheetting | |

NOTES

Mastic alone can be used for gaps <1/8-inch, when gap is located more than 10 inches from air handler and static pressure is less than 1 iwc.

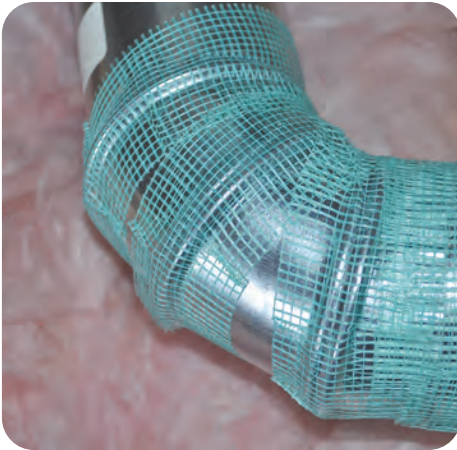
PPE



* location dependent **weather dependent

19-1 SEAL DUCTS WITH MASTIC

**METHOD A - FOR SMALL GAPS (LESS THAN 1/4 INCH)
INCLUDING ALL JOINTS, SEAMS, AND CRACKS IN DUCT SYSTEM**



A-1. Apply fiberglass mesh tape over all gaps, seams, joints, etc.

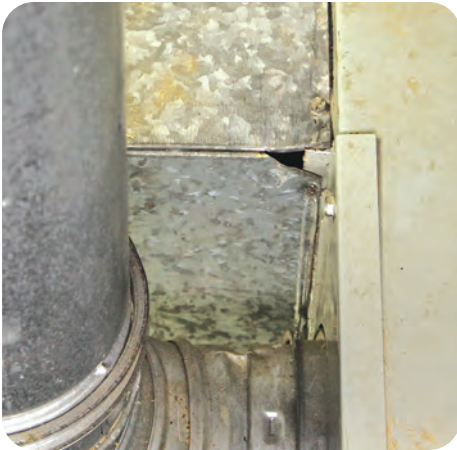


A-2. Apply mastic over all mesh tape and all gaps, seams, joints, etc.

NOTES

19-1 SEAL DUCTS WITH MASTIC

METHOD B - FOR MEDIUM GAPS (1/4-3/4 INCH) SUCH AS MINOR HOLES AND PENETRATIONS IN DUCT SYSTEM



B-1. Small holes and penetrations require one additional step



B-2. Apply temporary tape as a backer to hold mastic



B-3. Apply mastic over the tape



B-4. Push fiberglass mesh into the mastic

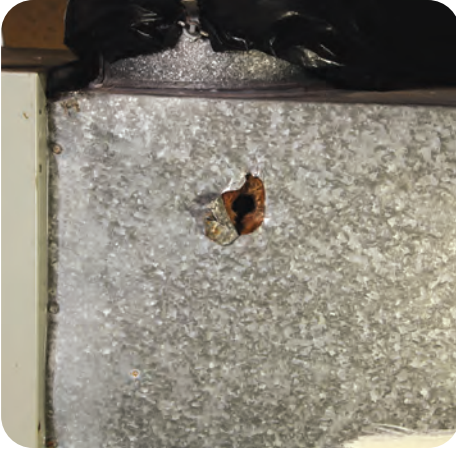


B-5. Apply additional mastic over mesh and tape, extending at least 1 inch past edges of tape in all directions

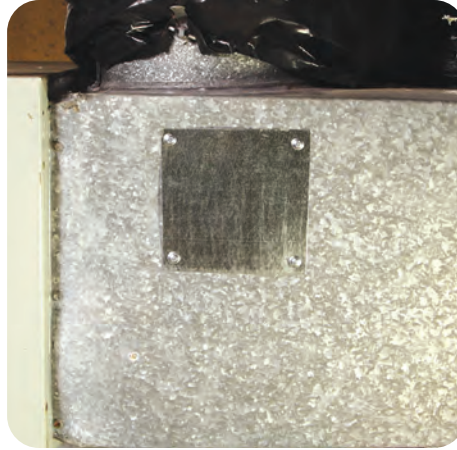
NOTES

19-1 SEAL DUCTS WITH MASTIC

METHOD C - FOR LARGER GAPS OR HOLES (OVER 3/4 INCH)



C-1. Larger holes require a different process



C-2. Cut patch that will extend over entire gap or hole and affix with mechanical fasteners



C-3. Apply mastic over edges and fasteners of patch and push fiberglass mesh into it

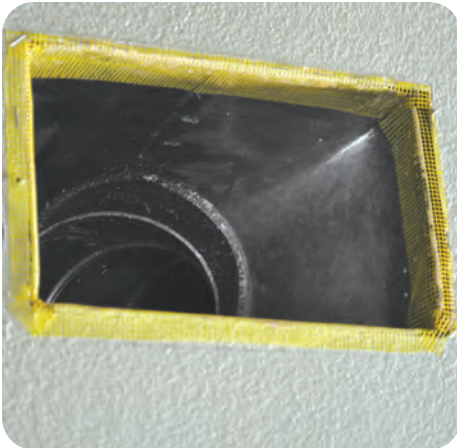


C-4. Apply additional mastic over mesh, extending at least 1 inch past tape and seam in all directions

NOTES

19-1 SEAL DUCTS WITH MASTIC

METHOD D - FOR CONNECTIONS BETWEEN DUCT BOOT AND SURFACE



NOTES

19-1 SEAL DUCTS WITH MASTIC

METHOD E - AT THE AIR HANDLER



E-1. Ensure that filter slot cover is removable so that occupant can change filter as needed, but does not allow for bypass air around air filter



E-2. Seal unnecessary holes in air handler cabinet with butyl tape

NOTES

20-1 INSULATE HARD PIPE DUCTS

Aligns with SWS [5.0107.1](#), [5.0105.2](#), ([6.0202.1](#))



TOOLS

- Measuring Tape
- Utility Knife

BEFORE YOU BEGIN

VERIFY DUCTS ARE:

- ✓ Connected properly
- ✓ Supported properly
- ✓ Air-sealed properly

AFTER

Well-supported and uniformly-insulated ducts perform at higher efficiency

MATERIALS

- Duct Insulation (min R-8) with Exterior Vapor Retarder
- UL-181 Tape
- Twine
- Zip Ties

PPE



* location dependent **weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

20-1 INSULATE HARD PIPE DUCTS



- 1.** Layer insulation around duct, fitting between duct and construction members as necessary and able



- 2.** Tape joints to secure insulation in place



- 3.** Insulation will not be compressed



- 4.** Tape around circumference of duct at regular intervals



- 5.** Twine or zip ties can also be used to offer additional support for insulation – but need not to cause compression on the insulation

NOTES

20-2 INSULATE FLEX DUCTS

Aligns with SWS 5.0107.1, 5.0105.2



TOOLS

- Measuring Tape
- Utility Knife
- Zip Tie Tensioner

BEFORE YOU BEGIN

VERIFY DUCTS ARE:

- ✓ Connected properly
- ✓ Supported properly
- ✓ Air-sealed properly

AFTER

Ducts in unconditioned spaces require a minimum R-8 insulation. If exposed to the exterior, R-12.

MATERIALS

- Duct Insulation (min R-8) with Exterior Vapor Retarder
- UL-181 Tape
- Twine
- Zip Ties

PPE



* location dependent **weather dependent

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

20-2 INSULATE FLEX DUCTS



- 1.** Secure duct liner to hard connections with zip tie and tensioner tool



- 2.** Pull insulation over hard connections as needed



- 3.** Secure vapor retarder layer at boots



- 4.** Seal new joints

NOTES

20-3 INSULATE SUPPLY BOOTS

Aligns with SWS [5.0107.1](#), [5.0107.2](#)



X Exposed duct boots are a prime location for energy loss

BEFORE YOU BEGIN

Ensure ducts are:

- ✓ Properly connected
- ✓ Properly supported
- ✓ Properly air-sealed

TOOLS

- Measuring Tape
- Utility Knife
- Zip Tie Tensioner

MATERIALS

- R-8 Minimum Flex Duct insulation
- Duct Insulation with Vapor Retarder
- Water Heater Blanket with Vapor Retarder
- Zip Ties
- Twine
- Spray Adhesive
- Mastic
- UL 181 Fiberglass Mesh Tape

PPE



20-3 INSULATE SUPPLY BOOTS



1. Insulate all exposed metal of the boot



2. Ensure a complete vapor barrier by sealing all seams with mastic

NOTES

• R-8 minimum for ducts in unconditioned spaces.

• R-12 minimum for ducts exposed to outside elements.

20-4 INSULATE PLENUM IN AN UNCONDITIONED SPACE

Aligns with SWS 5.0107.1



BEFORE

- ✗ Return and supply plenums left uninsulated with contact to unconditioned spaces allow for energy loss



AFTER

FINAL CHECKLIST

- ✓ Ducts are connected properly
- ✓ Ducts are supported properly
- ✓ Ducts are air-sealed properly

TOOLS

- Measuring Tape
- Utility Knife

MATERIALS

- R-8 Minimum Duct Insulation
- Spray Adhesive
- Twine
- Mechanical Fasteners
- Gypsum Board
- Mastic
- UL-181 Mesh Tape
- Butyl Tape

PPE



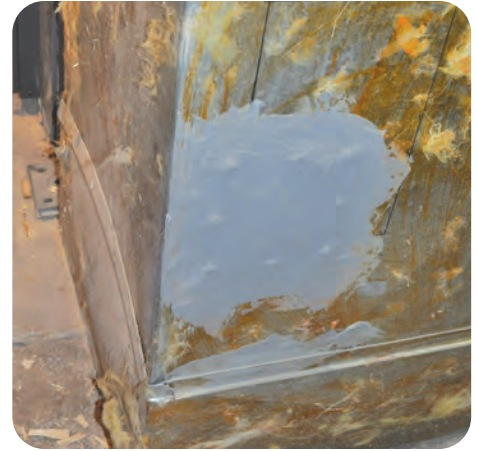
20-4 INSULATE PLENUM IN AN UNCONDITIONED SPACE



- 1.** Cover any unnecessary holes in the air handler cabinet



- 2.** Check return cavities inside building envelope to ensure they are sealed off from unconditioned spaces



- 3.** Patch holes in ducts and plenum with appropriate materials (see 19-1 Seal Ducts with Mastic)

NOTES



- 4.** Prepare plenum by removing any residue from old insulation

20-4 INSULATE PLENUM IN AN UNCONDITIONED SPACE



- 5.** Measure insulation to take maximum advantage of large sheets of duct insulation



- 6.** Cut to size for area to be covered. Insulate all exposed metal of the plenum



- 7.** To ensure a complete vapor barrier, trim insulation from vapor barrier to create overlap flap for seams, or tape seams with UL-181 tape



- 8.** Ensure clean surface for adhesion at overlap seam



- 9.** Spray adhesive over area where piece will be installed

NOTES

20-4 INSULATE PLENUM IN AN UNCONDITIONED SPACE



10. Ensure smooth and unrippled adhesion of insulation to metal of plenum



11. Spray adhesive along vapor retarder at seam to seal closed



12. Ensure overlapping flap securely adhered to the lower layer to maintain complete vapor barrier, or tape seams with UL-181 tape



13. Support insulation to prevent movement over time, securing in place without puncturing vapor retarder

NOTES

21-1 WINDOW INSTALLATION

Aligns with SWS 3.0201.9



BEFORE

✗ Single pane aluminum-frame windows offer little to no thermal break from outdoors



AFTER

FINAL CHECKLIST

- ✓ Window opens and closes properly
- ✓ All exterior edges are air-sealed
- ✓ Water will flow away from window

NOTES

Check file for age of house and complete any required lead testing before work begins.

PPE



TOOLS

- Measuring Tape
- Utility Knife
- Drill
- Spray Foam Gun
- Vacuum

MATERIALS

- Plastic Sheeting
- Shims
- Flashing Tape
- Mechanical Fasteners
- Backer Rod
- Spray Foam

21-1 WINDOW INSTALLATION



1. Measure window to be replaced



2. Remove existing window



3. Clean up sash or jam and repair any issues



4. Replace flashing as needed



5. Dry fit window



6. Level the window using shims and secure with mechanical fasteners

21-1 WINDOW INSTALLATION



7. Ensure window is operational



8. Caulk all exterior edges



9. Insulate and seal rough opening with backer rod and/or spray foam



10. Replace trim

NOTES

21-2 DOOR INSTALLATION

Aligns with SWS 3.0202.2



BEFORE

X In rare cases, doors are too damaged to be retrofitted and must be replaced



AFTER

FINAL CHECKLIST

- ✓ Weatherstrip and door bottom installed
- ✓ Door opens and closes properly
- ✓ All exterior trim is caulked
- ✓ Water will flow away from the door

NOTES

Check file for age of house and complete any required lead testing before work begins.

PPE



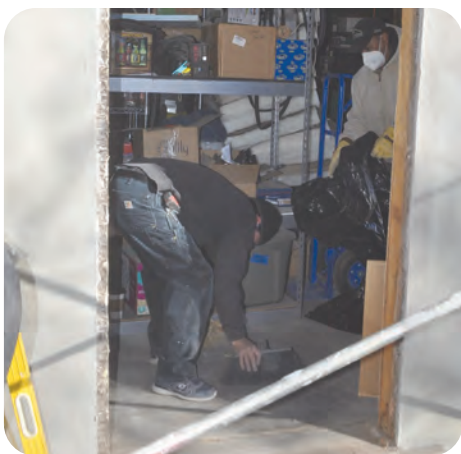
TOOLS

- Measuring Tape
- Utility Knife
- Saw
- Drill
- Level
- Caulk Gun
- Spray Foam Gun
- Jamb Saw

MATERIALS

- Lumber
- Shims
- Mechanical Fasteners
- Flashing
- Adhesive
- Spray Foam
- Caulk
- Insulation
- Weatherstrip
- Door Bottom
- Lock set

21-2 DOOR INSTALLATION



- 1.** Remove old door and clear away debris



- 2.** Measure opening and ensure that the door on location is the proper size



- 3.** Prepare opening by ensuring that jack studs are plumb and threshold is level



- 4.** Frame in and adjust opening as necessary to accommodate new door

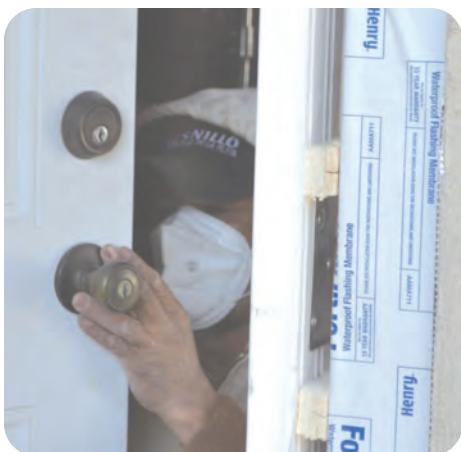


- 5.** Attach flashing, if necessary, to protect any new materials from water intrusion



- 6.** Using shims, locate door in frame, adjusting for level and plumb, and attach securely

21-2 DOOR INSTALLATION



- 7.** Ensure door is fully operational and lock set is aligned



- 8.** Insulate gaps between door jamb and frame



- 9.** Seal rough opening, to prevent both air and water intrusion



- 10.** Replace trim



- 11.** Seal along threshold, ensuring water will flow away from door

NOTES

22-1 WINDOW GLASS REPLACEMENT

Aligns with SWS 3.0201.1, 3.0201.4



BEFORE

✗ Broken, cracked or missing glass breaks the pressure and thermal boundary



AFTER

✓ Newly installed glass is sealed to prevent air and water infiltration

NOTES

Check file for age of house and complete any required lead testing before work begins.

PPE



TOOLS

- Heavy Work Gloves
- Glass Cutter
- Scraping Tool

MATERIALS

- Cleaning Solution
- New Window Pane
- Silicone Caulk
- Window Glazing
- Tape
- Glazing Points

22-1 WINDOW GLASS REPLACEMENT



1. Remove all broken glass



2. Clean all debris, caulk, etc., from sash



3. Measure rough opening for pane, size pane 1/8-3/16 inches less than RO

NOTES



4. Run interior bead of caulk

22-1 WINDOW GLASS REPLACEMENT



5. Install new glass, using tempered where code requires, that meets or exceeds previous glazing



6. Hold new pane with tape or stops



7. Caulk all edges

NOTES

23-1 INSULATE AN ELECTRIC DOMESTIC WATER HEATER

Aligns with SWS 7.0301.2



TOOLS

- Utility Knife

BEFORE YOU BEGIN

Check data plate on water heater to find existing insulation level (if any) and verify additional insulation is not prohibited

AFTER

- ✓ A properly insulated water heater safely reduces standby losses

MATERIALS

- Water Heater Insulation Blanket
- Foil Tape
- Tie Strap

PPE



95

23-1 INSULATE AN ELECTRIC DOMESTIC WATER HEATER



1. Insulate tank with minimum R-10 or better



2. Ensure a continuous vapor barrier with no gaps



3. Do not obstruct temperature and pressure relief valve (T&P)



4. Tape all seams and edges airtight



5. Cut flaps at access plates, tape them shut and then label from the exterior



6. Secure seams with tie strap and minimal compression

NOTES

23-2 INSULATE A GAS DOMESTIC WATER HEATER

Aligns with SWS 7.0301.2



TOOLS

- Utility Knife

BEFORE YOU BEGIN

Check data plate on water heater to find existing insulation level (if any) and verify additional insulation is not prohibited

AFTER

- ✓ A properly insulated water heater safely reduces standby losses

MATERIALS

- Water Heater Insulation Blanket
- Foil Tape
- Tie Strap

PPE



23-2 INSULATE A GAS DOMESTIC WATER HEATER



1. Insulate tank with minimum R-10 or better

2. Ensure a continuous vapor barrier with no gaps

3. Cut insulation to allow 6-inch space to draft diverter and flue pipe

NOTES



4. Do not obstruct burner access plate or combustion air intake

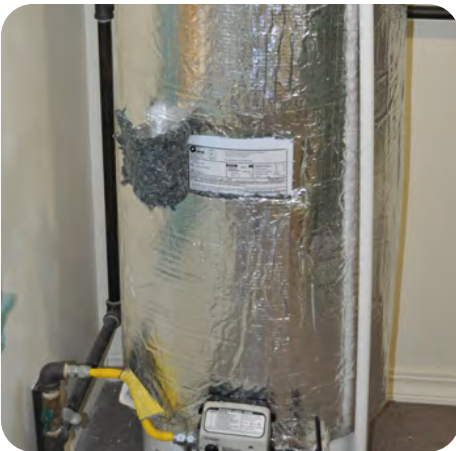
23-2 INSULATE A GAS DOMESTIC WATER HEATER



- 5.** Do not obstruct temperature and pressure relief valve (T&P)



- 6.** Tape all seams and edges airtight



- 7.** Cut flaps at access plates, tape them shut and then label from the exterior



- 8.** Secure seams with tie strap and minimal compression

NOTES

23-3 INSULATE DOMESTIC HOT WATER (DHW) PIPES

Aligns with SWS 7.0301.1



Insulate pipes to a minimum R-3 at least 6 feet from DHW on both hot and cold lines



Insulation should be sized properly, continuous, with mitered corners and no gaps.

TOOLS

- Utility Knife
- Measuring Tape

MATERIALS

- Pipe Insulation
- Tape or Tie Straps

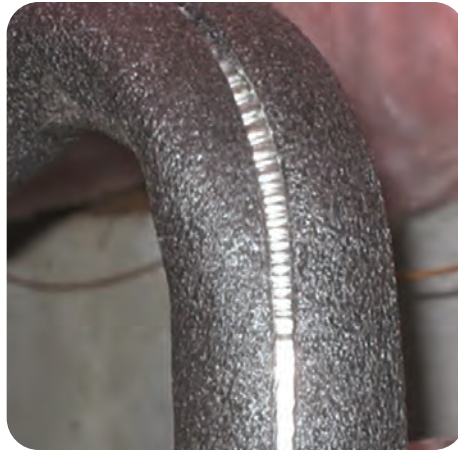
PPE



23-3 INSULATE DOMESTIC HOT WATER (DHW) PIPES



Insulation not kept back at least 6 inches from draft diverter is a fire hazard



Manufactured adhesive seam seal cannot be relied on to hold closed



Secure seams with tape



When path is partially obstructed or curved, shape insulation to the location to eliminate gaps

NOTES

24-1 INSTALL A LOW-FLOW SHOWERHEAD

Aligns with SWS 7.0201.1



BEFORE

✗ Higher flow showerheads waste water and cause water heaters to run more than necessary



AFTER

✓ Low-flow showerheads must be 2.5 gallon per minute (gpm) or less flow rate, to reduce heating load and encourage lower water use.

TOOLS

- Adjustable Wrench
- Pipe Wrench
- Channel Locks
- Buffer Material
- Rag
- Toothbrush/Wire brush

MATERIALS

- Thread Tape
- New Showerhead

PPE



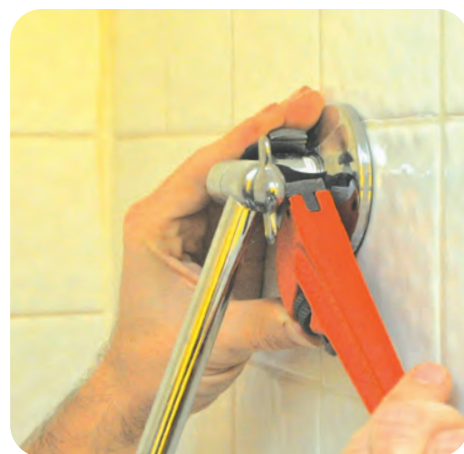
24-1 INSTALL A LOW-FLOW SHOWERHEAD



- 1.** Carefully remove old showerhead with adjustable wrench, taking care not to loosen shower arm



- 2.** If old showerhead does not have flat sides at connection, wrap with buffer material, such as a piece of rubber



- 3.** Then use pipe wrench or channel locks to loosen connection at shower arm



- 4.** Clean threads of shower arm well to remove old residue



- 5.** Wrap new thread tape around threads



- 6.** Install new showerhead according to occupant needs, such as hand-held, shutoff or swivel

24-1 INSTALL A LOW-FLOW SHOWERHEAD



- 7.** Ensure that connections will not leak while preventing damage by using buffer material



- 8.** Use thread tape at all connections



- 9.** Verify proper water flow and that there are no leaks

NOTES

24-2 INSTALL A LOW-FLOW FAUCET AERATOR

Aligns with SWS 7.0201.1



BEFORE

- ✗ Faucets without aerators produce excess flow and old aerators can impinge flow or cause leakage



AFTER

- ✓ Low-flow faucet aerators limit flow to 2.2 gpm or less and reduce heating load by encouraging lower water use

TOOLS

- Adjustable Wrench/
Aerator Wrenches
- Soft Rag

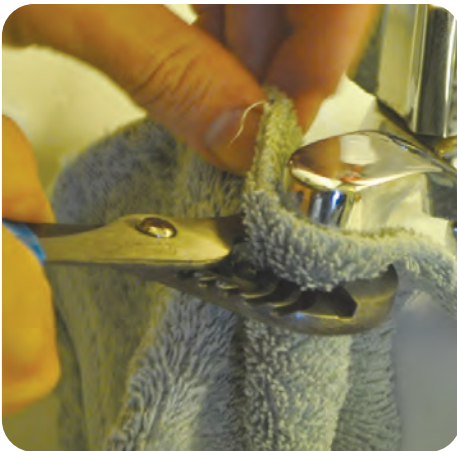
MATERIALS

- Thread Tape
- WaterSense Aerator

PPE



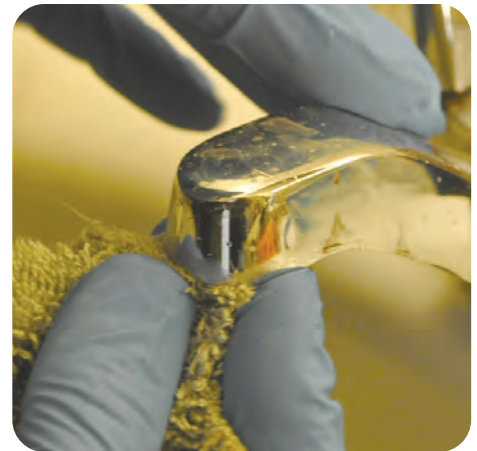
24-2 INSTALL A LOW-FLOW FAUCET AERATOR



- 1.** Using adjustable wrench or aerator wrench, gently remove old aerator, taking care not to damage faucet



- 2.** Once loose, continue removal by hand



- 3.** Clean threads of the faucet with a soft rag to remove any debris



- 4.** Verify size and type of aerator will work with faucet



- 5.** Wrap thread tape around new aerator if male, or faucet threads if it takes a female aerator



- 6.** Carefully install new aerator, ensuring any necessary rubber washers are in place and taking care not to cross-thread

24-2 INSTALL A LOW-FLOW FAUCET AERATOR



7. Do not overtighten aerator



8. Run water through new aerator to verify it is not cross-threaded and no water is leaking around sides



9. Remove old aerator from property and permanently dispose of it

NOTES

For kitchen sinks, 1.0-1.5 gpm save water without affecting performance. For lavatory sinks, as low as 0.5 gpm is adequate.

25-1 INSTALL ROOF VENT

Aligns with SWS [6.0101.2](#), [6.0201.1](#), [6.0201.2](#), [4.0188.2](#)



BEFORE

✗ Kitchens, bathrooms, and attics all have requirements for ventilation to the exterior, as well as dryer and combustion exhaust venting



AFTER

✓ A properly installed vent preserves the integrity of the roof

TOOLS

- Measuring Tape
- Drill
- Hole Saw
- Caulk Gun
- Utility Knife
- Mastic Brush
- Reciprocating Saw

MATERIALS

- Vent with Collar
- Caulk
- Mechanical Fasteners
- Joint Tape
- Mastic
- Metal Foil Tape
- UL 181 A-P Listed Tape

PPE



* if going in attic **location dependent ***weather dependent ****if using power tools

Tools and materials listed are only recommendations and may not include everything needed to complete the job.

25-1 INSTALL ROOF VENT



1. Determine the appropriate vent dependent on its use – attic ventilation, kitchen hood, bath fan, dryer exhaust (these should ideally be lower), or combustion exhaust
2. Locate ideal hole location from attic side of roof deck and drill center hole



3. Mark out size and location of hole on roof deck, verifying size of termination collar

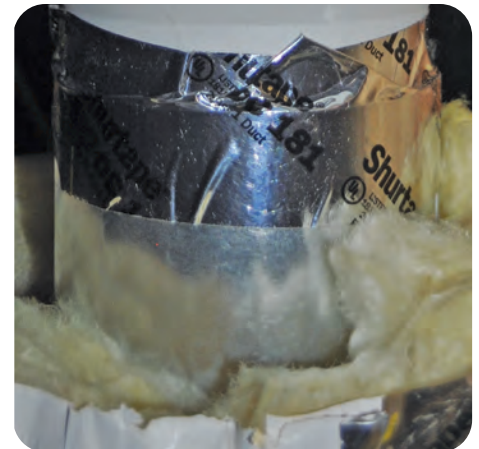
NOTES

25-1 INSTALL ROOF VENT



4. From roof side, cut hole slightly larger than termination collar. If shingle roof, cut just below one layer of shingles in order to preserve overlap

5. Run sealant around perimeter of vent and tuck under any surrounding uphill shingles. Seal uphill shingles over vent



6. Collar should extend down through roof into attic

7. Slide vent ducting to collar, sized to match the duct diameter, and attach with mechanical fasteners

8. Seal duct joints with mesh and mastic or UL 181 A-P listed tape to complete vent installation. Insulate as required

25-2 LOCATE AN EXTERIOR TERMINATION

Aligns with SWS 6.0101.2

CHECKLIST

- ✓ Locate all exhaust terminations to the outside – not attics and crawlspaces – and:



- ✓ At least 3 feet from the property line



- ✓ At least 3 feet from all operable openings



- ✓ At least 10 feet from a mechanical intake



- ✓ If near soffit, no open soffit venting for at least 6 feet on each side

NOTES

See these Job Aids
for PPE for appropriate
termination installations

17-1 Vent a Clothes
Dryer

18-1 Install Exhaust Fan
Flex Duct (Bath
Fan Only)

18-2 Install a Hard-
Ducted Exhaust
Vent

25-1 Install Roof Vent

Index of Standard Work Specifications Referenced in Field Guide:

**Note: Inclusion on this list does not imply that every Specification within the cited Detail is addressed in the Field Guide. Job Aids in parentheses () presume referenced SWS has been followed.

2020 SWS	Detail Title	Job Aids
<u>2.0101.1</u>	Hardwired (interconnected) Smoke Alarms	<u>A-2</u>
<u>2.0101.2</u>	Battery-Operated Smoke Alarms	<u>A-2</u>
<u>2.0102.1</u>	CO Detection and Warning Equipment	<u>A-2</u>
<u>2.0103.1</u>	Temperature and Pressure Relief Valve	<u>A-4, A-6</u>
<u>2.0202.1</u>	Un-Vented Subspaces – Ground Cover	<u>16-1, 16-2</u>
<u>2.0202.2</u>	Vented Subspaces – Ground Cover	<u>16-1, 16-2</u>
<u>2.0202.3</u>	Pier and Skirting Foundations – Ground Cover	<u>16-1, 16-2</u>
<u>2.0301.1</u>	Junctions/Splices Enclosed	<u>A-5</u>
<u>3.0101.1</u>	Air Sealing Holes	<u>2-1, 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, 8-1, 8-2, 13-1, 13-2, A-6</u>
<u>3.0102.1</u>	Sealing Non-Insulation Contact Recessed Light	<u>3-2</u>
<u>3.0102.2</u>	Sealing High-Temperature Devices	<u>3-1</u>
<u>3.0102.4</u>	Sealing Firewalls	<u>2-4, 13-3</u>
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Useful Acronyms in this Guide:

ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers, <https://www.ashrae.org>

EPS: Expanded Polystyrene – lightweight insulation board composed of foam beads, will absorb water

gpm: Gallons per Minute, measurement of water flow at a fixture

LED: Light-Emitting Diode, increasingly cost-effective and efficient lighting technology

IESNA: Illuminating Engineering Society of North America, <https://www.ies.org>

NECA: National Electrical Contractors Association, <https://necanet.org>

NEMA: National Electrical Manufacturers Association, <https://www.nema.org/Standards>

NFPA: National Fire Protection Association, <https://www.nfpa.org>

OSB: Oriented Strand Board, wood by-product pressed into sheets, similar to particle board but with larger pieces compressed together with adhesives

SWS: Standard Work Specification, <https://sws.nrel.gov>

UL: Underwriters Laboratories, <https://ul.org>

XPS: Extruded Polystyrene – lightweight insulation board characterized by smooth uniform foam appearance, often in pastel colors indicating manufacturer

A-2 Safety Measures

Smoke Alarm Installation

Aligns with [2.0101.1](#), [2.0101.2](#), NFPA 72

Smoke alarms, either battery-operated or hardwired (interconnected), will be listed and labeled in accordance with UL 217

Battery-operated smoke alarms will have sealed, non-replaceable 10-year batteries

Smoke alarms, either battery-operated or hardwired (interconnected), will be installed in the locations required by Authority Having Jurisdiction

NFPA 72 states that smoke alarms will be installed:

- Inside each bedroom
- Outside each sleeping area
- On every level of the home, including the basement
 - If a level does not have a bedroom, install in the living room or near the stairway to the upper level, or both locations
 - In the basement, install on the ceiling at the bottom of the stairs leading to the next level
- On walls at a height not more than 12 inches away from the ceiling (to the top of the alarm) or on the ceiling
- At least 10 feet from any cooking appliance
- Away from windows, doors, or ducts where drafts might interfere with their operation
- For pitched ceilings, install alarm within 3 feet of the peak, but not in the apex (within four inches of the peak)

Install smoke alarms in accordance with the manufacturer's instructions

Provide occupants the manufacturer's written instructions

Carbon Monoxide (CO) Detection and Warning Equipment

Aligns with [2.0102.1](#), NFPA 720

Select CO alarms that are listed and labeled in accordance with UL 2034, or approved by the authority having jurisdiction, have a minimum of 10-year manufacturer's warranty and contain internal, non-replaceable batteries

Install CO alarms in the locations required by the Authority Having Jurisdiction

NFPA 720 states that carbon monoxide alarms will be installed:

- In each sleeping area, within 10 feet of each bedroom door
- On every level of the home, including the basement
- More than 15 feet from heating or cooking appliances
- NOT in or near very humid areas, such as bathrooms

In addition, the International Association of Fire Chiefs recommends installing a CO detector near or over any attached garage.

Install CO alarms in accordance with the manufacturer's instructions, taking note of instructions for placement and height, as this can vary significantly by manufacturer

Provide occupants the manufacturer's written instructions

A-3 Baseload Lighting Measures

FOR ALL BASELOAD LIGHTING MEASURES:

Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information

Permanently remove uninstalled equipment from job site and recycle or dispose of removed equipment and refrigerant in accordance with local and federal law (e.g., EPA Section 608 of Clean Air Act of 1990)

Permanently decommission old equipment

Lighting Replacement

Aligns with [7.0103.1](#)

Discuss the lighting schedule with the client. At a minimum, replace any incandescent lamps that are on for one or more hours each day.

Educate client about incandescent lamp use, including using these lamps as little as possible.

Select replacement lighting that is appropriate for the intended application (e.g., enclosed, dimmable, potential for breakage, indoor vs. outdoor).

LEDs rated 2700-3000 K have similar color to incandescent bulbs.

Provide lighting level quality required for the intended application (e.g., task lighting, hazards lighting, nightlights) and approximate the lumen rating of incandescent lamp being replaced (see chart at right), except in circumstances where Lighting Reduction may be put into place (see [Article below](#)).

LED/Incandescent Lamp Equivalency Chart		
LED	Incandescent	Lumens
6 – 9 W	40 W	450 lm
8 – 12 W	60 W	800 lm
9 – 13 W	75 W	1100 lm
16 – 20 W	100 W	1600 lm
25 – 28 W	150 W	2600 lm

All replacement lamps are the highest level of efficiency within a technology (e.g., LED bulbs) and are ENERGY STAR® qualified, equivalent or better, and UL approved.

New fixtures or lamps facilitate upgrade to future lighting technologies

New lamps are rated no more than the rated wattage of fixture.

Install lighting in accordance with manufacturer specifications and applicable code (i.e., [NFPA 70](#), [NFPA 101](#), [NECA/IESNA 500](#))

If applicable, clean lens and reflector before installing new bulb

Install all electrical wiring according to applicable code (i.e., [NFPA 70](#))

Lighting Reduction

Aligns with [7.0103.2](#), [7.0103.7](#)

Replace or maneuver window coverings (e.g., blinds, shades, movable insulation) to maximize useful daylight where appropriate

Follow IESNA protocols for appropriate light levels for certain tasks when designing delamping procedure

Ensure final lighting levels are in accordance with ASHRAE 90.1 or 90.2

Ensure final egress lighting levels are in accordance with NFPA 70 and 101

Ensure that delamping does not impact required egress lighting, as required by ANSI/NFPA 101

De-energize circuit and lock out power before work begins

Remove bulbs or fixtures per plan ensuring that no open connections will remain after work is finished

Terminate all unused electrical connections in appropriate covered junction box per NFPA 70

Seal any penetrations created by removal as per ANSI/NFPA/ICC Fire Code

If removed bulbs or fixtures meet retrofit standards and are operational, store them in a dry location for reuse

Fixture Replacement

Aligns with [7.0103.3](#), [7.0103.4](#), [7.0103.5](#), [7.0103.6](#)

FOR ALL FIXTURE INSTALLATIONS:

De-energize circuit and lock-out power before work begins

Locate and install new fixtures in accordance with appropriate code (e.g., NFPA 101, NFPA 70, NECA/IESNA 500)

Ballast Replacement

Select pulse start, high-efficiency, electronic ballasts that meet the appropriate nationally recognized product standards (ANSI C82.1, ANSI C82.2, UL 924, UL 1029, NEMA) and have a ballast factor of 0.85 or greater

Select ballasts that match the input and output voltage of the existing fixture, that fit within the existing enclosure, and will support the necessary wattage of the bulbs

Install ballasts in accordance with manufacturer specifications

Clean the lens and reflector once installation is complete

Exit Sign Replacement

Select exit signs from the NEMA Premium Exit Sign List and that meet all applicable codes (UL 924, NFPA 70, and/or IBC and IFC, as appropriate)

Signs that include battery-backups that can maintain the total load for a minimum period of 1-1/2 hours and indicate system failure with visual and audible alarm

Signs that are able to be attached to the existing outlet box

Signs that are rated for a maximum of 5 watts per illuminated side

Signs with at least a 1-year warranty

Emergency Lighting Replacement

Select emergency light fixtures that are UL approved for location installed (i.e., indoor, outdoor, wet location)

Emergency light fixture has battery-backup that can maintain the total load for a minimum period of 1-1/2 hours, in accordance with section 700.12 of NFPA 70

Security Lighting

Select security light fixtures that are UL approved for location installed (i.e., indoor, outdoor, wet location)

Security light fixtures provide the required lighting conditions with the lowest possible energy-use, are vandal-proof, are dark-sky approved and are ENERGY STAR® qualified, equivalent or better

Aim light fixtures to minimize light emitted above the horizontal, beyond the perimeter of the property, and not directly into any window of a residence

Clean the lens and reflector once installation is complete

Install both photo and motion sensors and configure to only activate when sun is down and to switch off within 5 minutes if no motion is detected

Lighting Controls

Aligns with [7.0104.1](#), [7.0104.2](#), [7.0104.3](#), [7.0104.4](#), [7.0104.5](#)

FOR ALL CONTROL INSTALLATIONS:

Select controls that are compatible with the existing wiring and lighting fixture, and are UL approved and listed for the installed location

Install control in accordance with NFPA 70 and manufacturer specifications, in a secure location, and in location appropriate enclosure (e.g., weatherproof) or protected from physical damage

Occupancy Sensors

Do not install occupancy sensors in areas accessed for electrical and mechanical maintenance

Set controls to match the intended use of the space (i.e., time off setting not too short or too long)

Stand-Alone Timers

Select timer that has at least 10 hours of battery backup time, has at least two programmable schedules, and has an appropriate manual override

Do not install timers for egress lighting required by NFPA 101

Set timer to turn off exterior fixtures when there is sufficient daylight (civil twilight) or when lighting is no longer needed at night per ASHRAE 90.1 or 90.2

Set timer to turn off interior fixtures when light is no longer needed in the space

Motion Control Sensors

Select sensor that is location- and climate-appropriate (e.g., outdoor weatherproof fixture)

Locate sensor where it will minimize false starts

Set controls of motion sensor based on anticipated occupant usage or security needs

Set control to turn off lighting if no motion is detected for a maximum of 15 minutes

Outdoor Photo Sensors

Select sensor that is UL approved and listed for the installed location (e.g., UL 60730-1) and is location- and climate-appropriate (e.g., outdoor weatherproof fixture)

Select fixture that allows for replacement of photo sensor independently

Position sensor to properly sense natural light, but shielded from artificial light sources (e.g., other outdoor lighting)

Bi-Level Controls

Select control that has an appropriate manual override

Affix permanent labels near the switch location to indicate light level and fixture control

A-4 Specialized Field-Work Tasks

Install a Temperature and Pressure Relief Valve

Aligns with [2.0103.1](#)

Verify that T&P Valve meets IRC and ANSI Z21.22 requirements

Install in compliance with IRC, HUD code and according to manufacturer specifications

Install discharge tube such that it discharges to a readily observable location that is either 6 inches or less from the floor, 6 inches or less from an overflow pan OR to the outdoors

Locate discharge termination such that when it discharges it will not cause personal injury or structural damage

Ensure discharge tube flows by gravity and has no trap

Ensure drainage tube is not directly connected to dwelling drainage system

Ensure that drainage tube does not contain any valves or tees, nor ends with a threaded connection

Install Venting for a Fuel-Fired Appliance

Aligns with [5.0503.1](#)

Design combustion appliance venting, select vent materials, and install venting, terminations, and chimney liners in accordance with applicable code (i.e., NFPA 54, NFPA 31, IFGC) and manufacturer specifications

If conflict exists between code and manufacturer specifications, apply the more restrictive requirement

Provide Combustion Air for Fuel-Fired Appliances

Aligns with [5.0502.1](#)

Calculate and provide combustion air needs in conformance with the applicable code (i.e. NFPA 54, IFGC, or NFPA 31) and manufacturer requirements

The minimum required volume is 50 cubic feet per 1,000 BTU/h, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), then use alternative calculation from IFGC

In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply (i.e., more air rather than less)

A-5 Electrical Contractor Tasks

Enclose Junctions and Splices

Aligns with [2.0301.1](#)

Cover all junction boxes with a location-appropriate (e.g. wet-location, outdoor, indoor, etc.) UL listed cover per NEC

Enclose all wiring splices inside a location-appropriate (e.g. wet-location, outdoor, indoor, etc.) UL listed electrical enclosure per the NEC

Replace the Thermostat on a Forced Air System

Aligns with [5.0101.1](#)

Verify that sufficient number of thermostat wires is available to meet the needs of the replacement unit and the existing system

Select a double-setback programmable thermostat that allows for full functionality of the installed system (supplementary heat, emergency heat, fan only, ventilation control, etc.)

Install thermostat where it accurately reflects the temperature and humidity of the zone which it controls (i.e., not exposed to extreme temperatures, radiant heat sources, warm/cold walls, or drafts)

Connect supplementary heat to second-stage heating terminal in accordance with manufacturer specifications

For heat pumps, install and connect outdoor temperature sensor that is compatible with the thermostat in accordance with manufacturer specifications

Calculate and select an optimum thermal balance point for supplementary heat operation in accordance with ANSI/ACCA Manual S and manufacturer specifications

Program the thermostat to match the equipment and control board settings per manufacturer specifications

Set time delay for fan start in accordance with manufacturer specifications and as appropriate for the climate zone (e.g., no time delay for hot humid climates, longer time delay for cold climates)

Program the thermostat setbacks to a schedule that accommodates the occupant and reduces overall run time

Provide occupants/owners with user's manual, warranty information, installation instructions and installer contact information

A-6 HVAC/R Contractor Tasks

Domestic Hot Water

Install a Temperature and Pressure Relief Valve

Aligns with [2.0103.1](#)

Verify that T&P Valve meets IRC and ANSI Z21.22 requirements

Install in compliance with IRC, HUD code and according to manufacturer specifications

Install discharge tube such that it discharges to a readily observable location that is either 6 inches or less from the floor, 6 inches or less from an overflow pan OR to the outdoors

Locate discharge termination such that when it discharges it will not cause personal injury or structural damage

Ensure discharge tube flows by gravity and has no trap

Ensure drainage tube is not directly connected to dwelling drainage system

Ensure that drainage tube does not contain any valves or tees, nor ends with a threaded connection

Install an Electric Storage Tank Water Heater

Aligns with [7.0302.1](#)

Verify current plumbing infrastructure is sufficient to support the installation(s) and is leak-free

Select a water heater that: has an Energy Factor (EF) of 0.93 or better, fits in the installation space with required clearances, and provides sufficient hot water for the home and occupants

Install appliance where it is protected from freezing and accessible for service

Install appliance in compliance with appliance code (e.g., NFPA 70, IRC, IBC, IMC) and manufacturer specifications

If conflict exists between code and manufacturer specifications, apply the more restrictive requirement

Provide a level working space not less than 30" in length and 30" in width in front of the control side of the appliance

Install appliance and plumbing to allow for inspection, maintenance, and replacement of the appliance and its components, without disturbing other installed equipment, controls, piping and components, other than what requires repair/replacement

Ensure that anode rod is accessible for replacement

Install a Temperature and Pressure Relief Valve per IRC and manufacturer specifications (See article ["Install a Temperature and Pressure Relief Valve"](#) above)

Select piping material based on IRC requirements

If appliance is installed in or above conditioned space or in a location where water damage could occur, install a drain pan according to the requirements of the IRC

Drain pan to the exterior of the building

Include a separate water cut-off valve for both the hot and cold water lines

Install an expansion tank anytime a storage water heater is supplied with cold water that passes through a check valve, pressure reducing valve or backflow preventer

Connect the tank to the cold water supply line at a point that is downstream of all check valves, pressure reducing valves and backflow preventers

Size thermal expansion tanks in accordance with the tank's manufacturer instructions and applicable code (e.g., IRC, IBC)

Install dielectric unions when connecting copper to galvanized steel piping in accordance with the IRC and manufacturer specifications

Install heat traps on the inlet and outlet piping where not provided by manufacturer

Set discharge temperature to not exceed 120 degrees or as prescribed by local code

In multi-tank systems, install valves to isolate each tank from water heating system and install bypass piping

Permanently remove equipment from job site and recycle or dispose of removed equipment and refrigerant in accordance with local and federal law (e.g., EPA Section 608 of Clean Air Act of 1990)

Permanently decommission old equipment

Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information

Install a Fuel-Fired Storage Tank Water Heater

Aligns with [7.0302.2](#)

Verify current plumbing infrastructure is sufficient to support the installation(s) and is leak-free

Select a system that: is ENERGY STAR® certified, equivalent, or better, includes a low nitrogen oxide burner, fits in the installation space with required clearances, and provides sufficient hot water for the home and occupants

Install appliance where it is protected from freezing and accessible for service

Install appliance in compliance with appliance code (e.g., NFPA 31, NFPA 54, IRC) and manufacturer specifications. If conflict exists between code and manufacturer specifications, apply the more restrictive requirement.

Provide a level working space not less than 30" in length and 30" in width in front of the control side of the appliance

Install appliance and plumbing to allow for inspection, maintenance, and replacement of the appliance and its components, without disturbing other installed equipment, controls, piping and components, other than what requires repair/replacement

Ensure that anode rod is accessible for replacement

Install fuel supply components per NFPA 31 (for oil) and NFPA 54 (for gas) and manufacturer specifications. If conflict exists between code and manufacturer specifications, apply the more restrictive requirement.

Install an emergency fuel cut-off switch within reach of the water heater

If appliance is installed in or above conditioned space or in a location where water damage could occur, install a drain pan according to the requirements of the IRC

Drain pan to the exterior of the building

Include a separate water cut-off valve for both the hot and cold water lines

Install an expansion tank anytime a storage water heater is supplied with cold water that passes through a check valve, pressure reducing valve or backflow preventer

Connect the tank to the cold water supply line at a point that is downstream of all check valves, pressure reducing valves and backflow preventers

Size thermal expansion tanks in accordance with the tank's manufacturer instructions and applicable code (e.g., IRC, IBC)

Install a Temperature and Pressure Relief Valve per IRC and manufacturer specifications (See article ["Install a Temperature and Pressure Relief Valve"](#) above)

Select piping material based on IRC requirements

Install dielectric unions when connecting copper to galvanized steel piping in accordance with the IRC and manufacturer specifications

Install heat traps on the inlet and outlet piping where not provided by manufacturer

Set discharge temperature to not exceed 120 degrees or as prescribed by local code

In multi-tank systems, install valves to isolate each tank from water heating system and install bypass piping

Permanently remove equipment from job site and recycle or dispose of removed equipment and refrigerant in accordance with local and federal law (e.g., EPA Section 608 of Clean Air Act of 1990)

Permanently decommission old equipment

Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information

Heating and Cooling

Install Condensate Drain

Aligns with [5.0102.1](#)

Convey all condensate from all cooling coils, condensing furnaces, etc. to the exterior of the building, along condensate piping with not less than 1/8" per foot (1% slope) toward the termination point. Install condensate drain pumps when condensate cannot be drained by gravity.

When local code enforcement requires, condensate from condensing furnaces must first pass through a neutralizer if using waste lines for disposal

Seal all piping that conveys condensate

Install vents and traps on condensate drain lines in accordance with manufacturer specifications and applicable building code and in a manner that allows for cleaning of condensate lines without cutting the existing pipe

Install a secondary drain pan under all condensing appliances installed in or above conditioned space and where water damage may occur to the structure

Install an independent condensate drain for the secondary drain pan that drains to a visible termination location

Slope drain pan towards the condensate drain

Install a float switch that is interlocked with the system power circuit and will break the circuit when drainage fails to remove condensate

When there is potential for condensation or freezing of the drain line, insulate condensate drain lines to a minimum of R-4 with insulation that contains a Class II or greater vapor retarder

If termination of condensate drain is to the outdoors, direct it downward with an elbow fitting at the end of the exterior termination.

Provide Combustion Air for Fuel-Fired Appliances

Aligns with [5.0502.1](#)

Calculate and provide combustion air needs in conformance with the applicable code (i.e. NFPA 54, IFGC, or NFPA 31) and manufacturer requirements

In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply (i.e., more air rather than less)

The minimum required volume is 50 cubic feet per 1,000 BTU/h, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), then use alternative calculation from IFGC

Install Venting for a Fuel-Fired Appliance

Aligns with [5.0503.1](#)

Design combustion appliance venting, select vent materials, and install venting, terminations, and chimney liners in accordance with applicable code (i.e., NFPA 54, NFPA 31, IFGC) and manufacturer specifications

If conflict exists between code and manufacturer specifications, apply the more restrictive requirement

Isolate the Combustion Appliance Zone (CAZ)

Aligns with [5.0501.1](#), [3.0101.1](#), [5.0106.1](#) (See Job Aid [19-1](#)), [5.0107.1](#) (See Job Aid [20-1](#) and [20-4](#)), [5.0202.2](#) (See Job Aid [23-3](#)), [5.0502.1](#) (See [Article](#))

Air Sealing

Apply a continuous seal at all penetrations, gaps, cracks, etc. of the pressure boundary between the isolated room and conditioned space using sufficient pressure to push sealant into any gaps or cracks and contact any backing or infill material required

Select sealants that:

- Are compatible with their intended surfaces
- Allow for differential expansion and contraction between dissimilar materials
- Meet the requirements of the applicable fire safety code (e.g. thermal or ignition barriers), and
- For use inside the pressure boundary select low volatile organic compound (VOC) sealants that meet independent testing and verification protocols

Select materials that:

- Adequately support applied load and are permanent air barriers
- Meet the requirements of the applicable fire safety code (e.g. thermal or ignition barriers), and
- For use inside the pressure boundary select low volatile organic compound (VOC) materials that meet independent testing and verification protocols.

If backing or infill is installed, it will not bend, sag, or move once installed, and will adequately support any insulation installed on the surface

For small holes (less than 1/4"), if using backing or infill material, install at least 1/8" below the surface where sealant is applied.

For medium holes (1/4" to 3"), install backing or infill in or over all holes to be sealed

For large holes (greater than 3"), install rigid backing or infill in or over all holes to be sealed. Install support material for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

Support material installed for any walking/working surface (attics or floors) will support the weight of a worker and any insulation applied in the area

Mechanically fasten backing or infill materials sufficient to prevent movement

Remove any material from the sealing area that will prevent full adhesion of the selected sealant

Install only noncombustible materials and sealants with an ASTM E136 listing in contact with any device producing 200 degrees F or more (chimneys, vents, flues, etc.)

Sealing Ductwork

Remove and seal register/grill openings of any return or supply ducting in the isolated room

Seal all ductwork in the CAZ (See Job Aid [19-1](#)):

Select only UL 181 approved materials that are compatible with their intended surfaces, allow for differential expansion and contraction between dissimilar materials, and meet the requirements of the applicable fire safety code (e.g., thermal or ignition barriers)

Select low volatile organic compound (VOC) sealants for use inside the pressure boundary that meet independent testing and verification protocols

Clear surrounding insulation to expose joints being sealed, salvage for reuse if possible

If duct must be cut open to gain access, position the hole to make repair with appropriate materials feasible

Remove loose debris using a vacuum

Remove any substance that will prevent sealant adhesion (tape, oil, etc.) using appropriate solvent

Securely fasten all duct connections using appropriate mechanical fasteners according to [Chart 1](#)

Seal all accessible seams, cracks, joints, holes, and penetrations of duct system

Select method according to physical leak size:

Mastic alone is acceptable for holes less than 1/8" in size that are more than 10' from air handler if static operating pressure is less than 1" of Water Column (iwc)

Seal leaks less than 1/4" using fiberglass mesh and mastic

Seal leaks between 1/4" and 3/4" using a two stage process: Install temporary tape as a backing material, then seal with fiberglass mesh and mastic that extends at least 1" past the temporary tape on all sides

Repair leaks larger than 3/4" using a rigid duct patch. Mechanically fasten patch before applying mastic. Install fiberglass mesh and mastic over the seam, overlapping repair joint by at least 1" on all sides

Seal gaps between boot and surface connections using fiberglass mesh tape and mastic or appropriate flexible caulking. Ensure sealant is dry before reinstalling the register. Ensure the register can be removed and reinstalled by the dwelling occupant.

Seal any joints, cracks, and holes that are not gasketed or weatherstripped and are not needed for proper function or service of the unit using removable sealant (e.g., foil tape, gaskets, etc.)

Seal the filter slot with a durable, client removable filter slot cover (e.g., magnetic strip)

Duct Insulation:

Insulate all ductwork existing inside the isolated room (See also Job Aids [20-1](#) and [20-4](#)):

Select insulation that includes an exterior vapor retarder layer and with a flame spread and smoke development index of 25/50 when tested in accordance with ASTM E84 or UL 723

Remove damaged or wet duct insulation from premises

Verify ductwork is sealed before insulating

Insulate all ducts outside the thermal boundary to a minimum of R-8

Insulate all ducts exposed to the exterior to a minimum of R-12

Secure blanket insulation in full contact with the duct surface using mechanical fasteners (e.g., stick pins, metal wire)

Secure reflective insulation to duct in compliance with manufacturer specifications including required air spaces

Seal all seams and connections of the duct insulation using UL 181 approved tape so that no gaps exist in the vapor retarder

Post a dated receipt signed by the installer that minimally includes: Installed insulation type, coverage area, installed thickness, and installed R-value

If reflective exterior insulation is used the documentation must include the number and width of included air spaces

Plumbing

Insulate all plumbing pipes in the CAZ (see also Job Aid [23-3](#)):

Select insulation that is rated for the maximum operating temperature of the system, meets applicable fire safety code, and is R-3 or greater.

Install insulation over all distribution system components that allow insulation in a continuous manner without gaps

Seal all seams, joints, and connections of insulation with a durable sealant or mechanical fasteners (e.g., zip ties)

Install removable/reusable insulation over components that require regular maintenance

Post a dated receipt signed by the installer that minimally includes: Installed insulation type, coverage area, installed thickness, and installed R-value

Walls, Floors and Ceilings

Insulate all surfaces of the isolated room between the room and conditioned space to the applicable code minimum for the climate zone according to the IECC and applicable SWS

Provide outdoor combustion air to the isolated room according to article [“Provide Combustion Air for Fuel-Fired Appliances”](#)

Install an Air-to-Air Split System

Aligns with [5.0108.1](#), [5.0504.1](#), [5.0504.2](#), [5.0103.1](#), [5.0103.2](#), [5.0106.1](#), [5.0105.1](#)

Load Calculation

Perform residential load calculation in accordance with the current version of ANSI/ACCA Manual J (Residential Load Calculation) or equivalent using interior design temperatures of 75 degrees for cooling and 70 degrees for heating

Perform commercial load calculation in accordance with the current version of ANSI/ACCA Manual N (Commercial Load Calculation) or equivalent using interior design temperatures of 75 degrees for cooling and 70 degrees for heating

Room by room load calculations will be performed when installing a new duct system or in retro-commissioning projects

Calculated loads based on post-retrofit dwelling characteristics

Equipment Selection

Select residential equipment in accordance with the current version of ANSI/ACCA Manual S (Residential Equipment Selection) or equivalent

Select commercial equipment in accordance with the current version of ANSI/ACCA Manual CS (Commercial Applications, Systems and Equipment) or equivalent

Select cooling equipment capable of meeting the sensible and latent load of the building that is not sized more than 115% of total load or next available size

Select heating equipment of the lowest capacity required to meet the design heating load and provide the air volume required by any air conditioning equipment installed

Select system that is ENERGY STAR® certified or equivalent

Select outdoor units that are corrosion-protected for marine climate zones

Unit Location and Installation

Locate outdoor unit to provide clearance on all sides and top according to manufacturer specifications and service access according to applicable code, on a non-wicking equipment pad, ensuring unit is level, stable and elevated a minimum of 6" above the ground

Locate indoor unit in a dry location and within conditioned space (when feasible) that provides adequate service access according to manufacturer specifications and applicable code

Install units according to manufacturer specifications and applicable building code (e.g., IRC, IMC, IBC) and ANSI/ACCA Standard 5 (HVAC Quality Installation Standard)

Fuel Delivery

For fuel delivery on indoor units, select approved pipe type in accordance with applicable code (e.g., NFPA 54/ANSI/ACCA Z223.1, NFPA 31, IMC) and capable of supporting the total connected load of all appliances.

Locate/route gas piping/train to create the least pressure drop possible and all fuel piping so as to not create a trip hazard and not be damaged by water

Support fuel piping in compliance with applicable code

All piping installations must contain at a minimum: a manual fuel shut off valve, union joint, and a sediment trap for each appliance

If installed, vent all gas pressure regulators requiring venting to outside the building with code-approved rigid pipe

Terminate pipe in a safe location without any thread, coupling, fitting etc. that would allow a plug to be easily fitted

Seal all gas piping in accordance with manufacturer specifications

Install a secondary liquid propane safety detector system (e.g., valve, exhaust fan, alarm light) for propane piping installed below grade

If a gas pressure booster is necessary, confirm compatibility with the gas-fired equipment and check low and high gas pressure switches for proper operation

If a fuel pump is required on oil systems, design it in accordance with manufacturer specifications based on fuel type, distance from tank and equipment size. Install a serviceable strainer in the pump supply side. Pump must be interlocked with appliance to cut off when appliance is not functioning.

Use connectors and filter fittings for oil systems that approved by applicable code (e.g. NFPA 31, IMC)

Support

Ensure unit is level, stable, secured to ductwork, properly braced to prevent movement (seismic bracing), and elevated as required by applicable building code

For Horizontal Flow Systems in an Attic, support equipment on a fireproof platform that is elevated above the insulation level or suspend with threaded rod in accordance with local codes and manufacturer specifications. Install vibration pads/isolators according to manufacturer specifications

For Horizontal Flow Systems in a Subspace, support equipment on a non-wicking, fireproof material or suspend with threaded rod in accordance with local codes and manufacturer specifications. Install vibration pads/isolators according to manufacturer specifications.

For Upflow Systems on a Platform, support equipment on a durable, fireproof platform capable of supporting the weight of the equipment. Install vibration pads/isolators according to manufacturer specifications

For Downflow Systems, support equipment on ductwork capable of supporting the weight of the equipment

Connections, Intakes/Terminations

Install equipment connections (e.g., electrical service, condensate drains, ductwork, fuel, venting, refrigerant lines) to allow for necessary service and repair access to all portions of the equipment

Locate all intakes/terminations in compliance with manufacturer specifications and applicable building code

Electrical Wiring

Install electrical wiring according to NFPA 70, and provide an electrical disconnect within site of the unit.

Install all high voltage wiring inside of protective conduit and approved junction boxes, no wiring connections (high or low voltage) will occur outside of appropriate junction box

Condensate Drainage

Install a secondary drain pan with a float switch interlocked to the cooling system power under all units that exist in or above conditioned space

Pipe condensate to a properly sized sanitary drain or the outdoors and provide with traps as specified by the manufacturer and applicable building code

When there is potential for condensation or freezing of the drain line, insulate condensate drain lines to a minimum of R-4 with insulation that contains a Class II or greater vapor retarder

Refrigerant Lines and Charge

When installing refrigerant piping:

Select only manufacturer and code approved (e.g. IRC, IMC) refrigerant lines, fittings, etc., sized in accordance with manufacturer specifications for the installed equipment

Install refrigerant lines without kinks, crimps, or excessive bends

Route lines in a manner that protects it from damage by workers and occupants

Join lines using manufacturer-approved method(s)

Install proper filter dryer(s) on all systems

Install P-traps on suction line risers that are greater than 10' in height

Use manufacturer specifications to determine appropriate lengths and elevations of refrigerant lines between condensing units and indoor coils

Insulate all suction lines to a minimum of R-4 with an insulation that is a class II or better vapor retarder

Insulate all high pressure lines that pass through spaces where condensation may occur to a minimum of R-4 with an insulation that is a class II or better vapor retarder

Seal all seams, joints, etc. of insulation using compatible material (e.g., tape)

Install UV-resistant insulation on exterior lines or protected insulation from UV degradation

Secure and support refrigerant lines according to applicable code and in a manner that protects the line from damage by workers or occupants

If refrigerant lines are installed where they may be contacted by vehicles, people, tree limbs, etc., install a rigid sleeve or pipe duct over them that provides adequate impact protection

Install locking refrigerant caps on all refrigerant access ports

When installing refrigerant charge:

Before adjusting refrigerant to system verify that system is leak free, air flow of system is correct, and indoor and outdoor temperatures are within allowable range for refrigerant charge testing

Base refrigerant charge on manufacturer specifications for the equipment being serviced

Weigh in calculated refrigerant charge if outdoor conditions prevent accurate pressure measurements according to manufacturer specifications

Provide occupant/owner with refrigerant charge documentation according to ANSI/ACCA Standard 5 (HVAC Quality Installation)

Air Handler Sealing (see Job Aid [19-1](#))

Seal air handler and adjoining ductwork:

Select only UL 181 approved materials that are compatible with their intended surfaces, allow for differential expansion and contraction between dissimilar materials, and meet the requirements of the applicable fire safety code (e.g., thermal or ignition barriers)

Select low volatile organic compound (VOC) sealants for use inside the pressure boundary that meet independent testing and verification protocols

Clear surrounding insulation to expose joints being sealed, salvage for reuse if possible

If duct must be cut open to gain access, position the hole to make repair with appropriate materials feasible

Remove loose debris using a vacuum

Remove any substance that will prevent sealant adhesion (tape, oil, etc.) using appropriate solvent

Securely fasten all duct connections using appropriate mechanical fasteners according to [Chart 1](#)

Seal all accessible seams, cracks, joints, holes, and penetrations of duct system

Select method according to physical leak size:

Mastic alone is acceptable for holes less than 1/8" in size that are more than 10' from air handler if static operating pressure is less than 1" of Water Column (iwc)

Seal leaks less than 1/4" using fiberglass mesh and mastic

Seal leaks between 1/4" and 3/4" using a two stage process: Install temporary tape as a backing material, then seal with fiberglass mesh and mastic that extends at least 1" past the temporary tape on all sides

Repair leaks larger than 3/4" using a rigid duct patch. Mechanically fasten patch before applying mastic. Install fiberglass mesh and mastic over the seam, overlapping repair joint by at least 1" on all sides

Seal gaps between boot and surface connections using fiberglass mesh tape and mastic or appropriate flexible caulking. Ensure sealant is dry before reinstalling the register. Ensure the register can be removed and reinstalled by the dwelling occupant.

Seal any joints, cracks, and holes that are not gasketed or weatherstripped and are not needed for proper function or service of the unit using removable sealant (e.g., foil tape, gaskets, etc.)

Seal the filter slot with a durable, client removable filter slot cover (e.g., magnetic strip)

If air handler is installed in a building cavity (i.e., closet), seal the cavity to eliminate any return air leaks from adjoining chases (See article [“Isolate the Combustion Appliance Zone”](#))

Occupant Safety and Documentation

Install smoke detectors inside the supply duct plenum of systems that move more than 2,500 cubic feet per minute (CFM) in accordance with the applicable building code

Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information

Install a Furnace

Aligns with [5.0108.4](#), [5.0504.1](#), [5.0504.2](#), [5.0106.1](#)

Load Calculation

Perform residential load calculation in accordance with the current version of ANSI/ACCA Manual J (Residential Load Calculation) or equivalent using interior design temperatures of 70 degrees for heating

Perform commercial load calculation in accordance with the current version of ANSI/ACCA Manual N (Commercial Load Calculation) or equivalent using interior design temperatures of 70 degrees for heating

Room by room load calculations will be performed when installing a new duct system or in retro-commissioning projects

Calculated loads based on post-retrofit dwelling characteristics

Equipment Selection

Select residential equipment in accordance with the current version of ANSI/ACCA Manual S (Residential Equipment Selection) or equivalent

Select commercial equipment in accordance with the current version of ANSI/ACCA Manual CS (Commercial Applications, Systems and Equipment) or equivalent

Select heating equipment of the lowest capacity required to meet the design heating load and provide the air volume required by any air conditioning equipment installed

Select system that is ENERGY STAR® certified or equivalent

Unit Location and Installation

Locate unit in a dry location and within conditioned space (when feasible) that provides adequate service access according to manufacturer specifications and applicable code

Install unit according to manufacturer specifications and applicable building code (e.g., IRC, IMC, IBC) and ANSI/ACCA Standard 5 (HVAC Quality Installation Standard)

Fuel Delivery

Select approved pipe type in accordance with applicable code (e.g., NFPA 54/ANSI/ACCA Z223.1, NFPA 31, IMC) and capable of supporting the total connected load of all appliances.

Locate/route gas piping/train to create the least pressure drop possible and all fuel piping so as to not create a trip hazard and not be damaged by water

Support fuel piping in compliance with applicable code

All piping installations must contain at a minimum: a manual fuel shut off valve, union joint, and a sediment trap for each appliance

If installed, vent all gas pressure regulators requiring venting to outside the building with code-approved rigid pipe. Terminate pipe in a safe location without any thread, coupling, fitting etc. that would allow a plug to be easily fitted

Seal all gas piping in accordance with manufacturer specifications

Install a secondary liquid propane safety detector system (e.g., valve, exhaust fan, alarm light) for propane piping installed below grade

If a gas pressure booster is necessary, confirm compatibility with the gas-fired equipment and check low and high gas pressure switches for proper operation

If a fuel pump is required on oil systems, design it in accordance with manufacturer specifications based on fuel type, distance from tank and equipment size. Install a serviceable strainer in the pump supply side. Pump must be interlocked with appliance to cut off when appliance is not functioning.

Use connectors and filter fittings for oil systems that approved by applicable code (e.g. NFPA 31, IMC)

Support

Ensure unit is level, stable, secured to ductwork, properly braced to prevent movement (seismic bracing), and elevated as required by applicable building code

For Horizontal Flow Systems in an Attic, support equipment on a fireproof platform that is elevated above the insulation level or suspend with threaded rod in accordance with local codes and manufacturer specifications. Install vibration pads/isolators according to manufacturer specifications

For Horizontal Flow Systems in a Subspace, support equipment on a non-wicking, fireproof material or suspend with threaded rod in accordance with local codes and manufacturer specifications. Install vibration pads/isolators according to manufacturer specifications.

For Upflow Systems on a Platform, support equipment on a durable, fireproof platform capable of supporting the weight of the equipment. Install vibration pads/isolators according to manufacturer specifications

For Downflow Systems, support equipment on ductwork capable of supporting the weight of the equipment.

Connections, Intakes and Terminations

Install equipment connections (e.g., electrical service, condensate drains, ductwork, fuel, venting, refrigerant lines) to allow for necessary service and repair access to all portions of the equipment

Locate all intakes/terminations in compliance with manufacturer specifications and applicable building code

Electrical Wiring

Install electrical wiring according to NFPA 70, and provide an electrical disconnect within site of the unit.

Install all high voltage wiring inside of protective conduit and approved junction boxes, no wiring connections (high or low voltage) will occur outside of appropriate junction box

Install combustion venting in compliance with manufacturer specifications and applicable building code (e.g., IRC, IMC, IBC)

Condensate Drainage

Install a float switch interlocked to the cooling system power under all units that exist in or above conditioned space

Pipe condensate to a properly sized sanitary drain or the outdoors and provide with traps as specified by the manufacturer and applicable building code

When there is potential for condensation or freezing of the drain line, insulate condensate drain lines to a minimum of R-4 with insulation that contains a Class II or greater vapor retarder

Air Handler Sealing (See Job Aid 19-1)

Seal air handler and adjoining ductwork:

Select only UL 181 approved materials that are compatible with their intended surfaces, allow for differential expansion and contraction between dissimilar materials, and meet the requirements of the applicable fire safety code (e.g., thermal or ignition barriers)

Select low volatile organic compound (VOC) sealants for use inside the pressure boundary that meet independent testing and verification protocols

Clear surrounding insulation to expose joints being sealed, salvage for reuse if possible

If duct must be cut open to gain access, position the hole to make repair with appropriate materials feasible

Remove loose debris using a vacuum

Remove any substance that will prevent sealant adhesion (tape, oil, etc.) using appropriate solvent

Securely fasten all duct connections using appropriate mechanical fasteners according to [Chart 1](#)

Seal all accessible seams, cracks, joints, holes, and penetrations of duct system

Select method according to physical leak size:

Mastic alone is acceptable for holes less than 1/8" in size that are more than 10' from air handler if static operating pressure is less than 1" of Water Column

Seal leaks less than 1/4" using fiberglass mesh and mastic

Seal leaks between 1/4" and 3/4" using a two stage process: Install temporary tape as a backing material, then seal with fiberglass mesh and mastic that extends at least 1" past the temporary tape on all sides

Repair leaks larger than 3/4" using a rigid duct patch. Mechanically fasten patch before applying mastic. Install fiberglass mesh and mastic over the seam, overlapping repair joint by at least 1" on all sides

Seal gaps between boot and surface connections using fiberglass mesh tape and mastic or appropriate flexible caulking. Ensure sealant is dry before reinstalling the register. Ensure the register can be removed and reinstalled by the dwelling occupant.

Seal any joints, cracks, and holes that are not gasketed or weatherstripped and are not needed for proper function or service of the unit using removable sealant (e.g., foil tape, gaskets, etc.)

Seal the filter slot with a durable, client removable filter slot cover (e.g., magnetic strip)

If air handler is installed in a building cavity (i.e., closet), seal the cavity to eliminate any return air leaks from adjoining chases (See article ["Isolate the Combustion Appliance Zone"](#))

Occupant Safety and Documentation

Install smoke detectors inside the supply duct plenum of systems that move more than 2,500 cubic feet per minute (CFM) in accordance with the applicable building code

Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information

A-7 Chart 1: Duct Fastening

Metal to Metal	3 equally-spaced galvanized or stainless steel mechanical fasteners
Flex to Metal	UL-181 approved tie bands using a tie band tensioning tool
Flex to Flex	Rigid metal coupling of the same size at the flex duct between the two sections. Fasten both joints with UL 181 approved tie bands using a tied band tensioning tool
Duct Board to Duct Board	Cut duct board edges to create an overlapping joint on all contact surfaces. Fasten joints with outward clinching (stitch) staples every 2 inches Cover joint with UL 181 rated mastic embedded fiber tape and additional mastic that laps at least 1" past the edges of the tape on all sides
Duct Board to Flexible Duct	Install a metal take-off collar on the duct board specifically designed for the thickness of the duct board Bend all finger tabs down securely so collar shank is firmly seated against the exterior surface Attach flexible duct to collar with UL 181 approved tie bands using a tie band tensioning tool
Duct Board to Metal	Fasten duct board to metal duct using metal channel and mechanical fasteners spaced evenly on all sides Cover connection joint with UL 181 rated mastic embedded fiber tape and additional mastic that laps at least 1" past the edges of the tape on all sides
Duct Board Plenum to Air Handler Cabinet	Fasten using metal channel fastened with screws space a maximum of 6" with the duct board sandwiched between the channel flange In upflow air handler connections, install a flexible connection between supply plenum and unit that does not reduce the inside dimensions of the duct
Duct Boot to Subfloor	Minimum of 1 stainless steel or galvanized fastener per side
Duct Boot to Gypsum	If accessible, fasten a boot hanger to adjacent framing with mechanical fasteners, then connect boot to hanger with mechanical fasteners If inaccessible, fasten boot to gypsum with UL 181 rated fiber tape and mastic
Metal Plenum to Air Handler Cabinet	Install a flexible connection between plenum and unit that does not reduce the inside dimensions of the duct Fasten plenum on all sides with mechanical fasteners no more than every 6 inches

A-8 Multifamily Work Specifications

Multifamily projects performed by Minnesota Weatherization must incorporate the following work standards and guidelines.

Multifamily Code Compliance

Multifamily Projects must conform to Minnesota Building Code and the requirements of local code officials, including permitting requirements.

Multifamily Air Sealing

Exterior Roof Access Panels and Hatches

Aligns with [3.0103.2](#)

Select sealants that:

- are compatible with their intended surfaces,
- allow for differential expansion and contraction between dissimilar materials,
- meet the requirements of the applicable fire safety code (e.g. thermal or ignition barriers), and
- for use inside the pressure boundary select low volatile organic compound (VOC) sealants that meet independent testing and verification protocols

Select materials that:

- adequately support applied load and are permanent air barriers,
- meet the requirements of the applicable fire safety code (e.g. thermal or ignition barriers), and
- for use inside the pressure boundary select low volatile organic compound (VOC) materials that meet independent testing and verification protocols

Repair or adjust roof access to properly fit the curb/jamb and allow for ease of operation (e.g., hardware adjustment and/or replacement)

Remove any material from the sealing area that will prevent full adhesion of the selected sealant

Seal access frame/curb to both the exterior and interior side of the roof/wall

Seal roof access stop to frame/curb

Seal abandoned penetrations in the existing frame/curb

Insulate access with non-compressible insulation to an R-value sufficient to prevent condensation on either the conditioned or unconditioned side, based on local climate conditions

When access hatches are part of a fire-resistance-rated assembly or are used for smoke or heat removal, added materials are not permitted

Multifamily Heating & Cooling Systems

Engineering Evaluation

Multifamily heating system retrofits may require an engineering evaluation to determine system design

Consultation with Code Officials

Multifamily heating system retrofits may require consultation with local codes officials prior to system design and work commencing to ensure project success

Boiler Room Water Drainage

Aligns with SWS [5.0288.1](#)

Route maintenance blow-down piping to the nearest drain

Remove debris from drainage system and flush system removing any blockages

Verify that drainage system is capable of handling maximum volume of water

Clean blow-down pit out to handle the volume of water required to sufficiently reduce blow-down temperature for safe discharge

Clear blow-down pit connection to the drain system

Size sump pit to handle the volume of water required to sufficiently reduce water temperature for safe discharge

Verify that sump pump is rated for high-temperature application, operates correctly, and contains a check valve

Replace a Thermostat on a Hydronic System

Aligns with SWS [5.0201.1](#)

Verify that a sufficient number of thermostat wires are available to meet the needs of the replacement unit and the existing system

Select a double-setback programmable thermostat that allows for full functionality of the installed system (supplementary heat, emergency heat, fan only, ventilation control, etc.)

Install thermostat where it accurately reflects the temperature and humidity of the zone which it controls (i.e., not exposed to extreme temperatures, radiant heat sources, warm/cold walls, or drafts)

If applicable, install and connect outdoor temperature sensor that is compatible with the thermostat in accordance with manufacturer specifications

Calculate and select an optimum thermal balance point for supplementary heat operation in accordance with ANSI/ACCA Manual S and manufacturer specifications

Program the thermostat to match the equipment and control board settings per manufacturer specifications

Program the thermostat setbacks to a schedule that accommodates the occupant and reduces overall run time

Provide occupants/owners with user's manual, warranty information, installation instructions and installer contact information

See article "Isolate the Combustion Appliance Zone (CAZ)" subsection [Plumbing](#) in A-6 for Distribution Insulation

Clean and Tune Fuel-Fired Boilers

Aligns with SWS [5.0204.1](#)

Repair Diagnosis

Verify proper function and safety of the following system elements:

Thermostat, ignition system, gas valves, venting system, safety devices, electrical wiring, gas piping, burners, low water cutoff, blow-down systems, fuel delivery, distribution system, insulation, gauge glass, temperature and pressure measurement devices, expansion tanks, automatic fill valves, circulator pumps, zone valves, condensate drainage, air vents, combustion air

Service

Perform combustion testing that includes the following: Carbon monoxide, combustion efficiency, gas pressure testing, temperature rise, stack temperature

Adjust combustion as needed to meet BPI 1200 standards for carbon monoxide

Clean the following elements: heat exchangers, burners

Remove combustible/flammable materials from area

Repair or replace additional elements as needed

Purge, verify system pressure, and flush or skim steam boiler

Documentation

Post on equipment, or in a conspicuous location, a list of all systems and components inspected, results, and services performed that includes legible service personnel name, contact information, and date of service

Install a Boiler

Aligns with SWS [5.0203.1](#)

Load Calculation

Perform residential load calculation in accordance with the current version of ANSI/ACCA Manual J (Residential Load Calculation) or equivalent using interior design temperatures of 70 degrees for heating

Perform commercial load calculation in accordance with the current version of ANSI/ACCA Manual N (Commercial Load Calculation) or equivalent using interior design temperatures of 70 degrees for heating

Room by room load calculations will be performed when installing new distribution system components or in retro-commissioning projects

Distribution

See article “Isolate the Combustion Appliance Zone (CAZ)” subsection [Plumbing](#) in A-6

Equipment Selection

Select residential equipment in accordance with the current version of ANSI/ACCA Manual S (Residential Equipment Selection) or equivalent

Select commercial equipment in accordance with the current version of ANSI/ACCA Manual CS (Commercial Applications, Systems and Equipment) or equivalent

Select heating equipment of the lowest capacity required to meet the design heating load and provide the air volume required by any air conditioning equipment installed

Select system that is ENERGY STAR® certified or equivalent

Unit Location and Installation

Locate unit in a dry location and within conditioned space (when feasible) that provides adequate service access according to manufacturer specifications and applicable code

Install unit according to manufacturer specifications and applicable building code (e.g., IRC, IMC, IBC)

Fuel Delivery

Select approved pipe type in accordance with applicable code (e.g., NFPA 54/ANSI/ACCA Z223.1, NFPA 31, IMC) and capable of supporting the total connected load of all appliances.

Locate/route gas piping/train to create the least pressure drop possible and all fuel piping in order to not create a trip hazard and not be damaged by water

Support fuel piping in compliance with applicable code

All piping installations must contain at a minimum: a manual fuel shut off valve, union joint, and a sediment trap for each appliance

If installed, vent all gas pressure regulators requiring venting to outside the building with code-approved rigid pipe. Terminate pipe in a safe location without any thread, coupling, fitting etc. that would allow a plug to be easily fitted

Seal all gas piping in accordance with manufacturer specifications

Install a secondary liquid propane safety detector system (e.g., valve, exhaust fan, alarm light) for propane piping installed below grade

If a gas pressure booster is necessary, confirm compatibility with the gas-fired equipment and check low and high gas pressure switches for proper operation

If a fuel pump is required on oil systems, design it in accordance with manufacturer specifications based on fuel type, distance from tank and equipment size. Install a serviceable

strainer in the pump supply side. Pump must be interlocked with appliance to cut off when appliance is not functioning.

Use connectors and filter fittings for oil systems that approved by applicable code (e.g. NFPA 31, IMC)

Support

Situate equipment on a stable, non-wicking, and fireproof material

Ensure unit is level, stable, secured to ductwork, properly braced to prevent movement (seismic bracing), and elevated as required by applicable building code

Electrical Wiring

Install electrical wiring according to NFPA 70 and provide an electrical disconnect within site of the unit

Install all high voltage wiring inside of protective conduit and approved junction boxes, no wiring connections (high or low voltage) will occur outside of appropriate junction box

Connections

Install equipment connections (e.g., electrical service, drains, fuel, venting) to allow for necessary service and repair access to all portions of the equipment

Documentation

Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information

Multifamily Ventilation Systems

ASHRAE 62.2-2016

Multifamily ventilation system retrofits must comply with ASHRAE 62.2-2016 unless a variance is secured from the Minnesota Department of Commerce

Consultation with Code Officials

Multifamily ventilation system retrofits may require consultation with local codes officials prior to system design and work commencing to ensure project success

Variable Frequency Drives and Electrically Commutated Motors

Aligns with SWS [6.0101.6](#)

Evaluate motors for compatibility with variable frequency drive (VFD)

Analyze load profile and source equipment for use of VFD to provide variable ventilation rates

Replace motor and/or starter per the manufacturer's specifications and in compliance with applicable codes

If using a sensor-controlled strategy, install feedback sensors in accordance with manufacturer specifications at locations that will optimize the chosen control strategy

Install manual controls in accordance with manufacturer specifications at a location easy to access for continued operation

Set VFD and/or ECM parameters to accept feedback from sensors dependent upon chosen control strategy

Optimize system to meet design ventilation rates at the lowest possible speed setting

Install a Dedicated Air Handler for Multiple Dwellings

Aligns with SWS [6.0301.2](#)

Fan Selection

Select a fan that:

- has an electrically commutated motor (ECM) and/or utilizes (VFD) controllers
- can maintain a minimum operating static pressure of .25 inches of water column or greater
- motors 1 horsepower or larger must meet NEMA premium efficiency standards
- motors less than 1 HP must be rated by the Home Ventilation Institute to satisfy these requirements

Intake Location

Install intake to pull air from the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors

Install intake:

- A minimum of 6" from grade
- A minimum of 10' from contaminant sources or exhaust outlets
- Above local snow or flood line
- A minimum of 18" above an asphalt-based roof
- Never on a flat roof

Labeling

Label exterior intake fitting with the words "Ventilation Air Intake"

Pest Exclusion, Motorized Damper and Backdraft Damper

Install corrosion resistant screen, louver, or grille material over exterior intake with a hole size of no less than ¼-inch and no greater than ½-inch in any direction

Install a motorized damper or equivalent between the intake fitting and the return side duct connection

Damper will be open only when the air handler fan is operating

Design one or more supply fans located upstream of all the supply outlets to run continuously OR install a system of one or more backdraft dampers to isolate each dwelling unit from the common duct when the fan is not running

Wiring

Install all electrical wiring according to manufacturer specifications and applicable code

Fresh Air Filtration, Filter Accessibility and Fit

All mechanically-supplied outdoor air must pass through a filter before combining with conditioned air

Filtration must meet a minimum efficiency of MERV 8

Filter or air cleaning systems that intentionally produce ozone are not allowed

Install filtration in a readily accessible location for service

Filter opening must allow filter to be removed fully and inserted without bending or damaging the filter

Filter access panel must include gasket or comparable sealing mechanism and fit snugly against exposed edge of filter when closed

Filter plenum must be airtight and mechanically fastened to adjoining ductwork

Air Handler Mounting, Duct Plenum Connection and Sealing

Mount fan using mechanical fasteners per manufacturer specifications and applicable code (e.g., seismic restraints)

Isolate air handling unit from the building framing unless specifically designed to be attached directly

Attach ductwork to air handler via a flexible connection and that maintains the intended fan opening

Seal all air-moving portions of the system using UL-181 products

Sealing activities must not interfere with the operation of fire dampers, balancing dampers or backdraft dampers

System Control

Provide air flow by sequenced or scheduled operation of the damper or equivalent technology

Control system must operate both the air handler and the motorized damper or be interlocked to prevent damper operation when air handler is not on

Access

Ensure motorized damper, service disconnect switch, fan, filter and conditioning coils are accessible for maintenance according to NEC and applicable building codes

Fire Dampers

If fire dampers are required in the fresh air supply duct, install them according to applicable building code

Fire dampers must be accessible for inspection and/or testing

System Balancing

Adjust fan speed, dampers and registers until design specifications are met

Multiport Exhaust Fan Serving Multiple Dwellings

Aligns with SWS [6.0302.2](#)

Fan Selection

Select a fan that:

- has an electrically commutated motor (ECM) and/or utilizes (VFD) controllers
- can maintain a minimum operating static pressure of .25 inches of water column or greater
- motors 1 horsepower or larger must meet NEMA premium efficiency standards
- motors less than 1 HP must be rated by the Home Ventilation Institute to satisfy these requirements

Termination Location

Terminate exhaust system to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors

Install terminations: a minimum of 3 feet away from any property line; a minimum 3 feet away from operable opening to houses; a minimum of 10 feet away from mechanical intake; and above the snow line

If the termination is at the soffit, seal soffit vents within 6 feet of the termination

Pest Exclusion

Install corrosion resistant screen, louver, or grille material over exterior termination with a hole size of no less than ¼-inch and no greater than ½-inch in any direction

Backdraft Damper

Design one or more exhaust fans located upstream of all the exhaust inlets to run continuously, or install a system of one or more backdraft dampers to isolate each dwelling unit from the common duct when the fan is not running

Wiring

Install all electrical wiring according to manufacturer specifications and applicable code

Fan Mounting

Mount fan using mechanical fasteners per manufacturer specifications and applicable code (e.g., seismic restraints)

Isolate unit from the building framing unless specifically designed to be attached directly

Combining Air Streams

If combining ducts, combine them on the upstream side of fan using “Y”-fittings or collection boxes

Do not combine dryer, kitchen or garage exhausts streams with any other exhaust stream

Sealing

Seal all air moving portions of the system using UL-181 products without interfering with the function of dampers

Access

Ensure fan and service disconnect switch are accessible for maintenance according to NEC, or applicable building code

Fire Dampers

If fire dampers are required in the fresh air supply duct, install them according to applicable building code

Fire dampers must be accessible for inspection and/or testing

Sealing activities must not interfere with the operation of fire dampers, balancing dampers or backdraft dampers

System Balancing

Adjust fan speed, dampers and registers until design specifications are met

Install a Multi-Story Passive System

Aligns with SWS [6.0304.1](#)

Install intake to pull air from the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors

Install intake:

- A minimum of 6 inches from grade
- A minimum of 10 feet from contaminant sources or exhaust outlets
- Above local snow or flood line
- A minimum of 18 inches above an asphalt-based roof
- Never on a flat roof

Install corrosion resistant screen, louver, or grille material over the exterior terminations with a hole size of no less than $\frac{1}{4}$ inch and no greater than $\frac{1}{2}$ inch in any direction

System must contain a backdraft damper between all exterior terminations/intakes that only allows air flow in the desired direction

A system of one or more backdraft dampers shall be installed to isolate each dwelling unit from the common duct when the system is not operating

Intakes/supplies in dwelling units must minimize potential occupant discomfort and/or drafts

Multifamily Lighting Systems

Multifamily lighting retrofits must be Energy Star TM certified or DesignLight Consortium (DLC) certified

Further information is found in [A-3 Baseload Lighting Measures](#)

Multifamily Water Heating Systems

FOR ALL WATER HEATING SYSTEM INSTALLATIONS:

Permanently decommission old equipment. Remove decommissioned controls or labels them as abandoned

Provide occupants/owners with user's manual, warranty information, installation instructions and installer contact information and, when applicable, a clear description/plan of the final configuration of sensors and controls

Verify or Install a Drain Heat Recovery Device

Aligns with SWS [7.0301.3](#)

Verify current plumbing infrastructure is sufficient to support the installation(s)

Choose a location where cold-water draw is concurrent with a warm drain

Ensure vertical drop of drain is sufficient to allow installation of the recovery device

Install drain heat recovery device in accordance with manufacturer specifications (e.g., cold water counter flow)

Plumb the tempered water line (post-drain heat recovery device) as close to the primary fixture as possible (e.g., showerhead); or to fixtures that will have water use concurrent with drain heat recovery (e.g., shower that is supplying the drain water); or to the cold-water intake of the water heater

Install Recirculation System Temperature Modulation Controls

Aligns with SWS [7.0303.6](#)

Verify that existing plumbing and electrical systems are adequate for the new installation

Install sensors and controls in accordance with manufacturer specifications and applicable code (e.g., NFPA 70)

Mount controls on a stable and sturdy surface

When controls are using low voltage, separate the low voltage and line voltage wiring

Install controls, sensors, wiring and other components in a manner that does not expose occupants to hazardous conditions nor poses any unnecessary risk to the integrity of the installation

Clearly identify new controls with labels to identify purpose of control and its associated equipment ("this device controls boiler #2," etc.)

Log existing hot water supply set points

Permanently remove equipment from job site and recycle or dispose of removed equipment and refrigerant in accordance with local and federal law (e.g., EPA Section 608 of Clean Air Act of 1990)

Install a Multifamily Non-Heated Water Storage Tank

Aligns with SWS [7.0302.4](#)

Verify current plumbing infrastructure is sufficient to support the installation(s) and is leak-free

Select a water storage tank that fits in the installation space with required clearances and has an R-value of 12.5 or greater

Install appliance where it:

- Is protected from freezing
- Is accessible for service
- Will maximize efficient operation of the water heating system
- Will minimize distance between tank and primary hot water outlets
- Does not obstruct building egress or access, as required by applicable code (e.g., NFPA 101)

Install water heater in compliance with applicable code (e.g., NFPA 70, IRC, IBC, IMC) and manufacturer specifications

If conflict exists between code and manufacturer specifications, apply the more restrictive requirement

Install storage tank on a housekeeping pad

Provide a level working space not less than 30 inches in length and 30 inches in width in front of the control side of the appliance

Install appliance and plumbing to allow for inspection, maintenance and replacement of the appliance and its components, without disturbing other installed equipment, controls, piping and components, other than what requires repair/replacement

Ensure that anode rod is accessible for replacement

Install a Temperature and Pressure relief valve (T&P) per the IRC and manufacturer specifications (see article '[Install a Temperature and Pressure Relief Valve](#)' in A-4)

Pipe the valve to within 6 inches of the floor or drain pan or to the outdoors and must terminate in an observable location

Select piping material based on IRC requirements

If appliance is installed in or above conditioned space or in a location where water damage could occur, install a drain pan according to the requirements of the IRC

Drain pan to the exterior of the building

Install a separate water cut-off valve for both the hot and cold-water lines and install bypass piping

Install dielectric unions when connecting copper to galvanized steel piping in accordance with the IRC and manufacturer specifications

Install heat traps on the inlet and outlet piping where not provided by manufacturer

Where required, install temperature and pressure gauges on storage tank in an easily visible location

Permanently remove equipment from job site and recycle or dispose of removed equipment and refrigerant in accordance with local and federal law (e.g., EPA Section 608 of Clean Air Act of 1990)

Install a Multifamily Water Heating Systems Pump

Aligns with SWS [7.0303.3](#)

Verify current plumbing infrastructure is sufficient to support the installation(s) and is leak-free

Choose a pump built with materials suitable for potable water (i.e., bronze or stainless steel) and that is certified as lead-free

Install pumps according to manufacturer specifications and applicable code (e.g., IPC, IRC, NFPA 70)

If conflict exists between code and manufacturer specifications, apply the more restrictive requirement

Install and plumb pump to allow for inspection, maintenance and replacement of the pump

Install pumps in accordance with manufacturer specifications with sufficient straight-line piping before and after the pump

Install a water cut-off valve on both sides of the pump

Install a drain spigot in close proximity of the discharge end of the pump

Install pressure gauges to measure suction, discharge and pressure differential

When connecting non-ferrous metal pump to existing ferrous piping, install a dielectric union or a plastic-lined steel nipple a minimum of 4 inches long to connect the two piping systems

Do not insulate pumps

Install or reconnect controls and sensors in accordance with design specifications

When controls use low voltage, separate the low voltage and line voltage wiring

Install all electrical wiring in compliance with NFPA 70 and manufacturer specifications

If conflict exists between code and manufacturer specifications, apply the more restrictive requirement

Install grounding and bonding for pump as required by NEC (NFPA 70)

Permanently remove equipment from job site and recycle or dispose of removed equipment and refrigerant in accordance with local and federal law (e.g., EPA Section 608 of Clean Air Act of 1990)

Multifamily Water Heating Systems Gauges

Aligns with SWS [7.0303.4](#)

Verify current plumbing infrastructure is sufficient to support the installation(s) and is leak-free

Select gauges:

- With an appropriate range for the design specifications
- That can be easily read in the available light conditions

Install gauges:

- According to manufacturer specifications and applicable code (e.g., IPC, IRC, NFPA 70). If conflict exists between code and manufacturer
- To be easily read (e.g., not facing the wall, or so high a ladder or stool is needed to access)
- To not be adversely affected by other equipment through heat conduction
- Install surface-mount thermometers so that thermocouple for digital gauges is tight to the pipe and wrapped with insulation to exclude ambient temperature
- Install wet-mount thermometers so they are not in an air pocket (e.g., install on side of pipe, not on top of side-plumbed tanks)
- Install pressure gauges so they are not adversely affected by turbulent flow and vibration

If conflict exists between code and manufacturer specifications, apply the more restrictive requirement

Install a water cut-off valve on both sides of the gauge

When connecting non-ferrous metal pump to existing ferrous piping, install a dielectric union or a plastic-lined steel nipple a minimum of 4 inches long to connect the two piping systems