



Kansas SWS Field Guide - Supplemental Specifications for Manufactured Housing



Standard Work Specifications

Field Guide for

Manufactured Housing

created by

Kansas Housing Resources Corporation

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2.0105.4e

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Worker will check for presence of combustible gas leaks before work begins

Leaks will be repaired before work is performed

Objective(s):

Protect worker and occupant from exposure to hazards



Unsafe

Fuel leaks need to be repaired



Safe

Repairs need to be tested and verified to no longer leak

Tools:

1. Combustion gas detector
2. Spray bottle

Materials:

1. Noncorrosive leak detection fluid

Paraphrased from 2012 IRC G2417: Leakage will be located using an *approved* combustible gas detector, a noncorrosive leak detection fluid or an equivalent nonflammable solution. Matches, candles, open flames or other methods that could provide a source of ignition cannot be used. Where leakage or other defects are located, the affected portion of the *pipng system* will be repaired or replaced and retested.

2.0105.4e - Combustible gas detection

Measures

Measure 12 Repair - Gas Leak in Crawlspace (flagged)

Comment

#	Material / Labor	Description /Comment	Units
1	Unspecified	Misc Material	Each

Fuel leaks discovered during initial audit should be flagged



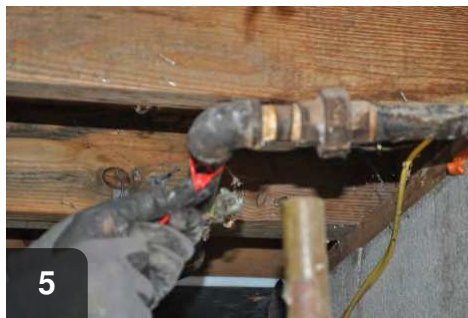
Use approved combustion gas sniffer to see if repaired line still leaks



Repeatedly test repair site for leakage over a 10min period



Allow testing solution to sit on newly repaired pipe joint for 10min



Confirm repair and remove flag

2.0201.2c

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

CO detection or warning equipment will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in accordance with ASHRAE 62.2 and authority having local jurisdiction

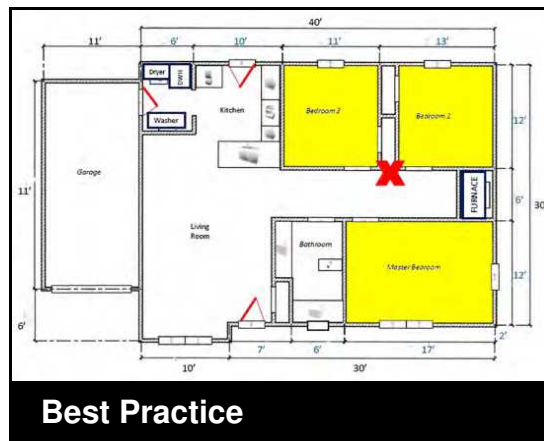
Installation will be accomplished by a licensed electrician when required by local code

Objective(s):

Alert occupant to CO exposure



Carbon Monoxide alarms should be installed according to local codes



Alarms should be mounted near sleeping areas--such as the one marked in red

All manufactured homes, even all electric homes, will receive CO alarms.

2.0201.3e

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

CAZ depressurization testing will be administered on all natural draft equipment

Objective(s):

Measure combined effect of mechanical system fans on combustion zone



Exhaust fans on, Check interior doors, Air handler on?

2.0201.3e - Depressurization test



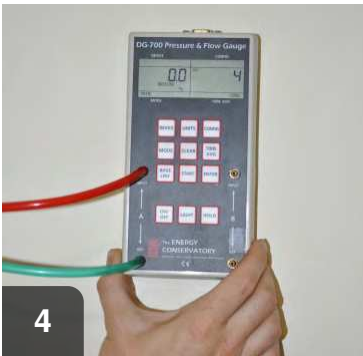
1 Place manometer reference hose to exterior of house



2 Attach test hose to be used in the interior of the house



3 Place test hose by combustion appliance



4 Take baseline reading



5 Turn on interior exhaust fans, including any clothes dryers



6 Is the air handler on?



7 Check interior doors for pressure differential either using smoke pencil or hand



8 Manometer reading should be within allowable limit (See 2.0299.1a-i)



9 If reading is within allowable limit, all is well

2.0201.3g

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

CO will be tested for in undiluted flue gases of combustion appliances

For CO levels exceeding 200 ppm as measured or 400 ppm air-free measurement, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)

If the outlet of the exhaust is accessible, include a CO test on all sealed- combustion and power-vented appliances (without atmospheric chimneys)

Objective(s):

Measure CO and report excessive levels



Unsafe

CO levels cannot exceed 200ppm as measured, unless to manufacturer specs



Best Practice

Test CO levels in undiluted flue gases and exhaust outlets, when accessible

Tools:

1. Combustion analyzer with probe
2. Drill

2.0201.3g - Carbon monoxide (CO) test in appliance vent



CO levels cannot exceed 200ppm, or 400ppm air-free CO



Test undiluted flue gases in induced-draft furnaces



Test undiluted flue gases in natural draft water heaters



Test accessible exhaust outlets for power-vented appliances



Test accessible exhaust outlets for direct-vent appliances

2.0201.3h

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

Final combustion testing will be conducted at project completion to ensure compliance with the above specifications

Objective(s):

Ensure safe operation of combustion appliance within the whole house system after any repair project



Unsafe combustion appliances must be removed, repaired, or replaced before weatherization work



Before leaving retrofit, test new combustion appliances to verify they are working safely

Testing at the conclusion of each day in which envelop or duct sealing measures have been performed is best practice. HVAC work must be completed before air sealing measures to minimize risk. Potential depressurization and drafting issues shall be identified and corrected before air sealing measures

2.0201.3h - Final test out



Complete spillage test using chemical smoke pencil



Complete carbon monoxide testing using a CO detector



Complete draft test using a manometer

2.0202.1a

Desired Outcome:

Elimination of combustion byproducts

Specification(s):

With the occupant's permission, unvented heaters will be removed, except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2

Units that are not being operated in compliance with ANSI Z21.11.2 should be removed before the retrofit but may remain until a replacement heating system is in place

Failure to remove unvented space heaters serving as primary heat sources has the potential to create hazardous conditions, and thus any further weatherization services will be reevaluated in the context of potential indoor air quality risks

Objective(s):

Eliminate sources of combustion byproduct within a living space



Unvented space heaters should be removed with the occupants' permission



Unvented space heaters can be replaced with properly vented space heaters

Refusal by client to remove an unvented heater will result in a deferral.

2.0202.1a - Removal



Secure permission to remove unvented space heaters from occupants



Ensure new combustion appliances are vented properly

2.0203.4b

Desired Outcome:

Sufficient air provided in the Combustion Appliance Zone (CAZ)

Specification(s):

Additional combustion air will be provided in accordance with 2012 IRC G2407 and authority having jurisdiction

Objective(s):

Ensure adequate combustion air for operation of the appliance



🗨️ Before

Combustion appliances in a confined space



👍 After

Additional combustion air supplied from high/low vents

Tools:

1. Drywall saw
2. Drill
3. Tin snips
4. Tape measure
5. Wire cutters

Materials:

1. Metal ducts
2. 1/4" galvanized hardware cloth mesh
3. Galvanized straps or L-brackets to secure high/low vents
4. Screws
5. Louvered grilles (optional)
6. Louvered doors (optional)

Combustion appliances require 50 cubic feet of volume for every 1,000 Btuh input. If this is not available, provide makeup air in accordance with the IRC G.2407 or local code.

When high/low tubes are used, use two metal ducts each having 1 in² of cross-sectional area for every 4,000 Btuh input. Extend each into the attic above the insulation level, and use 1/4" galvanized hardware cloth mesh on top to screen out insects and vermin. Terminate one tube within 12" of the ceiling, and one tube within 12" of the floor. The tubes may be concentric (one inside the other) to

save space, so long as the difference between the area of the larger and smaller tubes is equal to or greater than the 1 in²/4,000 Btuh requirement.

If using a single large opening in the ceiling, make the opening total 1 in² per 3,000 Btuh input.

If high/low vents extend horizontally through a CAZ wall, use vents with 1 in² of area per 2,000 Btuh of input.

Louvered grilles or doors may be used to connect the CAZ to larger sections of the home to achieve the required volume, but be aware that using this approach has higher potential for creating a carbon monoxide pathway into the home than does creating a sealed CAZ with high/low vents.

2.0203.4b - Additional combustion air (if action is required)



1
Select vent sizes based on the total input Btus in the CAZ. Concentric vents are shown



2
Cut hole in ceiling and mount high/low vents to framing



3
Fasten 1/4" galvanized hardware cloth over high/low vent openings



4
Complete installation by adding supports and fasteners as required for stability and durability



5
Terminate the low vent within 12" of the floor. This one is mounted inside a section of larger diameter metal duct

2.0203.4e

Desired Outcome:

Sufficient air provided in the Combustion Appliance Zone (CAZ)

Specification(s):

Occupants will be educated on the operation and maintenance of the CO alarm

Completed work on combustion appliances and recommended maintenance will be reviewed with occupant

Occupant will be provided information regarding the health effects and risks of high CO concentrations

Objective(s):

Ensure occupant can operate and maintain installations

Inform occupant regarding possible CO hazards



Before

Occupants may be unfamiliar with CO alarms and proper operation and maintenance



After

Clear and effective communication with occupants can ensure the proper operation of CO alarms

2.0203.4e - Occupant education



All homes should have CO alarms installed, whether hardwired or battery-operated



Discuss CO risks and proper operation of alarm with occupant



Explain routine maintenance of alarm

2.0204.1d

Desired Outcome:

Isolate combustion water heater closet from conditioned space

Specification(s):

Blower door assisted zonal pressure diagnostics will be used to verify isolation has been achieved

Objective(s):

Prevent combustion gases from entering living area



Before

The reading is closer to 0, indicating strong connection to the inside.



After

The reading is closer to 50, indicating strong connection to the outside.

Tools:

1. blower door assembly
2. manometer
3. 1/4" hose
4. steel tube or probe
5. drill

Water heater CAZs zoned out of the conditioned volume of the home shall be isolated from the conditioned volume to the fullest extent feasible. Removal of the water heater to air seal is not recommended.

2.0204.1d - Post-work testing/verification



Depressurize the house to 50 pascals.



Close the CAZ door or otherwise gain access to the CAZ.



Reading is closer to 50 pascals indicating combustion closet is connected to the outside.

2.0403.4a

Desired Outcome:

Durable, effective ground moisture barrier that provides ongoing access and minimizes ground vapor

Specification(s):

If existing conditions of the ground and skirting mandates, a moisture barrier that covers the crawl space ground will be installed with allowances for structural supports (piers) and accessibility

Objective(s):

Reduce ground moisture entering crawl space

Manufactured housing with an enclosed, unvented area below the belly (typical of permanent foundations) will be treated like enclosed crawlspaces and will have a vapor barrier installed. Manufactured Housing with typical skirting will be considered an open crawlsapce and no vapor barrier is warranted.

2.0602.2d

Desired Outcome:

Prevention of injury to the installer and occupant, and prevent damage to the structure, if required by authority having jurisdiction

Specification(s):

If aluminum wiring is present and there is a concern about the safety of its condition or the proposed work scope has the potential to compromise the safety of the wiring, work on the home will be stopped until the suspect wiring is inspected and determined to be safe by a licensed electrician

After energy retrofit is completed, wiring will be reinspected by a licensed electrician

Objective(s):

Prevent injury to installer and occupant

Prevent damage to structure

A licensed electrician will only be required to inspect aluminum wiring in manufactured homes when there is a safety concern or when the proposed work scope has the potential to negatively impact the condition of the aluminum wiring.

3.1001.4d

Desired Outcome:

Penetrations sealed to prevent air leakage and moisture movement between unconditioned and conditioned space

Specification(s):

Ceiling repair material must meet or exceed strength of existing ceiling material

Ceiling repair must span from truss to truss or add blocking as needed for support

The backing or infill will not bend, sag, or move once installed

All accessible damaged vapor barriers will be repaired

Penetrations through the air barrier must be repaired

Objective(s):

Ensure ceiling is structurally sound

Minimize air leakage

Ensure closure is permanent and supports expected wind and mechanical pressure loads

Ensure sealant does not fall out



 Before

Hole in drywall ceiling



In Progress

Drywall patch in place

Tools:

1. 6-inch and 12-inch drywall taping knives
2. Sanding block or sanding sponge
3. Utility knife
4. Keyhole saw
5. Screw gun

Materials:

1. Drywall or paneling
2. Fiberglass joint tape
3. Joint compound
4. Drywall screws
5. Support material if needed (typically 1X4, 1X6, or 2X4 dimensional lumber)

For holes in paneled ceilings, use matching panels for repairs. Consider replacing entire sections to avoid creating unsightly mismatched patches. For small holes, enlarge to a rectangular shape and install 1 X 4 blocks above two edges of the hole. For larger holes, enlarge opening to centers of nearest trusses and fasten the patch to the framing.

Interior patch work should strive for the highest quality of finished product. Clients shall be informed and agree to the type of patching performed. Sheetrock and lath and plaster holes should be finished to provide a smooth, nearly paint ready surface. Minimal to zero sanding is the desire

3.1001.4d - Ceiling hole repair



1
Replace any missing insulation and repair holes in vapor barrier



2
Prepare the hole by cutting the edges clean and square



3
Cut drywall and fasten in place



4
Add joint tape and first coat of joint compound

3.1101.1c

Desired Outcome:

Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs will maintain structural integrity

Specification(s):

All holes and penetrations on exterior surface of exterior walls will be sealed to ensure resistance to outdoor elements

Intentionally ventilated walls will not be sealed at vent locations (e.g., weep holes)

All holes and penetrations on the interior surface of exterior walls will be repaired

Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration

Objective(s):

Minimize air leakage

Maintain durability

Ensure resulting closure is permanent and supports expected load

Ensure sealant is effective and durable



Exterior penetrations need to be sealed with appropriate materials ensuring an air tight, weather tight seal.



Exterior penetrations have been sealed with appropriate materials ensuring an air tight, weather tight seal.

Tools:

1. caulk gun

Materials:

1. weatherproof caulk

Like material and/or compatible materials should be used for repairs.

3.1101.1c - Exterior wall air sealing



Seams on aluminum siding must be tight.



Through the wall exhaust fan sealing.



Do not seal intentionally ventilated wall assemblies!



Backing or infill substrate may be needed for some wall patches.



Exterior electrical outlet sealing.

3.1101.2c

Desired Outcome:

Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs will maintain structural integrity

Specification(s):

Like material and/or compatible materials will be used for repairs

Materials will be selected to comply with manufactured housing rules and regulations (e.g., Manufactured Housing Institute)

Objective(s):

Select materials to ensure durable and permanent repair



Before

Identify wall material and patch holes with like material, such as drywall or panelling



In Progress

Patch has been cut from drywall the same thickness as existing wall material

Tools:

1. Utility knife
2. Drill
3. Saw
4. Tape measure
5. Taping knife

Materials:

1. Drywall
2. Panelling
3. Fasteners
4. Wood for support
5. Spackle

3.1101.3b

Desired Outcome:

Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs to maintain structural integrity

Specification(s):

All accessible holes and penetrations in top and bottom plates will be sealed

Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration

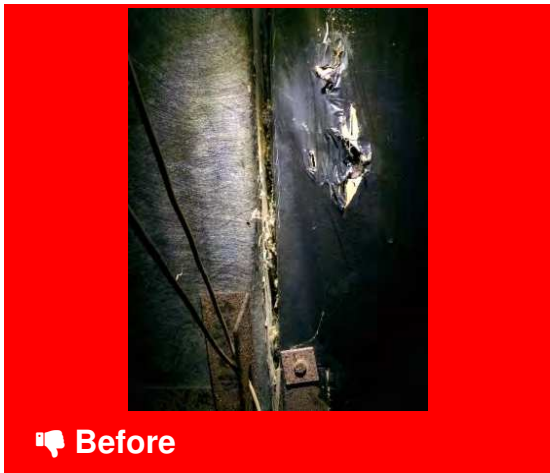
Objective(s):

Minimize air leakage

Maintain durability

Ensure resulting closure is permanent and supports expected wind and mechanical pressure loads

Ensure sealant is effective and durable



Cobwebs may indicate air leaks at the marriage line



Completed air sealing at marriage line

Tools:

1. Caulking gun
2. Reusable spray foam gun

Materials:

1. Extruded polystyrene ((XPS) foam board
2. Caulk
3. Spray foam
4. Foam backer rod or fiberglass batt insulation

3.1101.3b - Marriage wall air sealing of holes and penetrations



1 Clean belly wrap before air sealing



2 Stuff wide gaps in the marriage line with fiberglass insulation or foam backer rod before applying sealant



3 Apply foam or caulking over backer

3.1101.3c

Desired Outcome:

Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs to maintain structural integrity

Specification(s):

All accessible holes and penetrations at marriage lines will be sealed continuously at end walls, floors, and ceiling

Backing or infill will be provided at the marriage line as needed

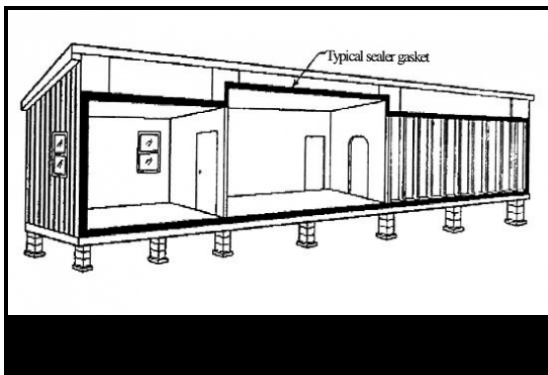
All remaining gaps will be sealed with an approved material

Objective(s):

Minimize air leakage

Maintain durability

Ensure sealant is effective and durable



Identify leaks in marriage line using a blower door

Tools:

1. Reusable spray foam gun
2. Caulking gun
3. Utility knife
4. Screw gun
5. Blower door
6. Chemical smoke dispenser

Materials:

1. Caulk
2. Spray foam
3. Foam board
4. Screws

3.1101.3c - Marriage line air sealing



Identify leaks in marriage line using a blower door and smoke



Foam, caulk, and seal leaks between halves of double wide manufactured homes

3.1201.6c

Desired Outcome:

Minimize air infiltration through existing leaky windows while maintaining safe egress for occupants

Specification(s):

Operable interior storm windows will be installed in accordance with manufacturer specifications

Objective(s):

Minimize air leakage

Provide safe egress for occupants



No interior storm window has been installed.



Storm window has been installed according to manufacturer specifications and operates smoothly.

Tools:

1. drill

Materials:

1. mechanical fasteners
2. weatherstripping

Interior Storm Windows must be audit approved

3.1201.6c - Installing operable storm window



1
Ensure the perimeter surfaces are clean and ready to accept sealant.



2
Install weatherstrip or other appropriate sealant to the perimeter of the opening.



3
Install the window, ensuring it is level in the opening.



4
Secure the window to the opening, being sure the mechanical fasteners compress the desired sealant.



5
Storm window has been installed according to manufacturers specifications and operates smoothly.

3.1201.6d

Desired Outcome:

Minimize air infiltration through existing leaky windows while maintaining safe egress for occupants

Specification(s):

Interior storm windows will be operable and egress rated in egress locations

Objective(s):

Provide safe egress for occupants



Only operable storm windows conforming to HUD standards may be installed in egress (bedroom) windows

Storm windows installed in egress (bedroom) windows must be operable or removable, and conform to the following standard: Voluntary Standard Egress Window Systems for Utilization in Manufactured Housing, AAMA 1704-85

3.1202.3e

Desired Outcome:

Glass complete and intact

Specification(s):

Replacement glass will be sized to original width, height, and depth

Stops will be replaced or installed

Glass will be sealed in accordance with original installation design

Glass will be selected with comparable tint and coating (color and look)

Tempered or safety glass will be used as required by local code

Objective(s):

Install, seal, and secure new glass in place



Sash should be completely clear debris before installing new glass



Replacement glass should match previous tint and dimensions, and be tempered, if location requires it

Tools:

1. Caulk gun
2. Tape measure

Materials:

1. New glass, measured to fit, tempered if necessary
2. Glazing or replacement stops
3. Adhesive sealant
4. Window cleaner

3.1202.3e - New glass installation



1
Measure sash for width of replacement glass -- cut glass to 1/4" less than sash width



2
Measure sash for height of replacement glass -- cut glass to 1/4" less than sash height



3
Apply sealant to sash with bead at least 3/16" wide



4
Run sealant bead around entire sash to seal glass from the interior



5
Install new glass, ensuring 1/8" gap from frame on all sides



6
Apply glazing or install replacement stops to seal window from exterior



7
Clean glass to ensure than no out of place adhesive or glazing remains to bake onto glass

3.1301.1d

Desired Outcome:

Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space

Specification(s):

Combustion air supplies will be labeled for identification and will not be blocked or sealed

Penetrations will be sealed to meet both the specific characteristics of the bottom board material and the characteristics (hole size and type) of the penetrations (e.g., electrical, PVC, gas line, dryer vent)

The patch will not bend, sag, or move once installed

Objective(s):

Ensure combustion equipment is not compromised

Minimize air leakage around penetrations



Before

Unsealed penetration through bottom board



After

Properly sealed penetration through manufactured home bottom board

Tools:

1. Outward clinching (stitch) stapler
2. Utility knife
3. Cordless driver/drill
4. Reusable foam gun
5. Caulking gun
6. Nail gun

Materials:

1. Belly/bottom board fabric
2. Belly/bottom board repair tape
3. Staples
4. Screws
5. Foam board
6. 1X2 nailers
7. Spray foam sealant
8. High quality exterior caulk

3.1301.1d - Bottom board penetrations



Label combustion air inlets with the words, "DO NOT SEAL"



Seal around penetrations with compatible materials like foam board, belly board, house wrap, or Flex Mend (tm)

3.1601.5b

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

Specification(s):

Ducts will be fastened with a minimum of three equally spaced screws

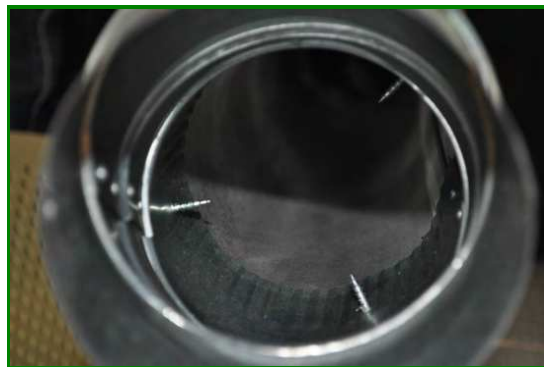
Objective(s):

Ensure durable joints



 Before

Reconnect ducts that have come undone, using fasteners to strengthen connection



 After

At minimum, use three fasteners evenly spaced

Tools:

1. Drill

Materials:

1. Fasteners

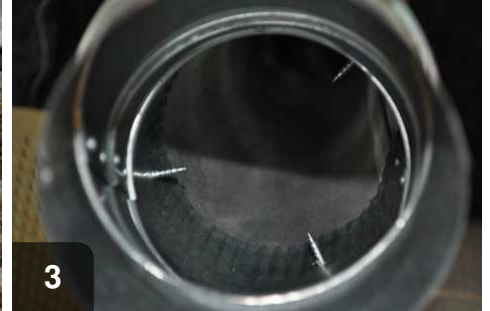
3.1601.5b - Metal to metal



1
Realign and join ducts to create a smooth transition



2
Use fasteners to hold duct together and prevent future dislocation



3
Attach ducts using a minimum of three, evenly-spaced fasteners

3.1601.5c

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

Specification(s):

Joints will be fastened with tie bands using a tie band tensioning tool

For oval flexible duct to metal connections, tie bands cannot be used; appropriate mechanical fastener will be used

All connections, regardless of fastener, will be sealed

Objective(s):

Ensure durable joints



Disconnected ducts are useless and need to be reconnect and securely fastened



Flexible duct should be securely fastened to metal ducting to prevent future dislocation and minimize leakage

Tools:

1. Band tensioner
2. Brush

Materials:

1. Tie bands
2. Mastic or other appropriate sealant

3.1601.5c - Flex to metal



1 Apply mastic to flange



2 Slide inner liner onto flange with sealant



3 Using band tensioner, securely attach liner in place with tie band



4 Slide insulation and outer casing over metal ducting



5 Extend insulation and casing until in contact with other insulation



6 Secure insulation and casing in place using tie band and band tensioner

3.1601.5e

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

Specification(s):

Metal take-off collar specifically designed for the thickness of the duct board will be used

All finger tabs will be bent down securely

Finger tabs will be longer than the thickness of the duct board and the shank will not extend beyond the thickness of the duct board

There will be an internal metal backer inside the duct board through which three evenly spaced screws can be secured; the metal backer will not interfere with air flow

Objective(s):

Ensure durable joints

Prevent the collar from moving into or out of the duct board or slipping



Bad Practice

Flex duct improperly attached to duct board.
No starting collar is installed.



Best Practice

Flex duct, starting collar, and backer ring installed and sealed to duct board

Tools:

1. Cordless driver/drill
2. 1/4" nut driver bit
3. Disposable brushes
4. Tin snips
5. Utility knife
6. Zip tie tensioning tool

Materials:

1. Galvanized metal backer rings
2. Tabbed starting collars
3. Rubber gloves
4. Zip ties
5. Duct sealing mastic
6. Fiberglass mesh tape

Make sure to use a starting collar that is made for the thickness of the duct board you are using. R-6 duct board is 1-1/2" thick. The correct starting collar would therefore have 1-1/2" of solid metal between the shoulder that fits against the outside of the duct board and the base of the tabs.

You may need to cut a slot in the duct board to slide the backer ring through. Use at least three equally spaced screws to fasten the starting collar to the backer ring.

3.1601.5e - Duct board to flexible duct



1 Gather materials



2 Place backer ring inside duct board. Insert collar and bend tabs into place.



3 Fasten the collar to the backer ring by driving at least three equally spaced screws through the collar, duct board



4 Coat joint between starting collar and duct board with mastic. Liberally coat the metal collar where flex attaches



5 Slide flex duct liner over mastic-coated metal collar



6 Secure with properly tensioned zip tie.



7 Coat seam with mastic



8 Pull insulation over duct liner and secure with a zip tie.

3.1601.5f

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

Specification(s):

Flange/c-channel will be fastened with screws with the duct board installed between c-channel flanges

Duct board plenum will be connected to air handler plenum with flexible duct in upflow units

Objective(s):

Ensure durable joints



Best Practice

Duct board plenum fastened with C-channel and screws

Tools:

1. Screw gun
2. Tin snips
3. Utility knife
4. Tape measure
5. Square

Materials:

1. Fiberglass duct board
2. C-channel (same width as duct board)
3. Sheet metal screws longer than the duct board thickness
4. Foil tape (for assembling duct board)
5. Mastic
6. Mesh tape (for gaps larger than 1/4")
7. Flex duct
8. Zip ties
9. Starting collar
10. Backing ring (fits inside duct board and fastens to starting collar)

3.1601.5g

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

Specification(s):

Predrill for screws or use ring shanked nails to fasten boot to wood

Objective(s):

Ensure durable joints



Unattached ducts are useless



Damaged ducts should be repaired and securely fastened and sealed

Tools:

1. Drill
2. Hammer

Materials:

1. Metal screws
2. Ring-shank nails

3.1601.5g - Boot to wood



1 Replace damaged ducting if necessary



2 Use ring-shank nails to hold ducting in place to subfloor



3 Drill pilot holes for metal fasteners



4 Use metal fasteners to secure duct to subfloor



5 After securely fastened, duct should be sealed with mesh and mastic

3.1601.5h

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

Specification(s):

If accessible, boot hanger will be fastened to adjacent framing with screws or nails

Boot will be connected to boot hanger with screws

If inaccessible, boot will be fastened to gypsum with a durable, adhesive sealant

Objective(s):

Ensure durable joints



Register boot fastened to framing and sealed to gypsum with spray foam

Tools:

1. Caulking gun or foam gun
2. Cordless driver/drill

Materials:

1. Polyurethane caulk
2. Mastic and mesh tape (for gaps larger than 1/4")
3. Screws
4. Fiberglass mesh tape (for gaps larger than 1/4")
5. Disposable brushes
6. Spray foam sealant

Fasten boot hangers to adjacent framing, or screw through the boot into adjacent framing. Polyurethane caulk is a durable adhesive, and can accommodate up to 50% expansion and

contraction. Mastic and mesh tape also form a strong, permanent seal. Spray foam may be used to seal boots into the opening once the boot is fastened in place

3.1601.5h - Boot to gypsum



Remove diffuser



Caulk the boot to the gypsum board. Angle the tip forward and force caulk into the joint



Wipe the caulk into the joint and smooth it as you go



Wipe away excess caulk (use water on siliconized acrylic, alcohol on silicone, and solvent on polyurethane caulk)

3.1601.5i

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

Specification(s):

Metal take-off collar with a lip and an internal metal backer will be used

Take-offs will be in accordance code requirements

Objective(s):

Ensure durable joints



Bad Practice

Improper attachment of flex to duct board



After

Flex duct correctly installed and sealed to duct board

3.1601.5i - Duct board to flex



Select a backer ring and flex duct installation tools



Cut the proper size hole in duct board



Select starting collar with tabs matching the thickness of the duct board



Insert the starting collar, bend tabs over and install at least 3 screws through the collar, duct board, and backer ring



Starting collar with tabs bent over and screws through the duct board and backer ring



Apply mastic liberally and install flex duct

3.1602.8b

Desired Outcome:

Deliver all air from air handler to the trunk duct without leakage or restriction

Specification(s):

Debris will be removed

Surface will be prepared for work (e.g., remove tape, oil)

Floor will be prepared to receive the appropriately sized plenum

Objective(s):

Provide unobstructed path for work access and air flow

Ensure adhesion of materials to be installed

Provide a properly sized plenum to maximize distribution of air flow (equal to the furnace discharge)



Closet prepared for furnace installation

Tools:

1. Shop vac
2. Scraper
3. Bench duster
4. Dust pan

Materials:

1. Rags

3.1602.8b - Preparation



Dust walls and floor of cabinet. Sweep debris into piles for pickup. Wipe down walls and floor



Vacuum cabinet clean



Inspect plenum for damage, then clean, scrape, and seal



Scrape loose material from insides of cabinet



Apply mastic to inside seams of plenum

3.1602.8c

Desired Outcome:

Deliver all air from air handler to the trunk duct without leakage or restriction

Specification(s):

Plenum will be rebuilt or repaired using compatible materials and will be:

- Mechanically fastened
- Sealed
- Durable
- Structurally sound
- Insulated
- Equipped with a vapor retarder where climate appropriate

If possible, flow diverter or turning vanes will be installed for air flow and/or balancing (e.g., bullhead Ts, offset air handler)

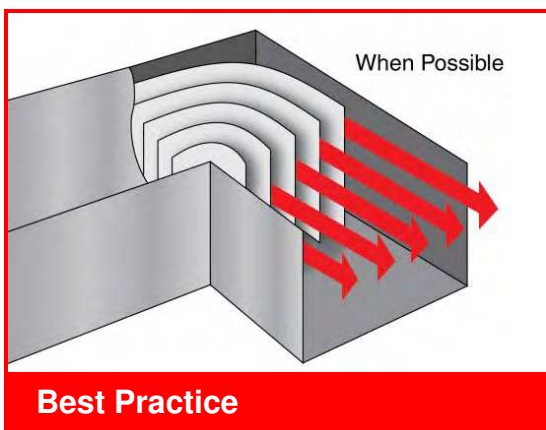
Objective(s):

Minimize restrictions

Maximize air flow and air distribution

Minimize moisture issues

Prevent condensation on plenum



Whenever possible, install turning vanes in plenums to reduce turbulence and improve airflow



Rebuilding and sealing a leaky existing plenum

Materials:

1. Starting collars and flanges
2. Zip ties
3. Mastic duct sealant
4. Fiberglass mesh tape
5. Sheet metal screws
6. Turning vanes
7. Duct board

IF the plenum is significantly damaged or leaky, it should be repaired or rebuilt to these specifications.

Using turning vanes reduces turbulence and increases air flow. Use mastic and mesh tape on the outside of duct board plenums. Properly install metal starting collars to duct board and flex duct to metal collars (see spec 3.1601.5e for detail)

3.1602.8d

Desired Outcome:

Deliver all air from air handler to the trunk duct without leakage or restriction

Specification(s):

Point of access options include:

Option 1: Through the trunk duct

- Repair and seal access hole in the trunk duct
- Install insulation
- Repair belly/bottom liner

Option 2: Remove crossover duct

- Reattach crossover duct
- Seal and insulate crossover duct
- Repair belly/bottom liner

Option 3: Remove air handler

- Install new gasket, if necessary
- Mechanically attach furnace to the structure
- Reconnect utilities
- Replace and seal panels

Option 4: Through the furnace panel

- Replace and seal panels

Objective(s):

Repair work access

Prevent condensation

Minimize heat loss and heat gain from plenum



Various methods can be employed, but the key is to seal the furnace to trunk duct connection

Tools:

1. Utility knife
2. Saw
3. Prybar
4. Screw gun
5. Hammer
6. Drill
7. Saw
8. Disposable brushes

Materials:

1. Belly repair tape
2. Mastic duct sealant
3. Fiberglass mesh tape
4. Insulation
5. Air handler gasket

Choose the least invasive and labor-intensive method that will allow full access for sealing.

Always wear hand protection when working with sharp objects.

3.1602.8d - Repair work access



Cut belly to expose duct trunk. Use a utility knife to cut access under furnace plenum



Create an opening large enough to completely seal the plenum to the trunk line



Using mastic and mesh tape, fully seal the furnace to the trunk line. Repair and seal the access holes in duct and belly



Removing the crossover duct may provide access to the plenum. Replace and seal the crossover duct after sealing plenum



Remove the furnace panel. If the plenum to trunk connection is accessible here, complete sealing from this point



Plenum to duct trunk connection coated with mastic sealant

3.1602.9a

Desired Outcome:

Deliver all air from trunk to trunk without leakage or restriction

Specification(s):

Installer prework assessment will be conducted to determine:

- Location
- Types
- Leakage points

Objective(s):

Verify scope of work



Locate the best access and egress points



Locate crossover duct and determine what type of system will work best for home

3.1602.9b

Desired Outcome:

Deliver all air from trunk to trunk without leakage or restriction

Specification(s):

Flexible crossover duct connections will be added, rebuilt, or repaired using compatible materials and will be:

- Mechanically fastened at both inner and outer liner
- Sealed using UL-listed sealant that is durable, structurally sound, insulated
- Equipped with a vapor retarder

Whenever possible, rigid elbow or equivalent will be installed in crawl space crossover ducts

Floor insulation will be in contact with the outer liner of the crossover duct

Crossover duct vapor retarder will be sealed to the bottom liner (e.g., belly fabric)

New flex duct installation will be insulated to a minimum of R-8

When feasible, 26-gauge hard duct should be installed

If a new crossover is required, it must be insulated to at least R-8 and be air sealed

Objective(s):

Ensure lasting durable connections

Minimize air leakage and heat transfer

Maintain duct diameter around the turns

Maximize air flow and distribution



 Before

Unattached ducts are useless



 After

Crossover ducts should be attached securely, sealed to reduce leakage, and insulated to R-8

Tools:

1. Band tensioner
2. Drill
3. Brush

Materials:

1. Tie bands
2. Mastic or other appropriate sealant
3. 26 gauge elbow duct
4. R-8 insulated flexible duct with vapor retarder

3.1602.9b - Flexible crossover duct connections



1 Attach elbow duct and orient in correct direction to minimize duct run



2 Fasten elbow in place with at least three evenly-spaced fasteners



3 Apply mastic at metal-to-metal connection



4 Apply mastic to all elbow joints and flange



5 Slide inner liner onto flange with sealant



6 Fasten inner inner with tie band using band tensioner



7 Extend insulation and exterior casing up over elbow until they reach belly



8 Secure insulation and outer casing place with tie band



9 Use band tensioner to ensure that insulation and casing remain tight against belly

3.1602.9c

Desired Outcome:

Deliver all air from trunk to trunk without leakage or restriction

Specification(s):

Crossover ducts will be installed so they are not in contact with the ground

Crossover ducts will be supported in accordance with flex duct manufacturer specifications, local codes

Support materials will be applied in accordance with manufacturer specifications for interior dimensions and will not crimp ductwork, dip, or sag

Objective(s):

Maximize air flow and distribution

Minimize condensation

Minimize air leakage and heat transfer



 Before

Flexible ducting should not come in contact with ground



 After

Supports should be evenly spaced, securely fastened to floor joists and should not compress or kink duct

Tools:

1. Drill
2. Utility knife

Materials:

1. Fabric straps
2. Fasteners

3.1602.9h

Desired Outcome:

Deliver all air from trunk to trunk without leakage or restriction

Specification(s):

Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and results will be documented and reported to the homeowner and/or program

Objective(s):

Document post-retrofit duct leakage test has been performed



Best Practice

Test duct performance using pressure pan or duct blaster, before and after work



Best Practice

Record readings before and after to determine improvement in performance

Tools:

1. Blower door
2. Manometer
3. Pressure Pan

Using a pressure pan, measure and record the pre and post duct leakage. With the HVAC system off, use a blower door to depressurize the home to -50 pascals. Measure and record all pressures for duct boots where accessible. Sealed ducts should read near 0 pascals. Completely disconnected ducts will read closer to -50 pascals. Determine leakage area and feasibility to minimize duct leakage

3.1602.9h - Performance testing



Set-up blower door to perform pressure pan testing. Depressurize to -50 pascals



Perform pressure pan test on ductwork before beginning work. Record result



Perform pressure pan test after work is completed and compare to 'before' reading



Record readings before and after to determine if performance has improved

3.1602.10b

Desired Outcome:

Deliver air from trunk to termination (register/diffuser) without leakage

Specification(s):

Excess flex duct will be removed between the takeoff at trunk and floor register boot

Objective(s):

Improve air flow



 Before

This duct is far too long, resulting in poor airflow.



 After

The duct has been shortened, and is now properly supported.

3.1602.10c

Desired Outcome:

Deliver air from trunk to termination (register/diffuser) without leakage

Specification(s):

Hard and flex duct branch connections will be rebuilt or repaired using compatible materials and will be mechanically fastened and sealed

Ends will be sealed

Objective(s):

Ensure lasting durable connections

Minimize air leakage

Maximize air flow and distribution



Here the worker is rebuilding a hard connection to the trunk line.



The duct has been sealed, ensuring proper airflow to the home.

Tools:

1. drill
2. tin snips
3. inspection mirror
4. utility knife

Materials:

1. metal boot material
2. mesh tape
3. mastic
4. replacement grille

3.1602.10c - Duct connection repairs



Measure the dimensions required for the new boot.



Fit the new boot on to the trunk line.



Seal the boot to the trunk line using mastic and mesh tape. An inspection mirror can make this easier.



Mechanically fasten the boot to the subfloor.



Install a new grille on the rebuilt boot.

3.1602.10d

Desired Outcome:

Deliver air from trunk to termination (register/diffuser) without leakage

Specification(s):

Access hole in the trunk/branch duct will be repaired and sealed

Insulation will be reinstalled

Bottom liner/belly will be repaired

Objective(s):

Repair work access

Minimize heat transfer



Access hole cut into manufactured home branch duct



Repaired, insulated, and sealed access hole in manufactured home duct and belly

Tools:

1. Utility knife
2. Disposable brushes
3. Outward clinching stapler
4. Scissors

Materials:

1. Fiberglass mesh tape
2. Mastic duct sealant
3. Foil tape
4. Insulation
5. Belly repair tape
6. Belly wrap
7. Staples
8. Solvent (acetone, paint thinner, denatured alcohol, Goof-Off, or similar) to clean aluminum duct
9. Spray adhesive for belly repairs

3.1602.10d - Repair work access



1
Thoroughly clean duct with solvent before applying foil tape and mastic



2
Secure edges of repair with foil tape and then liberally coat with mastic



3
Overlap foil tape with mastic by at least one inch on all sides



4
Replace or reinstall fiberglass belly insulation



5
Apply belly repair tape and fasten with outward clinching (stitch) staples. Spray adhesive will help adhere the tape

3.1602.11a

Desired Outcome:

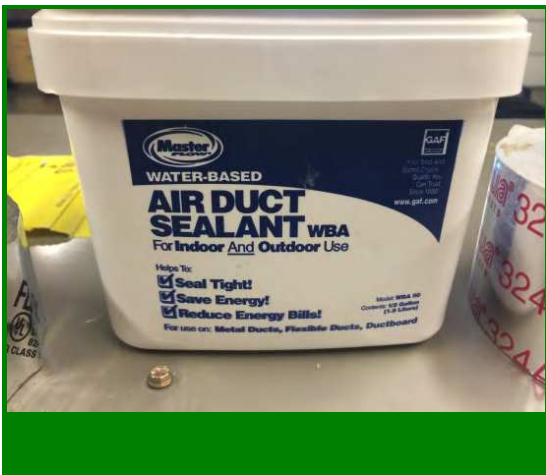
Ducts and plenums sealed to prevent leakage

Specification(s):

Any closure system used will meet or exceed applicable standards

Objective(s):

Ensure effectiveness of air sealing system



Mastic sealant is an approved, durable, and effective sealant

Tools:

1. Utility knife
2. Disposable brushes

Materials:

1. UL 181 B-FX tape (cover with mastic after assembly)
2. Fiberglass mesh tape (use, along with mastic, to cover gaps wider than 1/4-inch and to add strength to assemblies)
3. Mastic (air duct sealant) labeled UL 181 B-M
4. Spray polyurethane foam

Per the 2012 IRC, use tape labeled 181 B-FX and/or mastic labeled 181 BM. Seal and mechanically fasten all duct connections to metal flanges. Fasten round metal ducts with at least three screws equally spaced around the diameter, and make sure that the ducts and fittings are inserted at least 1". DO NOT USE unlisted duct tape as a sealant on any duct.

Exceptions:

1. Where a duct connection is made that is partially inaccessible, three screws or rivets shall be equally spaced on the exposed portion of the joint so as to prevent a hinge effect.
2. Continuously welded and locking-type longitudinal joints and seams in ducts operating at static pressures less than 2 inches of water column (500 Pa) pressure classification shall not require additional closure systems. "

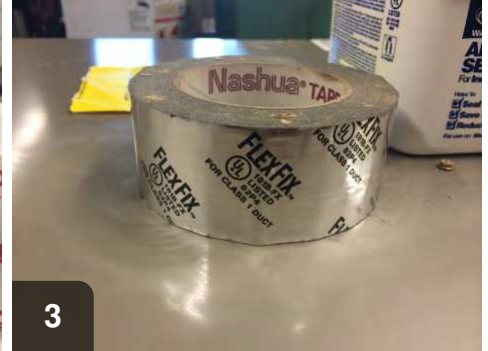
3.1602.11a - New component to new component sealant selection



Use fiberglass mesh tape to cover gaps; coat with at least 2mm of mastic



Coat seams with mastic (air duct sealant) conforming to standard UL 181 B-M



Use tape to assemble joints, then coat with at least 2mm of mastic

3.1602.11b

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

Duct surface to receive sealant will be cleaned

Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using fiberglass mesh and mastic

Mastic alone will be acceptable for holes less than ¼" that are more than 10' from air handler

Holes greater than ¾" will be patched with metal or joint will be rebuilt to reduce the gap size

Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages:

- They will be backed using temporary tape (e.g., foil tape) as a support before sealing
- They will be sealed using fiberglass mesh and mastic

Objective(s):

Eliminate air leakage into or out of ducts and plenums

Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct

Reinforce seal

Support mastic and fiberglass mesh during curing



Unsealed metal ductwork



Mastic and mesh tape used to seal metal ductwork

Tools:

1. Zip tie tensioning tool
2. Utility knife
3. Disposable brushes
4. Tin snips
5. Screw gun

Materials:

1. Mastic
2. Fiberglass mesh tape
3. Metal starting collar
4. Foil tape
5. Sheet metal

3.1602.11b - New component to existing component



1 Fasten collar into plenum with screws that reach through the tabs and plenum into a backing ring. Apply mastic liberally



2 Apply mastic to metal collar



3 Install duct liner onto collar and secure with properly tensioned zip tie



4 Apply additional mastic over zip tie and edge of flex duct liner

3.1602.11c

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

Duct surface to receive sealant will be cleaned

Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides

Seams, cracks, joints, holes, and penetrations larger than $\frac{3}{4}$ " will be repaired using rigid duct material

Fiberglass mesh and mastic will overlap repair joint by at least 1" on all sides

Fiberglass mesh and mastic will be the primary seal

Objective(s):

Eliminate air leakage into or out of ducts and plenums

Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct

Reinforce seal

Support mastic and fiberglass mesh during curing



 Before

Unsealed joints and connections need to be sealed to stop air leaks, improve durability, and minimize health risks



 After

Sealed ductwork connections help prevent leakage

Tools:

1. Brush

Materials:

1. Mastic
2. Fiberglass mesh tape

3.1602.11c - Existing component to existing component



1 Prepare work area by assessing any safety concerns and cleaning duct surface



2 Wrap joint with fiberglass mesh tape



3 Apply UL 181 mastic to seal joint

3.1701.1h

Desired Outcome:

The exterior of the seam is weathertight and connection between house and addition is properly sealed to minimize air leakage and moisture movement between unconditioned and conditioned space

Specification(s):

Floor repair material will meet or exceed strength of existing floor material

Repair will span from joist to joist and blocking added as needed to support floor

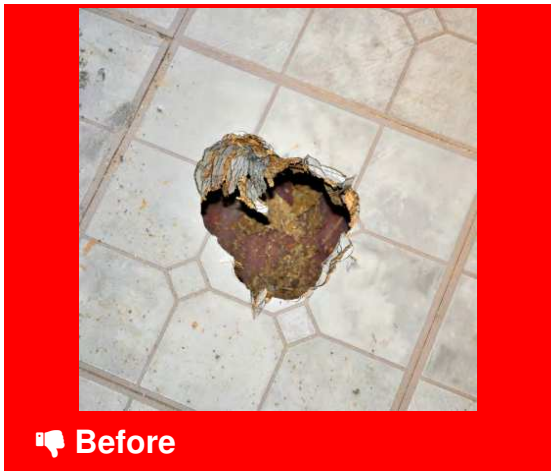
Patches smaller than 144 square inches will not require repairs from joist to joist

Floor repair material will be glued, fastened, and air sealed

Objective(s):

Ensure floor is structurally sound

Minimize air leakage



Holes in the floor should be repaired



Completed floor patches should be air sealed to prevent leakage from belly

Tools:

1. Saw
2. Tape measure
3. Caulk gun
4. Marker
5. Utility knife
6. Drill

Materials:

1. Plywood or other suitable subflooring material
2. Fasteners
3. Caulk
4. Sealant

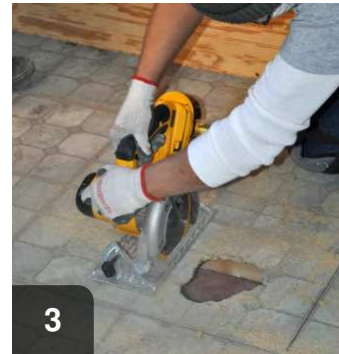
3.1701.1h - Floor repair



1 When possible, measure patch to reach surrounding joist. If not, blocking will be required.



2 Mark damaged area to be removed to create most efficient patch



3 Cut out damaged area of floor, with minimal damage to surrounding floor and joists



4 Once damaged area has been removed, measure for new patch and cut replacement subflooring to size



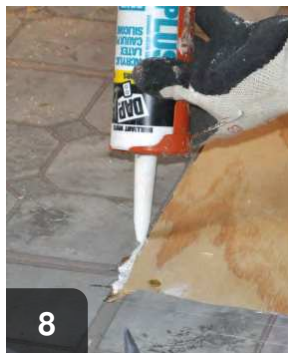
5 Clean debris from surrounding area and mounting surfaces



6 Apply sealant to mounting surfaces



7 Securely fasten new subfloor in place, attaching to joist or blocking as necessary



8 Seal gaps around patched in subfloor to create air seal between conditioned living space and crawl space

4.1003.10b

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

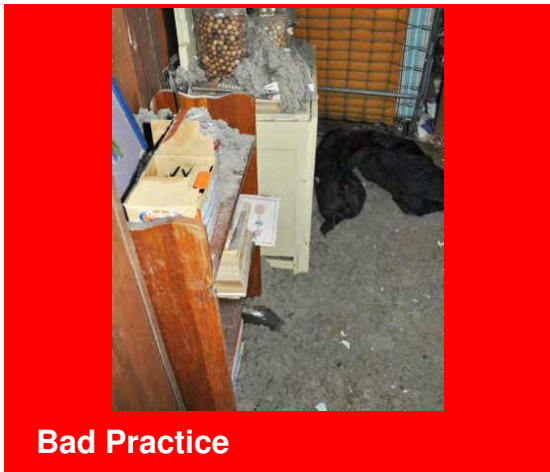
Specification(s):

Special precautions will be taken to limit fiberglass and construction dust exposure to the occupant and occupant belongings

Objective(s):

Protect occupant health and safety

Protect occupant belongings



Improperly prepared workspace with cellulose all over client belongings and bedroom



Worker has removed or covered occupant belongings. Be sure to ask permission before removing any client belongings

Tools:

1. Utility knife

Materials:

1. Plastic sheeting
2. Removable, low-residue tape

4.1003.10c

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

Equidistant holes will be drilled in a straight row parallel to the longitudinal exterior wall of the ceiling

If a longitudinal ceiling trim piece exists, trim piece will be removed and holes will be drilled behind the trim

Hole location and size will be placed to provide access to allow for consistent and uniform coverage of installed insulation throughout the attic assembly

There will be, at a minimum, one hole between each roof truss

Holes will be large enough to accommodate the chosen fill tube without damaging the ceiling material during installation

If a vapor barrier or ceiling-mounted insulation is present, access will be gained through them

Attic will be visually inspected for the location of existing insulation, obstructions, hazards, and construction type

Objective(s):

Create access to the full attic cavity

Determine insulation installation technique

Prevent damage to ceiling

Create a professionally finished ceiling



In Progress

Holes are drilled in such a fashion that they allow uniform coverage of attic insulation.

Tools:

1. holesaw bit
2. drill
3. borescope
4. camera



In Progress

Hole is the proper size in relation to the fill tube.

Materials:

1. protective plastic

Plastic plugs will be allowed for manufactured homes with written client permission

4.1003.10e

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot

Using fill tube, 100% of each cavity will be filled to a consistent density

Fill tube will be inserted within 6" of the end of each attic cavity

Insulation will be installed into the void of the attic cavity:

- If existing insulation is roof-mounted, insulation will be blown below
- If existing insulation is ceiling-mounted, insulation will be blown above
- If existing insulation is mounted at both locations, insulation will be blown in between

Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84

Objective(s):

Fill entire attic cavity to the prescribed R-value to reduce air infiltration

Avoid clogging of the cavity and the fill tube

Prevent damage to the ceiling

Fire safety will be maintained



Attic insulation should be consistently installed in each cavity to the edge.

Clarification: fill tube will be able to reach within 6 inches of the end of each cavity when inserted. Blown fiberglass will be used as the allowed insulation for manufactured housing.

4.1003.10e - Fiberglass blown insulation installation



1
If insulation is roof mounted, blow below it.



2
If insulation is ceiling mounted, blow above it.



3
If insulation is mounted at both the ceiling and the roof, blow between it.

4.1003.10f

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

Holes will be plugged or covered and sealed to be aesthetically pleasing

If existing trim was removed, it will be reinstalled

Objective(s):

Create an airtight seal

Create a visually acceptable ceiling finish



In Progress

Holes should be effectively sealed, as well as aesthetically pleasing.

Tools:

1. color matched plug

Materials:

1. color matched plug

Plastic plugs will be allowed for manufactured homes with written client permission.

4.1003.10g

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process

Objective(s):

Verify the integrity of the house has been maintained



In Progress

Verify that no damage has been done by the workers. When in doubt, verify with photo documentation.



Best Practice

Document and repair any damage the workers caused.

4.1303.1a

Desired Outcome:

Consistent thermal boundary between conditioned and unconditioned space that reduces heat flow

Specification(s):

Insulation will be installed in accordance with recommended R-value and density

Objective(s):

Insulate to prescribed R-value for the climate zone

Zone	Floor
1	R13
2	R13-R19
3	R19-R25
4 to 8	R25-R30

R-value should be determined by climate zone, and be listed in work order

Area de recubrimiento pa aplicaciones de
Peso neto por

Thermal Resistance R-value Resistencia al flujo calórico Valor R	Cavity Depth/ Installed Thickness inches Espesor instalado/ Espacio de la cavidad Pulgadas	Minimum Installed Density lbs/ft ³ Densidad mínima instalada libras/p ³
13	3.5	1.0
20	5.5	
14	3.5	1.4
22	5.5	
15	3.5	1.8
23	5.5	

* BBS = Blow-In Blanket® System; Sistema de Manto de Fibra de Vidrio al Soplo

Best Practice

Consult density chart on insulation packaging to determine proper insulation application to achieve prescribed R-value

Install insulation per audited approved work order instructions. Outriggers should be filled full with appropriate density to avoid settling. Bellies should be filled full with appropriate density to avoid excessive weight. Bellies are typically not dense packed and minimal settling is acceptable.

4.1303.1e

Desired Outcome:

Consistent thermal boundary between conditioned and unconditioned space that reduces heat flow

Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
- R-value
- Installed thickness and minimum settled thickness
- Number of bags installed in accordance with manufacturer specifications

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

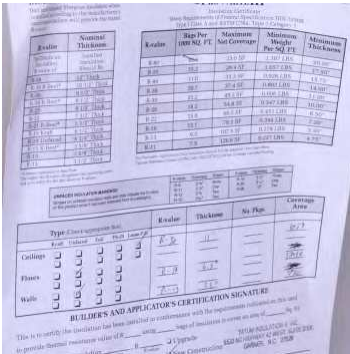
Comply with 16 CFR 460.17



Best Practice

Provide occupant with signed, dated receipt documenting information about insulation installed

4.1303.1e - Occupant education



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation



Communicate professionally with occupant to provide information and support

4.1303.2c

Desired Outcome:

Consistent thermal boundary between conditioned and unconditioned space that reduces heat flow

Specification(s):

Each cavity will be insulated to specified R-value and density

If insulation has facing, facing will be in contact with the heated side

Insulation will be in contact with subfloor

Insulation will not have gaps, voids, or be compressed

Insulation will be supported (e.g., metal insulation supports) to maintain a permanent contact with subfloor

Insulation will be notched around all wires, pipes, and blocks

Ducts and water lines will be insulated for climate conditions

Water lines will be located above the warm side of the insulation (toward the conditioned space), when feasible

A rigid air barrier will be installed in contact with the bottom of the joists, when feasible

Rigid air barrier will be fastened as to not sag, bend, or fall off

Seams, holes, and joints in the air barrier will be sealed

In cases where HVAC ducts hang below the level of the rigid air barrier and insulation, the ducts will be insulated and air barrier provided that is sealed to the rigid air barrier

Objective(s):

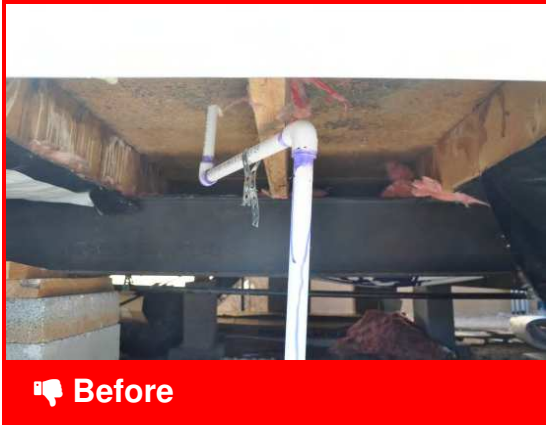
Eliminate voids

Minimize conductive heat transfer across the floor system

Ensure durability

Minimize convective heat transfer

Keep pipes from freezing



Uninsulated floors over unconditioned spaces are an energy drain



In addition to fiberglass batt insulation, a rigid air barrier will be sealed and mechanically fastened in place

Tools:

1. Utility knife
2. Tape measure
3. Metal snips
4. Drill
5. Caulk gun

Materials:

1. Fiberglass batts, may be kraft-faced
2. Metal tape
3. Insulation supports (lightning rods)
4. Fasteners
5. Caulk
6. Duct insulation

Blown fiberglass is the preferred insulation material for manufactured homes. Cellulose will not be installed. Belly repair and blow in fiberglass is option #1. Use the steps shown here as option #2 if the floor is completely accessible and open and it makes sense to use batt insulation.

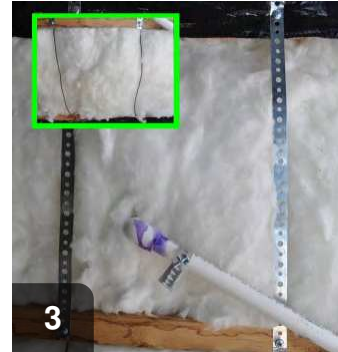
4.1303.2c - Insulate floors



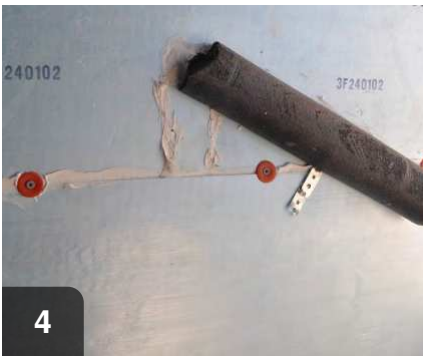
1 If fiberglass insulation is kraft-faced, ensure kraft is in contact with subfloor



2 Notch insulation around pipes, blocks, and other obstructions



3 To prevent insulation from moving away from subfloor, supports should be fastened in place



4 A rigid air barrier should be securely in place so prevent sagging, gaps and penetrations should be sealed



5 When ductwork or water pipes run below joists, insulation should be threaded above to fill joist cavity, uncompressed



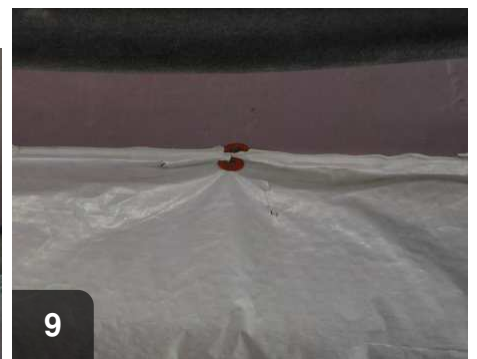
6 Water lines and ducts should be insulated if running below joists



7 A rigid air barrier should be mechanically fastened to hold it tight against the floor joists



8 When insulating around low-hanging ducts and water pipes, run a line of sealant before placing insulation



9 Insulation around ducting should be securely fastened and sealed to maintain air barrier

4.1303.2d

Desired Outcome:

Consistent thermal boundary between conditioned and unconditioned space that reduces heat flow

Specification(s):

Insulation materials will be of minimal water absorbency and flame spread, and smoke-developed index for insulation will be in accordance with 2012 IRC 2012, Sections R302.10.1 through R302.10.5

Foam plastic insulation will comply with 2012 IRC 2012, Section R316

Fasteners will be corrosion resistant

Objective(s):

Ensure durability

Prevent moisture damage



Bad Practice

Do not use absorbent insulation material, such as cellulose, in the floor cavity



Best Practice

Fiberglass batts are a good choice for insulating floor cavities

Materials:

1. XPS insulation board
2. Fiberglass batts
3. Corrosion resistant exterior screws

Use blown fiberglass only in manufactured homes.

4.1303.2d - Materials



XPS insulation board is a non-absorbent insulation option



XPS (extruded polystyrene) is safe for use in floor cavities



Do not use EPS (expanded polystyrene) foam board in floor cavities due to flame spread rate



Use only corrosion resistant, exterior screws as fasteners in floor cavities

4.1488.1b

Desired Outcome:

Water supply line does not freeze in cold climates

Specification(s):

Pipe freeze protection system will have thermostatic heat control and circuit protection

Insulation will be installed over pipe freeze protection system when necessary

Pipe will be protected from wind

Objective(s):

Ensure fire safety

Protect supply pipe from freezing



In Progress

Properly installed freeze protection heat tape



After

Insulated, freeze protected water line

Tools:

1. Utility knife
2. Rags

Materials:

1. Heat tape
2. Zip ties (to attach thermostat)
3. Electrical tape
4. 1/2" thick fiberglass insulation

If heat tape is needed, it will be installed this way. There is no requirement to install heat tape on existing waterlines and condensate lines.

To prevent pipe freezing and reduce the risk of fire, follow manufacturer's instructions carefully. Choose the proper length heat tape for the pipe to be protected. When using multiple lengths of heat tape on long pipes, start subsequent runs of heat tape one foot before the end of the previous run on

opposite sides of the pipe. Never overlap or cross heat tape with itself. Complete heat tape installation instructions may be found here: <https://www.foremost.com/mygreathome/mobile-home-repair/seasonal/how-to-install-heat-tape.asp>

Educate occupants on efficient and safe operation and maintenance of heat tape.

4.1488.1b - Installation



1
Install thermostat in firm contact with the pipe at the coldest point



2
Fasten heat tape to pipe with electrical tape every six inches.



3
Measure and cut insulation to fit water lines. Miter insulation at elbows and tees



4
Fasten insulation to water lines with zip ties



5
Cover all exposed portions of the water supply lines with insulation

4.1601.4h

Desired Outcome:

Lower conductive heat transfer by ducts and decrease condensation on duct vapor barrier

Specification(s):

All accessible joints, seams, and connections will be sealed with UL 181 approved mastics

Objective(s):

Minimize duct leakage



In Progress

Here the technician is inspecting work in progress, ensuring a good seal.



After

The duct boot has been properly sealed, even though the area is difficult to reach.

Tools:

1. inspection mirror

Materials:

1. mastic
2. duct boot

4.1601.4i

Desired Outcome:

Lower conductive heat transfer by ducts and decrease condensation on duct vapor barrier

Specification(s):

All metal fittings, including boots, elbows, and takeoffs, will be insulated separately using a minimum of R-8 duct wrap with a vapor barrier mechanically fastened (e.g., stitch staples, tie bands) and sealed with no exposed metal

Objective(s):

Minimize thermal conductance of the duct system

Minimize condensation



This elbow has been sealed, but is not insulated.



Fitting has been sealed and properly insulated.

4.1601.4j

Desired Outcome:

Lower conductive heat transfer by ducts and decrease condensation on duct vapor barrier

Specification(s):

Vapor barrier of all duct insulation will be taped to the flex duct using the taping system required by the manufacturer of the duct insulation

Vapor barrier will be sealed to the belly liner

Objective(s):

Ensure a complete vapor barrier



Crossover duct with vapor barrier mended and sealed to manufactured home belly

Tools:

1. Reusable spray foam gun
2. Utility knife
3. Scissors
4. Outward clinching (stitch) stapler

Materials:

1. UL-181 B-M foil or Mylar tape
2. Foam sealant
3. Staples

Clean vapor barrier thoroughly before applying UL 181B Mylar tape to cuts and seams. Repair belly if necessary, and use foam sealant to seal the vapor barrier to the belly.

5.3003.5a

Desired Outcome:

Refrigerant lines properly installed

Specification(s):

All liquid refrigerant lines will be insulated to a minimum of R-4

Vapor or high side lines will not be insulated unless specified by the equipment's manufacturer

Suction lines will be insulated to a minimum of R-4

For mixed humid, hot humid, and marine climates, heating and cooling refrigerant lines will be insulated

Objective(s):

Ensure refrigerant lines do not gain excessive heat

Prevent energy loss and condensation



Best Practice

Refrigerant line set should be insulated to an R-4 to maintain performance

5.3003.5b

Desired Outcome:

Refrigerant lines properly installed

Specification(s):

If exposed to sunlight, refrigerant line insulation will be protected from UV degradation in accordance with manufacturer specifications, 2012 IRC N1103.3.1, or local code

Objective(s):

Install insulation so it does not degrade



Bad Practice

Line set insulation is exposed to direct sunlight and is severely degraded.



Best Practice

Line set insulation is protected with integrated UV protection. Tapes and other sealants may be required.

Use rubberized pipe insulation for exterior conditions. Regular foam insulation not to be used.

5.3003.14e

Desired Outcome:

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

Specification(s):

CO in the undiluted flue gas will be less than 200 ppm as measured or 400 ppm air-free measurement (unless CO measurement is within manufacturer specifications)

Objective(s):

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable



Best Practice

CO levels should be less than 200 ppm to ensure safe operation

5.3003.14f

Desired Outcome:

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

Specification(s):

All testing and inspection holes will be sealed with manufacturer approved materials

Objective(s):

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable



The testing hole was left unsealed.



The hole in both walls has been properly sealed with a plug, cap, or other approved method.

Materials:

1. high temperature sealant
2. stainless steel plug or cap
3. stainless 5/16" bolt

Foil tape will be allowed on single wall pipe.

5.3003.14f - Testing/inspection holes



Apply high temperature sealant to the bolt, so that both holes will be sealed.



Screw the bolt into place, ensuring a proper seal on both pipes.



If sealing each wall individually, insert the plug into each hole.



Apply high temperature sealant to the perimeter of the plug.

6.6003.5c

Desired Outcome:

Contaminants properly removed from house

Specification(s):

Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards

Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief

Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety



Pressure should be measured in the CAZ to verify combustion appliances operate safely.

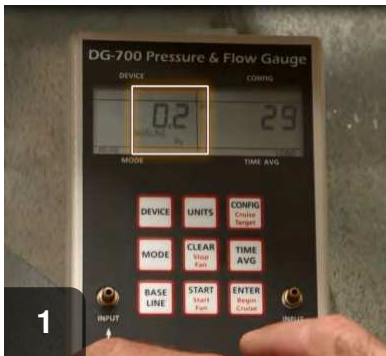


If depressurization in the CAZ exceeds acceptable limits, return air pathways or make up air may be needed.

Tools:

1. Manometer
2. Static pressure probe
3. 1/4" hoses
4. Smoke pencil
5. Combustion analyzer

6.6003.5c - Combustion safety



1 Set the house to natural conditions. With the manometer measuring CAZ WRT outside, perform the baseline procedure.



2 Turn on all exhausting appliances(vented outdoors), including the dryer, kitchen fan, and bath fans.



3 Close all doors. With your back to the CAZ, smoke doors with fans behind them. Smoke in:open door, smoke out:close it.



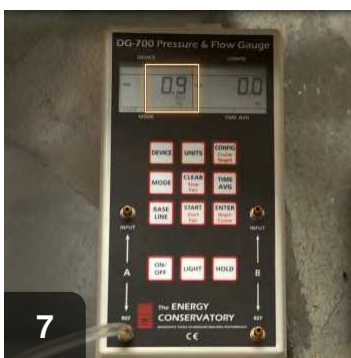
4 Measure CAZ pressure with the door open and record the reading. Close the door and record the reading



5 Turn on the air handler fan



6 Recheck all door positions for worst case depressurization. Smoke hits your toes, leave the door closed.



7 Measure CAZ pressure with the door open then closed. Record the readings. Recreate the WCD, or the most negative seen.



8 Fire the unit and check draft pressure using the manometer or combustion analyzer



9 Measure flue gases at steady state and record readings. Turn off the unit being tested per manufacturers instructions.

6.6205.1c

Desired Outcome:

Provide primary ventilation for common spaces

Specification(s):

No resistance greater than 3 pascals will exist between fan intake location with reference to the common area

Exhaust ventilation for common spaces will not be installed in bedrooms

Objective(s):

Ensure fresh air distribution to common areas



Tools:

1. digital manometer

The installation of whole house continuous exhaust ventilation in bathrooms will be allowed where it makes sense to do so and where excessive pressure differences don't result. Client's will be educated on the need to keep bathroom doors open when not in use where continuous ventilation has been installed.

6.6205.1c - Location



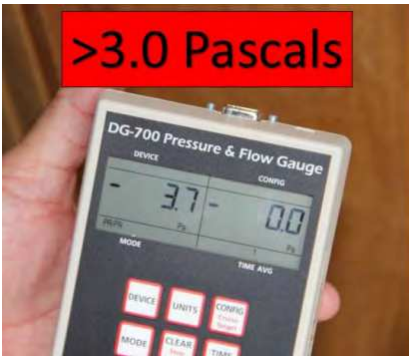
Locate the fan in question.



Connect a hose, and turn the manometer on to PR/PR.



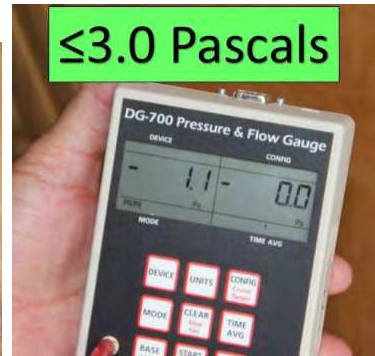
Turn on the exhaust fan.



If the pressure difference is greater than 3.0 pascals, pressure relief is needed.



If pressure relief is needed, it can be provided by a through the door transfer grille.



After pressure relief has been provided recheck the numbers, ensuring a reading within range.

6.6205.1f

Desired Outcome:

Provide primary ventilation for common spaces

Specification(s):

Occupant will be educated on:

- Purpose of the ventilation system
- Proper operation and use of controls
- Cost and benefit of system
- Manual shut off

A label indicating the presence and purpose of the ventilation system will be included or a copy of the system operation guide will be posted at the electrical panel

Operation guide or label will be permanently attached and in full sight

Objective(s):

Ensure occupant is educated on the safe and efficient operation of the system

Deliver intended air exchange



Clients should be educated on the purpose and operation of their new ventilation system.



Whole house ventilation should be clearly labeled.

7.8102.2e

Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

Specification(s):

A potable water expansion tank will be installed on the cold water side of newly installed water heaters when required by local code.

A direct connection with no valves between the storage tank and expansion tank will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications

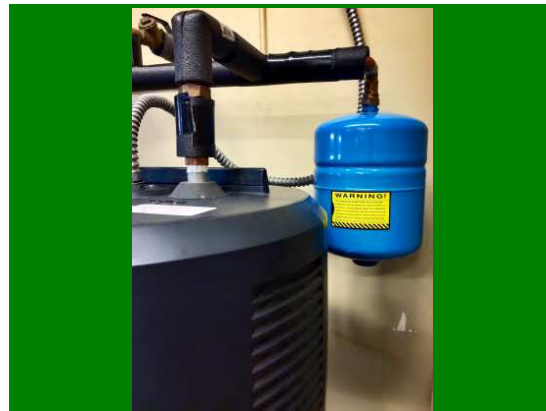
Objective(s):

Protect the storage tank from expansion



Bad Practice

Need to eliminate the valves between the storage tank and expansion tank



Best Practice

Expansion tank is installed on the cold water supply side

Appropriate licensing for installer required. Expansion tanks are only required to be installed only when in conjunction with weatherization installed replacement water heaters where required by code.

7.8102.2i

Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

Specification(s):

If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications

If additional insulation is installed, it will be installed based on fuel type, making sure not to obstruct draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates

The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications

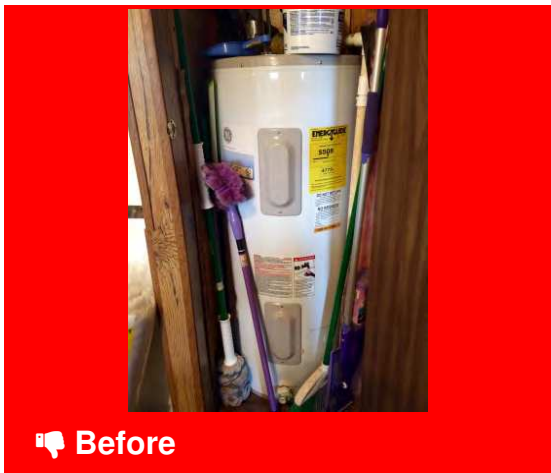
Pipe insulation must remain 3" from gas water heater vent

Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer

Objective(s):

Reduce standby loss from near tank piping and storage tank

Ensure insulation does not make contact with flue gas venting



 Before

Uninsulated storage-type water heater



 After

Storage-type water heater with additional insulation

Tools:

1. Outward clinching (stitch) stapler
2. Utility knife
3. Scissors
4. Straight edge

Materials:

1. R-11 tank wrap
2. Vinyl tape
3. Staples
4. Rags or terry-cloth towels
5. Foam pipe insulation

Check warning labels on tanks. Not all water heaters may be insulated. Leave the tops of gas water heaters uninsulated, and be sure to keep combustion chamber access panels and combustion air holes uncovered. Cut out around thermostats on electric units. Use staples or zip ties to mechanically fasten insulation in place. Do not rely on tape alone to hold the tank wrap. Maintain proper clearance from gas appliance vents to combustibles.

7.8102.2i - Thermal efficiency



1 Clean the entire outside of the water heater



2 Wrap blanket around tank and mark it where it overlaps. Add two or three inches and cut off using a straightedge and raz



3 Cut the insulation off at the mark. Peel away the excess insulation, leaving a flap of vapor barrier



4 Pull insulation blanket around the tank



5 Staple the flap to the blanket with outward clinching staples or use long zip ties to secure the blanket in place



6 Cut out around drain valve, P&T relief valve, and thermostats. Do not cover combustion access or air supply on gas units



7 Use remaining insulation for the top of electric water heaters. Tape up seams in the vapor barrier. Insulate water lines

7.8102.3d

Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

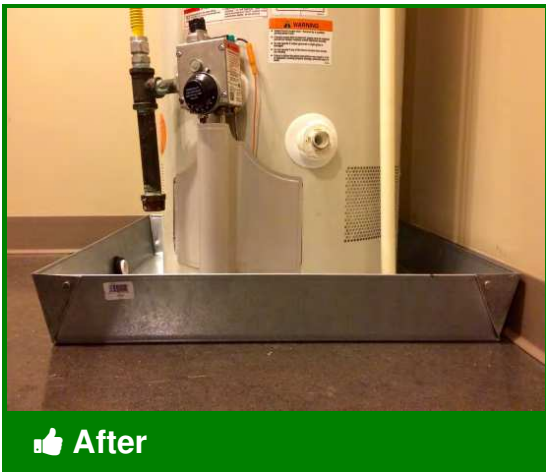
Specification(s):

An emergency drain pan will be installed with sides that extend a minimum of 4" above floor if leakage would cause damage to the home and in accordance with P2801.5 of the 2012 IRC

A ¾" drain line or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 IRC

Objective(s):

Collect and safely dispose of water escaping from the storage tank



Emergency drain pan with drain piped to outside

Tools:

1. PVC cutters
2. Tongue-and-groove pliers

Materials:

1. 4" deep drain pan
2. ¾" or 1" PVC drain fittings and pipe
3. PVC cement

Pans are necessary on new installs IF leakage would cause damage to the home. Pans are necessary and shall be installed on all new water heaters in manufactured homes.

7.8102.3h

Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

Specification(s):

Any accessible hot water lines at the appliance will be insulated to meet 2012 IRC N1103.4.2 or local requirements, whichever is greater

Objective(s):

Reduce line losses



Insulate accessible pipes to R-3 or better

Materials:

1. Foam pipe insulation
2. Spray adhesive
3. Zip ties

Hot water pipe insulation requirements are found in Chapter 11 of the International Residential Code, Section N1103.4.2 (R403.4.2). The code calls for a minimum of R-3. As a best practice, R-4 and R-5 pipe insulation is available through mechanical and industrial suppliers. Typical Foam pipe insulation R-values:

3/8" equals R-2 (NOT ALLOWED).

1/2" equals R-3.

5/8" equals R-4.

Maintain proper clearances from the water heater vent when installing foam pipe insulation.

