



Retrofitting Virginia - Single Family



Standard Work Specifications

Field Guide for

Single-Family Homes

created by

**Virginia Department of Housing and
Community Development**



Approved Variances - (Spec #/Approved Language)

2.0111.3a - Virginia WAP will ensure that debris in basements and crawlspaces that will cause injury or damage to the ground cover will be removed within reason.

2.0301.1a - Smoke alarms will be listed and labeled in accordance with UL 217 and be installed in accordance with the 2012 Virginia Uniform Statewide Building Code (VUSBC).

5.3001.1a, 5.3101.1a, 5.3101.1b, 5.3101.2a -Load Calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011(Residential Load Calculation) OR Weatherization Assistant v.8(or later) coupled with manufacturer specifications.

7.8103.1d - Virginia WAP proposes to address expansion tanks when DHW warrants replacement and/or the unit requires an expansion tank where local code requires.

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2.0100.1a

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Design will be incorporated to eliminate or minimize hazards (e.g., material selection, access to equipment for installation and maintenance, placement of equipment, ductwork and condensate lines)

Objective(s):

Prevent worker injuries

Reduce risk exposure to toxic substances and physical hazards

2.0100.1b

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Durable and wrist-protecting gloves will be worn that can withstand work activity

Objective(s):

Minimize skin contact with contaminants

Protect hands from sharp objects



Unsafe

Recognize potential risks



Safe

Wear appropriate hand protection

2.0100.1b - Hand protection



GOOD: Wear nitrile gloves when handling mastic



Inspect gloves for holes and damage to minimize risk

2.0100.1c

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

If the risk of airborne contaminants cannot be prevented, proper respiratory protection will be provided and worn (e.g., N-95 or equivalent face mask)

When applying low pressure 2-component spray polyurethane foam, air purifying masks with an organic vapor cartridge and P-100 particulate filter will be used

When applying high-pressure SPF insulation, supplied air respirators (SARs) will be used

Consult MSDSs for respiratory protection requirements

Objective(s):

Minimize exposure to airborne contaminants (e.g., insulation materials, mold spores, feces, bacteria, chemicals)



Unsafe

Workers need to properly protect their airways when retrofitting



Best Practice

Respiratory protection should be appropriate to the task being performed.

2.0100.1c - Respiratory protection



Whenever airborne contaminants are a possibility, wear an N-95 mask



For two-component spray insulation, P-100 respirators should be used



All P-100s should be fitted to the individual worker



When working with high-pressure spray foam, use a Supplied Air Respirator



When unsure what level of protection is necessary, check the MSDS

2.0100.1d

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

An electrical safety assessment will be performed

All electric tools will be protected by ground-fault circuit interrupters (GFCI)

Three-wire type extension cords will be used with portable electric tools

Worn or frayed electrical cords will not be used

Water sources (e.g., condensate pans) and electrical sources will be kept separate

Metal ladders will be avoided

Special precautions will be taken if knob and tube wiring is present

Aluminum foil products will be kept away from live wires

For arc flash hazards, NFPA 70E will be consulted

Objective(s):

Avoid electrical shock and arc flash hazards



Inspect house for unsafe electrical situations



Attics and crawl spaces and walls should be inspected closely for electrical safety before work begins

If probing a wall cavity, a non conductive material will be used.

2.0100.1d - Electrical safety



Use GFCIs and three-wire extension cords for all power tools



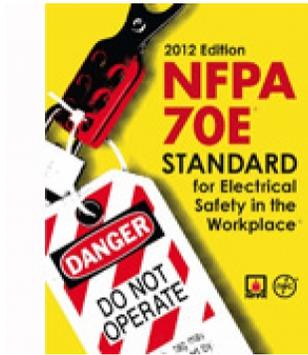
Electrical wiring should not be located near a water source



Use fiberglass ladders in place of metal



Recognize if knob and tube wiring is present and take special precautions



Follow NFPA 70E 2012 guidelines for arc flash hazards

2.0100.1e

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

All homes will have a carbon monoxide alarm

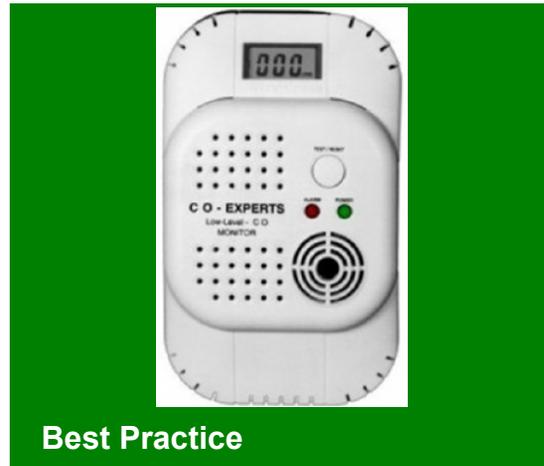
Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)

Objective(s):

Protect worker and occupant health



STOP WORK if CO levels are higher than 35ppm!!



Install carbon monoxide alarms

Tools:

1. CO meter

2.0100.1f

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

MSDSs and OSHA regulations will be consulted for protective clothing and equipment

Eye protection will always be worn (e.g., safety glasses, goggles if not using full-face respirator)

Objective(s):

Protect worker from skin contact with contaminants

Minimize spread of contaminants



 Before

Workers should be aware of work required and dress appropriately



 After

Ensure workers have proper protective equipment for work environment

2.0100.1g

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Access and egress points will be located before beginning work

Inspection will be conducted for frayed electrical wires

Adequate ventilation will be provided

Use of toxic material will be reduced

Objective(s):

Prevent build-up of toxic or flammable contaminants

Provide adequate access and egress points

Prevent electrical shock



👍 After

Locate all access and egress points of confined spaces before entering

2.0100.1g - Confined space safety



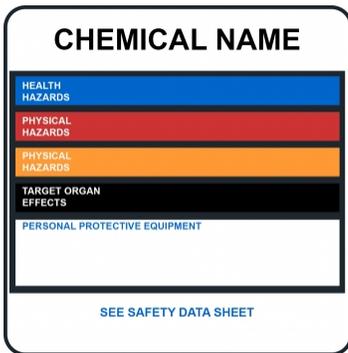
Perform visual inspection of confined spaces before beginning work



Check for frayed or worn electrical wires



In confined spaces, use a ventilator



Check GHS labels and Safety Data Sheets for all materials to minimize hazards

2.0100.1h

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Power tools will be inspected and used in accordance with manufacturer specifications and OSHA regulations to eliminate hazards such as those associated with missing ground prongs, ungrounded circuits, misuse of power tools, noise, and improper or defective cords or extension cords

All devices used will be verified as GFCI protected or double insulated

Exhaust gases from compressors and generators will be prevented from entering interior space

Objective(s):

Prevent power tool injuries

2.0100.1i

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Hazardous materials will be handled in accordance with manufacturer specifications or MSDS standards to eliminate hazards associated with volatile organic compounds (VOCs), sealants, insulation, contaminated drywall, dust, foams, asbestos, lead, mercury, and fibers

Appropriate personal protective equipment (PPE) will be provided

Workers will be trained on how to use PPE

Workers will be expected to always use appropriate PPE during work

Objective(s):

Prevent worker exposure to toxic substances

2.0100.1j

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Appropriate PPE will be used (e.g., knee pads, bump caps, additional padding)

Proper equipment will be used for work

Proper lifting techniques will be used

Objective(s):

Prevent injuries from awkward postures, repetitive motions, and improper lifting



Unsafe

Workers will take precautions to protect themselves on the job site



Best Practice

Hard hats, knee pads, bump caps, and team lifts help to prevent injury

2.0100.1k

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Hand tools will be used for intended purpose

Objective(s):

Prevent hand tool injuries

2.0100.11

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Caution will be used around power cords, hoses, tarps, and plastic sheeting

Precautions will be taken when ladders are used, when working at heights, or when balancing on joists

Walk boards will be used when practical

Appropriate footwear and clothing will be worn

Objective(s):

Prevent injuries due to slips, trips, and falls

2.0100.1m

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided

911 will be dialed when necessary

Objective(s):

Prevent heat stroke, heat stress, and cold stress related injuries



Attics and crawl spaces can be dangerous work places in the heat



Keep workers comfortable with hydration and cool vests

2.0100.1n

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply)

Use of flammable material will be reduced and fire-rated materials will be used

Objective(s):

Prevent a fire hazard

2.0100.1o

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Assess potential asbestos hazard; if unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material and to sample and test as needed

If suspected ACM is in good condition, do not disturb

If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s)

For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair in accordance with federal, state, and local requirements; only a licensed or trained professional may abate, repair, or remove ACM

When working around ACM, do not:

- Dust, sweep, or vacuum ACM debris
- Saw, sand, scrape, or drill holes in the material
- Use abrasive pads or brushes to strip materials

Asbestos abatement or repair work should be completed prior to blower door testing; exercise appropriate caution when conducting blower door testing where friable asbestos or vermiculite attic insulation is present to avoid drawing asbestos fibers into the living space (i.e., use positively pressurized blower door testing) unless the material has been tested and found not to contain asbestos

Objective(s):

Protect workers and occupants from potential asbestos hazards

Siding—removal of siding is allowed to perform energy conservation measures. All precautions must be taken not to damage siding.

Asbestos siding should never be cut or drilled. Recommended, where possible, to insulate through home interior.

Pipe insulation—encapsulation is allowed if performed by an Asbestos Hazard Emergency Response Act (AHERA) professional and should be conducted prior to blower door testing.

Where Asbestos (friable) is identified or assumed, the use of a blower door is prohibited.

Proof of professional abatement/removal must be presented prior to continuation of WX services if a ACM-based deferral has previously taken place.

2.0100.1p

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise

The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

Objective(s):

Protect workers and occupants from potential lead hazards

Testing is an allowable and should be done in accordance with the EPA RRP training. Job site set up and cleaning verification is required by a Certified Renovator. Abatement is not allowed.

2.0104.1b

Desired Outcome:

Work is completed safely without injury or hazardous exposure

Specification(s):

OSHA asbestos abatement protocol 29 CFR 1926.1101 will be followed if vermiculite insulation is present

If unsure whether material contains asbestos, a qualified asbestos professional will be contacted to assess the material and to sample and test as needed

When working around asbestos-containing material (ACM), the following will not be done:

- Dust, sweep, or vacuum debris
- Saw, sand, scrape, or drill holes in the material
- Use abrasive pads or brushes to strip materials

Attic insulation that looks like vermiculite (as opposed to fiberglass, cellulose, or urethane foams) will not be removed or disturbed

Objective(s):

Protect workers from toxic exposure



Material identified as vermiculite may contain asbestos



If asbestos is suspected, call an EPA-accredited professional

Where Asbestos (friable) is identified or assumed, the use of a blower door is prohibited.

2.0104.1b - Vermiculite



Do not disturb vermiculite by vacuuming, dusting, or sweeping



Do not disturb vermiculite by drilling, sanding, scraping, sawing, etc.

2.0105.1b

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)

Objective(s):

Protect worker and occupant health



STOP WORK if CO levels measure above 35ppm!!



Install carbon monoxide alarm if none are found.

Tools:

1. CO meter

2.0105.1c

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Raw fuel leaks will be monitored for before entering building spaces

If leaks are found, testing will be discontinued and condition reported to occupant immediately

Objective(s):

Protect worker and occupant health



 Before

Fuel leaks need to be repaired by appropriate professional



 After

Notify occupant of any leaks

Tools:

1. Gas sniffer
2. Bubble solution

2.0105.1c - Raw fuel



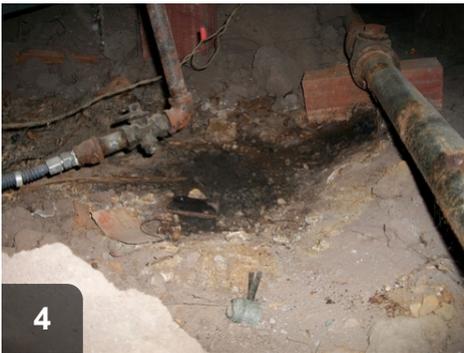
Check all raw fuel lines for leaks



Use multiple methods to test for leakage--bubble solution



If bubbles develop, leak is present. Notify occupant



Any leaks found should be reported to occupant and work stopped



Any leaks found should be reported to occupant and work stopped

2.0105.2b

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

When replacing existing thermostats, identify and dispose of any mercury containing thermostats in accordance with Environmental Protection Agency (EPA) guidance

Objective(s):

Protect workers and occupants from mercury exposure



Unsafe

Mercury thermostats should be replaced and disposed of properly



Unsafe

Do NOT dispose of mercury thermostats in the trash--find local recycling

Spill Risk: None, if units are intact.

Recommended Management: These products need to be properly disposed at household hazardous waste collection centers. Consult your local or state collection program regarding items taken.

**Contact thermostat-recycle.org or earth911.org for recycling options.

2.0105.2c

Desired Outcome:

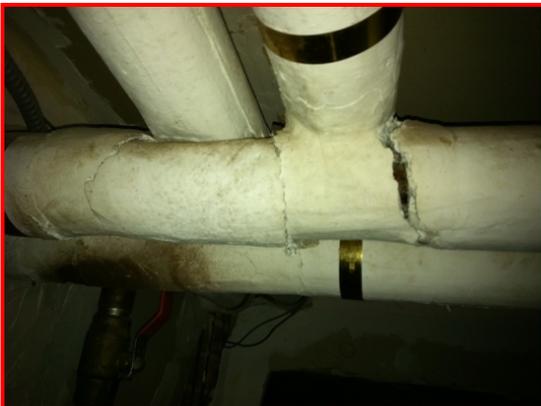
Work completed safely without injury or hazardous exposure

Specification(s):

Identify asbestos hazards in boiler and pipe insulation and remediate in accordance with EPA guidelines

Objective(s):

Protect workers and occupants from asbestos exposure



Unsafe

Suspicious pipe insulation may contain asbestos



When asbestos is suspected, call in EPA-accredited professionals.

Pipe insulation—encapsulation is allowed if performed by an Asbestos Hazard Emergency Response Act (AHERA) professional and should be conducted prior to blower door testing.

Where Asbestos (friable) is identified or assumed, the use of a blower door is prohibited.

2.0105.2d

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

Long sleeves and long pants should be worn as additional protection from liquid refrigerants and other skin hazards

Objective(s):

Protect worker from skin contact with liquid nitrogen



Unsafe

When working with refrigerants, short sleeves are inappropriate



Safe

When working with refrigerants, workers should dress appropriately

2.0110.1a

Desired Outcome:

Occupant and worker risk from hazardous materials minimized

Specification(s):

Materials that do not create long-term health risks for occupants and workers will be used

Objective(s):

Improve indoor air quality in the living space

2.0110.1b

Desired Outcome:

Occupant and worker risk from hazardous materials minimized

Specification(s):

Manufacturer specifications will be followed

Objective(s):

Reduce risk of exposure to harmful substances

Follow safety procedures

2.0110.1c

Desired Outcome:

Occupant and worker risk from hazardous materials minimized

Specification(s):

MSDSs will be provided onsite and available during all work

Objective(s):

Assess exposure risk

Prepare a response in case of emergency

2.0111.2a

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Fuel leaks will be repaired and inspected in accordance with the 2012 IRC

Objective(s):

Ensure site is safe and ready for upgrade



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. Testing solution

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.

2.0111.2a - Fuel leaks

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



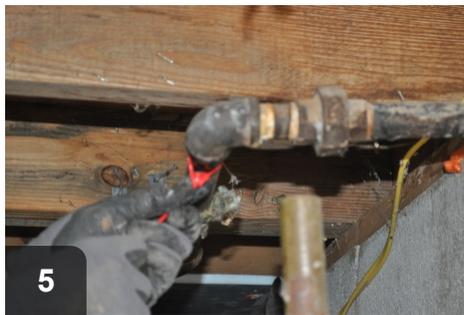
Use approved combustion gas sniffer to see if repaired line still leaks



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

2.0111.2b

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Electrical hazards will be eliminated and inspected in accordance with NFPA 70 National Electric Code

Objective(s):

Ensure site is safe and ready for upgrade

2.0111.2c

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Appropriate remediation will be completed before upgrade

Objective(s):

Ensure site is safe and ready for upgrade

Although mold testing is not an allowable expense, a visual inspection is required during the audit and final inspection. Limited water damage repairs that can be addressed by weatherization workers and correction of moisture and mold creating conditions are allowed when necessary in order to weatherize the home and to ensure the long term stability and durability of the measures. Where severe Mold and Moisture issues cannot be addressed, deferral is required.

2.0111.2d

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Plumbing leaks will be repaired before crawl space upgrade in accordance with the 2012 IRC

Objective(s):

Prepare site for upgrade

2.0111.2e

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Pest and termite treatment will be completed before crawl space upgrade and inspected in accordance with the 2012 IRC

Objective(s):

Prepare site for upgrade

Pest removal is allowed only where infestation would prevent weatherization. Infestation of pests may be cause for deferral where it cannot be reasonably removed or poses health and safety concern for workers. Screening of windows and points of access is allowed to prevent intrusion.

2.0111.2f

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Structural repairs and modifications will be inspected and completed before crawl space upgrade in accordance with the 2012 IRC

Objective(s):

Prepare site for upgrade

2.0111.2g

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Crawl space upgrades (e.g., sealing and insulation) are to be undertaken after appliance and HVAC system work has been completed and inspected

Objective(s):

Prepare site for upgrade

2.0111.2h

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Passive drains or sump pumps will be used to remove standing water

Objective(s):

Prepare site for upgrade

2.0111.2i

Desired Outcome:

Site properly prepared for upgrade

Specification(s):

Spaces with non-correctable standing water will not be considered for a closed crawl space

Objective(s):

Prevent possible damage to house

2.0111.3a

Desired Outcome:

Clean, safe, and easily accessible crawl space created

Specification(s):

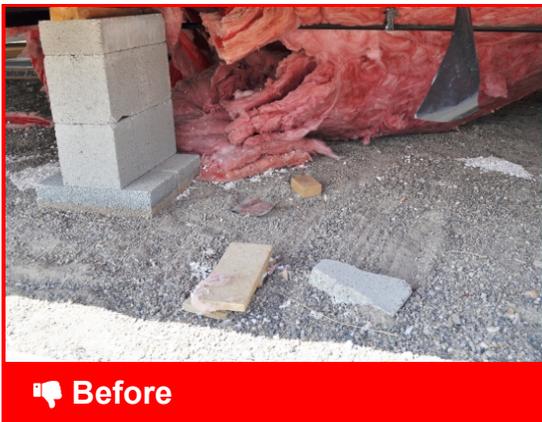
Under-floor grade will be removed of all vegetation and organic material

Debris that can cause injury or puncture ground covers (e.g., nails, glass, sheet metal screws, etc.) will be removed from the crawl space

Objective(s):

Minimize punctures in ground liner

Minimize habitat for pests (Integrated Pest Management—IPM) and contaminant sources



Crawl spaces with trash and overgrowth need to be made clean and safe.



Rake up and clear away trash and overgrowth.

Tools:

1. Rake
2. Shop vacuum
3. PPE

2.0201.1a

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

Emergency problems (e.g., gas leak, ambient CO levels that exceed 35 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested

Determine if combustion and dilution air is adequate for proper combustion and venting of all equipment within the CAZ

Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance

Objective(s):

Ensure system does not have fatal problems

Ensure combustion appliance has adequate combustion and dilution air



 Before

Unsafe combustion appliances indicate need for repair or replacement



 After

In cases of replacement, ensure new appliance is safe and sized properly

2.0201.1a - Assessment



Assess existing combustion appliances for damage and replace when necessary



When a simple filter cleaning or replacement will help, make it happen



Ensure there is adequate make-up air -- combustion air inlet in closet



Stop the misuse of combustion appliances -- camp heater in bedroom



Keep occupant apprised of any health or safety concerns

2.0201.1b

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

Inspect and test for gas or oil leakage at connections of natural gas, propane piping, or oil systems

If leaks are found, immediate action will be taken to notify occupant to help ensure leaks are repaired

The report will specify repair for leaks and replacement for hazardous or damaged gas or oil connectors and pipes

Objective(s):

Detect fuel gas leaks

Determine and report need for repair



 Before

Fuel lines should be inspected for leakage



 After

If leaks are found, notify occupant immediately to facilitate repair

Tools:

1. Gas sniffer
2. Spray bottle

Materials:

1. Bubble solution

2.0201.1b - Fuel leak detection



Inspect exterior gas and oil lines for leaks and damage



Inspect flex lines for damage, and check date on ring for pre-1973 hardware

2.0201.1c

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

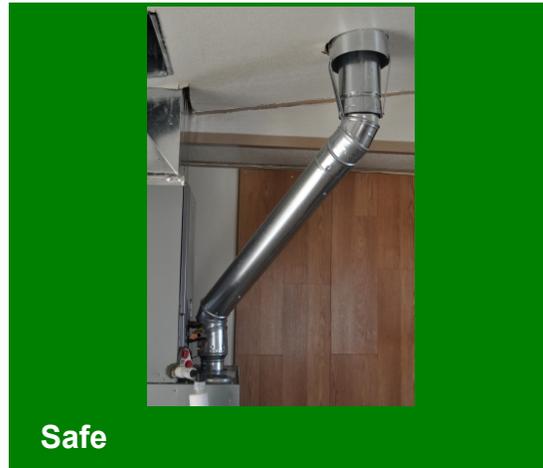
Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards

Objective(s):

Determine if a draft regulator is present and working and if vent system is in good condition and installed properly



If ventilation system puts occupants at risk, it needs immediate attention



Properly vented appliances make a house healthier and more efficient

2.0201.1c - Venting



Determine if a draft regulator is installed and working



Inspect ventilation systems for damage



Inspect ventilation systems for disconnected pipes



Inspect ventilation systems for inadequate slope



Inspect for missing draft diverter

2.0201.1d

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

Baseline pressure will be measured in Combustion Appliance Zone with reference to outdoors

Objective(s):

Measure pressure difference between combustion zone and the outside under natural conditions



Natural conditions--Winter set-up, Exhaust fans off, Interior doors open

Tools:

1. Manometer

2.0201.1e

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof, and will not be more negative than -3 pascals accounting for base pressure

Objective(s):

Measure combined effect of mechanical system fans on combustion zone



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

Tools:

1. Manometer

2.0201.1e - Depressurization test



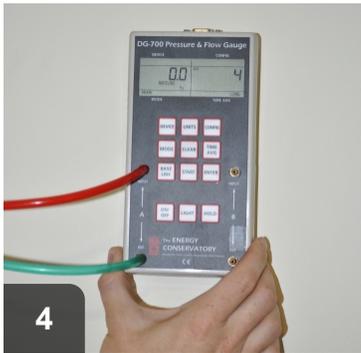
1 Place manometer reference hose to exterior of house



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 not be more negative than -3pa



9 If reading is within allowable limit, all is well

2.0201.1f

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate

Objective(s):

Detect excessive spillage of combustion gasses



Test natural draft furnace or water heater for spillage in excess of 2min

Tools:

1. Smoke pencil
2. Timer



Test all sides of natural draft flues since draft may be uneven

2.0201.1g

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

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

If CO levels exceed 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)

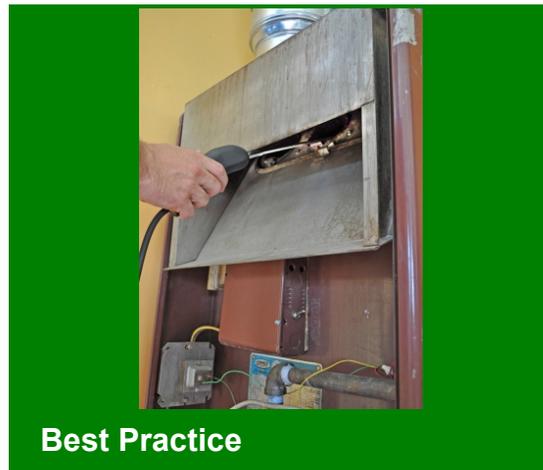
If the outlet of the exhaust is accessible, include a CO test on all sealed-combustion, direct vent, and power-vented appliances (without atmospheric chimneys)

Objective(s):

Measure CO and report excessive levels



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

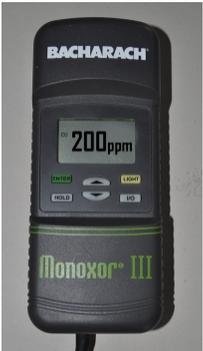


Test CO levels in undiluted flue gases and exhaust outlets, when accessible

Tools:

1. Combustion analyzer with probe

2.0201.1g - 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 furnaces



Test undiluted flue gases in natural draft water heaters.



Test accessible exhaust outlets for direct-vent appliances



Test accessible exhaust outlets for power-vented appliances

2.0201.1i

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

At the conclusion of each work day in which envelope or duct sealing measures have been performed, depressurization and spillage testing will be performed

Objective(s):

Ensure work completed in home has not adversely affected the operation of combustion appliances



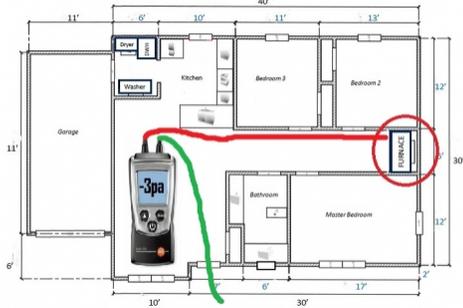
Conduct spillage and depressurization testing at the end of the work day

Tools:

1. Manometer
2. Smoke pencil
3. Timer

Virginia WAP requires draft testing to be performed with the manometer or combustion analyzer. A strength of draft calculation will be performed using the BPI method for minimum acceptable draft: $\text{Temperature Outside} / 40 - 2.75$ e.g. 80 degree outside temperature would be $80/40 = 2. 2-2.75 = -.75$, the lowest draft allowable under this weather condition.

2.0201.1i - Combustion safety testing at completion of retrofitting home



Run depressurization test at the end of the work day



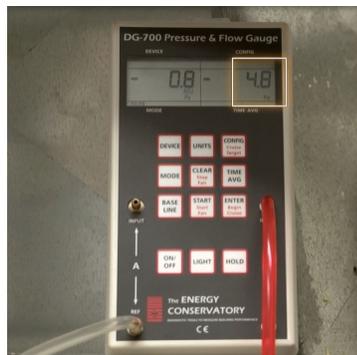
Complete spillage test using chemical smoke pencil



Test for spillage on all sides of draft diverter



Complete spillage testing on all combustion appliances



Draft should be tested in a straight section of the flue, 12-24" after the first elbow.



Complete carbon monoxide testing using a CO detector

2.0201.2a

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

Where applicable, combustion air will be provided from the outside and installed in accordance with the 2012 IRC for the type of appliance installed

Objective(s):

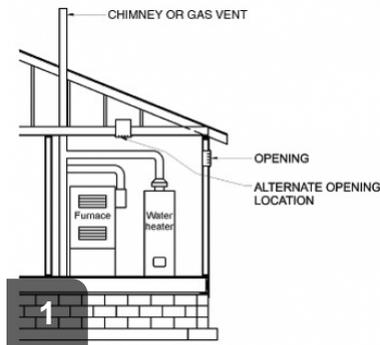
Prevent combustion byproducts from entering the house

Image 1: For homes with one permanent opening, see 2012 IRC: G2407.6.2 (304.6.2): a minimum free area of 1 in² per 3,000 Btu/h (734 mm²/kW) of total input rating of all appliances

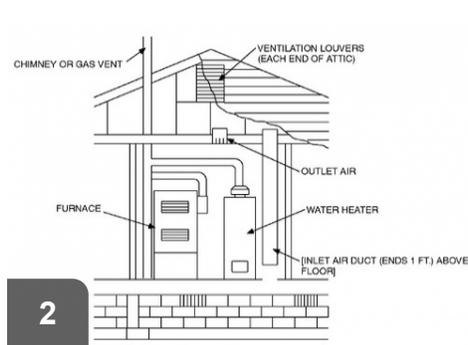
Image 2: For homes with two permanent vertical duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in² per 4,000 Btu/h (550 mm²/kW) of total input rating of all appliances

Image 3: For homes with two permanent horizontal duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in² per 2,000 Btu/h (1,100 mm²/kW) of total input rating of all appliances

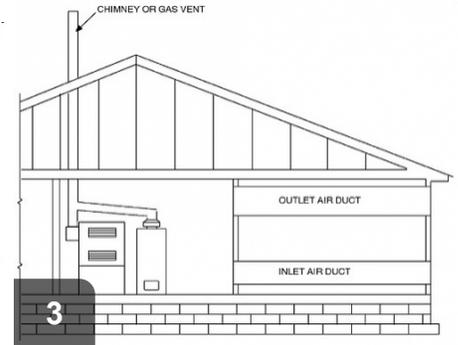
2.0201.2a - Outside combustion make-up air



min free area of 1 sqin per 3,000 Btu/h
(734 mm²/kW) of total input rating



min free area of 1 sqin per 4,000 Btu/h
(550 mm²/kW) of total input rating



min free area of 1 sqin per 2,000 Btu/h
(1100 mm²/kW) of total input rating

2.0201.2b

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

New appliance will be installed in accordance with manufacturer specifications, 2012 IRC G2427.8, and additional applicable codes

Replacement equipment venting will be assessed to ensure other existing equipment is not adversely affected

Objective(s):

Prevent combustion byproducts from entering the house



 Before

Damaged combustion appliances beyond repair should be replaced



 After

Sealed-combustion, direct-vent appliances should replace unsafe appliances

2.0201.2b - New appliances



Two-pipe 90% efficiency furnaces are viable replacement appliances



Direct vent combustion appliances are also viable replacements

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

Objective(s):

Alert occupant to CO exposure



Best Practice

Carbon Monoxide alarms should be installed according to local codes



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

Tools:

1. Drill

Materials:

1. CO alarm
2. Fasteners

2.0201.2d

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

Gas ovens will be tested for CO

A clean and tune will be conducted if measured CO in the undiluted flue gases of the oven vent at steady state exceeds 200 ppm or 800 ppm by air-free measurement

Objective(s):

Ensure clean burn of gas ovens



If air-free CO reading exceeds 800ppm, order a clean and tune



Test gas oven for carbon monoxide using a combustion gas analyzer

Tools:

1. Combustion analyzer with probe

2.0201.2e

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

Specify clean and tune if the flame has any discoloration, flame impingement, or an irregular pattern or if burners are visibly dirty, corroded, or bent

Objective(s):

Ensure clean burn and operation of gas range burners



Discoloration is a clear sign that a gas range needs a clean and tune



A properly operating gas range burner should have an even blue flame

2.0201.2e - Gas range burners



Yellow, uncontrolled flames indicate the need for a clean and tune



Gas ranges should be cleaned and tuned if improper operation is evident



Blue, even flames indicate burners are working properly

2.0201.2f

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

If the solid fuel burning appliance is the primary heat source and has signs of structural failure replace solid fuel burning appliance with UL-listed and EPA - certified appliances if the existing appliance is not UL-listed

Objective(s):

Ensure safe operations of solid fuel burning appliances



Unsafe

Unsafe solid fuel burning appliances should be replaced



Safe

New appliances should be UL-listed and EPA-certified

Since 1988, the EPA has regulated particulate emissions from wood heaters. The limit is 7.5 grams per hour for non-catalytic appliances, and 4.1 grams per hour for catalytic appliances.

2.0201.2f - Solid fuel burning appliances



Locate data plate to find out appliance ratings



Check appliance rating plates for EPA and UL markings
(or CSA, ETL, or WH markings)

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 re-evaluated in the context of potential indoor air quality risks

Objective(s):

Eliminate sources of combustion byproduct within a living space

2.0202.1b

Desired Outcome:

Elimination of combustion byproducts

Specification(s):

Occupant will be educated on potential hazards of unvented combustion appliances (primary or secondary) within a living space

Objective(s):

Inform occupant about possible hazards associated with combustion byproducts and moisture

2.0203.1a

Desired Outcome:

Sufficient air provided in the Combustion Appliance Zone (CAZ)

Specification(s):

The required volume of indoor air will be determined in accordance with 2012 IRC Section G2407.5.1 or G2407.5.2 and authority having jurisdiction, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), 2012 IRC Section G2407.5.2 will be used

Objective(s):

Determine if existing conditions meet the combustion air calculation

2.0203.1b

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

2.0203.2a

Desired Outcome:

Flue gasses successfully removed from the house

Specification(s):

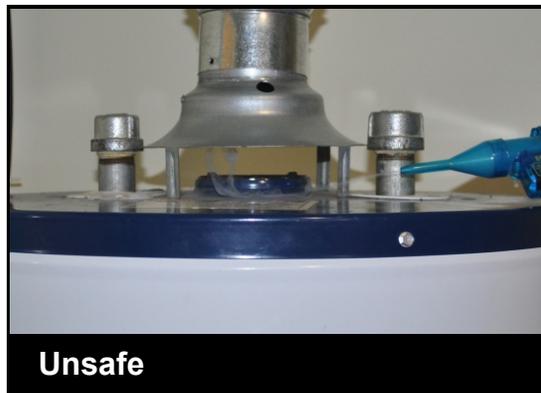
If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate

Objective(s):

Ensure appliance is not spilling longer than two minutes



Orphaned water heaters have oversized flues after a furnace is removed



Spillage should not exceed 2 minutes, if present

Tools:

1. Smoke pencil

2.0203.2b

Desired Outcome:

Flue gasses successfully removed from the house

Specification(s):

A chimney liner will be installed in accordance with the 2012 IRC or applicable NFPA standard

Objective(s):

Allow water heater to vent properly

Prevent damage to the chimney



Unlined masonry chimney



Flue liner with rain cap

Tools:

1. hammer drill
2. disposable brushes
3. tin snips
4. 5/16" nut driver
5. pulling cone
6. rope
7. caulking gun
8. tape measure
9. 4 1/2" angle grinder with metal cutoff wheel

Materials:

1. Flexible chimney liner
2. Rain cap
3. Top plate
4. Elbows
5. Tees (if required to connect multiple appliances)
6. Refractory cement
7. Bricks
8. Mortar

Connect chimney liner to appliance in accordance with applicable codes.

2.0203.2b - Flue gas removal (chimney liner or approved methods)



1 Measure from the bottom termination to the chimney crown. Add one foot to the measurement and cut the liner to length



2 Pull chimney liner into position (from top or bottom, whichever is easier) with a rope and pulling cone



3 Measure and mark the flexible chimney liner at 4 inches above the chimney



4 Cut the flexible chimney liner to length



5 Install top plate over opening and attach it to the liner



6 Fasten the rain cap to the chimney liner



7 Seal around penetrations in chimney with refractory (furnace) cement



8 Connect appliance vent to the chimney liner



9 Use refractory (furnace) cement to seal metal water heater or furnace vents to the masonry chimney

2.0203.2c

Desired Outcome:

Flue gasses successfully removed from the house

Specification(s):

If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate

Objective(s):

Ensure appliance is not spilling longer than two minutes



Before

If spillage continues to exceed 2 min, additional repairs are required



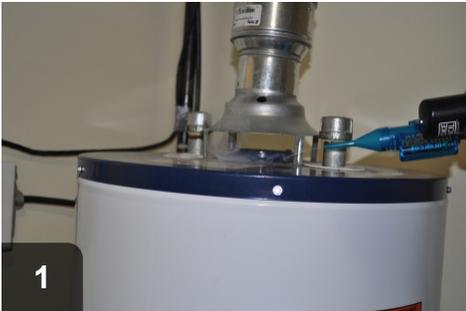
After

The elimination of the oversized chimney should prevent spillage

Tools:

1. Smoke pencil

2.0203.2c - Retesting spillage



Retest for spillage. If spillage remains, more repair is needed.



Repipe the flue to eliminate the oversized chimney



When repairs have been completed, no spillage should occur

2.0203.2d

Desired Outcome:

Flue gasses successfully removed from the house

Specification(s):

The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with 2012 IRC G2407.5.1 and authority having jurisdiction

Objective(s):

Determine if existing conditions meet the combustion air calculation

2.0203.2e

Desired Outcome:

Flue gasses successfully removed from the house

Specification(s):

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

Objective(s):

Ensure adequate combustion air for operation of the appliance

2.0203.2f

Desired Outcome:

Flue gasses successfully removed from the house

Specification(s):

All homes will have a functioning CO alarm

If CO levels in interior living spaces exceed outdoor levels, investigate potential sources and take appropriate action to reduce them (e.g., have a qualified professional tune, repair or replace improperly operating combustion appliances; apply weather stripping or conduct air sealing between the garage or crawl space and the home)

Objective(s):

Ensure occupant health and safety

Ensure indoor CO levels do not exceed outdoor CO levels

2.0203.2g

Desired Outcome:

Flue gasses successfully removed from the house

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 risk of high CO concentrations; EPA describes possible expanded actions, and offers client education information in an appendix to the protocols

Objective(s):

Ensure occupant can operate and maintain installations

Inform occupant regarding possible CO hazards

2.0299.1a

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Specification(s):

Manufacturer's certified negative pressure tolerance rating:

- Limit -2 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



A natural draft water heater with indicative flue highlighted

Atmospheric water heater only
(Cat I, natural draft),
open-combustion
appliances

Limit: -2 pascals

Best Practice

Tools:

1. Manometer

2.0299.1b

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

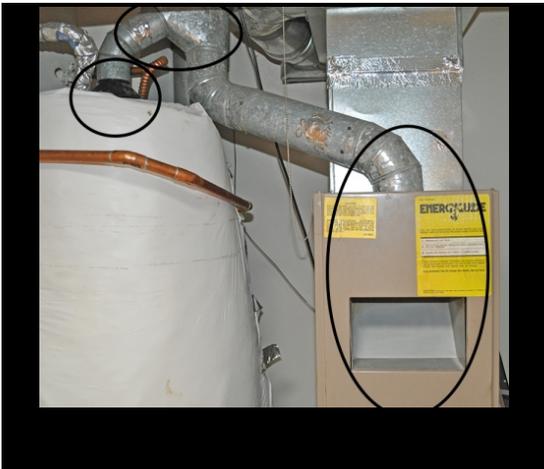
Specification(s):

Manufacturer's certified negative pressure tolerance rating:

- Limit -3 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Natural draft water heater and natural draft furnace with common vent

Atmospheric water heater
(Cat I, natural draft)
and atmospheric furnace
(Cat I, natural draft),
common-vented,
open-combustion
appliances

Limit: -3 pascals

Best Practice

Tools:

1. Manometer

2.0299.1b - Atmospheric water heater (Category I, natural draft) and atmospheric furnace (Category I, natural draft), common-vented, open-combustion appliances



Common vent of natural draft appliances highlighted

2.0299.1c

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Specification(s):

Manufacturer's certified negative pressure tolerance rating:

- Limit -5 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Category I 70% efficiency gas furnace with intake vent highlighted

Gas furnace or boiler,
Cat I or Cat I fan-assisted,
open-combustion
appliances

Limit: -5 pascals

Best Practice

Tools:

1. Manometer

2.0299.1c - Gas furnace or boiler, Category I or Category I fan- assisted, open-combustion appliances



Cat I 80% efficiency furnace



Oil boiler

2.0299.1d

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

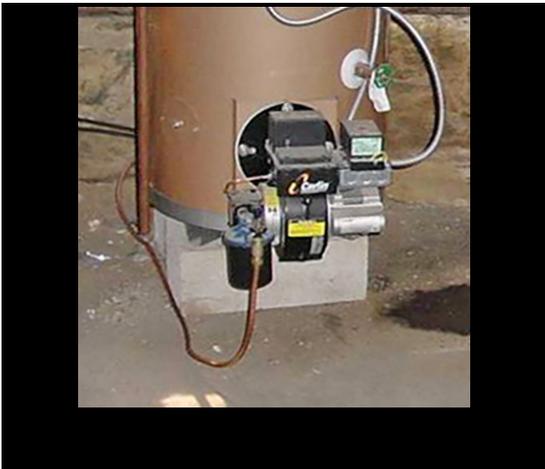
Specification(s):

Manufacturer's certified negative pressure tolerance rating:

- Limit -5 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Oil burner

Oil or gas unit
with power burner,
low- or high-static
pressure burner,
open-combustion
appliances

Limit: -5 pascals

Best Practice

Tools:

1. Manometer

2.0299.1e

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Specification(s):

Manufacturer's certified negative pressure tolerance rating:

- Limit -7 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Wood-burning stove

Closed, controlled
wood-burning
appliances

Limit: -7 pascals

Best Practice

Tools:

1. Manometer

2.0299.1f

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Specification(s):

Manufacturer's certified negative pressure tolerance rating:

- Limit -15 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Induced draft furnace

Induced-draft appliances
(fan at point of exit at wall),
Cat I with induced-draft,
open-combustion
appliances

Limit: -15 pascals

Best Practice

Tools:

1. Manometer

2.0299.1g

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Specification(s):

Manufacturer's certified negative pressure tolerance rating:

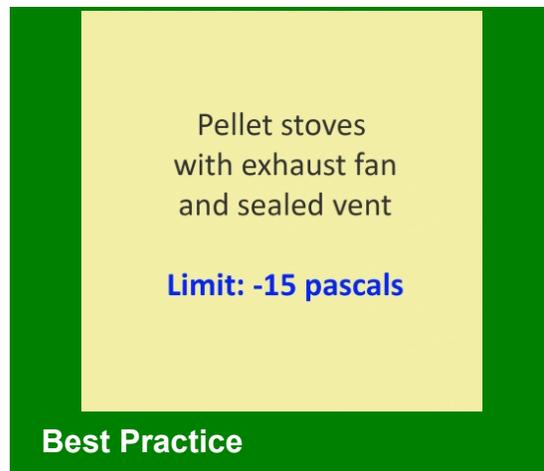
- Limit -15 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Pellet stove



Tools:

1. Manometer

2.0299.1h

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Specification(s):

Manufacturer's certified negative pressure tolerance rating:

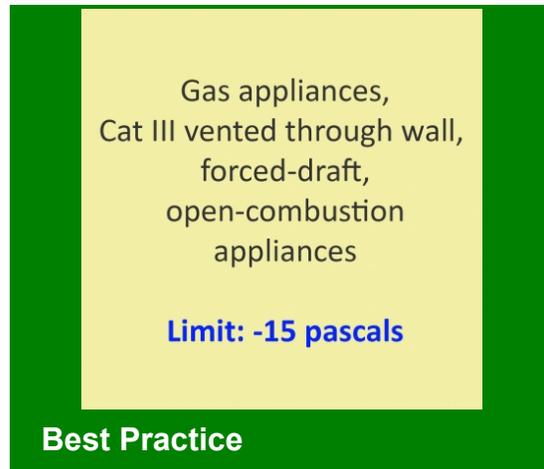
- Limit -15 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Single-pipe 90% efficiency furnace with forced draft



Best Practice

Tools:

1. Manometer

2.0299.1h - Gas appliances, Category III vented through the wall, forced draft, open-combustion appliances



Power-vented water heater

2.0299.1i

Desired Outcome:

Ensure appliances meet manufacturer's certified negative pressure tolerance rating

Specification(s):

Manufacturer's certified negative pressure tolerance rating:

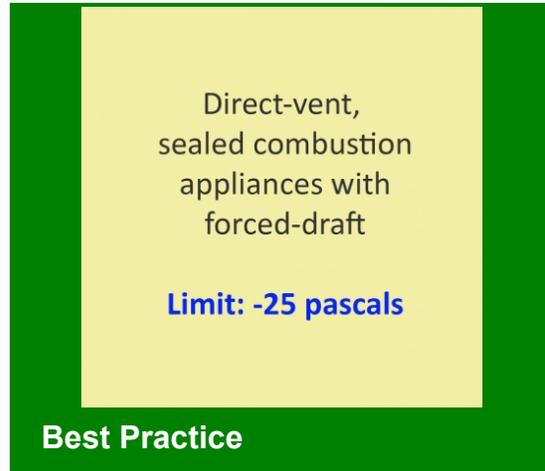
- Limit -25 pascals

Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Forced draft appliance with sealed combustion



Tools:

1. Manometer

2.0299.1i - Direct-vent, sealed combustion appliances with forced draft



Two-pipe 90% efficiency furnace



Direct-vent Rinnai



Exterior vent for Rinnai

2.0301.1a

Desired Outcome:

Properly installed smoke alarms

Specification(s):

Smoke alarms will be listed and labeled in accordance with UL 217 and installed (hardwired) in accordance with the 2012 IRC or as required by the authority having jurisdiction

Objective(s):

Ensure proper installation



Hard-wired smoke alarm mount with alarm missing



Smoke alarms will be listed and labeled in accordance with UL 217 and installed in accordance with the 2012 Virginia Uniform Statewide Building Code.

2.0301.1a - Smoke alarm (hardwired)



Smoke alarms should be UL-217 rated and comply with NFPA 72



Homes should have hard-wired smoke alarms in all sleeping areas

2.0301.1b

Desired Outcome:

Properly installed smoke alarms

Specification(s):

Battery operated alarms will be installed in accordance with the 2012 IRC and manufacturer specifications

Objective(s):

Ensure proper installation



All homes should have UL-217 rated smoke alarms

Paraphrased from 2012 IRC R314: Smoke alarms will be permitted to be battery operated when installed in buildings without commercial power or when alterations or repairs do not result in the removal of interior wall or ceiling finishes exposing the structure to provide access for hard-wiring, unless there is an attic, crawl space, or basement available with could provide access.

2.0301.1b - Smoke alarm (battery operated)



Ceiling mounted smoke alarms can be battery-operated



Wall mounted smoke alarms must be mounted within 12 inches of the ceiling

2.0301.2a

Desired Outcome:

Properly installed CO alarms or monitors

Specification(s):

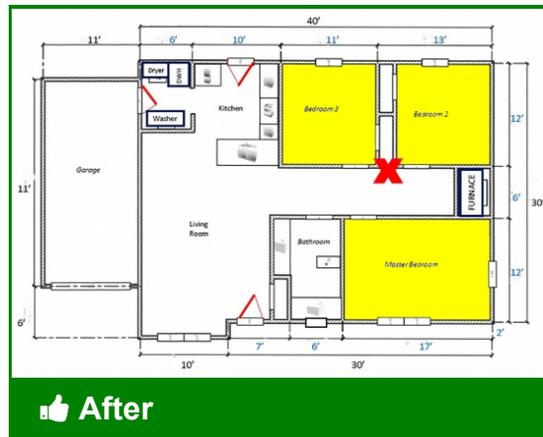
Hardwired CO detection or warning equipment will be installed in accordance with ASHRAE 62.2 or as required by the authority having jurisdiction

Objective(s):

Ensure proper installation



Occupant safety is compromised when houses do not have CO alarms



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

Tools:

1. Hammer

Materials:

1. Nails

Paraphrased from 2012 IRC R315: An approved CO alarm will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in dwelling units within which fuel-fired appliances are installed and in dwelling units that have attached garages. CO detectors will comply with UL 2075. Single-station CO alarms will comply with UL 2034 and will be installed in accordance with this code and the manufacturer's installation instructions. Per WPN 14-01, full compliance with ASHRAE 62.2.2013 and NFPA 720 is required.

2.0301.2a - CO detection and warning equipment (hardwired)



Mount alarm to wall close to bedrooms



Plug alarm into outlet. In addition, cord can be stapled into place

2.0301.2b

Desired Outcome:

Properly installed CO alarms or monitors

Specification(s):

Battery operated CO detection or warning equipment will be installed in accordance with ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction

Objective(s):

Ensure proper installation



 Before

Houses should have carbon monoxide monitors installed near sleeping areas



 After

Battery operated CO alarms should be UL-2075 or UL-2034 compliant

Paraphrased from 2012 IRC R315: An approved CO alarm will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in dwelling units within which fuel-fired appliances are installed and in dwelling units that have attached garages. CO detectors will comply with UL 2075. Single-station CO alarms will comply with UL 2034 and will be installed in accordance with this code and the manufacturer's installation instructions. Per WPN 14-01, full compliance with ASHRAE 62.2.2013 and NFPA 720 is required.

2.0402.1a

Desired Outcome:

Water and conditions conducive to mold growth, wood rot, and pests eliminated

Specification(s):

Ground will be sloped away from the house at a rate of 6" of fall within 10'

Objective(s):

Drain water away from the foundation wall

2.0402.1b

Desired Outcome:

Water and conditions conducive to mold growth, wood rot, and pests eliminated

Specification(s):

If downspouts are present (e.g., gutters, overhangs, French drain), they will be drained a minimum of 6' away from the house

Objective(s):

Prevent roof water from leaking into the crawl space or basement

2.0402.1c

Desired Outcome:

Water and conditions conducive to mold growth, wood rot, and pests eliminated

Specification(s):

Foundation walls will be waterproof

Exterior foundation drains will be installed

Objective(s):

Prevent water from leaking into the crawl space or basement

2.0402.1d

Desired Outcome:

Water and conditions conducive to mold growth, wood rot, and pests eliminated

Specification(s):

Interior grading will be sloped to one or more collection points, if possible

Objective(s):

Collect interior water for removal

2.0402.1e

Desired Outcome:

Water and conditions conducive to mold growth, wood rot, and pests eliminated

Specification(s):

One or more drains or sump pumps will be installed

Objective(s):

Remove interior water from the crawl space or basement

Sump pumps are an allowable expense under the Virginia WAP.

2.0403.1a

Desired Outcome:

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

Specification(s):

Care will be taken to prevent punctures during installation

Objective(s):

Protect ground moisture barrier from damage during other crawl space work

2.0403.1b

Desired Outcome:

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

Specification(s):

A ground moisture barrier that covers 100% of the exposed crawl space floor will be installed

Objective(s):

Reduce ground moisture entering the crawl space



 Before

Uncovered crawl space floors can cause moisture damage



 After

Ground moisture barrier to cover 100% of floor is installed last

Materials:

1. Plastic sheeting (at least 4 mil)
2. Furring strips
3. Fasteners

2.0403.1c

Desired Outcome:

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

Specification(s):

A ground moisture barrier with a rating of no more than 0.1 perm will be used

A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745

Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home (5 years), and it will need replacing to remain effective

Objective(s):

Ensure crawl space is accessible for service and maintenance without damaging the integrity of the ground moisture barrier



Barrier must be at least 4 mil, able to withstand puncture and last 10 yrs

Materials:

1. Plastic sheeting (at least 4 mil)
2. Furring strips
3. Fasteners

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <math><0.5</math> (which translates to 4mil or thicker). From 2007 IRC definition of vapor retarders: Class I: ≤ 0.1 perm (called impermeable), Class II: 0.1 to 1.0 perm (called semi-impermeable), Class III: 1.0 perm to 10 perms (called semi-permeable).

2.0403.1d

Desired Outcome:

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

Specification(s):

When seams exist, they will be overlapped a minimum of 12" using reverse or upslope lapping technique

Objective(s):

Keep water under the liner

Reduce the likelihood of damage at seams



Ground moisture barriers help keep moisture from permeating floor.



Ground moisture barrier overlaps at least 12 in and is securely fastened

Tools:

1. Stapler
2. Utility knife
3. Drill

Materials:

1. Ballast
2. Plastic sheeting (at least 4mil)
3. Furring strips
4. Seam tape - moisture resistant

2.0403.1d - Overlap seams



Securely fasten moisture barrier to wall at least 6 inches from ground



Overlap seams at least 12 inches, using a shingle method to keep water out

2.0403.1e

Desired Outcome:

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

Specification(s):

Ground moisture barrier will be fastened to ground with durable fasteners or ballast(s) and extend a minimum of 6" up the foundation wall

Objective(s):

Prevent movement of the ground moisture barrier



Fastening of moisture barrier is required and must last at least 10 years



Ground moisture barrier should extend up the wall and be held in place

Tools:

1. Stapler
2. Drill

Materials:

1. Plastic sheeting (at least 4 mil)
2. Furring strips
3. Fasteners

2.0403.1e - Fastening



Seams can be taped to prevent water leakage



Ballast or fasteners can hold barrier in place securely

2.0403.2a

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

Care will be taken to prevent punctures during installation

Objective(s):

Protect ground moisture barrier from damage during other crawl space work

2.0403.2b

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

An air barrier and ground moisture barrier, covering 100% of the exposed crawl space floor, will be installed and sealed to the wall's air and moisture barrier in accordance with ASTM E1643 and manufacturer's recommendations

Ground moisture barrier will be fastened to ground in accordance with manufacturer's recommendations and extend a minimum of 6 inches up the foundation wall

Objective(s):

Reduce ground moisture entering the crawl space

Create a continuous and durable connection between the wall and ground air and moisture barriers



 Before

Uncovered crawl space floors can lead to moisture issues



 After

Ground moisture barrier should cover 100% of floor and at least 6" of walls

Materials:

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

2.0403.2c

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

A ground moisture barrier with a rating of no more than 0.1 perm will be used

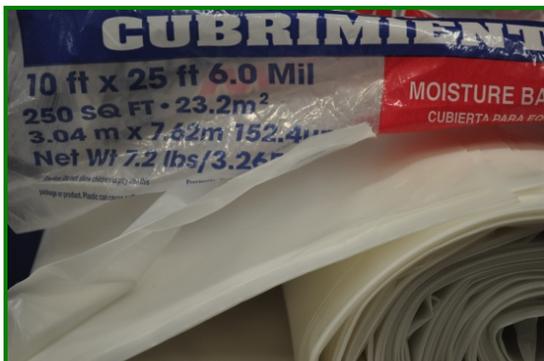
A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745

Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home (5 years), and it will need replacing to remain effective

Objective(s):

Reduce ground vapor entering the crawl space

Ensure crawl space is accessible for service and maintenance without destroying the integrity of the moisture barrier



Best Practice

Barrier must be at least 4 mil, able to withstand puncture and last 10 yrs

Materials:

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <math><0.5</math> (which translates to 4mil or thicker). From 2007 IRC

definition of vapor retarders: Class I: ≤ 0.1 perm (called impermeable), Class II: 0.1 to 1.0 perm (called semi-impermeable), Class III: 1.0 perm to 10 perms (called semi-permeable).

2.0403.2d

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

When seams exist, they will be overlapped a minimum of 12" with reverse or upslope lapping technique

For wall to floor connection, the wall moisture barrier will be installed under the ground moisture barrier

Objective(s):

Keep water under the liner



Ground moisture barriers help keep moisture from permeating floor



Ground moisture barrier overlaps at least 12 in and is securely fastened

Tools:

1. Stapler
2. Utility knife
3. Drill

Materials:

1. Ballast
2. Plastic sheeting (at least 6 mil)
3. Furring strips
4. Moisture-resistant adhesive tape

2.0403.2d - Overlap seams



Securely fasten moisture barrier to wall at least 6 inches from ground



Overlap seams at least 12 inches, using a shingle method to keep water out

2.0403.2e

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

The air barrier and ground moisture barrier will be fastened to the ground to prevent movement in accordance with ASTM E1643 and manufacturer's recommendations

Objective(s):

Prevent movement and uplift of the air barrier and ground moisture barrier



Moisture barrier needs to be held in place with more permanent fasteners



Ballast or fasteners should be used to hold barrier in place securely

Tools:

1. Drill
2. Stapler

Materials:

1. Plastic sheeting (at least 4 mil)
2. Furring strips
3. Fasteners

2.0403.2f

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

A durable sealant compatible with the air barrier and ground moisture barrier will be used

Objective(s):

Maintain continuous air barrier and ground moisture barrier



 Before

Crawl spaces lacking moisture barrier risk moisture penetration of floor



 After

Ground moisture barriers in unvented spaces should be sealed

Tools:

1. Utility knife

Materials:

1. Moisture-resistant adhesive tape

2.0403.2f - Sealing seams



Tape wall seams and press to ensure airtight bonding of adhesive



Tape (overlapped) floor seams to prevent movement and water leakage

2.0403.2g

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

A durable sealant, compatible with the air barrier and ground moisture barrier, will be used

Physical attachments will be provided where practical (e.g., masonry columns, footings)

Objective(s):

Maintain continuous air barrier and ground moisture barrier

2.0403.2h

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

The air barrier and ground moisture barrier will not interfere with the established drainage pattern

Objective(s):

Ensure proper drainage

2.0403.2i

Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

Specification(s):

Interior drainage collection points will be accessible from above and below the air barrier and ground moisture barrier

Objective(s):

Remove water above and below the air barrier and ground moisture barrier

2.0403.3a

Desired Outcome:

Durable, effective vapor retarder minimizes leakage from ground and air

Specification(s):

An air barrier and vapor retarder will be installed on the interior side of the exterior wall in accordance with 2012 IRC R408. 3

Objective(s):

Prevent air and moisture penetration

2.0403.3b

Desired Outcome:

Durable, effective vapor retarder minimizes leakage from ground and air

Specification(s):

An air barrier and vapor retarder will be installed a minimum of 1' or as high as possible above outside grade

Objective(s):

Prevent air and moisture penetration

2.0403.3c

Desired Outcome:

Durable, effective vapor retarder minimizes leakage from ground and air

Specification(s):

Where termite pressure exists, a 3" inspection gap will be maintained from the top of the insulation to the bottom of any wood

Objective(s):

Allow for termite detection

2.0403.3d

Desired Outcome:

Durable, effective vapor retarder minimizes leakage from ground and air

Specification(s):

Vapor retarder will be attached with a durable connection

Vapor retarder will be sealed at punctures and all 12" overlapped seams to prevent air entry

Objective(s):

Ensure vapor retarder maintains a fixed position on the exterior wall

Ensure vapor retarder is air tight

2.0403.3e

Desired Outcome:

Durable, effective vapor retarder minimizes leakage from ground and air

Specification(s):

Vapor retarder will be installed a minimum of 6" above interior grade

Vapor retarder will be attached with a durable connection

Vapor retarder will be sealed at punctures and all 12" overlapped seams to prevent air entry

Objective(s):

Prevent ground moisture penetration

2.0601.1a

Desired Outcome:

Live unsafe wiring identified and brought to local codes

Specification(s):

Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring

Objective(s):

Ensure occupant safety

Preserve the integrity and safety of the house



Knob and tube wiring should be identified before work begins



Distinctive "knobs" are highlighted. This wiring can be a safety hazard

2.0601.1b

Desired Outcome:

Live unsafe wiring identified and brought to local codes

Specification(s):

Non-contact testing method will be used to determine if wiring is live

Objective(s):

Protect occupant safety

Preserve the integrity and safety of the house



Knob & tube wiring needs to be tested to determine if still live. Red=live



Live wiring should be dammed or professionally disabled before insulating

Tools:

1. Non-contact wire tester

2.0601.1c

Desired Outcome:

Live unsafe wiring identified and brought to local codes

Specification(s):

Live knob and tube will not be covered or surrounded; required by the National Electrical Code (NEC) or authority having jurisdiction

A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring

A dam that does not cover the top will be created to separate insulation from the wire path

Objective(s):

Ensure occupant safety

Preserve the integrity and safety of the house



 Before

Live knob & tube wiring may get hot and should not be insulated over



 After

Dams should be installed to hold back loose fill insulation

Tools:

1. Drill
2. Tape measure
3. Non-contact wire tester

Materials:

1. Plywood
2. Drywall
3. Fasteners

NEC guidelines and local jurisdictions are very particular on the treatment of knob & tube wiring. Check your local codes.

2.0601.1c - Isolation and protection



Have a certified electrician verify that wiring is safe to work around



A sign should be posted at all entrances to warn of knob & tube wiring



Warning sign should remind to contact certified electrician for repairs



Many jurisdictions require a sign in Spanish as well



Damming should extend above installed height of insulation



With dams in place, insulation can begin

2.0601.1d

Desired Outcome:

Live unsafe wiring identified and brought to local codes

Specification(s):

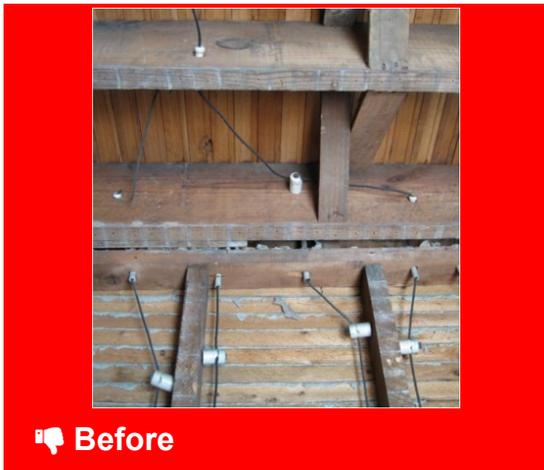
Exposed wiring will be replaced with new appropriate wiring in accordance with the NEC and local codes

Old wiring will be rendered inoperable by licensed electrician in accordance with the NEC and local codes

Objective(s):

Ensure occupant safety

Preserve the integrity and safety of the house



 Before

Knob and tube wiring may get hot and cannot be insulated over



 After

If possible, k&t wiring should be disabled and replaced with modern wiring

Tools:

1. Non-contact wire tester

Materials:

1. Romex as needed

NEC guidelines and local jurisdictions have many codes dealing with the treatment of knob & tube wiring. Check your local codes.

2.0601.1d - Replacement



The entire knob and tube system should be disabled



Many electricians will remove old exposed wiring to prevent reactivation



Exposed knob and tube should be replaced with modern wiring



With modern wiring in place and old k&t disabled, insulation can begin

2.0701.2a

Desired Outcome:

Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

Specification(s):

A durable, easily seen sign will be installed at all accesses inside of the crawl space (minimum 8 ½" x 11")

A minimum expected service life of 10 years will be ensured

Objective(s):

Prevent damage to the crawl space after upgrade



Crawl space access points should have signage to alert occupant and workers



Best Practice

Sign should be highly-visible, securely-fastened, and durable

2.0701.2b

Desired Outcome:

Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

Specification(s):

Those entering the crawl space will be cautioned not to damage the air barrier, ground moisture barrier, insulation, and mechanical components specific to the crawl space type

Anyone entering the crawl space will be alerted that immediate repairs are needed in case of damage

Installer contact information will be included on the sign in case there are questions or needs for repairs

Objective(s):

Prevent damage to the crawl space after upgrade

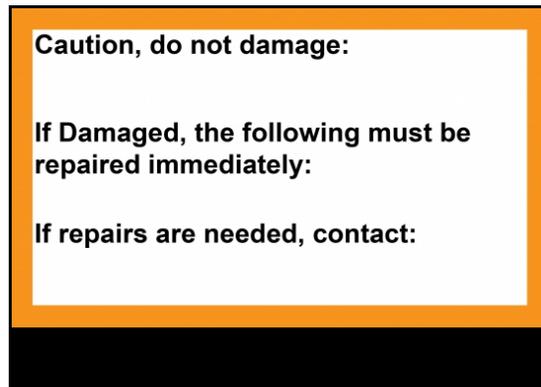
Educate anyone entering the crawl space

Provide occupants with a way to contact the installer



Best Practice

Mount sign where clearly visible to anyone entering crawl space



Be sure sign includes relevant information to aid occupant in repairs

Tools:

1. Printer
2. Staple gun

Materials:

1. Paper
2. Laminant
3. Staples

2.0701.2b - Sign content

Cuidado, no dañar:

Si está dañado, estos deben ser reparados inmediatamente:

Si es necesario realizar alguna reparación, ponerse en contacto con:

Hacer la señal en español también

2.0701.2c

Desired Outcome:

Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

Specification(s):

Language prohibiting storage of hazardous and flammable materials will be provided on site

Objective(s):

Prevent storage of hazardous or flammable materials in the crawl space

Maintain indoor air quality

Prevent a fire hazard



Mount sign where anyone entering the crawl space can see it

**PROHIBITED: DO NOT store
Hazardous or Flammable
Materials in this space**

Alert those entering the crawl space never to store hazardous materials

Tools:

1. Staple gun
2. Printer

Materials:

1. Paper
2. Laminant
3. Staples

2.0701.2c - Hazard warning

**PROHIBIDO: NO almacenar
Materiales Inflamables o
Peligrosos en este espacio**

Hacer la señal en español también

3.1001.1a

Desired Outcome:

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a chase

Repairs will be completed before work

Objective(s):

Repair moisture-related issues

3.1001.1b

Desired Outcome:

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

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

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

Objective(s):

Minimize hole size to ensure successful use of sealant

Ensure closure is permanent and supports any load (e.g., wind, insulation)

Ensure sealant does not fall out

3.1001.1c

Desired Outcome:

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

Sealants will be compatible with their intended surfaces

Sealants will allow for differential expansion and contraction between dissimilar materials

Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction

Objective(s):

Select permanent sealant

Ensure sealant meets or exceeds the performance characteristics of the surrounding materials

3.1001.1d

Desired Outcome:

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

Only non-combustible sealant will be used in contact with chimneys, vents, and flues

Local codes will be referenced

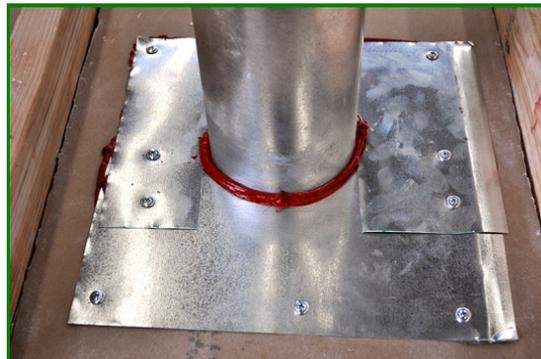
Objective(s):

Prevent a fire hazard



Before

Gaps around combustion exhaust flues need to be sealed



After

Sealed penetrations and chases should utilize high-temperature materials

Tools:

1. Drill/screwdriver
2. Caulk gun
3. Metal snips

Materials:

1. High-temperature caulking
2. 26-gauge steel sheeting

See 3.1402.1c for Clearance Requirements

3.1001.1d - High temperature application



1 Prepare work area by removing any insulation and debris



2 Use high-temperature caulking (600F min)



3 Apply first ring of caulking to match shape of opening



4 Apply second ring of caulking to size and shape of rigid material



5 Fasten rigid material (26-gauge steel) and apply additional caulking



6 Fasten rigid material to cover penetration and seal against flue with caulk

3.1001.2a

Desired Outcome:

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a chase

Repairs will be completed before work begins

Objective(s):

Repair moisture-related issues



👤 Before

Investigate under insulation in chases to verify they are undamaged



Before

Water damage in chase due to hole to the outside

Tools:

1. flashlight
2. headlamp
3. hammer
4. prybar
5. circular saw
6. reciprocating saw
7. borescope
8. mirror

Removing the batt over this chimney chase provided access to see a large hole and water damage in the chimney wall.

3.1001.2a - Pre-inspection



1 Locate and expose chases to prepare for inspection and capping/sealing



2 Clear away insulation and debris to allow inspection



3 Carefully investigate areas with high potential for water leaks

3.1001.2b

Desired Outcome:

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

Entire opening will be spanned with rigid material

Material will be cut to fit and fastened as required

Objective(s):

Reduce opening to what can be sealed with sealant



Unsealed standard chases covered with drywall can be leakage points



The air barrier is maintained by capping chases with rigid material

Tools:

1. Drill/screwdriver
2. Caulk gun

Materials:

1. XPS
2. Drywall
3. Caulk
4. Sheet metal
5. OSB or plywood

3.1001.2b - Standard chase (interior walls covered with drywall or plaster)



Clear area of debris and insulation in preparation for work



Apply sealant all the way around opening



Trim rigid material, such as drywall or XPS, to size and place over sealant



Fasten rigid material appropriately, such as with screws

3.1001.2c

Desired Outcome:

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

Material will be used that can be exposed to the interior of the house and meet the flame and smoke spread indexes as required in 2012 IRC R302.9

Objective(s):

Prevent a fire hazard



Paneled drop soffits typically are more combustible than plain drywall



When sealing on attic side, drywall and XPS are viable materials

Tools:

1. Drywall saw
2. Tape measure
3. Caulk gun
4. Drill

Materials:

1. Drywall
2. XPS
3. Fire-block sealant
4. Fasteners

EPS or bead-board are not acceptable materials.

3.1001.2c - Non-standard chase (interior walls covered with wood or paneling)



Sealing with drywall reduces overall combustibility of paneled chases



Sealing with XPS also reduces overall combustibility of paneled chases

3.1001.2d

Desired Outcome:

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

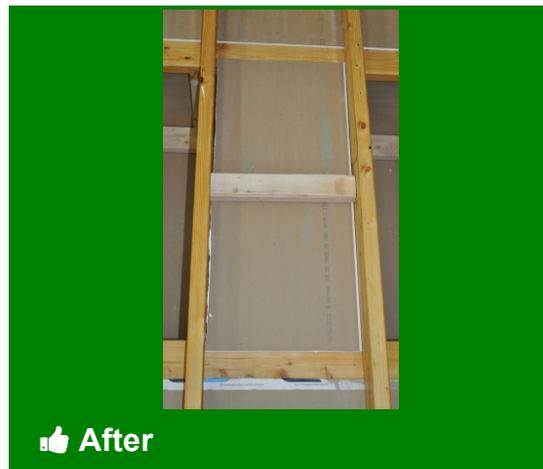
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

Objective(s):

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

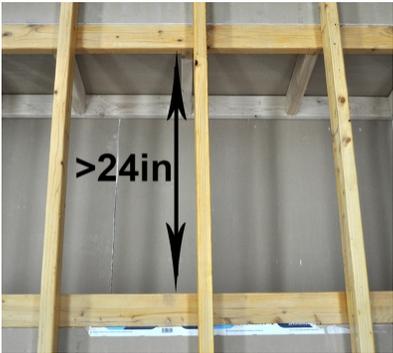
Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners

3.1001.2d - Support



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

3.1001.2e

Desired Outcome:

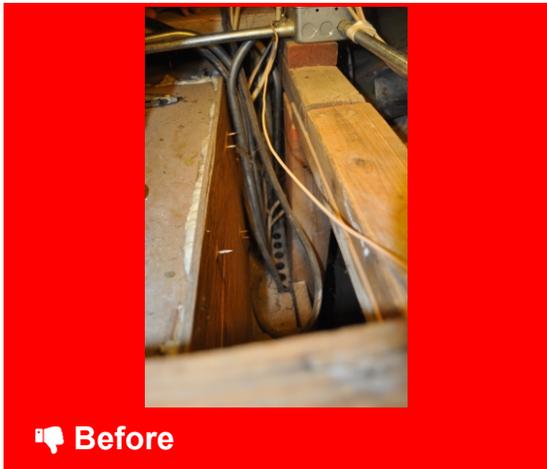
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Objective(s):

Provide airtight, durable seal that does not move, bend, or sag



Chases need to be capped and sealed to prevent leakage



Chase is sealed along all cracks, gaps, and penetrations

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Spray foam
2. Caulk

Always wear protective gloves when working with sealants.

3.1001.2e - Joint seal



Chase has been capped but needs to be sealed



Sealant is used to fill in all cracks and gaps along edges of chase cap



Cap is sealed

3.1001.2f

Desired Outcome:

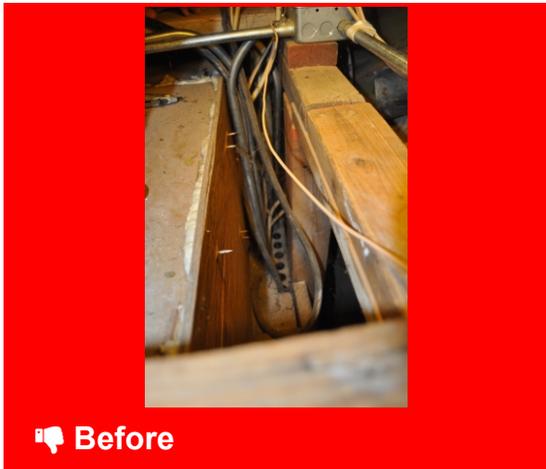
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

All remaining gaps at the top of the chase will be sealed

Objective(s):

Ensure airtight seal from one finished side of the chase to the other



Chases need to be capped and sealed to prevent leakage



Chase is sealed along all cracks, gaps, and penetrations

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Spray foam
2. Caulk

Always wear gloves when working with sealant.

3.1001.2f - Adjacent framing



Sealant is used to fill in all cracks and gaps along edges of chase cap Extend seal along adjacent framing

3.1001.3a

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):

Repair moisture-related issues

3.1001.3b

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with spray polyurethane foam (SPF)

Sealants will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Prevent air leakage from wall cavity to attic



Before
Wall cavities are open to attic



After
Whatever option chosen, test for visible air movement with smoke pencil

Tools:

1. Utility knife
2. Saw
3. Insulation machine
4. Caulk gun
5. Spray foam gun

Materials:

1. Drywall
2. XPS
3. Spray foam
4. Caulk
5. Fasteners
6. Dense packable insulation
7. Lumber

3.1001.3b - Sealing methods



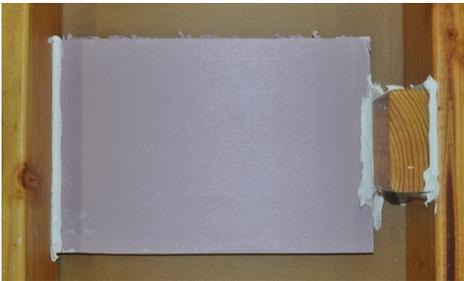
Option 1: Dense pack cavities through wood cap fastened in place



Option 2: Bridge cavities with spray foam



Option 3, Step 1: Apply sealant around opening and on surrounding framing



Option 3, Step 2, Option A: Cap with XPS and seal exposed joints



Option 3, Step 2, Option B: Cap with drywall and seal exposed joints

3.1001.3c

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

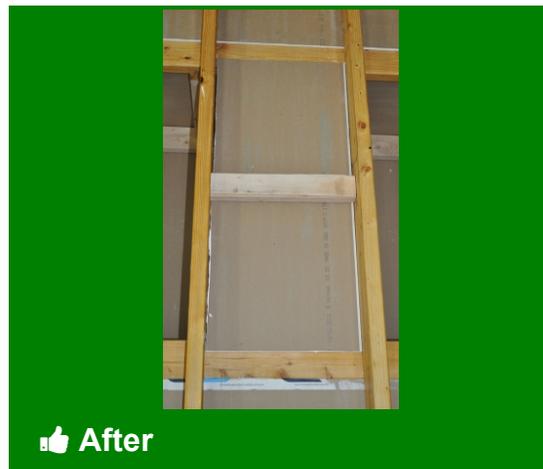
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

Objective(s):

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

Tools:

1. Saw
2. Drill
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners

3.1001.3c - Support



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

3.1001.3d

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Objective(s):

Provide airtight, durable seal that does not move, bend, or sag



Balloon framing needs to be capped and sealed to prevent leakage



All edges of the cap should be sealed to surrounding surfaces

Tools:

1. Spray foam gun
2. Caulk gun

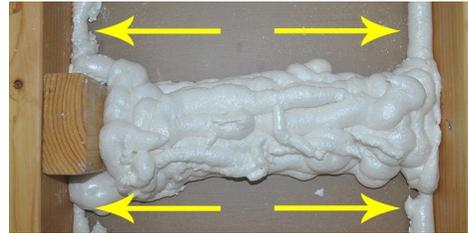
Materials:

1. Spray foam
2. Caulk

3.1001.3d - Joint seal



For rigid material applications, extend sealant along all seams



Extend sealant or SPF along joist to seal all gaps

3.1001.3e

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

All remaining gaps at the top of the opening will be sealed

OR

All remaining gaps at the top of the chase will be sealed

Objective(s):

Ensure airtight seal from one finished side of the wall assembly to the other



Before

Balloon framing needs to be capped and sealed to prevent leakage



All edges of the cap should be sealed to surrounding surfaces, including adjacent framing

Tools:

1. Spray foam gun
2. Caulk gun

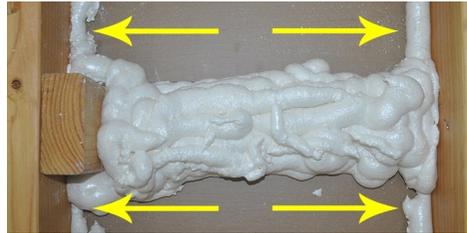
Materials:

1. Spray foam (SPF)
2. Caulk

3.1001.3e - Adjacent framing



For rigid material applications, sealant should be applied to framing



When using SPF to bridge cavity, extend SPF along joist and adjacent framing

3.1003.1a

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):

Repair moisture-related issues

3.1003.1b

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Prevent air leakage from dropped ceiling to attic



Damage to an older ceiling reveals the new ceiling below



Rigid material sealed in place creates an air barrier

Tools:

1. Utility knife
2. Saw
3. Drill
4. Insulation machine
5. Caulk gun
6. Spray foam gun
7. Tape measure

Materials:

1. Caulk sealant
2. Rigid material -- XPS or Drywall
3. Spray foam
4. Fasteners
5. Dense packable insulation
6. Wrapped fiberglass batts

3.1003.1b - Sealing methods



Prepare work area by removing existing insulation and debris



Option 1, Step 1: Run a bead of sealant around damage in old ceiling



Option 1, Step 2: Cover openings with rigid material, either XPS or drywall



Option 2: Seal with rigid material along face of stud cavities



Option 3: Dense pack cavities through fastened wood plate



Option 4: Bridge cavities at new ceiling level with wrapped batts and SPF



Whatever option chosen, test with chemical smoke to verify no leakage

3.1003.1c

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

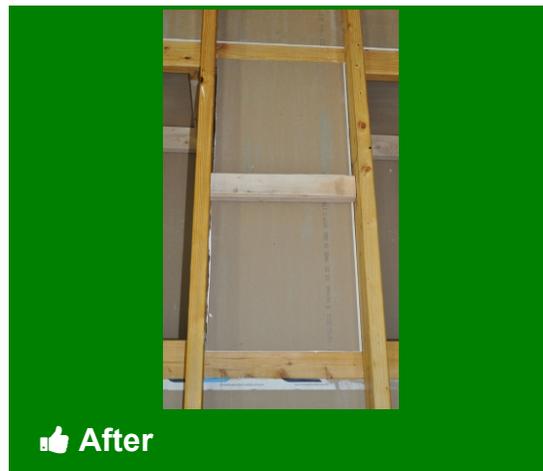
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

Objective(s):

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

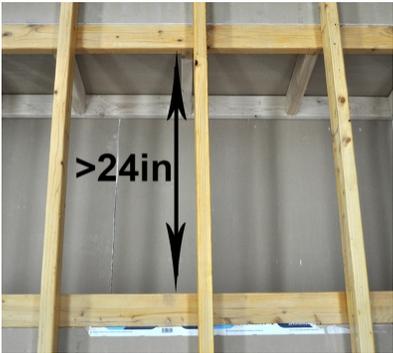
Tools:

1. Saw
2. Drill
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners

3.1003.1c - Support



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

3.1003.1d

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Objective(s):

Provide airtight, durable seal that does not move, bend, or sag



Damage to an old ceiling reveals a newer ceiling below



No gaps should remain after sealant is applied

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Caulk
2. Spray foam

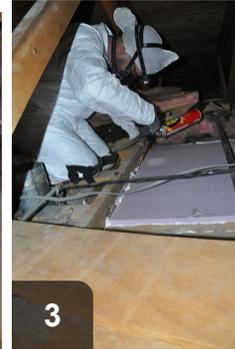
3.1003.1d - Joint seal



Apply sealant to surrounding surfaces before setting cap in place



Sealant should extend along joists and into seams at top plates



Once cap is set, apply sealant to remaining gaps and along all seams

3.1003.1e

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

All remaining gaps will be sealed at the top of the dropped ceiling

OR

All remaining gaps at the top of the chase will be sealed

Objective(s):

Provide airtight framing from one finished side of the dropped ceiling to the other



Damage to an older ceiling reveals the new ceiling below



No gaps should remain after spray foam is applied

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

1. Spray foam
2. Caulk sealant

3.1003.1e - Adjacent framing



Caulk along all joists before setting cap



Use sealant to fill all remaining gaps

3.1003.2a

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):

Repair moisture-related issues

3.1003.2b

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Ceiling or roof and wall air and thermal barriers will be connected with a rigid airtight connection around the perimeter

OR

If ceiling will support an air barrier and insulation, a rigid airtight barrier (e.g., gypsum) will be attached to current ceiling either above or below

OR

Intermediate framing will be used to support air and thermal barrier

OR

Rigid airtight thermal barrier will be installed at the roof sheathing

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Prevent air leakage from dropped ceiling to attic

3.1003.2c

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

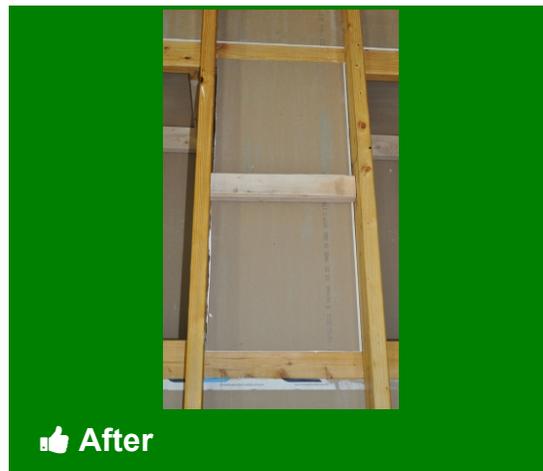
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

Objective(s):

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners

3.1003.2c - Support



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

3.1003.2d

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Objective(s):

Provide airtight, durable seal that does not move, bend, or sag



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after sealant is applied

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

1. Spray foam
2. Caulk

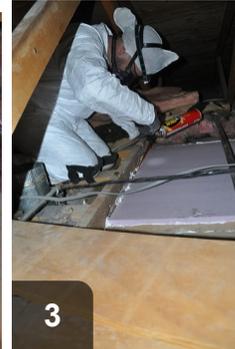
3.1003.2d - Joint seal



Apply sealant to surrounding surfaces before setting cap in place



Sealant should extend along surround joist and into seams at top plates



Once cap is set, apply sealant to remaining gaps and along all seams

3.1003.2e

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

All remaining gaps will be sealed at the top of the dropped ceiling

OR

All remaining gaps at the top of the chase will be sealed

Objective(s):

Provide airtight framing from one finished side of the dropped ceiling to the other



Before
Dropped soffits need to be capped and sealed to prevent leakage



After
No gaps should remain after sealant is applied along adjacent framing

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

1. Spray foam
2. Caulk sealant

3.1003.2e - Adjacent framing



Sealant should have been along all joists and adjacent framing before cap was set



Additional sealant should fill in all remaining gaps after cap has been set

3.1003.3a

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):

Repair moisture-related issues

3.1003.3b

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Prevent air leakage from dropped ceiling to attic



Unsealed drop soffits over tubs and closets can be a point of leakage



Capped soffits minimize leakage to and from unconditioned spaces

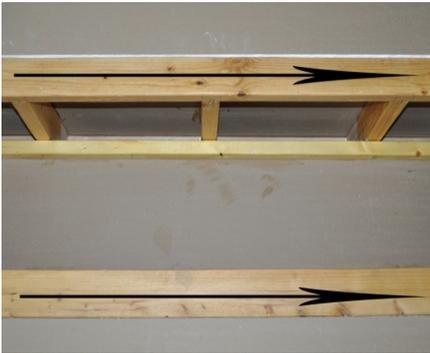
Tools:

1. Utility knife
2. Saw
3. Tape measure
4. Insulation machine
5. Drill
6. Caulk gun
7. Spray foam gun
8. Smoke pencil

Materials:

1. XPS
2. Drywall
3. Plywood
4. Caulk
5. Spray foam
6. Dense packable insulation
7. Fasteners
8. Wrapped fiberglass batts

3.1003.3b - Above closets and tubs



Option 1, Step 1: Apply sealant to top plates or other relevant surfaces



Option 1, Step 2: Cover soffit with rigid material, such as drywall



Option 1, Step 3: Secure the rigid material with screws



Option 2: Cover face of stud bay with rigid material, like XPS or plywood



Option 3: Dense pack cavity through fastened wood cap



Option 4: Bridge stud bay with wrapped fiberglass and spray foam



All Options: Test with smoke pencil to verify no air movement

3.1003.3c

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

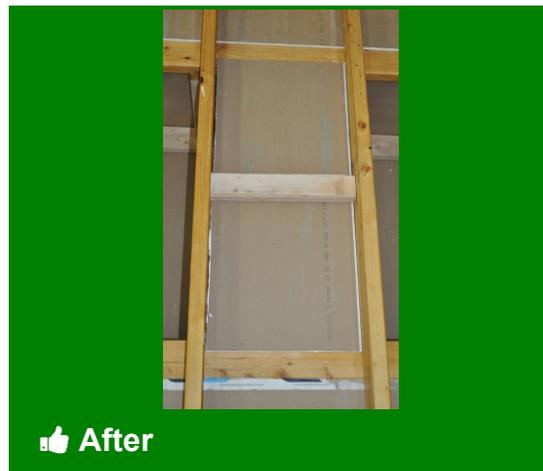
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

Objective(s):

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners

3.1003.3c - Support



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

3.1003.3d

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Objective(s):

Provide airtight, durable seal that does not move, bend, or sag



Before
Uninsulated soffits can cause leakage to and from unconditioned spaces



After
No gaps should remain after spray foam is applied

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

1. Caulk
2. Spray foam

3.1003.3d - Joint seal



Caulk surrounding surfaces before setting cap in place



Sealant should extend along surround joist and into seams at top plates



Once cap is set, apply sealant to remaining gaps and along all seams

3.1003.3e

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

All remaining gaps at the top of the dropped ceiling will be sealed

Objective(s):

Provide airtight framing from one finished side of the dropped ceiling to the other



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after sealant is applied along adjacent framing

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

1. Caulk sealant
2. Spray foam

3.1003.3e - Adjacent framing



Apply sealant to surrounding surfaces before setting cap in place



Sealant should extend along adjacent framing and into seams at top plates



Additional sealant should fill in all remaining gaps after cap has been set

3.1003.4a

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):

Repair moisture-related issues

3.1003.4b

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Entire opening will be spanned with rigid material installed in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Prevent air leakage from dropped ceiling to attic

3.1003.4c

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

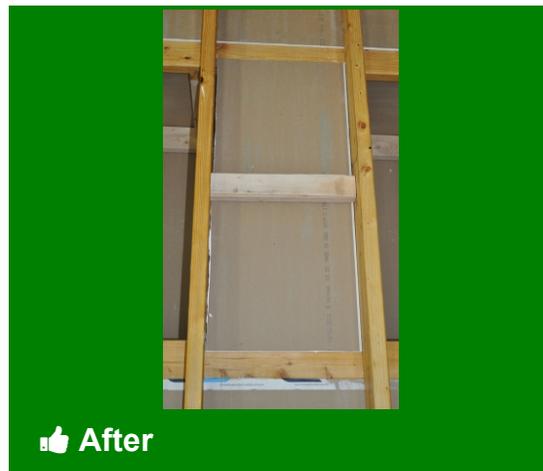
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

Objective(s):

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

Tools:

1. Saw
2. Drill
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners

3.1003.4c - Support



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

3.1003.4d

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Pre-fabricated units may be used when meeting the desired outcome

Objective(s):

Provide airtight, durable seal that does not move, bend or sag



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after spray foam is applied

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Spray foam
2. Caulk sealant

3.1003.4d - Joint seal



1

Caulk surrounding surfaces before setting cap in place



2

Sealant should extend along surround joist and into seams at top plates



3

Once cap is set, apply sealant to remaining gaps and along all seams

3.1003.4e

Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

Specification(s):

All remaining gaps will be sealed at the top of the dropped ceiling

OR

All remaining gaps at the top of the chase will be sealed

Objective(s):

Provide airtight framing from one finished side of the dropped ceiling to the other



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after sealant is applied along adjacent framing

Tools:

1. Spray foam gun
2. Caulk gun

Materials:

1. Spray foam
2. Caulk

3.1003.4e - Adjacent framing



1
Sealant should have been along all joists and framing before cap was set



2
Additional sealant should fill in all remaining gaps after cap has been set

3.1003.6a

Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):

Repair moisture-related issues

3.1003.6b

Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

Air flow will be blocked at soffit in locations where access allows

Objective(s):

Provide continuous air barrier across soffit openings



👎 Before

Accessible drop soffits should be sealed to prevent heat gain/loss



👍 After

Completely sealed drop soffits and chases minimize heat transfer

Tools:

1. Measuring tape
2. Utility knife
3. Caulk gun
4. Spray foam gun
5. Saw
6. Drill

Materials:

1. Caulk
2. Spray foam
3. Lumber
4. XPS
5. Fasteners

There is a variety of ways to seal soffits. Please examine 3.1003.6c and 3.1003.6d for more information.

3.1003.6c

Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

Specification(s):

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

Objective(s):

Prevent air leakage from wall to attic

Reduce opening to what can be sealed with sealant

Ensure closure is permanent and supports any load (e.g., wind, insulation)

Bring soffit into thermal boundary



Standard soffits are often open to the attic and uninsulated



Rigid material encloses the soffit into the conditioned living space

Tools:

1. Drill/screwdriver
2. Caulk gun

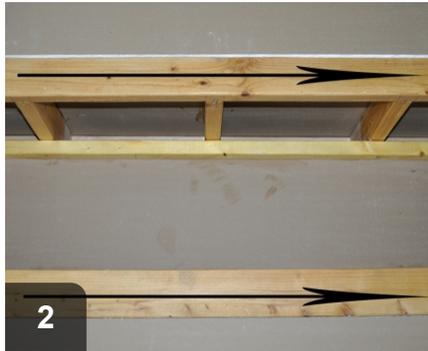
Materials:

1. Drywall
2. Sealant

3.1003.6c - Option 1: bring soffit inside (seal at top)



Soffits open to the attic need to be sealed to maintain air barrier



Apply sealant along top plates



Cap soffit with rigid material, such as drywall, cut to size



Fasten cap with screws to set sealant and create air barrier



Insulate over now-capped soffit

3.1201.1a

Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

Objective(s):

Protect worker and occupant from potential lead hazards



Best Practice

In homes built before 1978, test paint before beginning renovation

Tools:

1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

3.1201.1a - Lead paint assessment



1
Clean tools and sample site to prevent contamination



2
Cut sample site at an angle to expose all older paint layers



3
Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4
Check swab for reaction



5
Red indicates lead positive. White indicates lead negative.



6
If negative, verify validity of test with provided calibration card



7
Lead in calibration card should test positive and turn red



8
Record test results to maintain documentation

3.1201.1b

Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

Specification(s):

Existing weather stripping and sash sealant will be removed

Surface where the sill meets the sash will be cleaned

Seal between the fixed components of the window (e.g., jambs, sill) will be continuous and complete while maintaining the operability of the window

Continuous and complete weather stripping will be installed on the bottom of the lower sash where it makes contact with the sill and at the top of the upper sash where it makes contact with the upper part of the window frame

Objective(s):

Form a complete seal from the outer edge of the sash to the jamb

Maintain operability of the window

3.1201.1c

Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

Specification(s):

Locks will be installed so that the rails of the upper and lower sashes are flush and in full contact

No gaps will be visible between the two sashes

Locks will be installed to achieve compression of the two sashes

Objective(s):

Form a secure connection between the two sashes

3.1201.2a

Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

Objective(s):

Protect worker and occupant from potential lead hazards



Best Practice

In homes built before 1978, test paint before beginning renovation

Tools:

1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

3.1201.2a - Lead paint assessment



1 Clean tools and sample site to prevent contamination



2 Cut sample site at an angle to expose all older paint layers



3 Break capsule and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White is lead negative



6 If negative, verify validity of test with provided calibration card



7 Lead in calibration card should test positive and turn spot red



8 Record test results to maintain documentation

3.1201.3a

Desired Outcome:

Doors operable and weather tight

Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

Objective(s):

Protect worker and occupant from potential lead hazards



Best Practice

In homes built before 1978, test paint before beginning renovation

Tools:

1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

3.1201.3a - Lead paint assessment



1
Clean tools and sample site to prevent contamination



2
Cut sample site at an angle to expose all older paint layers



3
Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4
Check swab for reaction



5
Red indicates lead positive. White is lead negative



6
If negative, verify validity of test with provided calibration card



7
Lead in calibration card should test positive and turn spot red



8
Record test results to maintain documentation

3.1201.3b

Desired Outcome:

Doors operable and weather tight

Specification(s):

Door will be adjusted to properly fit the jamb and allow for ease of operation (e.g., hinge replacement, re-plane door, door strike adjustment)

Objective(s):

Ensure proper operation of the door



Daylight visible around door can indicate it does not hang true and leaks



With proper adjustment, doors should hang true and minimize leakage

Tools:

1. Screwdriver
2. Planer

Materials:

1. Shims

3.1201.3b - Door operation and fit



After examining how door hangs, remove door from hinges



Adjust hinge plates to bring door back into true



Adjust strike plate to allow for secure and smooth operation



Rehang door to verify adjustments worked and door operates smoothly

3.1201.3c

Desired Outcome:

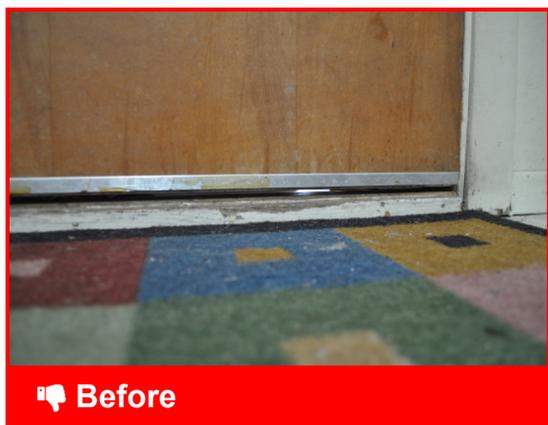
Doors operable and weather tight

Specification(s):

Details that reduce air infiltration will be repaired, replaced, sealed, or installed in accordance with State Energy Conservation Code or local code—whichever is more stringent (e.g., weather stripping, door bottoms, trim replacement with foam)

Objective(s):

Reduce air infiltration



Daylight visible around an exterior door indicates air infiltration



Weatherstripping and a door bottom minimize air infiltration around doors

Tools:

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

Materials:

1. Weatherstripping (Q-lan)
2. Door bottom
3. Fasteners
4. Caulk

3.1201.3c - Air infiltration



Remove leaky door in order to affix door bottom



Measure and trim door, if necessary, to allow for door bottom



Trimming to allow for door bottom



Cut door bottom to width of door



Ensure door bottom fits snugly around door and fasten into place



Measure doorway for weatherstripping



Notch upper ends of side weatherstripping to allow for top piece



Weatherstripping should fit snugly into rabbit and against other pieces



Rehang door and verify fit, operation, and lack of air infiltration

3.1201.3d

Desired Outcome:

Doors operable and weather tight

Specification(s):

Details that reduce water infiltration will be repaired, replaced, sealed, or installed (e.g., adjust threshold, caulk jamb to threshold, caulk trim, flashing)

Objective(s):

Reduce water infiltration



 Before

Daylight visible under exterior doors indicate water can leak in



 After

By adjusting the threshold and sealing along it, water should be kept out

Tools:

1. Caulk gun
2. Screwdriver
3. Pry bar

Materials:

1. Caulk sealant

3.1201.3d - Water infiltration



Adjust threshold to minimize gap and keep water out



Caulk along threshold from inside and outside to prevent water infiltration

3.1202.1a

Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

Objective(s):

Protect worker and occupant from potential lead hazards



Best Practice

In homes built before 1978, test paint before beginning renovation

Tools:

1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

3.1202.1a - Lead paint assessment



1 Clean tools and sample site to prevent contamination



2 Cut sample site at an angle to expose all older paint layers



3 Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White is lead negative



6 If negative, verify validity of test with provided calibration card



7 Lead in calibration card should test positive and turn spot red



8 Record test results to maintain documentation

3.1202.1b

Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

Putty and push points will be removed

Broken or cracked glass will be removed

Objective(s):

Safely remove old glass



Broken glass with failed repairs needs to be replaced



Large pieces of glass have been removed but sash still needs preparation

Tools:

1. Putty knife
2. Chisel
3. Utility knife
4. Shop vacuum
5. Tape measure

Materials:

1. Tape

Always wear heavy work gloves when working with glass. See also 2.0100.1b for Hand Protection.

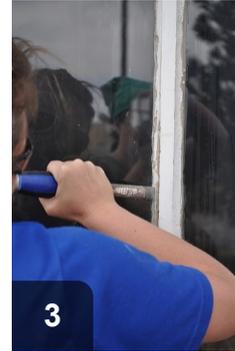
3.1202.1b - Broken glass removal



1 Always wear heavy work gloves when working with glass



2 Cut through caulk bead and glazing to ease removal



3 Remove old putty and glazing to expose metal points holding glass in place



4 With points and glass removed, measure opening for replacement pane



5 Cut replacement glass 1/8" smaller than measured opening

3.1202.1c

Desired Outcome:

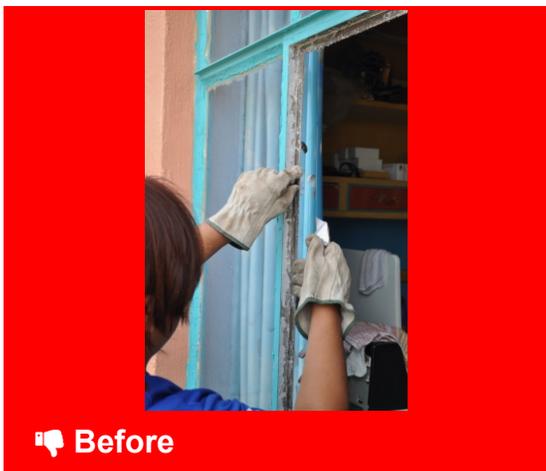
Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

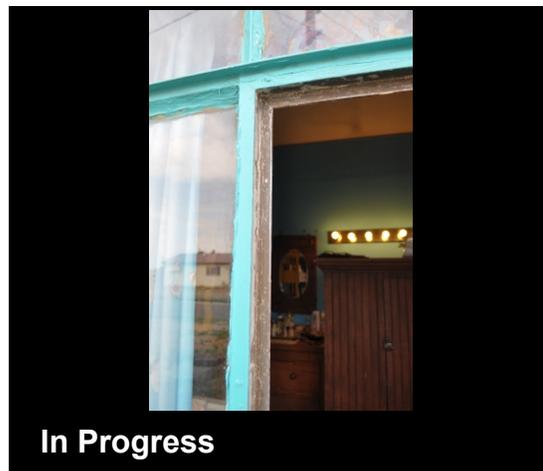
Opening will be cleaned

Objective(s):

Prepare opening for new glass



Remove all debris from sash either by sand paper, knife, or chisel



Mount new glass onto a clean surface

Tools:

1. Chisel
2. Utility knife

Materials:

1. Sand paper
2. Cleaning solution
3. Rags

3.1202.1c - Sash preparation



1
Debris in the sash can cause new glass to seal improperly



2
Check closely to remove all pieces of broken glass and debris



3
With sash cleaned, glass will fit properly and glazing will seal

3.1202.1d

Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

Glass will be sized 1/8" to 3/16" smaller than opening to allow for movement of frame

Safety glass will be installed in accordance with local codes

Push points will be provided on each side to secure glass in frame

Glazing compound will be added in accordance with manufacturer specifications

Objective(s):

Ensure glazing compound will adhere to sash

Install, seal, and secure new glass in place

Allow glazing compound to harden to ensure secure installation



With sash prepared, installation of new pane can begin



Replacement glass should be securely fixed with points and glazing

Tools:

1. Caulk gun
2. Tape measure
3. Paint brush

Materials:

1. Primer
2. Window glazing
3. Push points
4. Shims
5. Replacement glass
6. Tape

Always wear heavy work gloves when working with glass. See also 2.0100.1b for Hand Protection.

3.1202.1d - New glass installation



1 Always wear heavy work gloves when working with glass



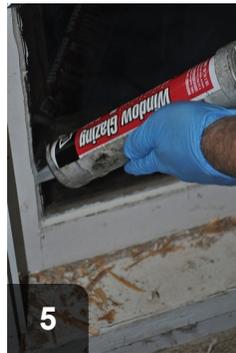
2 With broken glass removed, measure opening for replacement glass



3 Cut replacement glass 1/8" smaller than measured opening



4 Use shims to center glass while installing push points



5 With push points in place, glaze to air seal new glass pane in sash



6 Secure pane in place with tape to hold until glazing sets

3.1202.2a

Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

Objective(s):

Protect worker and occupant from potential lead hazards



Best Practice

In homes built before 1978, test paint before beginning renovation

Tools:

1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

3.1202.2a - Lead paint assessment



1 Clean tools and sample site to prevent contamination



2 Cut sample site at an angle to expose all older paint layers



3 Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White is lead negative



6 If negative, verify validity of test with provided calibration card



7 Lead in calibration card should test positive and turn spot red



8 Record test results to maintain documentation

3.1202.2b

Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

Window stops and damaged glass will be removed

Objective(s):

Safely remove old glass



Before

Broken glass with failed repairs needs to be replaced



In Progress

After larger pieces are removed, the sash still needs preparation

Tools:

1. Putty knife
2. Chisel
3. Utility knife
4. Shop vacuum
5. Tape measure

Materials:

1. Tape

Always wear heavy work gloves when working with glass. See also 2.0100.1b for Hand Protection.

3.1202.2b - Broken glass removal



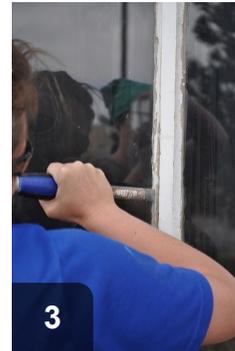
1

Always wear heavy work gloves when working with glass



2

Cut through caulk or glazing to simplify removal



3

Remove old putty and glazing from glass to expose pin nails holding glass



4

With pins and glass removed, measure opening for replacement pane



5

Cut replacement glass 1/8" smaller than measured opening

3.1202.2c

Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

Opening will be cleaned

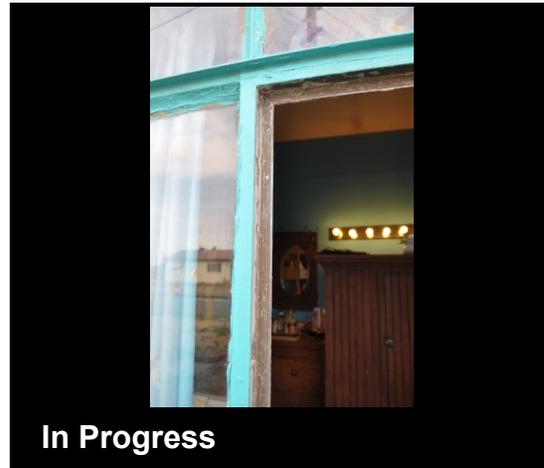
Glazing tape will be removed or replaced

Objective(s):

Prepare opening for new glass



Remove all debris, glazing tape, and glass from sash



Sash surface must be clean before mounting new glass

Tools:

1. Chisel
2. Utility knife

Materials:

1. Cleaning solution
2. Rags

3.1202.2c - Opening preparation



1
Debris in the sash can cause new glass to seal improperly



2
Check closely to remove and collect all broken glass and debris



3
With sash cleaned, glass will fit properly and glazing will seal

3.1202.2d

Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

Specification(s):

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

Stops will be replaced or installed

Wood stops will be sealed to glass with appropriate sealant

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

Tempered glass will be installed as required by local codes

Glazing compound will be added in accordance with manufacturer specifications

Objective(s):

Install, seal, and secure new glass in place

Allow glazing compound to harden to ensure secure installation



With sash prepared, new pane installation can begin



Replaced glass should be held in place while glazing sets

Tools:

1. Caulk gun
2. Tape measure
3. Light-duty hammer

Materials:

1. Trim

Always wear heavy work gloves when working with glass. See also 2.0100.1b for Hand Protection.

3.1202.2d - New glass installation



1 Always wear heavy work gloves when working with glass



2 With broken glass removed, measure rough opening for replacement glass size



3 Cut replacement glass 1/8" smaller than measured opening size



4 With sash prepared, shim glass to center in opening and reinstall stops



5 Apply window glazing to air seal new pane

3.1203.1a

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

Specification(s):

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Objective(s):

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Tools:

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3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

3.1203.1a - Lead paint assessment



1
Clean tools and sample site to prevent contamination



2
Cut sample site at an angle to expose all older paint layers



3
Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4
Check swab for reaction



5
Red indicates lead positive. White indicates lead negative



6
If negative, verify validity of test with provided calibration card



7
Lead in calibration card should test positive and turn spot red



8
Record test results to maintain documentation

3.1203.1b

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

Specification(s):

Interior stops, sashes, parting strips, and pulleys will be removed

Opening will be cleaned

Objective(s):

Provide a clean opening for replacement window unit



 Before

Wooden window still in opening



In Progress

Wood window with sashes removed before replacement

Tools:

1. Stiff bladed scraper or putty knife
2. Single-edge razor blade scraper

3.1203.1b - Opening preparation



Wood double-hung window



Remove stop moulding (non-lead based paint). For lead based paint work requirements, visit <http://www2.epa.gov/lead>



Remove sashes and balances (tracks). Remove sash cords and pry pulleys out of the jamb in older units



Scrape loose paint and thoroughly clean opening

3.1203.1c

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

Specification(s):

Replacement window will be installed in accordance with manufacturer specifications, ensuring that the exterior stops are caulked

Objective(s):

Ensure replacement window operates properly

Ensure replacement window has a weather tight fit



Window opening ready to receive replacement window



Replacement window installed, with stop molding replaced and caulked

Tools:

1. Utility knife
2. Hammer
3. Sharp-bladed prybar
4. Nail set punch
5. Cordless driver/drill
6. Caulking gun
7. HEPA vacuum (for lead-based paint work)

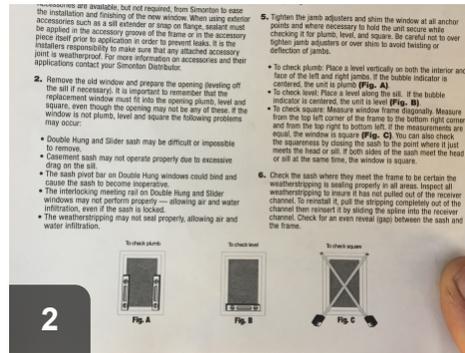
Materials:

1. Window, door, and trim caulk
2. 6-mil polyethylene plastic

3.1203.1c - Replacement window installation



1 Prepare and clean opening before installing new window



2 Check opening for plumb, level, and square



3 Measure diagonally both ways across opening. If measurements are equal, the opening is square



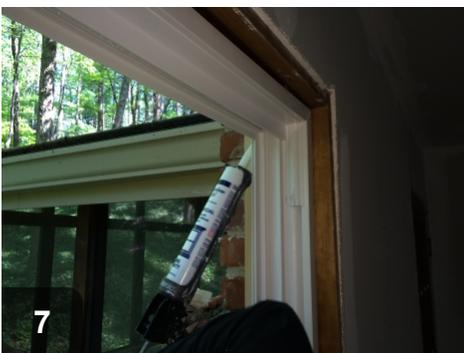
4 Apply caulk to stop molding and install the new window in accordance with manufacturer's instructions.



5 Tighten jamb adjusters and shim as necessary to achieve plumb, level, and square. Fasten window into opening



6 Make sure the sashes open, close, and lock properly. Check that the sashes are parallel with the frame as shown



7 Caulk new window to existing stop molding



8 Reinstall and caulk interior stop molding



9 Completed installation

3.1203.2a

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

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Tools:

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4. Camera

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3.1203.2a - Lead paint assessment



1
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2
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3
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4
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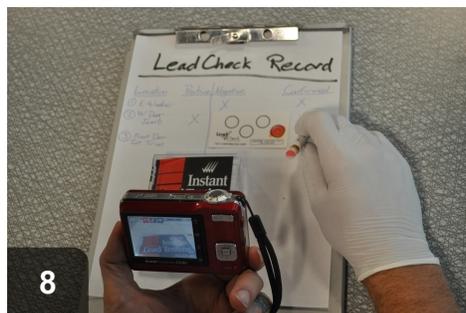
5
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6
If negative, verify validity of test with provided calibration card



7
Lead in calibration card should test positive and turn spot red



8
Record test results to maintain documentation

3.1203.2b

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

Specification(s):

Replacement window will be laid out with trim

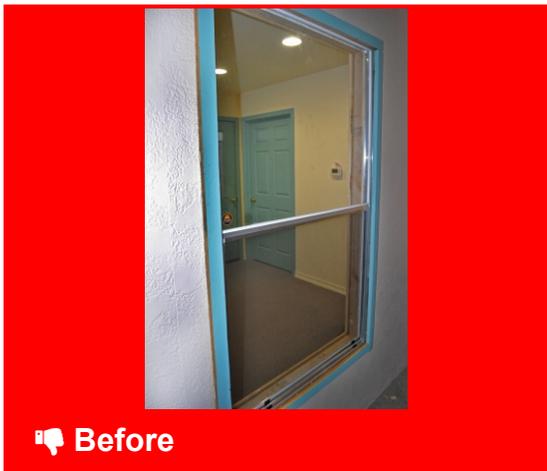
Exterior trim will be removed or exterior siding will be cut back to fit new window with trim

Existing window will be removed

Window opening will be flashed in accordance with accepted industry standards

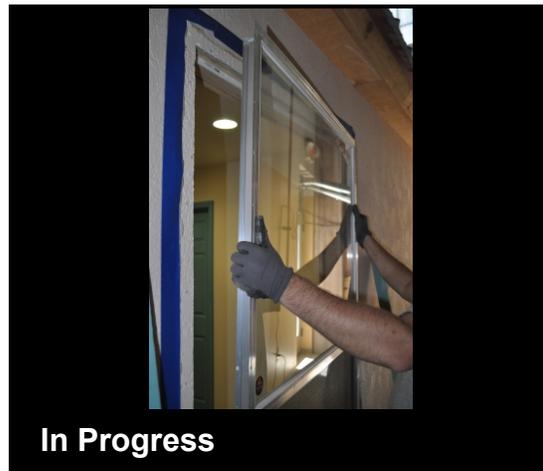
Objective(s):

Provide a clean and properly flashed opening for replacement window unit



 Before

Single pane window in newer home



In Progress

Window is removed to allow for replacement with double pane unit

Tools:

1. Pry bar
2. Utility knife
3. Drill

Materials:

1. Window and door flashing

3.1203.2b - Opening preparation



1
Single pane window needs to be replaced with double pane



2
Cut through caulk at stops to break seal



3
Remove stops while attempting to keep damage to rough opening to minimum



4
Remove interior trim



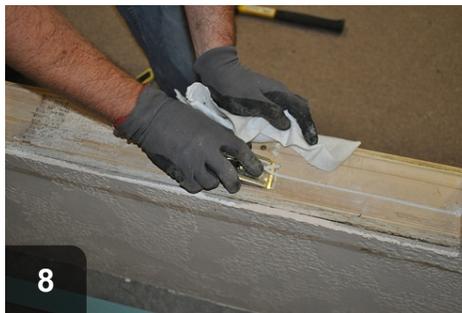
5
Remove exterior trim



6
Remove exterior fasteners to free window



7
Remove window from rough opening



8
Clean rough opening to remove old caulk and debris



9
Install flashing along sides and bottom of rough opening

3.1203.2c

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

Specification(s):

Mounting detail will be determined based on depth of window and location of window liner

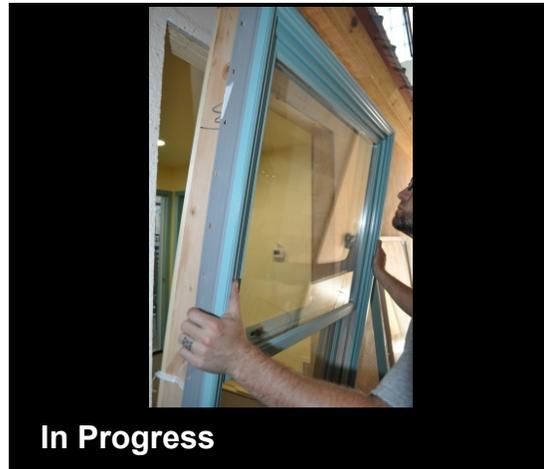
Objective(s):

Allow for good fit and finish of replacement window



Before

Single pane window is being removed



In Progress

Double-pane unit replaces previous single-pane one

Tools:

1. Tape measure
2. Utility knife

3.1203.2c - Replacement unit preparation



1 Measure rough opening depth to determine best method of installation



2 Clean old sealant off exterior surface to allow for flange installation



3 Install unit following appropriate detail for rough opening and unit depth

3.1203.2d

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

Specification(s):

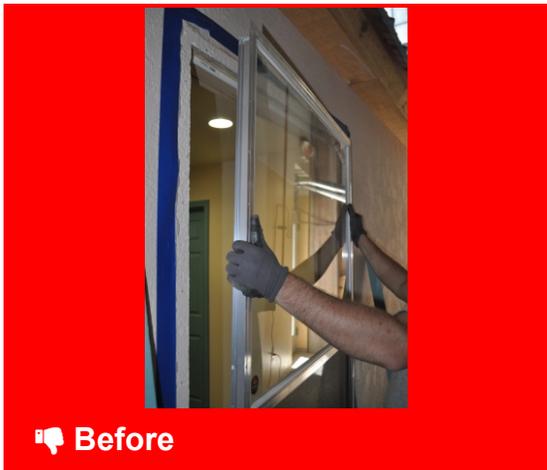
Replacement windows will be installed in accordance with manufacturer specifications and will be integrated with flashing

Gaps between the new window and existing frame will be sealed with low-expanding foam

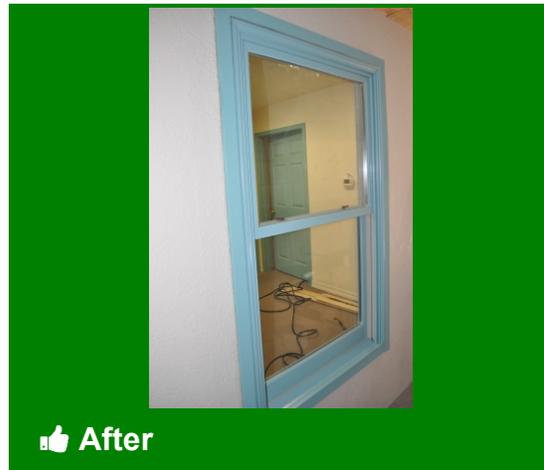
Objective(s):

Ensure replacement window operates properly

Ensure replacement window is weather tight



Single pane window is being removed to install double pane unit



Double pane unit installed with trim in place

Tools:

1. Utility knife
2. Spray foam gun
3. Drill
4. Hammer
5. Saw

Materials:

1. Fasteners
2. Flashing
3. Low-expansion spray foam
4. Backer rod
5. Primed trim

3.1203.2d - Replacement window installation



Install flashing to manufacturer specs and industry standards



Flanges have been folded out to allow for easy installation



Fasten window flange securely around exterior of entire window



With window secured in place, check for proper function



Check that sash locks align properly, indicating window is plumb



Fill interior gap with compressible foam or appropriate sealant



Prime and replace interior trim and, if needed, sill



Replace exterior trim and patch exterior siding or finish as needed

3.1402.1a

Desired Outcome:

Air leakage prevented and indoor air quality protected

Specification(s):

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

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

Objective(s):

Ensure resulting closure is permanent and supports any load (e.g., insulation)

Ensure sealant does not fall out



Before
Gaps around floor penetrations, such as plumbing, HVAC, and electrical



After
Gaps should be sealed to maintain air barrier

Tools:

1. Headlamp

Materials:

1. Backer rod
2. Sealant

3.1402.1a - Backing and infill



Prepare work space by removing any insulation



Infill with backer rod



Apply appropriate caulking to ensure backing/infill does not move



Visually inspect to verify no gaps remain

3.1402.1b

Desired Outcome:

Air leakage prevented and indoor air quality protected

Specification(s):

Sealants will be used to fill holes no larger than recommended by manufacturer specifications

Sealants will be compatible with their intended surfaces

Sealants will allow for differential expansion and contraction between dissimilar materials

Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction

Objective(s):

Create a permanent seal

Ensure sealant meets or exceeds the performance characteristics of the surrounding materials



Bad Practice

Avoid sealants that do not allow for expansion between dissimilar materials



Best Practice

Flexible sealants compensate for differential expansion and maintain a seal

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

1. Caulk
2. Spray foam

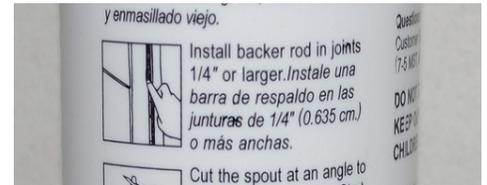
3.1402.1b - Sealant selection



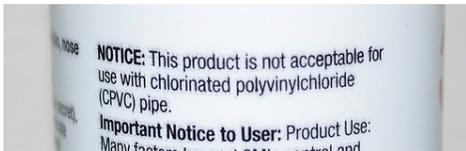
Caulking can be used to span gaps up to 1/4 inch



Spray foam can be used to span gaps up to 3 inches



Check manufacturer specifications to verify spanning capabilities



Also check manufacturer specs for incompatibility with intended surfaces

3.1402.1c

Desired Outcome:

Air leakage prevented and indoor air quality protected

Specification(s):

Only non-combustible materials will be used in contact with chimneys, vents, and flues in accordance with authority having jurisdiction

Objective(s):

Prevent a fire hazard



Gaps around floor penetrations allow air and moisture movement



Use non-combustible materials, like 26-gauge steel and high-temp caulk

Tools:

1. Caulk gun
2. Metal snips
3. Drill/screwdriver

Materials:

1. High-temperature caulk
2. 26-gauge steel sheeting

3.1402.1c - High temperature application



Prepare work area by removing any insulation and debris



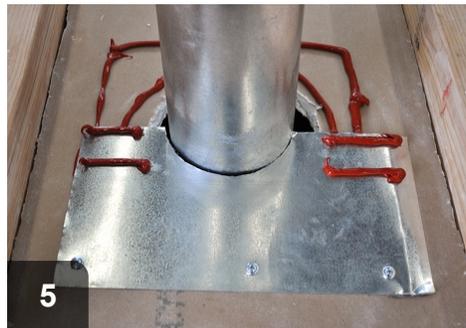
Use high-temperature caulking (600F min)



Apply first ring of caulking to match shape of opening



Apply second ring of caulking to size and shape of rigid material



Fasten rigid material (26-gauge steel) and apply additional caulking



Fasten rigid material to cover penetration and seal against flue with caulk

3.1402.3a

Desired Outcome:

Well-sealed exterior wall prevents leakage and pests

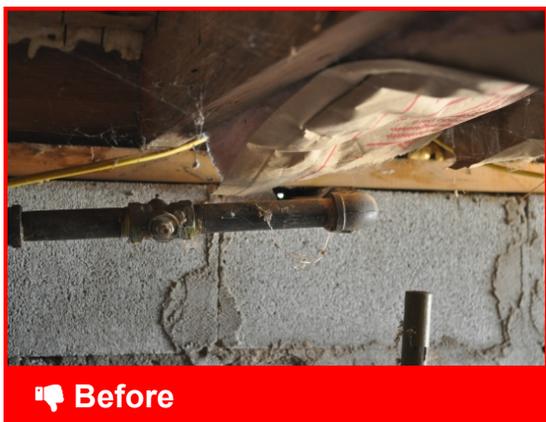
Specification(s):

Penetrations will be sealed with a durable material

A minimum expected service life of 10 years will be ensured

Objective(s):

Prevent air and moisture penetration into crawl space



Light showing through penetration in exterior block wall



Sealed with durable material to prevent air and water leakage, and pests

Tools:

1. Caulk gun
2. Sprayfoam gun
3. Metal snips
4. Drill

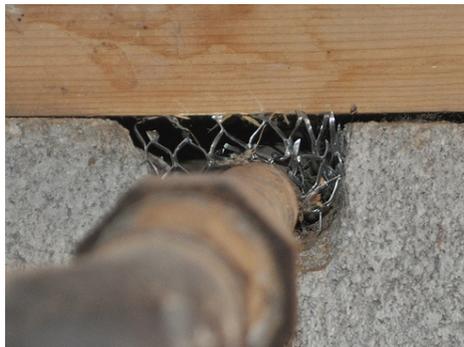
Materials:

1. Caulk
2. Sprayfoam
3. Metal mesh
4. Fasteners

3.1402.3a - Seal penetrations



Measure holes to determine the best backing and fill strategy



In holes larger than 1/4 inch, wire mesh should be used for backing



Sprayfoam or caulk seal the hole

3.1402.3b

Desired Outcome:

Well-sealed exterior wall prevents leakage and pests

Specification(s):

If penetration is greater than ¼ inches, caulking, steel wool, or other pest-proof material will be used to fill the penetration before sealing

Objective(s):

Prevent pest entry



 Before

For bigger holes, extra steps should be taken to keep out pests



 After

Choose the backing and infill strategy that works best for the hole size

Tools:

1. Caulk gun
2. Sprayfoam gun
3. Metal snips
4. Drill

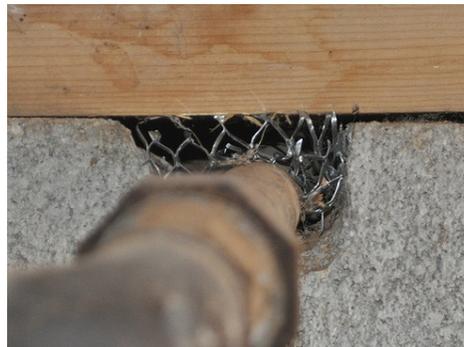
Materials:

1. Caulk
2. Sprayfoam
3. Metal mesh
4. Rigid backing

3.1402.3b - Pest exclusion



For holes larger than 1/4", rigid backing should be used to keep pests out



Metal mesh or other rigid materials should be cut to fill the space



Sprayfoam can be used to seal the hole and hold mesh in place

3.1501.1a

Desired Outcome:

Openings from garage sealed to prevent leakage

Specification(s):

All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed

Objective(s):

Prevent air leakage and pollutant entry



Penetrations between the garage and house can leak hazardous fumes



Seal penetrations to minimize risks and air leakage

Materials:

1. Backer Rod
2. Caulk
3. Spray foam

3.1501.1b

Desired Outcome:

Openings from garage sealed to prevent leakage

Specification(s):

All joints and connections in ductwork will be fastened and sealed with UL 181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus- embedded-fabric systems

Objective(s):

Prevent air leakage and pollutant entry



 Before

Unsealed joints and connections need to be sealed to prevent health risks.



 After

Sealed ductwork connections help prevent leakage.

Materials:

1. Mesh tape
2. Mastic

3.1501.1b - Ductwork



Prepare work area by assessing any safety concerns.



Wrap joint with fiberglass mesh tape.



Apply UL 181 mastic to seal joint.

3.1501.1c

Desired Outcome:

Openings from garage sealed to prevent leakage

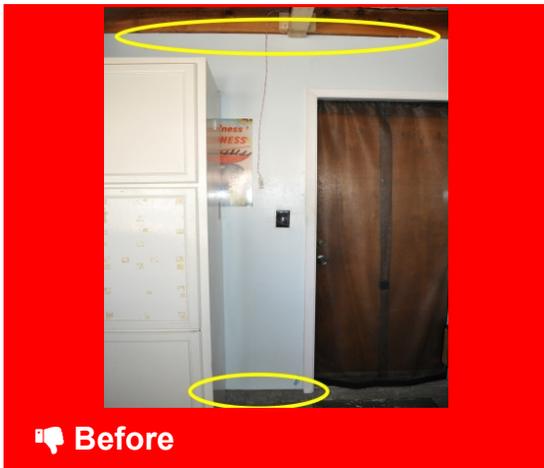
Specification(s):

All cracks in house and garage separation wall will be sealed, including cracks between mud sill, rim joists, subfloors, and bottom of gypsum board, ensuring the air sealing enhances the integrity of the fire resistance construction of that wall

All cracks in ceiling surfaces will be sealed

Objective(s):

Prevent air leakage and pollutant entry



Cracks in shared walls of attached garages are a potential leakage site



Air sealing reduces pollutant entry, but does not diminish fire resistance

Materials:

1. Sprayfoam
2. Fire-block caulk

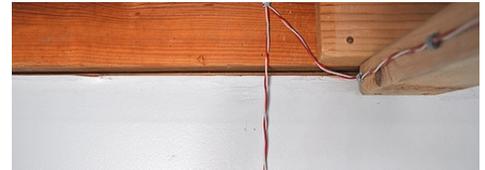
3.1501.1c - Cracks



Determine which walls are shared between garage and living space



Inspect wall and ceiling for cracks and penetrations



Clear work area of obstacles and debris



Apply appropriate sealant dependent upon size of crack and location



Ensure sealant does not decrease wall's fire resistance

3.1501.1d

Desired Outcome:

Openings from garage sealed to prevent leakage

Specification(s):

Weather stripping, door sweep, and threshold will be installed to stop air leakage

Objective(s):

Prevent air leakage and pollutant entry



Daylight visible under door to garage indicates leakage



Door sweep, with weatherstripping, will minimize air exchange with garage

Tools:

1. Caulk gun
2. Screwdriver
3. Utility knife
4. Hacksaw
5. Saw
6. Tape measure
7. Drill
8. Planer

Materials:

1. Weatherstripping (Q-lan)
2. Door sweep
3. Caulk
4. Fasteners

3.1501.1d - Garage to house door



Remove door for access to work space and to install sweep



Measure for weatherstripping around door



Install weatherstripping into rabbit around door



Corners of weatherstripping should be snug and secure



Adjust threshold to minimize contaminant and water infiltration



Caulk along threshold to minimize water and contaminant infiltration



Cut door sweep to width of the door



Ensure door sweep fits tightly against bottom of door and fasten in place



Rehang door to verify snug fit and smooth operation

3.1501.1e

Desired Outcome:

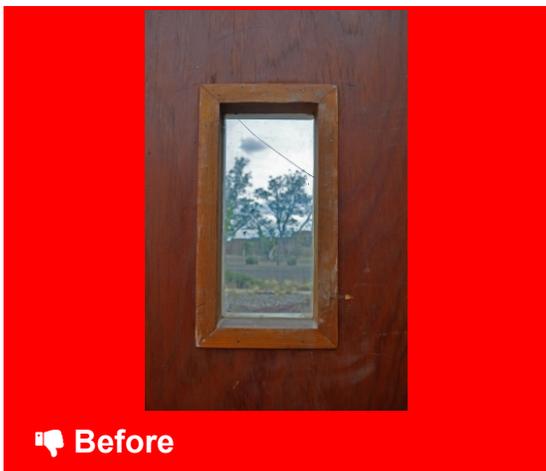
Openings from garage sealed to prevent leakage

Specification(s):

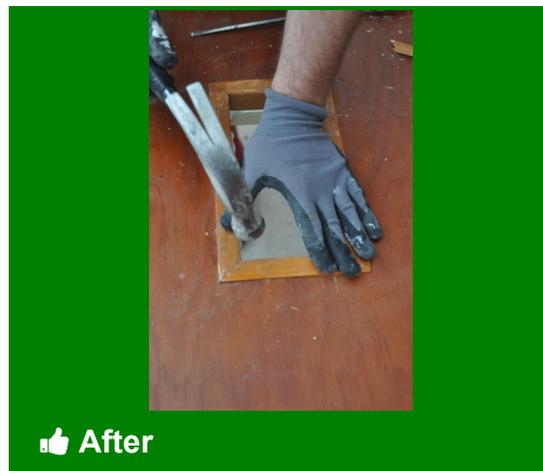
Broken glass panes in doors will be replaced, pointed, and glazed where needed

Objective(s):

Prevent air leakage and pollutant entry



Broken glass in exterior and garage doors allows for leakage. Replace it



With new glass in place, take care to tightly seal and replace stops

Tools:

1. Hammer
2. Pry bar
3. Caulk gun
4. Tape measure

Materials:

1. Brads
2. Caulk
3. Glazing
4. New glass cut to size of rough opening

3.1501.1e - Glass



Remove stops, taking care not to damage them



Remove broken glass and clean old sealant and glazing from rough opening



Measure rough opening and cut new glass to size



Apply sealant to rough opening and place new glass



Seal glass into place from inside as well to ensure no air infiltration



Replace stops and rehang door

3.1501.1f

Desired Outcome:

Openings from garage sealed to prevent leakage

Specification(s):

CO alarms will be installed in accordance with ASHRAE 62.2, applicable codes and manufacturer specifications

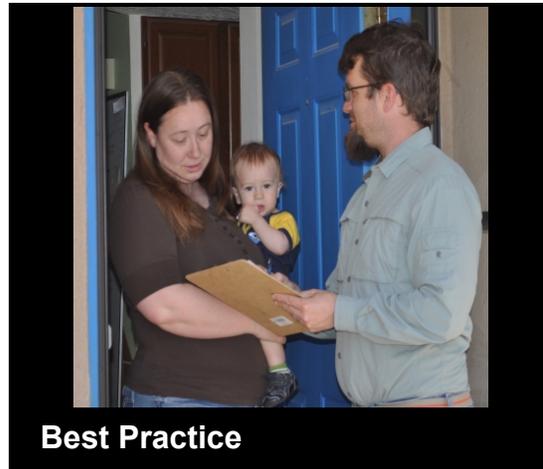
Objective(s):

Warn occupants of CO exposure from attached garage



Best Practice

Carbon monoxide alarms should be installed throughout the house



Best Practice

Occupants should be alerted to CO alarm locations and maintenance

CO alarms should be installed one per floor and near sleeping areas.

3.1501.1g

Desired Outcome:

Openings from garage sealed to prevent leakage

Specification(s):

Occupant will be educated on need to keep door from garage to house closed and not to warm up vehicles or use any gas engine appliances or grills in the garage, even if the main door is left open

Objective(s):

Reduce risk of CO poisoning inside of garage and adjacent rooms



Unsafe

Communicate importance of never running vehicles in a closed garage



Best Practice

Speak with occupant about hazards of using gas appliances in the garage

3.1501.1g - Occupant education



Occupants should never run vehicles in a closed garage



Occupants should not light combustibles inside garages



Speak with occupant about hazards of using gas appliances in the garage

3.1601.3a

Desired Outcome:

Ducts and plenums properly supported

Specification(s):

Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 ½" wide material

Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction

Metal ducts will be supported by 1/2 inch wide eighteen gauge metal straps or 12-gauge galvanized wire at intervals not exceeding 10 feet or other approved means

Objective(s):

Eliminate falling and sagging



Before

Ducts should not be allowed to droop and drag, adding distance to run



After

Properly supported ducts minimize heat loss and maximize duct run

Tools:

1. Metal snips
2. Utility knife
3. Drill
4. Stapler

Materials:

1. 18 gauge metal strap (at least 1/2" wide)
2. 12 gauge galvanized wire
3. Fabric support straps (at least 1 1/2" wide)
4. Staples
5. Fasteners

3.1601.3a - Support (applies to all duct types)



BAD: Make sure supports DO NOT compress insulation or duct



Flex ducts should have supports no less than every 4 feet



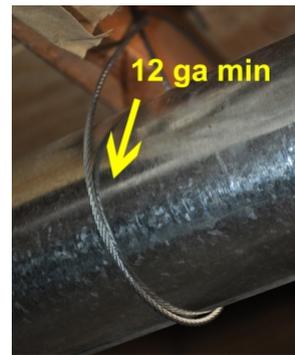
Durable strap should be at least 1 1/2 inches wide



Metal ducts should be supported every 10 feet or less with straps or wire



Metal straps should be at least 18 gauge and 1/2 inch wide



Metal wire should be at least 12 gauge and galvanized

3.1602.1a

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

Any closure system used will be in accordance with 2012 IRC Chapter 16

Objective(s):

Ensure effectiveness of air sealing system

3.1602.1b

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

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

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 prior to 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 (mastic and fiberglass mesh) to the duct

Reinforce seal

Support mastic and fiberglass mesh during curing

3.1602.1c

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

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

Fiberglass mesh and mastic will become the primary seal

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 fiberglass mesh and mastic during curing



 Before

Unsealed joints and connections need to be sealed to prevent health risks



 After

Sealed ductwork connections help prevent leakage

Materials:

1. Mastic
2. Fiberglass mesh tape

3.1602.1c - Existing component to existing component



1 Prepare work area by assessing any safety concerns



2 Wrap joint with fiberglass mesh tape



3 Apply UL 181 mastic to seal joint

3.1602.4a

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

All gaps between boot and interior surface that defines conditioned space will be air sealed

Gypsum edge will be wetted before applying water-based sealant

Sealants will be continuous and be in accordance with 2012 IRC R302.9

Objective(s):

Prevent air leakage

Prevent a fire hazard



Gaps around duct boots allow for leakage to and from the attic



Use a mesh in mastic system to seal duct boot to interior surface

Tools:

1. Utility knife
2. Spray bottle
3. Putty knife

Materials:

1. Mastic
2. Mesh tape

3.1602.4a - Duct boot to interior surface



1
Remove grill to expose duct boot and gaps



2
Wet the edges of the drywall to ensure a good bond



3
Cut mesh tape to fit around duct boot and cover gaps



4
Apply mastic over mesh tape to create heat resistant, durable bond



5
Once mastic is set, grill can be replaced and mastic should not show

3.1602.4b

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

Accessible connections and joints will be made airtight using approved material

Objective(s):

Ensure ducts and plenums will not leak



Locate unsealed ducts constructed from building cavities



Return plenum lined with fiberglass duct board and sealed with mastic

Tools:

1. disposable brushes
2. tape measure
3. utility knife
4. rubber gloves
5. framing square or T-square
6. tin snips

Materials:

1. mastic
2. fiberglass duct board
3. UL 181 listed mastic tape
4. spray polyurethane foam
5. sheet metal
6. screws

Use approved materials to seal ductwork; cover organic materials with airtight, non-organic material such as mastic, metal, or duct board.

From NFPA 90B 4.2.1.3: "The interior of combustible ducts shall be lined with noncombustible material at points where there might be danger from incandescent particles dropped through the register or heater, such as directly under floor registers, the bottom of vertical ducts, or heaters having a bottom return."

From NFPA 90B 4.3.1.1: "Duct coverings, duct linings, and tapes used in duct systems shall have a maximum flame spread index of 25 without evidence of continued progressive combustion and a

maximum smoke developed index of 50 when tested in accordance with ASTM E 84 or ANSI/UL 723..."

3.1602.4b - Wooden plenums and building cavities



Identify building cavities used as ducts



Seal penetrations around AC lineset and wiring



Cut and Install appropriate board material to create an airtight duct



Seal all seams and joints with duct mastic

3.1602.4c

Desired Outcome:

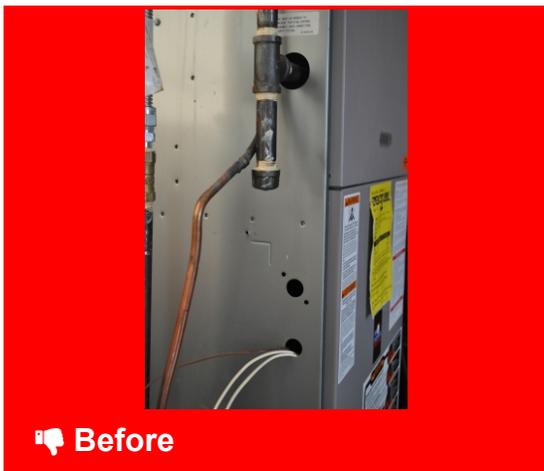
Ducts and plenums sealed to prevent leakage

Specification(s):

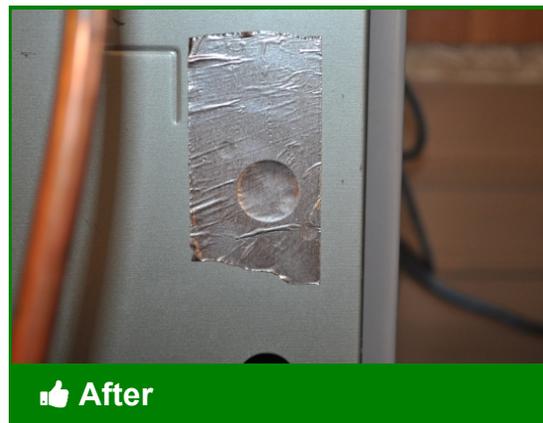
Joints will be closed and cracks and holes not needed for proper function of unit will be sealed using removable sealant (e.g., foil tape) or in accordance with the original equipment manufacturer directions (if available)

Objective(s):

Reduce air leakage while maintaining accessibility



Unnecessary holes in the air handler cabinet need to be sealed



Use removable foil tape to seal holes

Materials:

1. Foil tape

3.1602.4c - Air handler cabinet



1
Unnecessary holes in the air handler cabinet should be sealed



2
Removable foil tape should be used to seal



3
Fully cover holes with tape to seal completely

3.1602.4d

Desired Outcome:

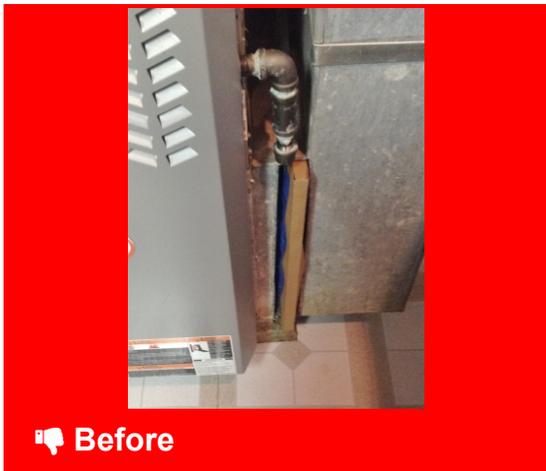
Ducts and plenums sealed to prevent leakage

Specification(s):

A pre-manufactured or site manufactured durable filter slot cover will be installed

Objective(s):

Reduce air leakage while maintaining accessibility



Uncovered filter slots are a point of leakage



Filter slots should be covered

3.1602.5a

Desired Outcome:

The return duct installed to prevent air leakage

Specification(s):

Debris and dirt will be cleaned out of the return platform

Objective(s):

Allow for the application of rigid materials and sealants



Dirty, unsealed return platform needs to be cleaned out before sealing



Vacuum out debris and dirt from the return to prepare work area

Tools:

1. Shop vacuum

3.1602.5b

Desired Outcome:

The return duct installed to prevent air leakage

Specification(s):

Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space

Backing or infill will not bend, sag, or move once installed

Material will be rated for use in return duct systems

Objective(s):

Minimize hole size to ensure successful use of sealant

Ensure closure is permanent and supports any load (e.g., return air pressure)

Ensure sealant does not fall out



Before

Leakage from air return into wall cavities should be eliminated



In Progress

Only materials rated for use in higher temperature areas should be used

Tools:

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

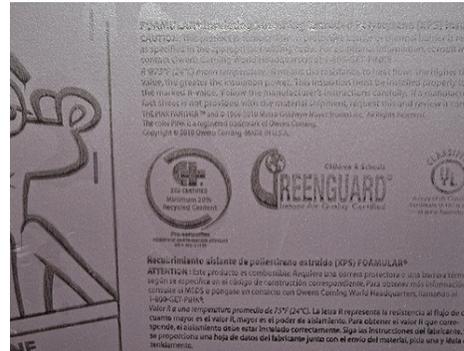
Materials:

1. XPS
2. Drywall
3. Fire-resistant caulk
4. Fasteners

3.1602.5b - Infill and backing



Do NOT use EPS in air returns due to proximity to combustion appliances



XPS (extruded polystyrene) and drywall are safe for use in air returns

3.1602.5c

Desired Outcome:

The return duct installed to prevent air leakage

Specification(s):

Sealants will be continuous and be in accordance with 2012 IRC R302.9

Objective(s):

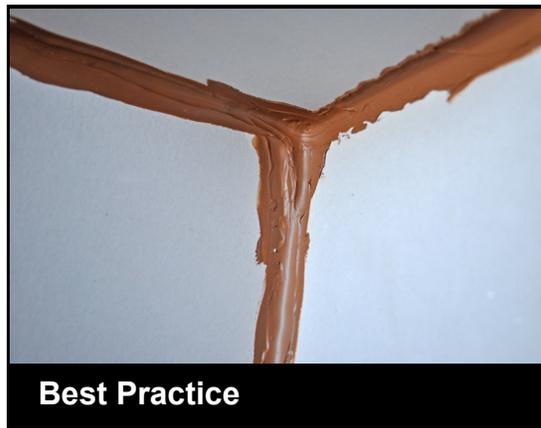
Select permanent sealant

Ensure sealant meets or exceeds the performance characteristics of the surrounding materials



Best Practice

Sealants, like mesh and UL 181 mastic, meet IRC, ASTM, and UL specs



Best Practice

Caulk sealants will be continuous

Tools:

1. Caulk gun
2. Utility knife
3. Taping knife

Materials:

1. Fiberglass mesh
2. Siliconized caulk
3. UL 181 mastic

Paraphrased from 2012 IRC R302.9: Wall and ceiling finishes will have a flame spread index of 200 or less and a smoke-developed index of 450 or less

4.1001.1a

Desired Outcome:

Ensure safety from fire and prevent air leakage

Specification(s):

A fire-rated air barrier system (i.e., equivalent to 5/8 fire code gypsum wallboard) will be used to separate non-IC rated recessed lights from insulation, using one of the methods below:

A fire-rated airtight closure taller than surrounding attic insulation will be placed over non-IC rated recessed lights

OR

The non-IC rated light fixture will be replaced with an airtight and IC- rated fixture

OR

The fixture(s) may be replaced with surface mounted fixture and opening sealed

OR

Air sealing measures as approved by the authority having jurisdiction

Objective(s):

Prevent a fire hazard

Prevent air leakage through fixture



Non-IC rated recessed light fixtures should be dammed from insulation



Sealed box around non-IC light should be taller than surrounding insulation

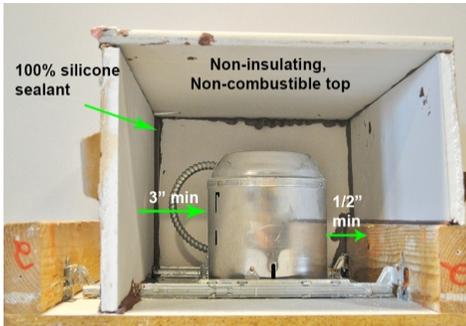
Tools:

1. Utility knife
2. Tape measure

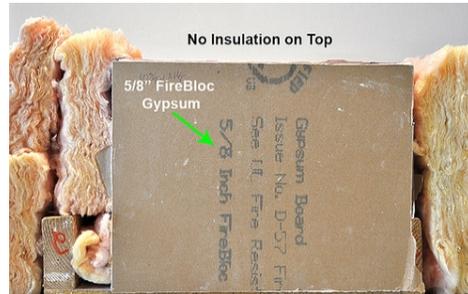
Materials:

1. 5/8" fire-rated drywall
2. Fire-rated caulk sealant

4.1001.1a - Air barrier system



Box should be constructed with clearances in mind



Sealed box should be constructed of fire-rated drywall



OR non-IC can light can be replaced with IC-rated recessed light

4.1001.1b

Desired Outcome:

Ensure safety from fire and prevent air leakage

Specification(s):

The top-fire rated enclosure material will have an R-value of 0.5 or less

The top of the enclosure will be left free of insulation

Objective(s):

Prevent heat build up



Non-IC rated recessed lights create excess heat and are a fire risk



Once dammed from insulation, it should still not have insulation on top

Tools:

1. Utility knife
2. Caulk gun

Materials:

1. Drywall

4.1001.1c

Desired Outcome:

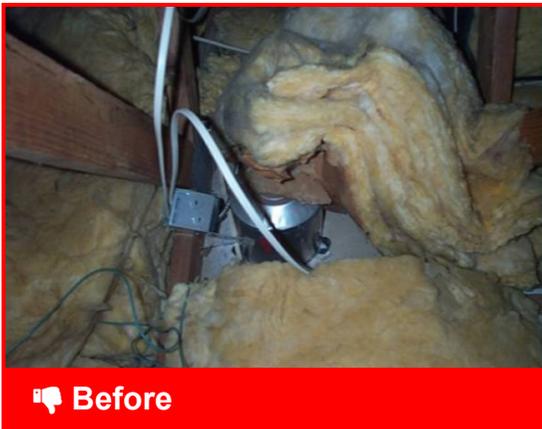
Ensure safety from fire and prevent air leakage

Specification(s):

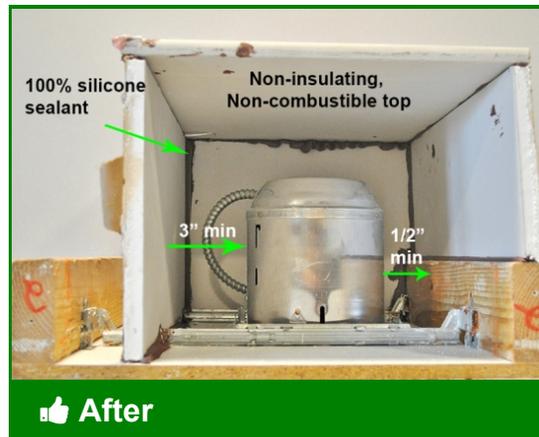
The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast

Objective(s):

Keep an air space around the fixture



Non-IC rated recessed lights produce excess heat and can be a fire risk



A 3 inch clearance should be kept from boxing materials

Tools:

1. Utility knife
2. Tape measure
3. Caulk gun

Materials:

1. Fire-rated sealant
2. Drywall

4.1001.1d

Desired Outcome:

Ensure safety from fire and prevent air leakage

Specification(s):

Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only

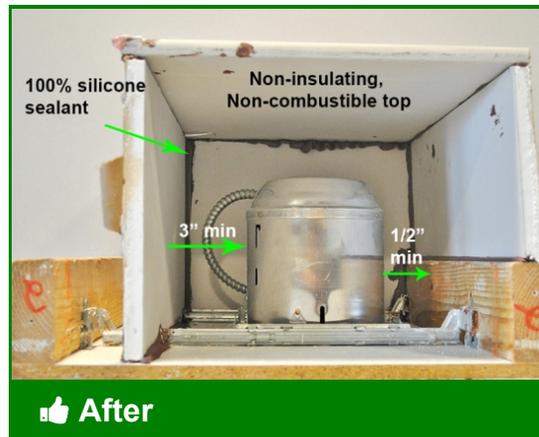
Objective(s):

To prevent air leakage, completely adhere the sealant to all surfaces to be sealed



Before

Non-IC recessed light fixtures produce excess heat and can be a fire risk



After

Entire box should be sealed, but none should come in contact with light

Tools:

1. Caulk gun
2. Spray foam gun
3. Putty knife

Materials:

1. Fire-rated silicone caulk
2. UL-181 mastic
3. Spray foam

4.1001.2a

Desired Outcome:

Insulation kept away from contact with live wiring

Specification(s):

Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring

Objective(s):

Determine if knob and tube wiring exists



Unsafe

Identify knob and tube wiring in homes to insulate properly and safely

4.1001.2a - Identifying knob and tube wiring



More knob & tube wiring



Knob & tube wiring again

4.1001.2b

Desired Outcome:

Insulation kept away from contact with live wiring

Specification(s):

Non-contact testing method will be used to identify live wiring

Objective(s):

Ensure safety of occupants, workers, and house

Plan where remediation is needed



Knob & tube wiring needs to be tested to determine if still live. Red=live



Live wiring should be dammed or professionally disabled before insulating

Tools:

1. Non-contact wire tester

4.1001.2c

Desired Outcome:

Insulation kept away from contact with live wiring

Specification(s):

Live knob and tube will not be covered or surrounded; required by the National Electrical Code (NEC) or authority having jurisdiction

A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring

A dam that does not cover the top will be created to separate insulation from the wire path

OR

Knob and tube wiring will be replaced with new appropriate wiring by a licensed electrician in accordance with local codes

Remaining knob and tube wiring will be rendered inoperable by licensed electrician in accordance with local codes

Objective(s):

Ensure work can be completed safely

Protect occupant and house

Ensure future work can be done safely

Prevent the overheating of the wiring



Knob & tube wiring radiates heat and cannot be insulated over



Before insulation, wiring should be dammed or disabled and replaced

Tools:

1. Non-contact wire tester
2. Drywall
3. Plywood
4. Saw
5. Drill
6. Tape measure

Materials:

1. Fasteners
2. Romex as needed

NEC guidelines and local jurisdictions often closely prescribe the treatment of knob & tube wiring. Check your local codes.

4.1001.2c - Isolate or replace



If electrician determines wiring is safe and keeps it active, isolate wires



To isolate, dams higher than intended insulation depth should be installed



Warning of knob & tube should be posted at all entrances to related spaces



Warning signs should encourage the use of certified electrician for repairs



Some jurisdictions require warning signs in Spanish as well



If knob & tube can be replaced, all existent k&t should be disabled



Many electricians will removed exposed wires to prevent reactivation



Modern wiring should replace all knob & tube

4.1001.3a

Desired Outcome:

Combustible materials kept away from combustion sources

Specification(s):

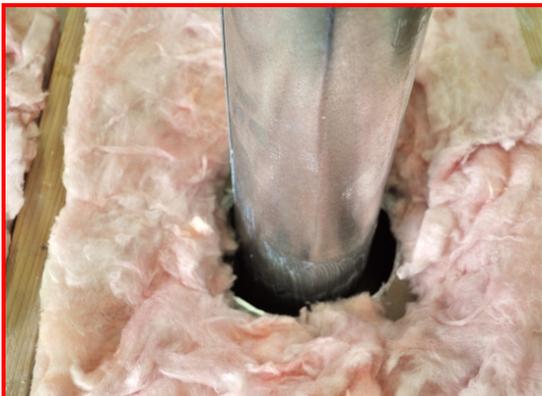
Holes, penetrations, and bypasses will be sealed

Dams will be fixed in places that maintain required clearance

Objective(s):

Prevent air leakage

Ensure insulation dams maintain clearance



 Before

Gaps and penetrations in attic need to be sealed to maintain air barrier



 After

Chimneys, flues, and light fixtures should be dammed to prevent fire

Tools:

1. Metal snips
2. Caulk gun
3. Fasteners

Materials:

1. 26-gauge steel sheeting
2. High temperature caulk
3. Caulk
4. Backer rod
5. Spray foam

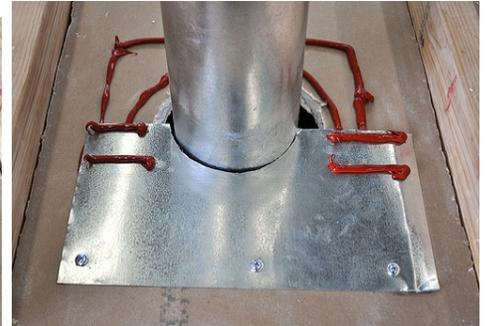
4.1001.3a - Verify attic prep



Gaps around flues and penetrations need to be sealed before insulating



High temperature caulk should be used for flues and chimneys



26-gauge steel should be used to construct seals and dams on flues



Only construct dam after sealing has been completed properly



Dammed chimneys, flues and light fixtures prevent fires

4.1001.3b

Desired Outcome:

Combustible materials kept away from combustion sources

Specification(s):

A rigid dam having a height greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion flue vent and dam

Chimney vents will have an airspace clearance to combustibles in accordance with 2012 IRC M1801.3.4

Objective(s):

Ensure dam material does not bend, move, or sag

Prevent a fire hazard



To prevent fire hazards, flues, chimneys, and light fixtures require dams



Observe a 3 inch minimum clearance for dams around flues and chimneys

Tools:

1. Metal snips

Materials:

1. 26-gauge steel sheeting
2. Fasteners

4.1001.3c

Desired Outcome:

Combustible materials kept away from combustion sources

Specification(s):

Insulation will not be allowed between a heat-generating appliance and a dam unless material is rated for contact with heat generating sources

Objective(s):

Prevent a fire hazard



 Before

Dams around flues, chimneys, and light fixtures should hold back insulation



 After

Clear dams of any loose insulation in order to minimize risk of fire

4.1001.3d

Desired Outcome:

Combustible materials kept away from combustion sources

Specification(s):

Documentation of material and R-value will be provided to occupant

Objective(s):

Provide occupant with documentation of installation



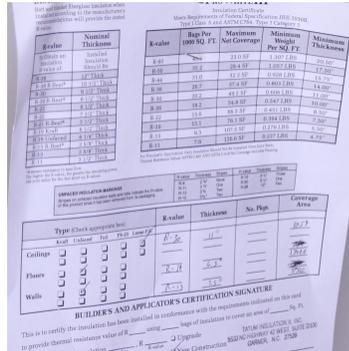
Best Practice

Provide occupant with documentation of and about insulation installed

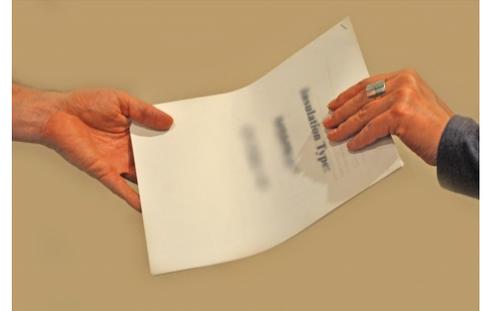
4.1001.3d - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1001.4a

Desired Outcome:

Attic ventilation meets code requirements and insulation is protected from wind washing

Specification(s):

If soffit venting or eave venting is present, baffles will be mechanically fastened to block wind entry into insulation or to prevent insulation from blowing back into the attic

If soffit venting or eave venting is present, baffles will be installed to maintain clearance between the roof deck and baffle in accordance with manufacturer specifications

Installation will allow for the highest possible R-value above the top plate of the exterior wall

Objective(s):

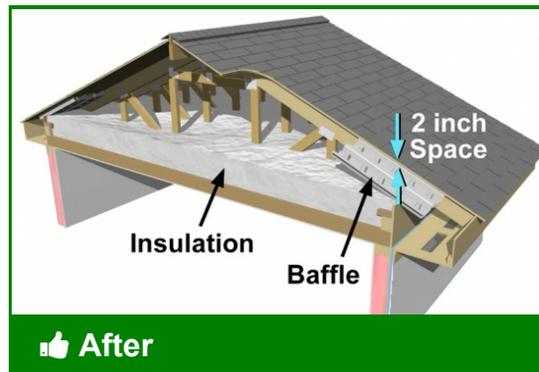
Ensure insulation R-value is not reduced

Maintain attic ventilation



Before

Insulation should not block vented eaves



After

Baffles installed in vented attics to allow air flow past insulation

Tools:

1. Stapler

Materials:

1. Baffles
2. Staples

4.1001.4a - Installation



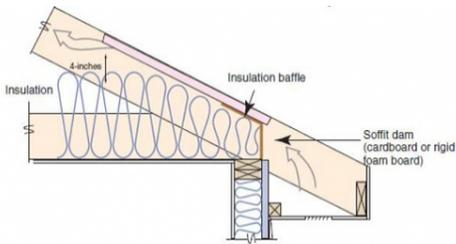
Allow a standard two inch gap for air flow through eave



Baffles should be securely fastened to prevent movement over time



Once baffles are properly installed, insulation can be placed against them



Baffles also hold insulation from falling into eave

4.1003.3a

Desired Outcome:

Insulation reduces heat flow through unvented roof

Specification(s):

Code compliant ventilation will be installed before insulation

Objective(s):

Reduce possibility of moisture issues



Unvented flat roofs should have venting installed



Vents in the space below the roof help maintain proper air flow

Tools:

1. Saw
2. Grinder
3. Metal snips
4. Drill

Materials:

1. Metal lath
2. Stucco

4.1003.3a - Ventilation



Unvented flat roofs should have venting installed



Vents in the space below the roof help maintain proper air flow



Mushroom capped vents in the roof are equally important to air flow

4.1003.3b

Desired Outcome:

Insulation reduces heat flow through unvented roof

Specification(s):

Roof cavities will be blown with loose fill insulation (or roof cavities will be dense packed with insulation) without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value



Before

Vent reveals attic is insulated with old rug -- not adequate.



In Progress

Attic will be dense packed to r-value specified on Work Order.

Tools:

1. Insulation machine

Materials:

1. Loose fillable or dense packable insulation

4.1003.3c

Desired Outcome:

Insulation reduces heat flow through unvented roof

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



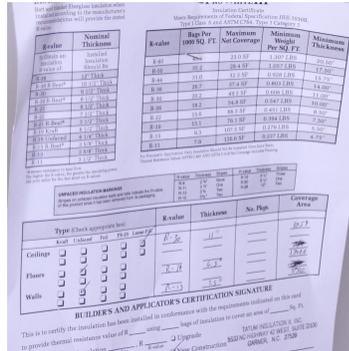
Best Practice

Provide occupant with documentation of and about insulation installed

4.1003.3c - Occupant education



Communicate professionally with occupant to provide information and support



4.1004.1a

Desired Outcome:

Airtight cavity and insulated knee wall

Specification(s):

All knee walls will have top and bottom plate or blockers installed using rigid materials

When knee wall floor and walls are being insulated, the floor joist running under the knee wall will be air sealed

If fabric is used before dense packing, it will be secured, according to manufacturers specifications or with furring strips every wall stud

If rigid material is used, material will be installed to cover 100% of the surface of the accessible knee wall area

If foam sheathing is used, sheathing will be listed for uncovered use in an attic or covered with a fire barrier

Objective(s):

Eliminate bending, sagging, or movement that may result in air leakage

Prevent air leakage through the top or bottom of the knee wall

Ensure material will not tear under stress from wind loads or insulation



 Before

Knee walls often need sealing and insulation



 After

Knee wall is prepped for dense pack insulation

Tools:

1. Tape measure
2. Utility knife
3. Caulk gun
4. Spray foam gun
5. Drill
6. Stapler

Materials:

1. Drywall
2. XPS
3. Caulk
4. Spray foam
5. Fasteners
6. Staples

4.1004.1a - Backing



Knee walls missing top plates need one created from rigid material



Top plate holds dense pack insulation in cavity



New top plate should be sealed to surrounding joists and studs



Bottom plates also need to be installed. Measure for size



Cut to size and attempt to install in line with air barrier above



Seal to surrounding joist



If using house-wrap or fabric, tack in place with furring strips or staples



Drywall is also a good barrier for dense packing knee walls

4.1004.1b

Desired Outcome:

Airtight cavity and insulated knee wall

Specification(s):

All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates

Insulation that is blown behind fabric or air barrier material will be blown dense to a minimum specification of 3.5 pounds per cubic foot for cellulose

Follow manufacturer's requirements for fiberglass dense pack applications

Objective(s):

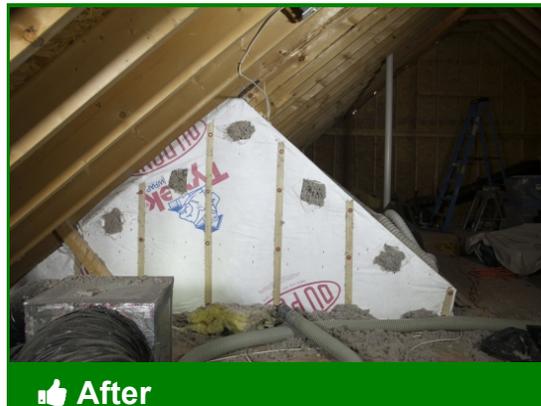
Eliminate misalignment of existing insulation

Prevent insulation from settling or moving



Before

Existing batt insulation should be adjusted to fit properly



After

If properly dense-packed, insulation should hold in place when finished

4.1004.1b - Installation



Attach furring strips to create pockets for dense-pack insulation



Insulation should meet manufacturer specifications for density.

4.1004.2a

Desired Outcome:

Airtight cavity and properly insulated knee wall

Specification(s):

All knee walls will have a top and bottom plate or blockers installed using a rigid material

All joints, cracks, and penetrations will be sealed in finished material, including interior surface to framing connections

Objective(s):

Eliminate bending, sagging, or movement that may result in air leakage

Prevent air leakage through the top or bottom of the knee wall

Create an air barrier



Top plate is missing from knee wall



New top plate is sealed to adjacent framing

Tools:

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

Materials:

1. XPS
2. Lumber
3. Caulk
4. Spray foam
5. Fasteners

4.1004.2a - Knee wall prep for batts



Top plate has been cut and fit to size



Top plate has been sealed to adjacent framing



Bottom plate is also missing. Space is measured so XPS can be cut



Bottom plate is cut to size



Bottom plate is placed in line with interior air barrier



Bottom plate is also sealed to surrounding joist and framing

4.1004.2b

Desired Outcome:

Airtight cavity and properly insulated knee wall

Specification(s):

Insulation will be installed using one of the following methods:

- New batts will be installed in accordance with manufacture specifications
- All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates

Objective(s):

Eliminate misalignment of existing insulation



Before
Knee wall with batts improperly installed and missing from stud bays



After
Properly fit insulation filling full volume of stud bay

Tools:

1. Utility knife
2. Tape measure

Materials:

1. Fiberglass batts

4.1004.2b - Installation



Where existing insulation is improperly installed, fix it



Kraft-face should go to "warm in winter" side and batt should fill bay



Batts should fill entire volume of knee wall stud bays

4.1004.2c

Desired Outcome:

Airtight cavity and properly insulated knee wall

Specification(s):

If rigid material is used, material will be installed to cover 100% of the surface of the knee wall

If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier

Objective(s):

Prevent insulation from settling or moving



 Before

Knee walls with batt insulation require covering



 After

Foam sheathing? Needs to be covered with a fire barrier

Tools:

1. Utility knife
2. Tape measure
3. Drill

Materials:

1. Drywall
2. House wrap

4.1004.2c - Backing knee wall



Fiberglass batts in attic knee walls can be held in place by house wrap



If foam sheathing is used, it needs to be covered with a fire barrier

4.1005.1a

Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces

All electrical junctions will be flagged to be seen above the level of the insulation

Open electrical junction boxes will have covers installed

Objective(s):

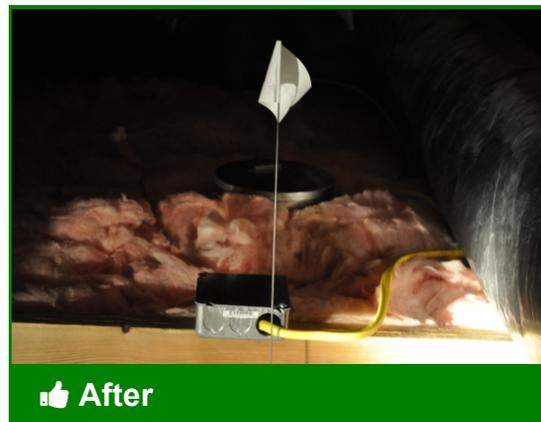
Access the workspace

Provide location of electrical junctions for future servicing

Prevent an electrical hazard



Remove flooring in attic spaces to access floor cavities and insulate



Flag electrical junctions to make future maintenance and repairs easier

Tools:

1. Hammer
2. Pry bar

Materials:

1. Flags

4.1005.1a - Preparation



Pry up flooring to access floor cavities



Check cavity for electrical junctions and penetrations



If electrical junctions are found, they should be enclosed and flagged



Air seal any penetrations

4.1005.1b

Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

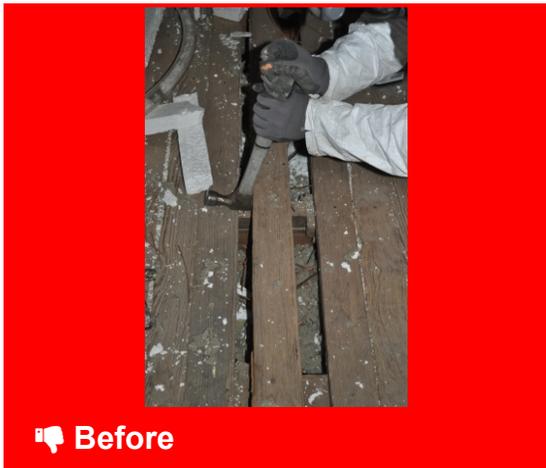
Specification(s):

Batt insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to the prescribed R-value

Objective(s):

Insulate to prescribed R-value



Accessible attic floors should be air sealed and insulated



Insulate floor cavities to prescribe R-value from the work order

Tools:

1. Hammer
2. Utility knife
3. Tape measure

Materials:

1. Fiberglass batts

4.1005.1b - Installation



Insert fiberglass batts into floor cavities, kraft-face down



Fill entire volume of floor cavity



Once insulated, flooring should be reinstalled

4.1005.1c

Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



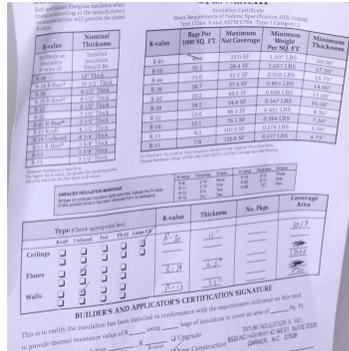
Best Practice

Provide occupant with documentation of and about insulation installed

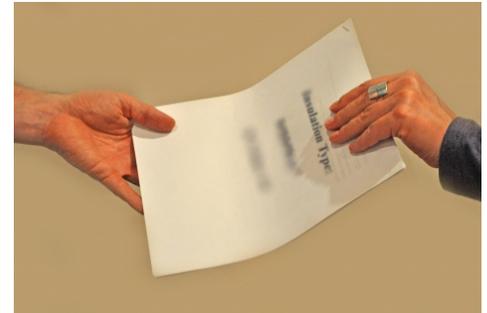
4.1005.1c - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1005.2a

Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces

Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier

All electrical boxes will be flagged to be seen above the level of the insulation

Open electrical junctions will have covers installed

Insulation dams and enclosures will be installed as required

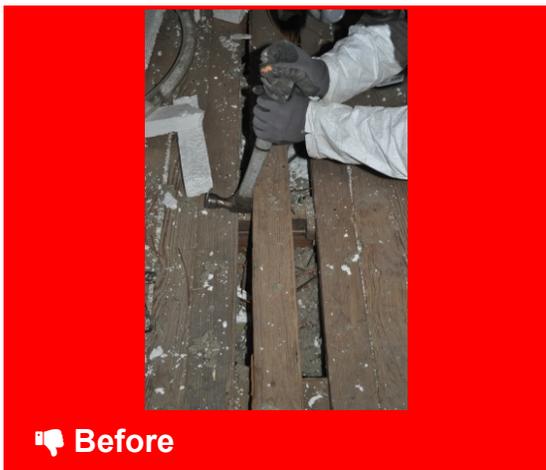
Objective(s):

Access the workspace

Verify uniformity of insulation material

Provide location of electrical boxes for future servicing

Prevent an electrical hazard



Accessible attic floors should be air sealed and insulated



Depth markers and insulation dams aid in proper insulation of attic spaces

Tools:

1. Pry bar
2. Hammer
3. Caulk gun
4. Utility knife
5. Staple gun
6. Spray foam gun
7. Tape measure

Materials:

1. Flags
2. Depth markers
3. Staples
4. XPS
5. Caulk
6. Spray foam

4.1005.2a - Preparation



Check cavity for electrical junctions and penetrations



Flag and install covers on electrical junctions



Seal any penetrations



Non-IC (insulation contact) can lights should be covered with a dam and have no insulation on top



Install depth markers and insulation dams above height of insulation

4.1005.2b

Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

Existence of air barrier material in line with the knee walls will be installed or verified when dense packing

Air barrier material will not bend, sag, or move once dense packed

Objective(s):

Hold dense pack in place



Before

When missing, bottom plates must be installed under knee walls



After

New bottom plates complete air barrier and hold insulation in place

Tools:

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

Materials:

1. Spray foam
2. XPS
3. Drywall
4. Plywood
5. Fasteners
6. Caulk sealant

4.1005.2b - Air barrier



Measure floor cavity for new bottom plate



Cut rigid material, such as XPS, to size to snugly fit into cavity



Align block with air barrier of conditioned space



Air seal around new bottom plate with spray foam

4.1005.2c

Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

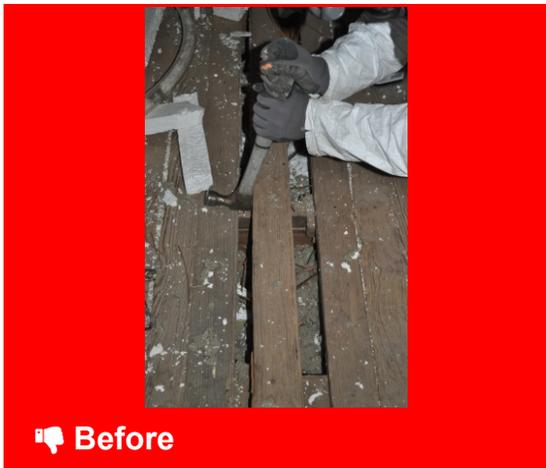
All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value

Objective(s):

Reduce heating and air conditioning costs

Improve comfort

Minimize noise



Accessible attic floor should be air sealed and insulated



Check chart on package to ensure proper insulation depth to achieve R-value

Tools:

1. Insulation machine

Materials:

1. Loose fill insulation

4.1005.2c - Installation



Use depth markers to ensure insulation has reached prescribed R-value



Where flooring cannot be removed, verify insulation is meeting R-value goal

4.1005.2d

Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the 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 settled thickness
- Number of bags installed in accordance with manufacturer specifications

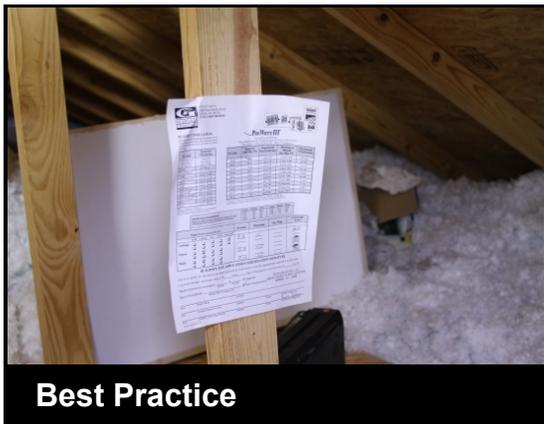
Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

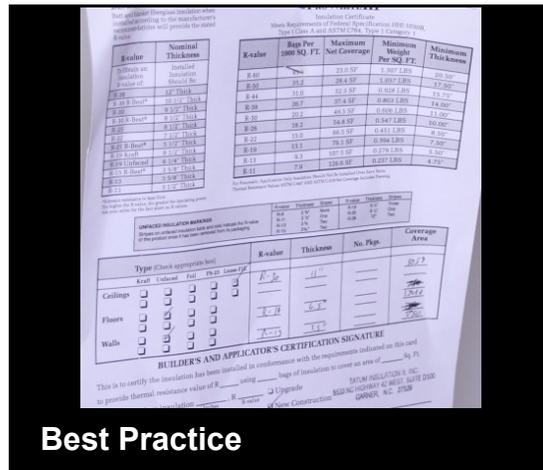
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



Best Practice

Information on insulation installed should be posted nearby



Best Practice

Posted info includes insulation type, r-value, depth, coverage area, etc.

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For loose-fill, the receipt must show the coverage area, initial installed thickness, minimum settled thickness, R-value, and the number of bags used. To figure out the R-value of the insulation, use the data that the manufacturer gives you. The receipt must be dated and signed by the installer.

4.1005.4a

Desired Outcome:

Insulation controls heat transfer through ceiling

Specification(s):

Existing insulation will be in contact with the air barrier prior to installing additional insulation on top

Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier

All electrical junction boxes will be flagged to be seen above the level of the insulation

Open electrical junction boxes will have covers installed

Insulation dams and enclosures will be installed as required

Objective(s):

Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing

Prevent an electrical hazard

4.1005.4b

Desired Outcome:

Insulation controls heat transfer through ceiling

Specification(s):

The correct depth and number of bags will be blown in accordance with manufacturer specifications

Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value

4.1005.4c

Desired Outcome:

Insulation controls heat transfer through ceiling

Specification(s):

Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources

Objective(s):

Prevent a fire hazard

4.1005.4d

Desired Outcome:

Insulation controls heat transfer through ceiling

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

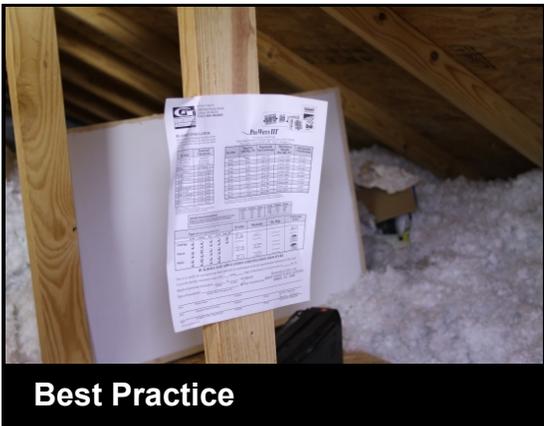
Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

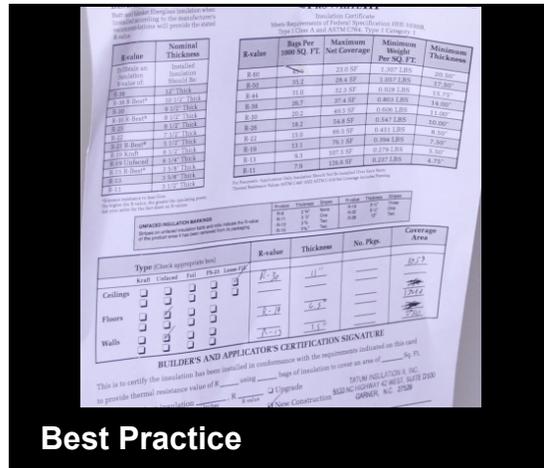
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



Best Practice

Written documentation of insulation type and efficiency will be provided



Best Practice

Information should include depth of loose fill installed and once settled

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For loose-fill, the receipt must show the coverage area, initial installed thickness, minimum settled thickness, R-value, and the number of bags used. To figure out

the R-value of the insulation, use the data that the manufacturer gives you. The receipt must be dated and signed by the installer.

4.1005.5a

Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

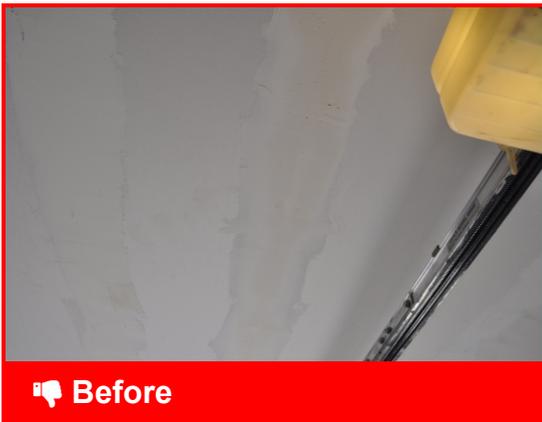
Specification(s):

Existence of air barrier material in line with the knee walls will be installed or verified when dense packing

Air barrier material will not bend, sag, or move once dense packed

Objective(s):

Hold dense pack in place



This finished garage below a bonus room is an unconditioned space



Rigid material forms an air barrier located under the bonus room stem wall

Tools:

1. Drywall saw
2. Utility knife
3. Tape measure
4. Straight edge

Materials:

1. XPS or other rigid material

4.1005.5a - Air barrier



Snap chalk lines to keep access cuts clean and easy to repair



Cut through garage ceiling to access joist cavities below bonus room



The rigid block should be placed in line with the stem wall above



Measure joist cavity depth



Measure joist cavity width



Cut XPS, or other rigid material, to measured size of joist cavity



Rigid block should fit snugly into joist cavity to prevent insulation leaks



Rigid block will hold the insulation in place under the bonus room above

4.1005.5b

Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

Each cavity will be 100% filled to consistent density:

- Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot
- Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density per the manufacturer's recommendations

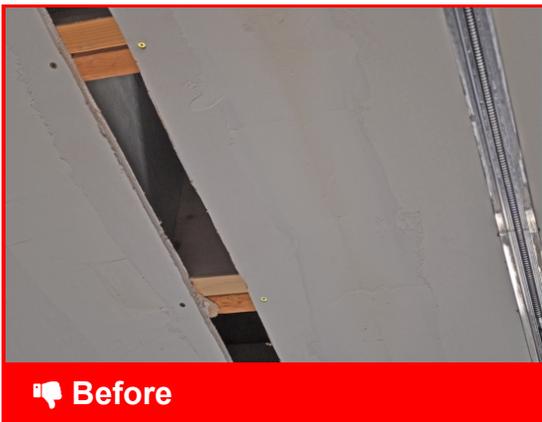
The number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

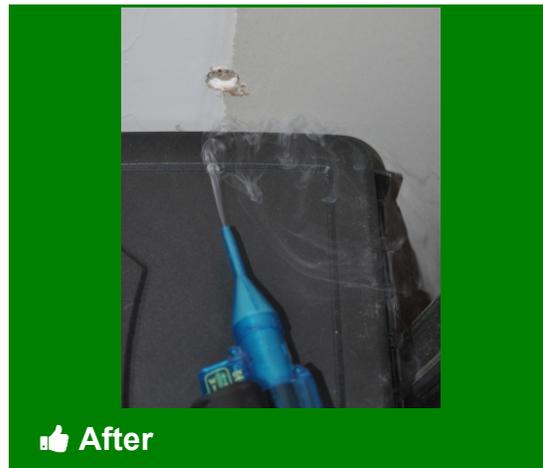
Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows



With rigid block in place under bonus room stem wall, insulation can begin



Chemical smoke at 50pa indicates insulation is at appropriate density

Tools:

1. Insulation machine
2. Drill
3. Smoke pencil
4. Blower door
5. Small hole saw bit

Materials:

1. Cellulose insulation
2. Dense packable insulation
3. Spackle
4. Seam tape

4.1005.5b - Fill floors



Blow insulation into cavities to density appropriate for chosen material



Close cavities with access panel cut out at the beginning



Cut small test holes in cavities to verify specified density has been met



Set up blower door and depressurize bonus room to -50pa wrt outside



With blower door running, chemical smoke should not draw into test holes



Tape and spackle access panel and test holes to repair garage ceiling

4.1005.5c

Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources

Objective(s):

Prevent a fire hazard



 Before

Dams around flues, chimneys, and light fixtures should hold back insulation



 After

Clear dams of any insulation or debris in order to minimize risk of fire

4.1005.5c - Safety



No insulation on top of non-insulation contact (non-IC) rated fixtures

4.1005.5d

Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

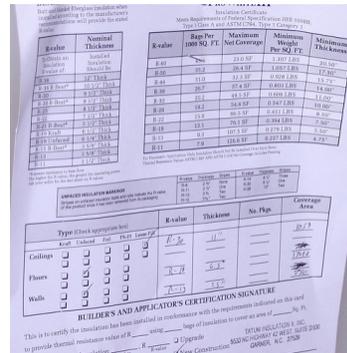
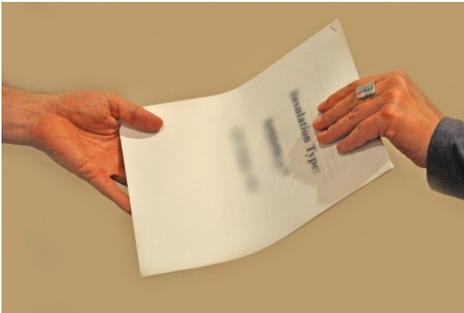


👍 After

Documentation of insulation installed should be provided in writing

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For all insulation except loose-fill and aluminum foil, the receipt must show the coverage area, thickness, and R-value of the insulation you installed. The receipt must be dated and signed by the installer. To figure out the R-value of the insulation, use the data that the manufacturer gives you.

4.1005.5d - Onsite documentation



Rather than posting in the insulated space, a "receipt" may be provided

Information should include insulation type, r-value, coverage area, etc.

4.1006.1a

Desired Outcome:

Pull-down attic stair properly sealed and insulated

Specification(s):

Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly

Pull-down stair rough opening will be surrounded with a durable dam that is higher than the level of the attic floor insulation

Counter-weights should be considered to ease accessibility for excessively heavy hatches

Objective(s):

Achieve uniform R-value

Prevent loose insulation from entering the living area



 Before

Insulation needs to be dammed to keep from falling through during operation



 After

Insulated pull-down stairs cover installed to prevent air leakage

Tools:

1. Tape measure
2. Drill
3. Saw
4. Caulk gun

Materials:

1. Caulk sealant
2. Lumber
3. XPS
4. Pre-fabricated stairwell cover

4.1006.1a - Installation



Stairs and hatch should both be insulated to match r-value of attic

4.1006.1b

Desired Outcome:

Pull-down attic stair properly sealed and insulated

Specification(s):

Entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space

Pull-down stair frame will be caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, or solid material that allows attic door operation

Objective(s):

Prevent air leakage



 Before

Unsealed pull-down stairs leads to air leakage to and from the attic



 After

To preserve thermal envelope, an airtight seal needs to be created

Tools:

1. Caulk gun

Materials:

1. Weatherstripping
2. Spray foam
3. Caulk

4.1006.1b - Sealing



Seal around frame of pull-down stairs with appropriate sealant



Weatherstrip around stair panel to encourage a tight seal



Remember to seal finish details and trim



Insulation and sealing should be airtight but openable

4.1006.2a

Desired Outcome:

Attic access door properly sealed and insulated

Specification(s):

Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly

Attic hatches rough opening will be surrounded with a durable protective baffle that is higher than the level of the surrounding attic floor insulation

Objective(s):

Achieve uniform R-value on the attic door or hatch

Achieve uniform R-value on the attic floor

Prevent loose attic floor insulation from entering the living area



 Before

Uninsulated attic hatches and access panels weaken the thermal envelope



 After

Hatch cover or panel access door should match r-value of attic insulation

Materials:

1. XPS
2. Lumber
3. Weatherstripping
4. Fasteners

4.1006.2a - Installation



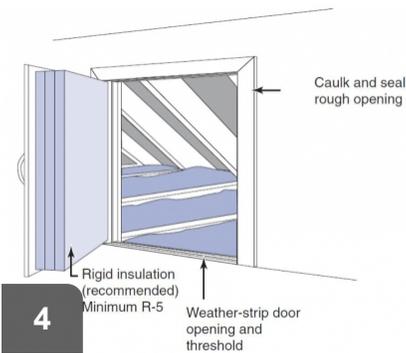
Create hatch cover that matches R-value of surrounding insulation



Build dam to hold back attic insulation and hold cover in place tightly



Weatherstrip underside of hatch cover to create tight seal



Alternate installation for vertical access panel to attic

4.1006.2b

Desired Outcome:

Attic access door properly sealed and insulated

Specification(s):

Access hatch frames will be sealed using caulk, gasket, weatherstrip, or otherwise sealed with an air barrier material, suitable film, or solid material

Options will include installing a latch or lock or frictionally engaged components of a pre-fabricated unit above the opening that do not require a latch

The measure must include a protective baffle or insulation barrier

Objective(s):

Prevent air leakage



Unsealed attic hatches and panel doors allow air leakage to and from attic



Once sealed, air leakage at attic hatch or door should be minimized

Materials:

1. Weatherstripping
2. 3/4" Lumber
3. Caulk

4.1006.2b - Sealing



Remember to seal around finish details and framing on interior



Build insulation dam from 3/4 inch lumber and seal around base



Weatherstrip around bottom edge of hatch cover to create air tight seal

4.1006.2c

Desired Outcome:

Attic access door properly sealed and insulated

Specification(s):

Insulation will be permanently attached and in complete contact with the air barrier

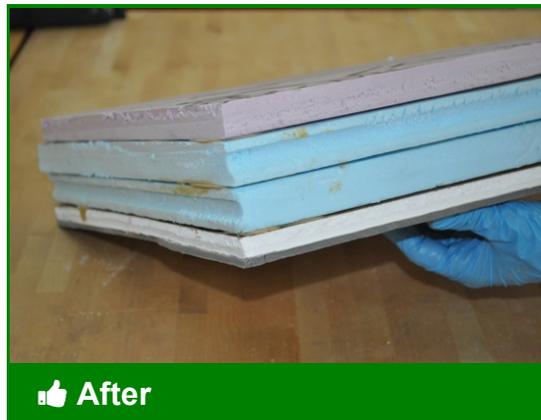
Objective(s):

Insulate to prescribed R-value



 Before

Unsealed and uninsulated attic hatches and access doors allow leakage



 After

Rigid insulation on back of new hatch cover attached firmly and squarely to allow for airtight fit

Tools:

1. Caulk gun
2. Utility knife

Materials:

1. XPS
2. Adhesive

4.1006.2c - Attachment



1 Apply foam tape to "warm side" face of attic hatch



2 Ensure an air tight seal by making sure foam tape has no gaps



3 Apply strong adhesive to "cold-side" of hatch



4 Adhesive should ring perimeter as well as criss-crossing hatch to ensure complete attachment of insulation



5 Affix XPS insulation to "cold-side" of hatch with adhesive, ensuring XPS is tight and square to hatch



6 Repeat adhesive and XPS layers to reach maximum R-value without making hatch excessively heavy or awkward



7 All XPS layers should be attached firmly to one another and square to hatch

4.1088.3a

Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):

Holes and penetrations will be sealed

Bypasses will be blocked and sealed

Objective(s):

Prevent air leakage

4.1088.3b

Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):

Insulation will be installed in accordance with manufacturer specifications and will be in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions

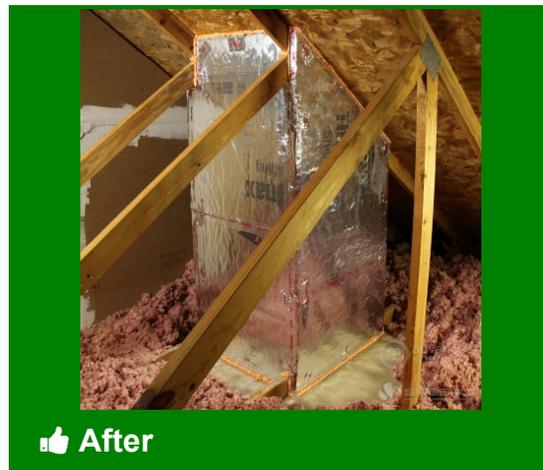
Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value



Uninsulated, unsealed skylight well



Insulated, air sealed skylight well

Tools:

1. stapler
2. tape measure
3. utility knife
4. caulking gun
5. foam gun

Materials:

1. caulk
2. one-part foam sealant
3. insulation (fiberglass, cellulose, spray polyurethane foam, polyisocyanurate board, extruded polystyrene board, or other as needed to achieve specified R-value)
4. air barrier material (drywall, foam board, paneling, hardboard, etc.)

Air-permeable insulation such as fiberglass or cellulose should be covered with a sealed attic-side air barrier.

4.1088.3b - Installation



1
Skylight well



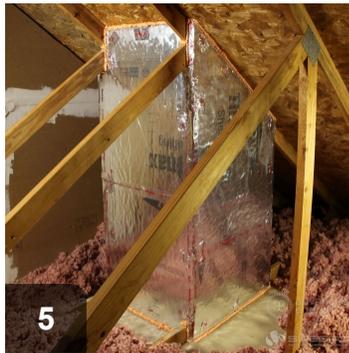
2
Carefully seal all seams and joints



3
Install insulation in complete contact with all sides of the cavity.



4
Install an attic-side air barrier.



5
The air barrier may be constructed from rigid insulation board. Seal the attic side air barrier

4.1088.3c

Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):

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

- Insulation type
- Coverage area
- R-value
- Installed thickness and settled thickness (settled thickness required for loose-fill only)
- Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



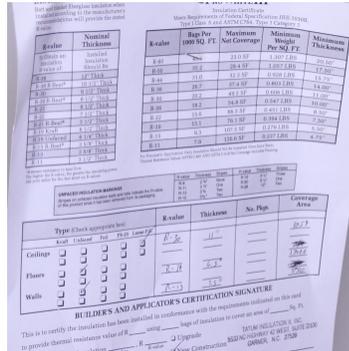
Best Practice

Provide occupant with documentation of and about insulation installed

4.1088.3c - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1101.1a

Desired Outcome:

Walls properly prepared to receive dense pack insulation

Specification(s):

Lead and asbestos safety procedures will be followed

Cavities will be free of hazards, intact, and able to support dense pack pressures

Drilling hazards (e.g., wiring, venting, fuel piping) will be located

Blocking will be installed around:

- All openings to inside crawl space and basement for fibrous material
- High temperature fire-rated materials
- Wiring and electrical hazards
- Heat sources

Access to exterior wall cavities will be gained, sheathing will be drilled as needed and probed to locate each cavity, wall studs, and blockers

Interior will be masked and dust controlled during drilling when accessing from interior

Electricity supply will be confirmed and will support blowing machine power demand

Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed

Hose outlet pressure will be at least 80 IWC or 2.9 psi for cellulose insulation; for other types of dense pack insulation, check manufacturer specification for blowing machine set up

Objective(s):

Prevent damage to house

Provide a clean work space

Provide thorough access to allow 100% coverage

Ensure proper equipment and process results in consistent density

Prevent settling and retard air flow through cavities

Protect worker and occupant health

4.1101.1b

Desired Outcome:

Walls properly prepared to receive dense pack insulation

Specification(s):

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

- Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot
- Loose fiber glass material will be installed and will be specifically approved for air flow resistance per manufacturer's specifications

The number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation density will be verified by bag count, core sampling, or infrared camera with the blower door at 50 pascals to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows

4.1102.1a

Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):

Holes and penetrations will be sealed

Bypasses will be blocked and sealed

Objective(s):

Prevent air leakage



Penetrations and bypasses create places where blown in insulation can leak



Sealed penetrations offer leakage protection and keep insulation in place

Tools:

1. Caulk gun

Materials:

1. Backer rod
2. Spray foam
3. Caulk

4.1102.1a - Sealing



Open walls to be insulated and drywalled need air sealing



Penetrations and bypasses should be sealed to keep insulation in cavities



Use backer rod or other infill for larger penetrations



Seal penetration with caulk or fire-block, as appropriate

4.1102.1b

Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

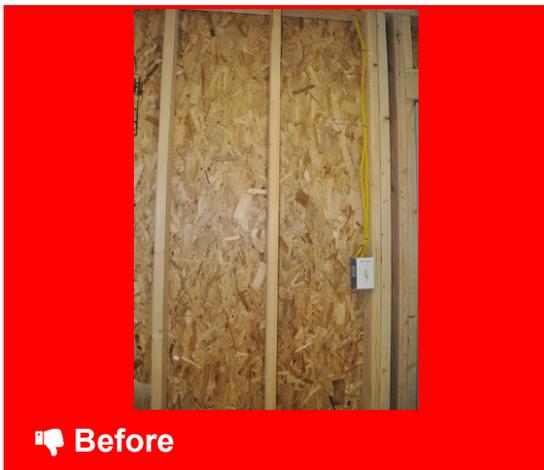
Specification(s):

Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value



Open walls should be insulated



Well-insulated rooms are significantly more comfortable in all seasons

Tools:

1. Insulation machine
2. Staple gun

Materials:

1. Loose fillable insulation
2. Netting
3. Staples
4. Fiberglass batts

4.1102.1b - Installation



Wall should be netted and insulation blow in to prescribed r-value



OR: Wall can be insulated using batts installed without gaps

4.1102.1c

Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):

Verification of complete installation without gaps, voids, compressions, misalignments, or wind intrusions will be provided

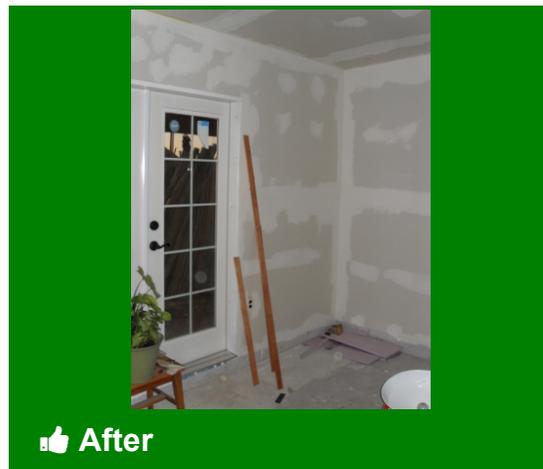
Objective(s):

Install insulation correctly



 Before

Verify insulation is properly installed before drywalling



 After

Once proper installation is verified, begin drywalling to finish wall

Tools:

1. Hands
2. Eyes

4.1102.1c - Pre-drywall verification



Take a visual and physical inspection of insulation installation

4.1102.1d

Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):

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

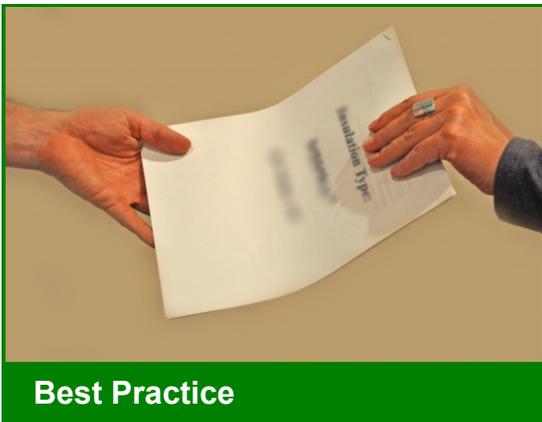
- Insulation type
- Coverage area
- R-value
- Installed thickness and settled thickness (settled thickness required for loose-fill only)
- Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

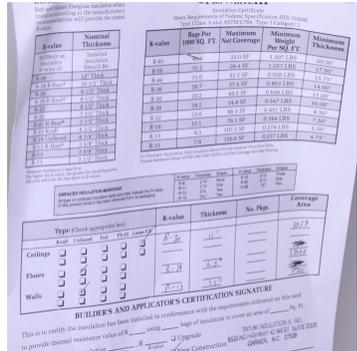


Provide occupant with documentation of and about insulation installed

4.1102.1d - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1103.1a

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

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

- Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density
- Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit air flow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using BPI-102 "Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications – Material Specification" or ASTM C 522, E 283, or E 2178; the number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows



Make accurate count of insulation bags to be installed



Install insulation to correct density (at least 3.5 pounds per cubic foot for cellulose, or 1.5 pounds for fiberglass)

Tools:

1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape

Materials:

1. cellulose or fiberglass insulation (any fiberglass material used must be specifically approved for air flow resistance by the manufacturer)
2. wooden, plastic, or foam plugs to fill installation holes
3. piece of fiberglass batt or towel to stop insulation from blowing out around the hose

4.1103.1a - Exterior dense pack



1 Calculate the number of bags needed and verify the number you actually install.



2 Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI.



3 Adjust the pressure with the blower controls.



4 Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes.



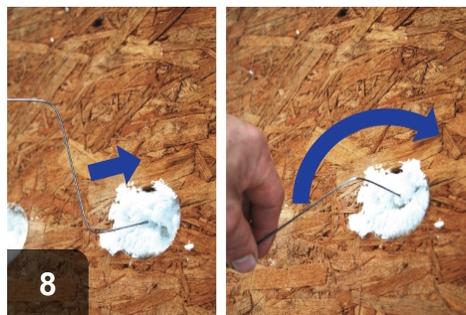
5 With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation.



6 Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density



7 Check that cavities are filled and are the proper density.



8 Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.



9 Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke

4.1103.1b

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed Comply with 16 CFR 460.17

INVOICE		615915	
SOLD TO ABC CAA		SHIP TO MAX PRODUCTION	
ADDRESS 1 INDUSTRIAL WAY		ADDRESS 123 LOOKALIKE DR	
CITY, STATE, ZIP OVRTOWN, USA		CITY, STATE, ZIP ANYTOWN, USA	
CUSTOMER ORDER NO.	ORDER BY	TERMS	DATE
			6/10/15
ORDERED	SHIPPED	DESCRIPTION	PRICE UNIT AMOUNT
		1,040 ft ²	\$0.60/ft ² 624.00
		3.5 inches thick	
		R-15	
		Fiberglass dense pack insulation	
		(18 bags) (30lb.ea)	



Installer shall provide a dated insulation receipt showing coverage area, R-value, and thickness

Obtain a dated insulation receipt showing coverage area, R-value, and thickness from the installer.

4.1103.2a

Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

Specification(s):

Details remaining in or between completed wall sections will be located and accessed

Objective(s):

Ensure the last gaps and framing edges in the thermal boundary, roof-wall joints, floor-wall joints, etc., are found and finished



Cavities missing insulation allow greater heat transfer than insulated ones



Either from inside or outside, using IR camera to locate cavities for fill

Tools:

1. Infrared camera
2. Drill
3. Hole saw
4. Tape measure
5. Probe

4.1103.2b

Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

Specification(s):

Backing will be provided and all newly uncovered openings will be sealed with air barriers, foam, or mastic, maintaining all required clearances

Objective(s):

Ensure the air barrier is connected across all accessible house elements



Unsealed penetrations should be sealed to ensure insulation stays in place



Once air barrier has been preserved by sealing, insulation can begin

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Fire-block, when necessary

4.1103.2c

Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

Specification(s):

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

- Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density
- Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit airflow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using BPI-102 "Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications—Material Specification" or ASTM C 522, E 283, or E 2178; the number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows



Make accurate count of insulation bags to be installed



Install insulation to correct density (at least 3.5 pounds per cubic foot for cellulose, or 1.5 pounds for fiberglass)

Tools:

1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape

4.1103.2c - Dense packing



1 Calculate the number of bags needed and verify the number you actually install.



2 Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI.



3 Adjust the pressure with the blower control knobs.



4 Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes.



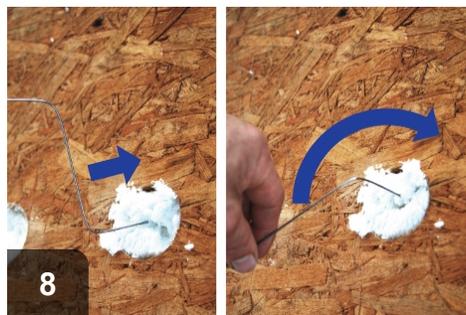
5 With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation.



6 Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density.



7 Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.



8 Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.



9 Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke.

4.1103.2d

Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

Specification(s):

Completed wall sections will be viewed using infrared camera with blower door operating

Any voids or low density areas will be drilled and re-packed

Objective(s):

Establish air barrier and thermal boundary

Confirm no voids or hidden air flows remain



Uninsulated exterior wall cavities to be insulated



Reduced temperature difference indicating insulated wall cavities

Tools:

1. Infrared camera

4.1103.2d - Quality assurance



Depressurize house (if safe) to -50pa wrt outside



Inspect for voids and low density areas



Reduced temperature difference indicating insulated wall cavities

4.1103.2e

Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

Specification(s):

Installation holes will be plugged as follows:

- Exterior holes will be weather barrier patched
- Interior holes will be coated and patched to match original interior surface

All construction debris and dust will be collected and removed

Objective(s):

Ensure house is returned to watertight and clean condition



With insulation complete, wall needs to be patched to better-than-found



When repair is finished, it shouldn't be obvious any work was done

Tools:

1. Taping knife
2. Caulk gun
3. Drill
4. Paint brush

Materials:

1. Spackle
2. House wrap
3. Lath
4. Stucco
5. Fasteners
6. Adhesive
7. Primer
8. Drywall
9. XPS

4.1103.2e - Close holes



For interior access, locate access holes at studs for easier patching



Once drywall patches are spackled, prime and paint.



For exterior access, use a drop cloth or gutter to help with clean up



Plug holes with rigid material that will not move or sag over time



For stucco and plaster patches, lath will need to be used to hold weight



If possible, maintain house wrap, or replace it after holes are plugged



Put siding back in place, or return exterior finish to match remaining wall

4.1301.1a

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Sealing the floor system will be completed before insulating

Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.

4.1301.1a - Sealing



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

4.1301.1b

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

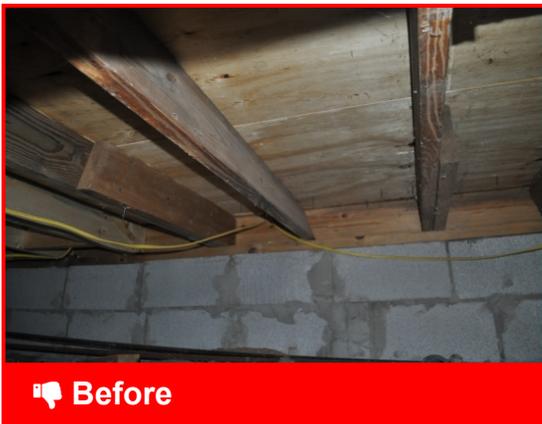
Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to subfloor

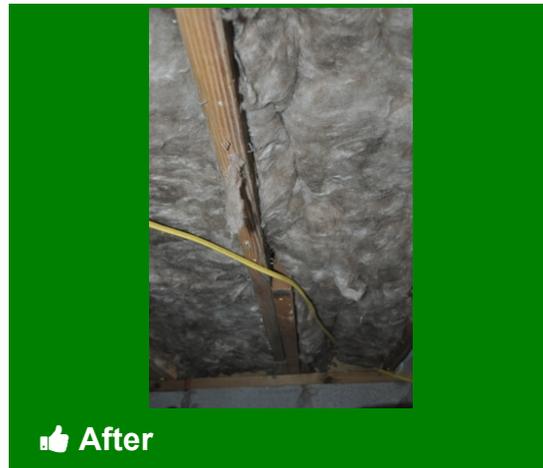
Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value



Uninsulated floors above unconditioned spaces are an energy drain



Batts should fill most of joist bay and be in full contact with subfloor

Tools:

1. Utility knife
2. Tape measure

Materials:

1. Kraft-faced fiberglass batts to work order specifications

4.1301.1b - Installation

Measures

Measure 8 Floor Ins. R-11		Components F1					
Comment		Estimated					
#	Material / Labor	Description /Comment	Units	Qty	Unit Cost	Total	Q.
1	Insulation	Floor Insulation - Kraft-faced Batts - R-11	SqFt	1180	\$0.22	\$259.60	<input type="checkbox"/>
2	Labor	Floor Insulation - Kraft-faced Batts - R-11	SqFt	1180	\$0.35	\$413.00	<input type="checkbox"/>
3	Miscellaneous Su	Floor Insulation - Kraft-faced Batts - R-11	Each	1	\$100.00	\$100.00	<input type="checkbox"/>



Order and install insulation as called for in Work Order

If precise r-value cannot be purchased, choose option with greater r-value

Install kraft-faced batts with paper against subfloor



Ensure batts are in full contact with subfloor and remain uncompressed

4.1301.1c

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Batts will be secured with physical fasteners

Objective(s):

Ensure insulation remains in contact with subfloor



Fiberglass batts should not be hanging away from subfloor



"Lightning rods" or twine can be used to hold batts in contact

Tools:

1. Utility knife
2. Drill
3. Staple gun

Materials:

1. Lightning rods
2. Twine
3. Fasteners

4.1301.1c - Securing batts



Batt should be in contact with subfloor without being compressed



Twine fastened across bays in a zig-zag pattern can also be used

4.1301.1d

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



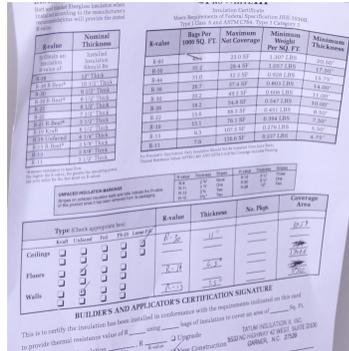
Best Practice

Provide occupant with documentation of and about insulation installed

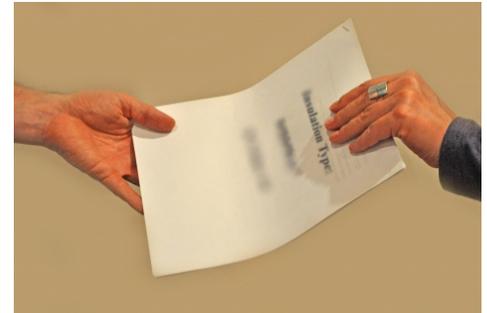
4.1301.1d - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1301.2a

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Sealing the floor system will be completed before insulating

Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.

4.1301.2a - Sealing



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

4.1301.2b

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

When using netting or fabric, staples will be placed according to manufacturer specifications

Netting or fabric will meet local fire codes

Objective(s):

Secure insulation



Before

Uninsulated floors above unconditioned spaces are an energy drain



In Progress

Netting is secured to joists and sills to create cavities for insulation

Tools:

1. Utility knife
2. Scissors
3. Stapler

Materials:

1. Fabric netting
2. Staples

4.1301.2b - Netting, fabric



1 Secure netting across each joist to create separate cavities



2 Secure netting across sills to prevent leakage of insulation



3 Keep netting taut while stapling to prevent wrinkles and leakage



4 Staples should be kept tightly together, placed no more than 1 1/2" apart

4.1301.2c

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications

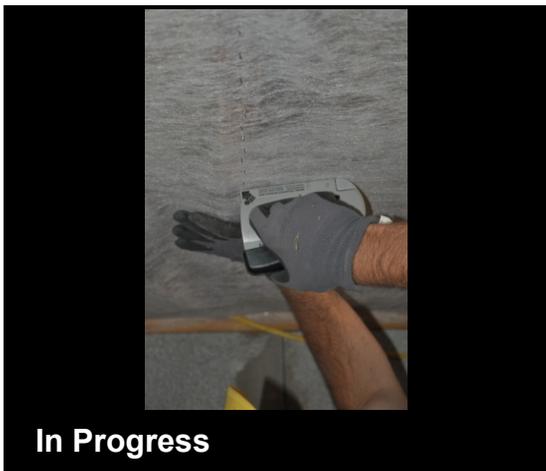
Insulation will be installed to prescribed R-value

Insulation will be in continuous contact with air barrier

Objective(s):

Insulate to prescribed R-value

Ensure a continuous thermal boundary between conditioned and unconditioned space



With netting in place, insulation can begin



Cavities filled to manufacturer specs to achieve prescribed r-value

Tools:

1. Utility knife
2. Insulation machine

Materials:

1. Loose fill fiberglass or cellulose

4.1301.2c - Installation

Measures

Measure 7		Floor Ins. R-30		Components F1			
Comment							
#	Material / Labor	Description /Comment	Units	Qty	Unit Cost	Total	Q
1	Insulation	Floor Insulation - Net & Fill - R-30	SqFt	1180	\$0.59	\$696.20	<input type="checkbox"/>
2	Labor	Floor Insulation - Net & Fill - R-30	SqFt	1180	\$0.35	\$413.00	<input type="checkbox"/>
3	Miscellaneous Su	Floor Insulation - Net & Fill - R-30	Each	1	\$100.00	\$100.00	<input type="checkbox"/>



Order and install insulation based on specifications in work order

Always wear proper PPE when blowing in insulation

Cut holes in each individual cavity to insert insulation machine nozzle



Nature Blend Cellulose Insulation
R13 to R60

2 Lleue la maq Mezcla Natur
3 Soplar al font el Valor-R des

Nature Blend Loose Fill Formula						Coverage Chart for Thermal Acoustical Application		
# Bags 8 1/2"	Total Volume (cubic feet)	Volume of Cellulose (cubic feet)	No. bags (100 lbs) per 100 sq ft			2" x 8", 16" o.c.		
			By Volume	By Weight	By R-Value	By Volume	By Weight	By R-Value
13	4.4	4.0	17.4	67.6	0.38	15.8	63.5	0.35
18	6.1	5.5	27.9	35.8	0.61	25.5	39.6	0.56
22	8.8	8.2	33.2	30.1	0.73	30.5	32.8	0.67
26	7.8	7.0	38.6	25.9	0.85	35.6		
30	5.2	4.9	43.2	21.0	0.97	44.6	26.9	0.79
34	11.4	10.3	62.5	16.1	1.09	49.6	17.0	0.80
38	14.6	13.1	82.0	12.2	1.20	54.7	12.7	1.73
42	17.7	15.9	101.9	9.6	2.24	66.6	10.1	2.17

DO NOT ADD



Ensure that hole is large enough for nozzle without allowing for outflow

Consult manufacturer specs on insulation packaging for proper installation

Blow in insulation to prescribed r-value

4.1301.2d

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

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

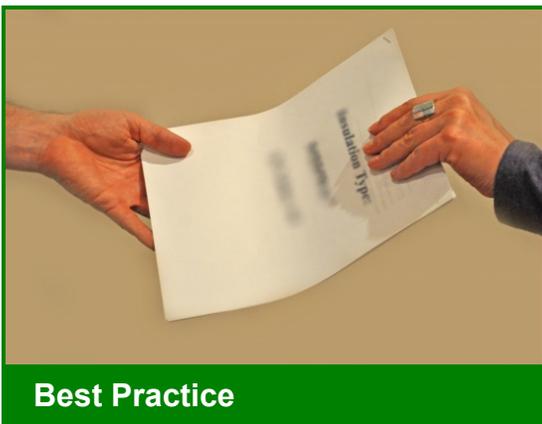
Objective(s):

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



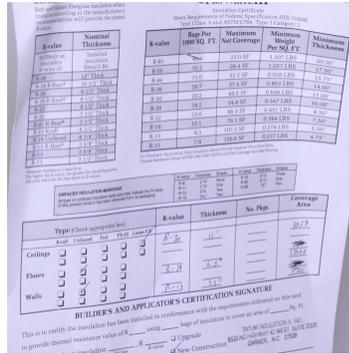
Best Practice

Provide occupant with documentation of and about insulation installed

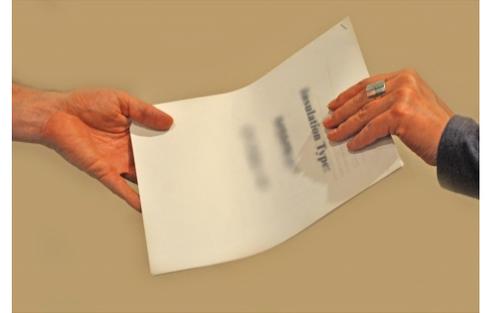
4.1301.2d - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1301.3a

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Sealing the floor system will be completed before insulating

Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

Tools:

1. Caulk gun

Materials:

1. Backer rod
2. Caulk
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.

4.1301.3a - Sealing



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

4.1301.3b

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

Seams and penetrations will be sealed

Objective(s):

Relocate air barrier



 Before

Uninsulated floors over unconditioned spaces are an energy drain



 After

Rigid barriers provide air sealing and create cavities for insulation

Tools:

1. Utility knife
2. Saw
3. Drill
4. Caulk gun

Materials:

1. Rigid material - drywall, XPS, plywood
2. Fasteners
3. Caulk

4.1301.3b - Rigid air barrier



Attach barrier to joists using appropriate fasteners for chosen material



When possible, align seams with joist. Seal all seams with caulk



Pay particular attention to sealing at complex joints to prevent leakage



Remember to seal along sills as well

4.1301.3c

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value



 Before

Once rigid barrier is sealed, insulation can be blown in



 After

Tools:

1. Insulation machine
2. Caulk gun

Materials:

1. Loose fill insulation
2. Caulk

4.1301.3c - Installation

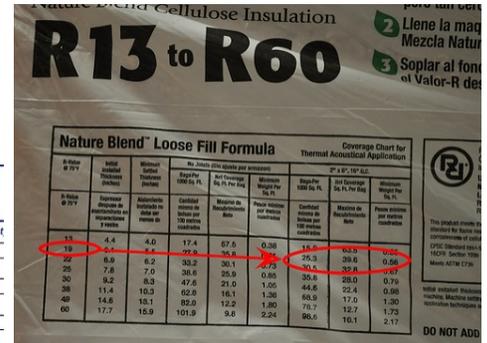


Make sure to wear proper PPE when working with insulation

Measures

Measure 7		Floor Ins. R-19	Components F1				
Comment			Estimated				
#	Material / Labor	Description / Comment	Units	Qty	Unit Cost	Total	Qt
1	Insulation	Floor Insulation - Loose-fill + Rigid Barrier - R-19	SqFt	1180	\$0.37	\$436.60	<input type="checkbox"/>
2	Labor	Floor Insulation - Loose-fill + Rigid Barrier - R-19	SqFt	1180	\$0.35	\$413.00	<input type="checkbox"/>
3	Miscellaneous Su	Floor Insulation - Loose-fill + Rigid Barrier - R-19	Each	1	\$100.00	\$100.00	<input type="checkbox"/>

Purchase and install loose fill to r-value specified on Work Order



Check manufacturer specifications for proper density to reach r-value



Drill hole slightly larger than hose in rigid barrier



Loose fill cavities created by rigid barrier



Once filled to prescribed density, prepare plug to preserve rigid barrier



Plug should be sealed in place to prevent leakage

4.1301.3d

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

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



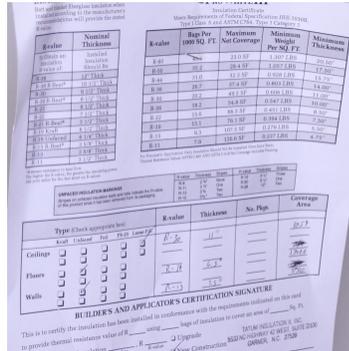
Best Practice

Provide occupant with documentation of and about insulation installed

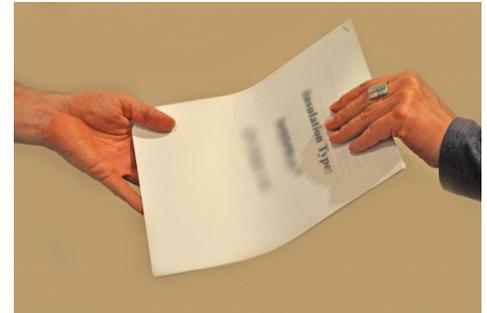
4.1301.3d - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1301.4a

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Sealing the floor system will be completed before insulating

Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

Tools:

1. Caulk gun

Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.

4.1301.4a - Sealing



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk small gaps and to hold backer rod in place

4.1301.4b

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

Seams and penetrations will be sealed

Objective(s):

Relocate air barrier



 Before

Uninsulated floors over unconditioned spaces are an energy drain



 After

Rigid barriers allow for air sealing and create cavities for insulation

Tools:

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

Materials:

1. Rigid material -- drywall, XPS, plywood
2. Fasteners
3. Caulk

4.1301.4b - Rigid air barrier



Securely fasten rigid barrier, aligning seams with joist when possible



Seal all seams with caulk to prevent leakage



Pay particular attention at complex joints



Remember to caulk along sills

4.1301.4c

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value



 Before

Once rigid barrier is sealed, insulation can be blown in



 After

Rigid barrier should be resealed to maintain air barrier after filling

Tools:

1. Insulation machine
2. Caulk gun

Materials:

1. Dense packable insulation
2. Caulk

4.1301.4c - Installation



Ensure that proper PPE is worn while working with insulation

Measures

Measure 7 Floor Ins. R-19		Components F1					
Comment		Estimated					
#	Material / Labor	Description / Comment	Units	Qty	Unit Cost	Total	Qty
1	Insulation	Floor Insulation - Dense-pack + Rigid Barrier - R-19	SqFt	1180	\$0.37	\$436.60	
2	Labor	Floor Insulation - Dense-pack + Rigid Barrier - R-19	SqFt	1180	\$0.35	\$413.00	
3	Miscellaneous Su	Floor Insulation - Dense-pack + Rigid Barrier - R-19	Each	1	\$100.00	\$100.00	

NOMINAL 30-LB. BAG COVERAGE CHART FOR CLOSED CAVITY APPLICATION

Thermal Resistance	Cavity Depth/Insulation Thickness	Installed Density	Minimum Weight per Area	Number of Bags per 1,000 Sq. Ft.	Maximum Coverage per Bag
R-value	inches	lb/ft ³	lb/ft ²	Bags	Sq. Ft.
14.0	1.5	0.25	17.5	57.1	17.4
15.0	3.0	2.0	0.563	18.4	51.4
15.1	(nominal 2x6)	2.2	0.662	21.4	46.8
15.2	2.4	2.4	0.700	22.3	42.8
15.3	1.8	2.0	0.667	22.6	42.5
15.4	1.8	1.8	0.625	23.5	40.4
22.8	5.0	2.0	0.877	20.8	22.7
22.9	(nominal 2x6)	2.2	1.006	20.8	23.9
22.9	2.4	2.4	1.180	20.7	27.3
24.1	2.8	2.8	1.180	20.7	29.2

The coverage per bag shown in the above chart is for the unfilled area (positive only) and does not account for the space taken up by wall studs, plates, headers, corners, window framing, etc. Depending on the construction details in a given structure, gross coverage for the overall wood framed wall area may vary.

Fill cavities to specified r-value from Work Order

Check manufacturer specifications for r-value before filling



Drill hole slightly larger than nozzle into rigid barrier with hole saw



Dense pack insulation into floor cavities



When filled to specified density and r-value, fill access hole



Plug access hole and seal to maintain air barrier

4.1301.4d

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



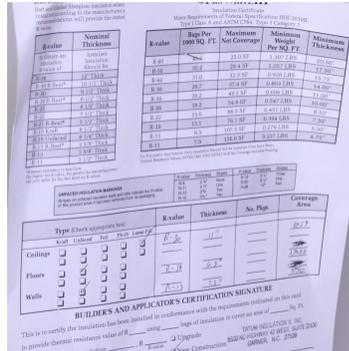
Best Practice

Provide occupant with documentation of and about insulation installed

4.1301.4d - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1301.5a

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Air barrier will be installed between joists and sealed

Air barrier will be placed to the most interior edge of the top plate of the wall below

Objective(s):

Separate cantilevered floor from conditioned floor space

Allow for insulation



Before

Cavities are open allowing unconditioned air to communicate within the space between floors.



After

Cavity has been blocked, sealed, and insulated. Rigid air barrier is hidden behind insulation in this photo

Tools:

1. tape measure
2. utility knife
3. flashlight
4. caulking gun
5. foam gun

Materials:

1. rigid air barrier (plywood, OSB, drywall, rigid foam board)
2. caulk or foam sealant
3. dense-pack cellulose or fiberglass insulation
4. batt insulation
5. two-part spray polyurethane foam (optional)

1. Stuff the cavities with fiberglass insulation as a backer, and then apply two-part spray polyurethane foam to seal the openings. 2. Cut and install drywall, plywood, OSB, or rigid foam board in each cavity, then seal around the edges with foam or caulk. 3. Install dense-pack insulation in cantilevered

area, being careful to extend it inward past the supporting wall (this also accomplishes insulating the cantilevered floor area).

Install insulation at the required R-value in permanent contact with the subfloor under the cantilevered section.

4.1301.5a - Air barrier



Measure cavity to determine size necessary for blocking.



Measure and cut blocking to fit snugly between floor joists.



Ensure the blocking is placed to the most interior edge of the top plate of the wall below.



Air seal blocking around its perimeter edges with foam or caulk.



Cut batt insulation to match the size of the blocking.

4.1301.5b

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Air barrier will be insulated between joist from top plate of the wall below to subfloor above

Cantilevered subfloor will be insulated in complete contact with the floor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to the air barrier

Insulation will be installed to prescribed R-value

Objective(s):

Insulate to prescribed R-value



Before
Cavities are open and subfloor of conditioned space above is uninsulated.



After
Batt insulation is installed to either fill the cavity or be properly supported to maintain contact with the subfloor.

Tools:

1. drill
2. mechanical fasteners
3. claw hammer or pry bar

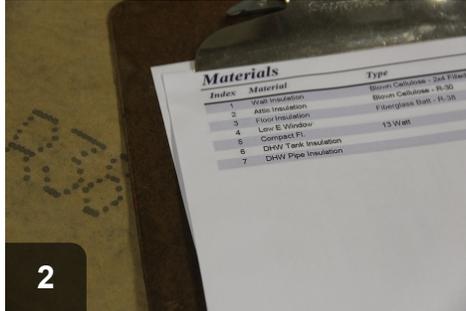
Materials:

1. batt insulation - kraft-faced or unfaced
2. insulation supports

4.1301.5b - Installation



1 Cavities are open and subfloor of conditioned space above is uninsulated.



2 Insulation R-value to be installed matches the work order.



3 Here the worker is removing the kraft facing, which may be needed in some areas.



4 Ensure the batt is positioned correctly.



5 Batt insulation is installed to either fill the cavity or be properly supported to maintain contact with the subfloor.

4.1301.5c

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Batts will be secured with physical fasteners

Objective(s):

Ensure insulation remains in contact with subfloor and air barrier



Insulation should be secured to prevent drooping or movement



"Lightning rods" or twine should keep full contact with the subfloor

Tools:

1. Utility knife
2. Drill
3. Staple gun

Materials:

1. Lightning rods
2. Twine
3. Fasteners

4.1301.5c - Attachment



Batts should have full contact with subfloor without being compressed



Twine fastened across bays in a zig-zag pattern can also be used

4.1301.5d

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

Exterior soffit material will be installed and sealed

Objective(s):

Cover and protect insulation



Cavities have been insulated but are still exposed.



After all accessible cavities have been air sealed and insulated, replace sheathing and siding to cover insulation.

Tools:

1. claw hammer
2. drill
3. mechanical fasteners

Materials:

1. OSB/Plywood(where existing)
2. Vinyl Soffit(where existing)

4.1301.5d - Exterior soffit



1
Cantilevered floors should be insulated to preserve thermal boundary



2
Seal off floor cavities using previously removed materials, in this case OSB and vinyl soffit.



3
Re-install any materials that were removed, such as OSB, J-channels, and vinyl soffit.



4
Completed installation

4.1301.5e

Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



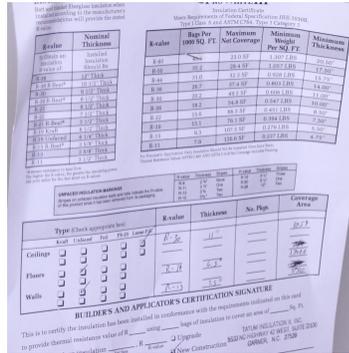
Best Practice

Provide occupant with documentation of and about insulation installed

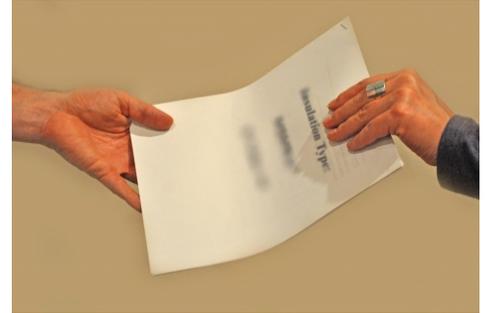
4.1301.5e - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

4.1401.1a

Desired Outcome:

Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below

Specification(s):

All band/rim joist areas will be open and accessible for SPF application

All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation

Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt

Grease and oil will be removed using appropriate cleaners or solvents

Moisture content of all wood substrate materials will be checked to ensure it is below 20%

Objective(s):

Prepare all substrate surfaces for the application of SPF

4.1401.1b

Desired Outcome:

Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below

Specification(s):

SPF will be applied to desired thickness, using pass thickness maximum in accordance with manufacturer specifications, onto subfloor between floor joists and all rim/band joists

When applied to first floor, SPF will be continuous from subfloor surface, over band/rim joist and sill plate, and in contact with foundation below

When applied to second story floor or above, SPF will be continuous from subfloor surface, over band/rim joist, and in contact with top plate below

Objective(s):

Insulate and seal floors

4.1401.1c

Desired Outcome:

Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below

Specification(s):

If SPF exceeds a thickness of 3", all SPF will be separated from the occupied interior space of the building with an approved thermal barrier material (typically ½" or thicker gypsum wallboard or an approved thermal barrier coating)

Application to rim/band joist up to 3" can be left exposed if the foam is Class I

Local codes will be confirmed and followed for fire protection requirements

Objective(s):

Provide necessary fire protection for combustible SPF insulation

4.1401.1d

Desired Outcome:

Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

4.1401.2a

Desired Outcome:

Closed crawl spaces insulated to achieve best thermal performance possible

Specification(s):

The rim joist, sill plate and adjacent surfaces will be sufficiently clean and free of debris to allow for the proper adhesion of any caulks, adhesives or spray foam used during installation.

Objective(s):

Prepare all surfaces for the installation of insulation

4.1401.2b

Desired Outcome:

Closed crawl spaces insulated to achieve best thermal performance possible

Specification(s):

A foam-based insulation will be installed so as to create a continuous thermal and pressure boundary. If rigid insulation is used, all edges will be sealed and the insulation will be installed tightly to the wood to prevent the movement of moisture throughout the assembly. Insulation will be installed in accordance with local/national code requirements and/or manufacturer's instructions regarding flame spread.

Objective(s):

Improve thermal performance Prevent moisture condensation on the inside of the band joist

4.1401.2c

Desired Outcome:

Closed crawl spaces insulated to achieve best thermal performance possible

Specification(s):

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

- Coverage area
- Thickness
- R-value

Objective(s):

Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17

4.1402.2a

Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

Specification(s):

Regional IECC will be followed for required R-values

Objective(s):

Improve thermal performance of the basement and living space

	Continuous Rigid Insulation, Interior or Exterior	Interior Cavity Insulation
Zone 1	0	0
Zone 2	0	0
Zone 3	5	13
Zone 4, except marine	10	13
Zone 5 and marine 4	15	19
Zone 6-8	16	19

Best Practice

Find your regional zone and insulation application to determine r-value

4.1402.2b

Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

Specification(s):

A continuous air barrier will be installed on the warm side of the insulation

Objective(s):

Prevent condensation on the basement wall



 Before

Basement shows no sign of ground water penetration, but needs insulation



 After

Insulation and drywall create an air barrier

Tools:

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

Materials:

1. XPS insulation board
2. Kraft-faced fiberglass batts
3. Drywall
4. Spackle
5. Seam tape
6. Fasteners

4.1402.2b - Air barrier



XPS insulation board is a non-absorbent insulation option



The drywall still provides an air barrier to keep moisture build up on wall



OR Kraft-faced fiberglass batts can be used with paper toward living space



Both kraft-face and drywall create air barrier, but batts are absorbent

4.1402.2c

Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

Specification(s):

When absorbent insulation materials are installed, assembly will remain vapor permeable to the interior in all climate zones except Zone 7

Objective(s):

Provide drying potential to the basement



Kraft-faced fiberglass insulation is absorbent



Drywall typically has a perm rating of 50--good for zones 1-6

Tools:

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

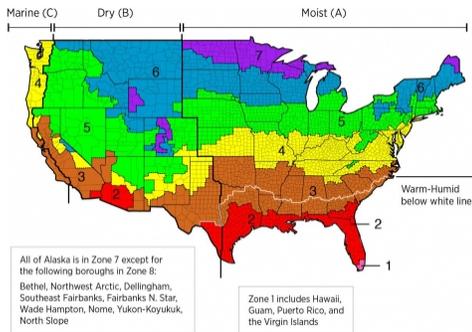
Materials:

1. Drywall
2. Kraft-faced fiberglass batts
3. Spackle
4. Seam tape
5. Fasteners

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50.

In zones 7 & 8 (AK, parts of MN, ND, WI, MI, WY, CO, and ME), vapor retarders should be used to minimize freezing. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <math><0.5</math> (which translates to 4mil or thicker). From 2007 IRC definition of vapor retarders: Class I: ≤ 0.1 perm (called impermeable), Class II: 0.1 to 1.0 perm (called semi-impermeable), Class III: 1.0 perm to 10 perms (called semi-permeable).

4.1402.2c - Vapor permeability



Determine in which zone you are working before selecting work materials



Many light-weight drywall brands have higher perm ratings for humid zones



In zones 7&8, vapor permeability is undesirable. Use a vapor retarder

4.1601.2a

Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

Specification(s):

Duct insulation on all ducts located in unconditioned spaces will be a minimum of R-8, in accordance with local code, or buried under attic insulation, whichever is greater, and have an attached vapor retarder

Hot humid and warm coastal regions will not bury ducts

Objective(s):

Decrease heat loss and condensation problems



 Before

Uninsulated ducts in unconditioned spaces are an energy drain



 After

Properly insulated ducts operate at much higher rates of efficiency

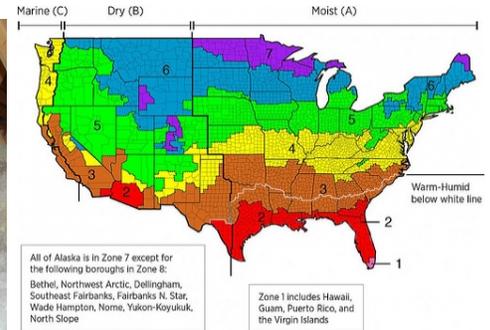
4.1601.2a - Selection of duct insulation material



Ducts in unconditioned areas should have r-8 insulation with vapor barrier



OR ducts can be buried in loose fill in attic spaces in drier climates



Burying ducts is discouraged in warm coastal and hot humid regions

4.1601.2b

Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

Specification(s):

All joints, seams, and connections in ductwork shall be securely fastened and sealed with UL 181 B-M mastics (adhesives) or mastic- plus-embedded-fabric systems installed in accordance with the manufacturer's instructions before insulation is applied

Objective(s):

Minimize duct leakage



 Before

Unsealed joints and connections need to be sealed to prevent health risks



 After

Sealed ductwork connections help prevent leakage

Tools:

1. Putty knife

Materials:

1. Mesh tape
2. Mastic

4.1601.2b - Duct sealing



1 Prepare work area by assessing any safety concerns



2 Wrap joint with fiberglass mesh tape



3 Apply UL 181 mastic to seal joint

4.1601.2c

Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

Specification(s):

Duct insulation will be secured to the duct system using metal wire or rot-proof nylon twine

Pattern of the wire or twine will be sufficient to securely hold the duct insulation tight to the duct

Objective(s):

Ensure a secure connection between the duct system and the duct insulation



Before

Materials holding insulation in place should not compress or kink duct



After

Durable materials can be attached without compressing insulation

Tools:

1. Scissors
2. Metal snips

Materials:

1. Nylon twine
2. Wire
3. Tie bands

4.1601.2d

Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

Specification(s):

Using a tape approved by the manufacturer, all seams and connection of the duct insulation will be taped

No gaps will exist between pieces of duct insulation

Objective(s):

Prevent gaps in the vapor barrier of the insulation



 Before

Unsecured and sealed insulation around ducts is useless



 After

All seams should be sealed with UL-181 duct tape to preserve vapor barrier

Tools:

1. Utility knife

Materials:

1. UL-181 tape
2. R-8 duct insulation with vapor barrier

5.3001.1a

Desired Outcome:

Equipment sized properly and operates efficiently

Specification(s):

Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications

Objective(s):

Properly size equipment for load

Weatherization Assistant v.8(or later) load calculations are also allowed.

5.3001.1b

Desired Outcome:

Equipment sized properly and operates efficiently

Specification(s):

Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications

Objective(s):

Ensure equipment is able to heat, cool, and dehumidify the house

5.3001.1c

Desired Outcome:

Equipment sized properly and operates efficiently

Specification(s):

New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass around the filters

Objective(s):

Particle removal to protect equipment and help maintain indoor air quality

5.3003.1a

Desired Outcome:

Data for commissioning and future service work is recorded

Specification(s):

Equipment will be visually inspected

Information will be recorded from the equipment data plates indoors and outdoors

Objective(s):

Ensure technician has equipment data necessary for commissioning and future service work

5.3003.2a

Desired Outcome:

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

Specification(s):

Nozzle size will be correct for design input and within equipment firing rate of the heating system manufacturer

Objective(s):

Ensure equipment operates as designed

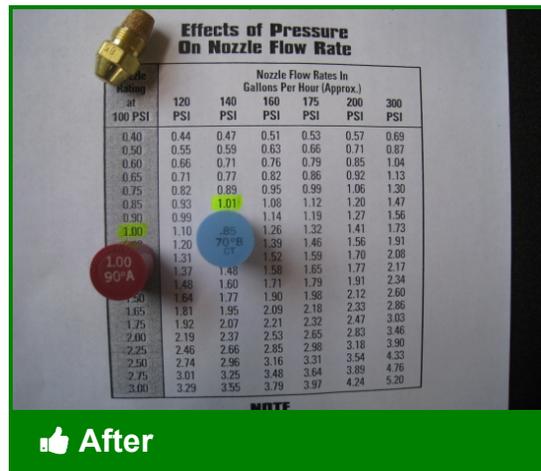
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Locate nozzles on oil-fired water heaters and furnaces



Verify that nozzle size is appropriate for model by consulting flow chart

Tools:

1. Calipers

5.3003.2b

Desired Outcome:

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

Specification(s):

Measurement will be verified in accordance with manufacturer specifications

Objective(s):

Ensure equipment operates as designed

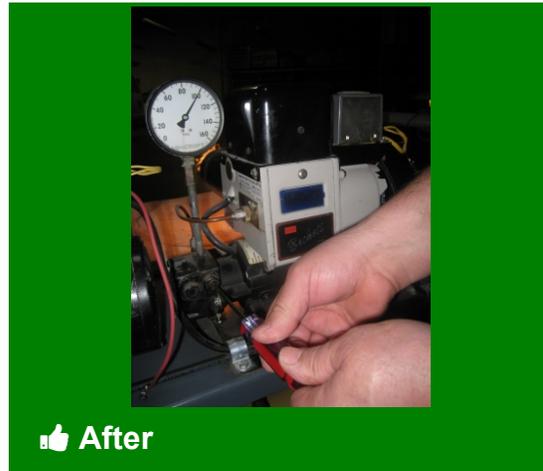
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Check oil-fired furnaces and water heaters for proper fuel pressure



👍 After

Verify that fuel pressure matches manufacturer's specifications

5.3003.2c

Desired Outcome:

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

Specification(s):

Measurement will be verified in accordance with manufacturer specifications

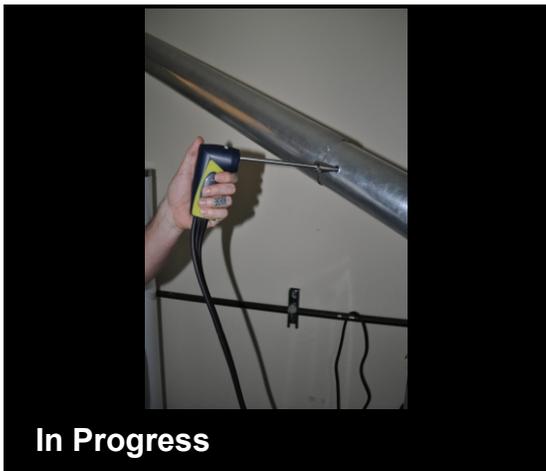
Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Test flue gases to determine steady state efficiency



At steady state, this furnace tests at 83%-- within manufacturer tolerances

Tools:

1. Combustion analyzer with probe

5.3003.2d

Desired Outcome:

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

Specification(s):

Smoke spot reading will be in accordance with burner manufacturer specifications

If smoke test is more than actionable levels, specify a clean and tune

Objective(s):

Ensure equipment operates as designed

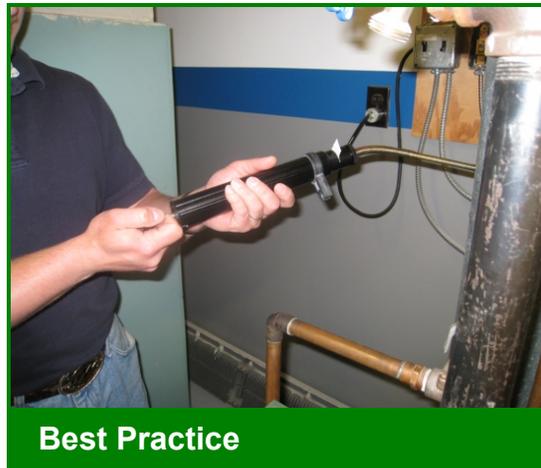
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Verify oil-fired furnaces and water heaters are operating safely



Best Practice

Smoke tests determine if oil-fired appliances burn cleanly by testing soot

Tools:

1. Smoke testing pump

Materials:

1. Filter paper

5.3003.2d - Oil system: smoke test (This test must be conducted before any combustion testing is completed)



1 Place filter paper in testing pump and draw air through paper



2 Remove paper and verify draw was successful by checking for soot



3 Compare level of soot deposit against smoke chart. A rating of 0 is ideal



4 Appliances with ratings of 3 or higher should be cleaned and tuned

5.3003.2e

Desired Outcome:

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

Specification(s):

Net stack temperature will be measured and verified in accordance with manufacturer specifications

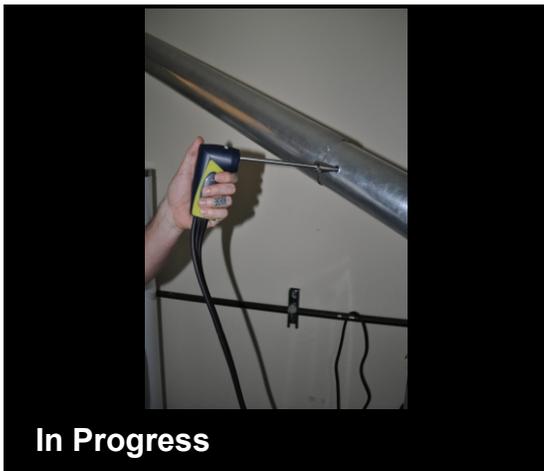
Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Verify oil-fired appliances are not burning hotter than manufacturer specs



T-stack minus T-air equals net stack temperature. Check against specs

Tools:

1. Combustion analyzer with probe

T=temperature. T-stack minus T-air = Delta T or Net Stack Temperature.

5.3003.2f

Desired Outcome:

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

Specification(s):

Measurement will be verified in accordance with industry manuals and manufacturer specifications

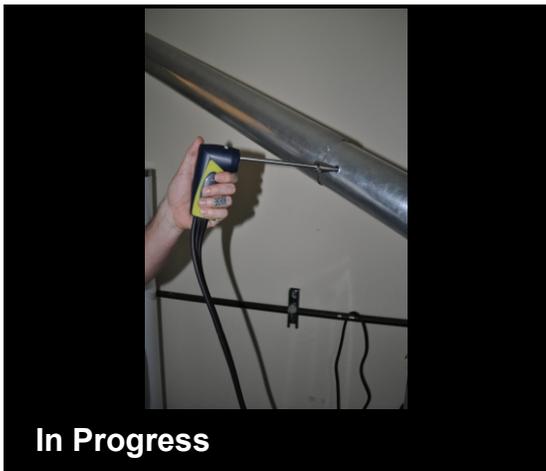
Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Verify oil-fired appliances are burning safely by testing CO₂ and O₂ levels



Levels should be within industry standards and match manufacturer specs

Tools:

1. Combustion analyzer with probe
2. Drill

15.4% should be the highest allowable level of CO₂ produced by an oil-fired appliance.

O₂ levels in the atmosphere are at a constant 20.9%. O₂ readings in appliances vary due to O₂ density and the efficiency of the combustion process.

5.3003.2g

Desired Outcome:

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

Specification(s):

Excess air will be calculated and shown to be in accordance with manufacturer specifications

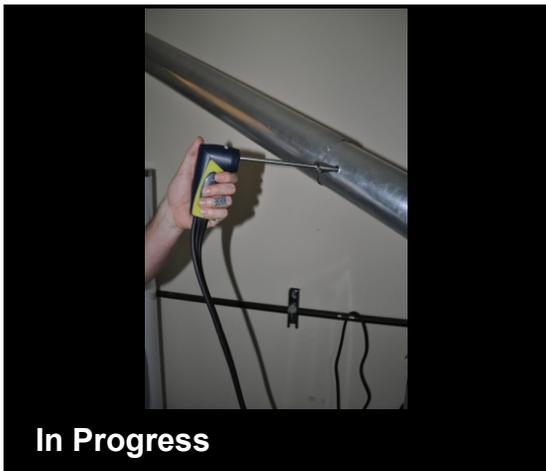
Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Oil-fired appliances require an appropriate level of air mixed with the oil



The percentage of Excess Air (EA) should be within manufacturer specs

Tools:

1. Combustion analyzer with probe
2. Drill

5.3003.2h

Desired Outcome:

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

Specification(s):

Undiluted flue gases will be checked with a calibrated combustion analyzer

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)

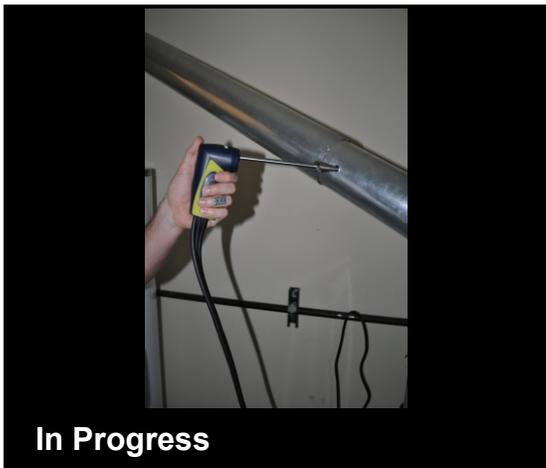
Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



In Progress

Test oil-fired appliances for CO in the flue gases to verify safe levels



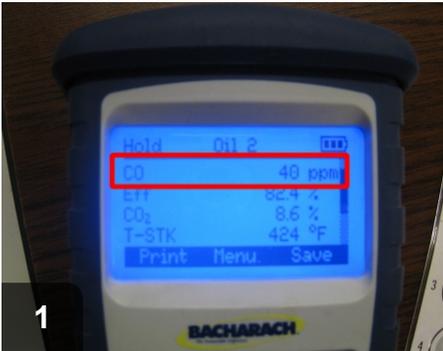
After

CO should measure less than 200ppm

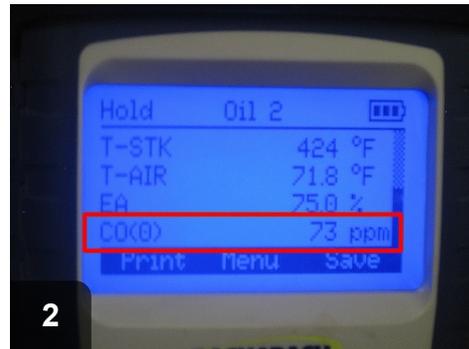
Tools:

1. Combustion analyzer with probe
2. Drill

5.3003.2h - CO in flue gas



CO should measure less than 200ppm



Air-free CO, or CO(0), should be less than 400ppm

5.3003.3a

Desired Outcome:

Air flow is properly tested

Specification(s):

Total system air flow will be measured by:

- Temperature rise
- Flow plate
- Fan depressurization device (e.g., Duct Blaster, DucTester)

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

5.3003.3b

Desired Outcome:

Air flow is properly tested

Specification(s):

External static pressure will be in accordance with manufacturer specifications

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

5.3003.3c

Desired Outcome:

Air flow is properly tested

Specification(s):

Pressure drop across cooling coils will be in accordance with manufacturer specifications

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

5.3003.3d

Desired Outcome:

Air flow is properly tested

Specification(s):

Pressure drop across filter will be in accordance with manufacturer specifications

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

5.3003.3e

Desired Outcome:

Air flow is properly tested

Specification(s):

Air flow will be measured at each register to ensure proper air flow delivery

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

5.3003.3f

Desired Outcome:

Air flow is properly tested

Specification(s):

Supply wet bulb and dry bulb air temperatures will be recorded

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

5.3003.3g

Desired Outcome:

Air flow is properly tested

Specification(s):

Return wet bulb and dry bulb air temperatures will be recorded

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

5.3003.3h

Desired Outcome:

Air flow is properly tested

Specification(s):

Temperature rise between the supply and return will be in accordance with manufacturer specifications

Objective(s):

Ensure equipment operates as designed

Ensure equipment operates efficiently

Ensure equipment provides comfort

Ensure equipment operates safely

Ensure equipment is durable

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

Objective(s):

Ensure refrigerant lines do not gain excessive heat

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

5.3003.5c

Desired Outcome:

Refrigerant lines properly installed

Specification(s):

Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment

Objective(s):

Ensure system moves appropriate volume of refrigerant

5.3003.5d

Desired Outcome:

Refrigerant lines properly installed

Specification(s):

Refrigerant lines will be installed without kinks, crimps, or excessive bends

Objective(s):

Ensure system moves appropriate volume of refrigerant

5.3003.5e

Desired Outcome:

Refrigerant lines properly installed

Specification(s):

Refrigerant lines will be routed, supported, and secured to house in a manner that protects the line from damage by workers or occupants

Objective(s):

Ensure refrigerant lines do not move, vibrate, or sag

Protect lines from damage

5.3003.10a

Desired Outcome:

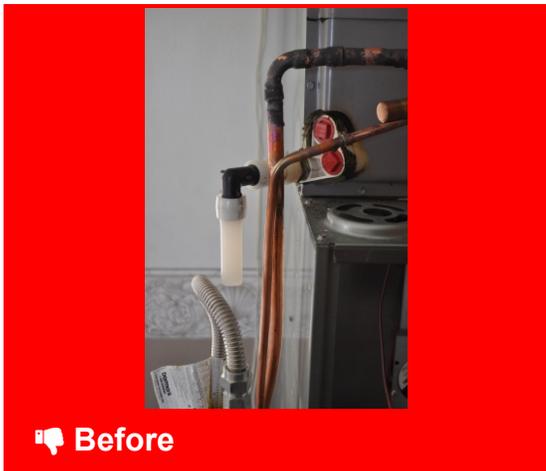
Equipment and condensate drain operate as designed

Specification(s):

Connections in condensate drain system will be watertight

Objective(s):

Ensure condensate drain connections do not leak



Before

HVAC equipment needs condensate drainage to prevent water damage



In Progress

Drainage pipes should be sealed to be watertight

Tools:

1. Hacksaw
2. Crimper

Materials:

1. Pex piping and angles
2. PVC piping and angles
3. Purple primer

5.3003.10b

Desired Outcome:

Equipment and condensate drain operate as designed

Specification(s):

Condensate drainlines will be insulated with a minimum 1" of insulation with a vapor retarder when there is potential for condensation or freezing on the drainline

Objective(s):

Ensure condensate drain connections do not leak



 Before

Once drainage pipes cross into unconditioned space, they can freeze



 After

Pipes in unconditioned spaces should be insulated with 1" pipe insulation

Tools:

1. Tape measure
2. Utility knife

Materials:

1. 1" thick pipe insulation
2. Zip ties

5.3003.10c

Desired Outcome:

Equipment and condensate drain operate as designed

Specification(s):

Secondary drain pan and float switch will be installed when overflow could damage finished surfaces

OR

Float switch in the primary condensate drain for upflow systems will be installed when overflow could damage finished surfaces

Objective(s):

Ensure condensate drain connections do not leak



A float switch should be installed to prevent overflow and damage

5.3003.10d

Desired Outcome:

Equipment and condensate drain operate as designed

Specification(s):

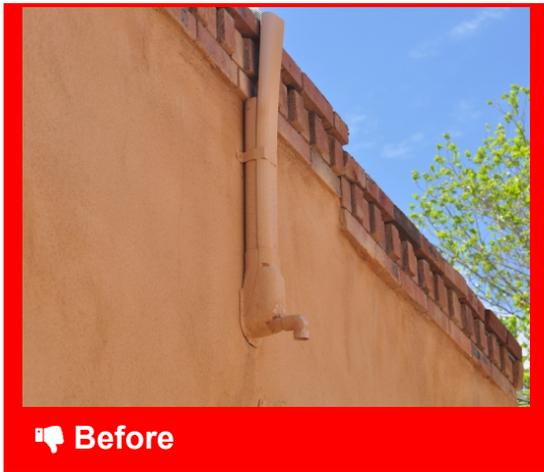
Condensate drain pumps will be installed when condensate cannot be drained by gravity

Power source for pump will be installed

Operation and drainage of pump will be verified

Objective(s):

Ensure condensate drain connections do not leak



HVAC equipment that drains upward through a roof cannot drain naturally



For non-gravity draining systems, a pump is necessary

5.3003.10d - Pumps



HVAC unit is mounted to "historic" adobe wall which cannot be penetrated



Instead, unit is drained by utilizing a pipe and pump in the next room



The pump is connected directly into the sewage system

5.3003.10e

Desired Outcome:

Equipment and condensate drain operate as designed

Specification(s):

Vents and traps will be installed on condensate drainlines

Trap supplied with the equipment will be used and manufacturer specifications will be followed

Objective(s):

Ensure condensate drain operates as designed

Ensure condensate drain does not leak air

5.3003.10f

Desired Outcome:

Equipment and condensate drain operate as designed

Specification(s):

Condensate from all cooling coils or evaporators shall be conveyed from the drain pan outlet to an approved place of disposal

Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than 1/8 unit vertical in 12 units horizontal (1% slope)

Condensate shall not discharge into a street, alley, or other areas where it would cause a nuisance

Objective(s):

Prevent water damage from drain system malfunction

5.3003.10g

Desired Outcome:

Equipment and condensate drain operate as designed

Specification(s):

All secondary drain pans will have a float switch and be drained away through a drainline

Objective(s):

Prevent water overflowing the pan and draining onto the ceiling below



Float switches should be installed in drainage pans to prevent overflow

5.3003.10h

Desired Outcome:

Equipment and condensate drain operate as designed

Specification(s):

Condensate drain will be terminated in accordance with local codes

Objective(s):

Ensure condensate does not leak to the house

Ensure condensate drain does not freeze

5.3003.14a

Desired Outcome:

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

Specification(s):

Heating equipment will be placed in operation in accordance with applicable NFPA standards and manufacturer specifications when available

Objective(s):

Ensure equipment:

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

5.3003.14b

Desired Outcome:

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

Specification(s):

Measurement will be verified by a certified professional in accordance with fuel type and manufacturer specifications

Objective(s):

Ensure equipment:

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

5.3003.14c

Desired Outcome:

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

Specification(s):

Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)

Objective(s):

Ensure equipment:

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

5.3003.14d

Desired Outcome:

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

Specification(s):

Excess combustion air will be calculated and verified in accordance with industry manuals (e.g., Testo, Bacharach)

Objective(s):

Ensure equipment:

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

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 100 ppm

Objective(s):

Ensure equipment:

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

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

6.6002.1a

Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

Specification(s):

Ventilation ducts will be as short, straight, and smooth as possible

Ventilation ducts will not be smaller than the connections to which they are attached

Objective(s):

Effectively move the required volume of air



🗨️ Before

Duct work for exhaust fans should be short, smooth, and not pinch down



👍 After

Duct is the same size as the outlet and makes shortest run possible

Tools:

1. Metal snips
2. Drill

Materials:

1. Metal duct piping
2. Fasteners

See also ASHRAE 62.2-2013.

6.6002.1b

Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

Specification(s):

Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes

Objective(s):

Prevent condensation from forming or collecting inside of the ductwork



 Before

Uninsulated ducts in unconditioned spaces are an energy drain



 After

R-8 insulation with a vapor barrier should be securely wrapped around ducts

Tools:

1. Utility knife
2. Metal snips

Materials:

1. R-8 insulation with vapor barrier
2. Nylon twine
3. Wire
4. UL-181 duct tape

See also ASHRAE 62.2-2013. Check local codes to see if R-8 is accepted level of insulation.

6.6002.1c

Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

Specification(s):

Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 ½" wide material

Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction

Metal ducts will be supported by 1/2" or wider 18-gauge strapping or 12 gauge or thicker galvanized wire no less than 10' apart

Objective(s):

Effectively move the required volume of air

Preserve the integrity of the duct system

Eliminate falling and sagging



Ducts should not be allowed to droop or sag to maximize efficiency



Supports should be evenly spaced to allow for minimal distance of run

Tools:

1. Drill
2. Metal snips
3. Utility knife

Materials:

1. Durable straps at least 1 1/2" wide
2. 18 gauge metal strap at least 1/2" wide
3. 12 gauge galvanized wire
4. Staples
5. Fasteners

See also ASHRAE 62.2-2013.

6.6002.1c - Duct support



BAD: Make sure supports DO NOT compress insulation or duct



Flex ducts should have support straps at least every 4 feet



Support straps should be at least 1 1/2 inches wide



Metal ducts should be supported at 10 feet or less with wire or metal strap



Metal strap should be at least 18 gauge and 1/2 inch wide



Metal wire should be at least 12 gauge and galvanized

6.6002.1d

Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

Specification(s):

Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws

Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic- plus-embedded-fabric systems, or tapes

Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool

PVC-to-PVC materials will be fastened with approved PVC cement

Other specialized duct fittings will be fastened in accordance with manufacturer specifications

In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Objective(s):

Effectively move the required volume of air

Preserve the integrity of the duct system



Fan duct is disconnected and venting into the attic space.



Fan has been vented with sealed, insulated duct material.

Tools:

1. drill
2. tie band tensioner
3. brush

Materials:

1. tie bands
2. insulated flex duct
3. mastic
4. PVC primer
5. PVC cement

6.6002.1d - Duct connections



Apply mastic to the connection fitting.



Snug duct liner onto connection fitting.



Use zip tie and tensioner to secure liner to connection fitting.



Apply mastic to fan connection.



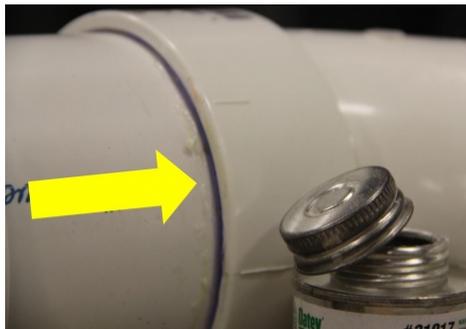
Using mechanical fasteners, secure connection fitting to fan connection.



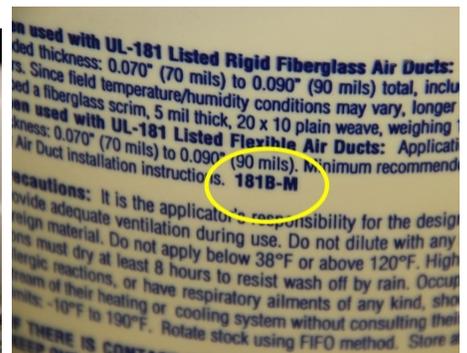
Snug insulation to fan housing and strap into place.



Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum.



PVC-to-PVC connections should use PVC primer and cement.



Sealants should show UL181-M or UL181B-M.

6.6002.1e

Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

Specification(s):

Flexible materials will be UL 181 listed or Air Diffusion Council approved

Rigid, kitchen fans gauges shall meet code requirements or authority having jurisdiction

Objective(s):

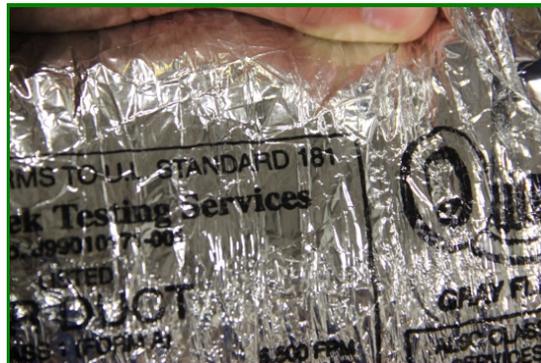
Effectively move the required volume of air

Preserve the integrity of the duct system



Bad Practice

Existing duct is installed incorrectly and is not UL listed



Best Practice

This flexible duct conforms to UL 181

Materials:

1. All materials should be UL 181 Listed
2. 30-gauge minimum Rigid Duct

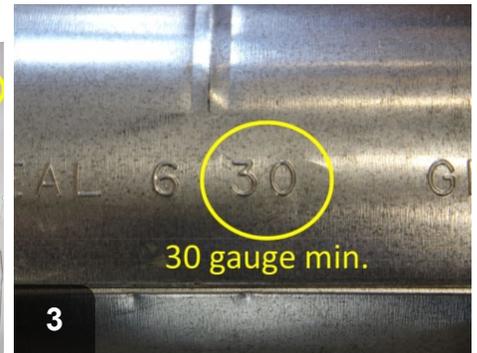
6.6002.1e - Duct materials



Look for the Air Diffusion Council seal.



Flex installed should meet or exceed UL181.



When rigid duct is being used, its wall thickness should be 30 gauge minimum.

6.6002.2a

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

A hole no greater than a 1/4" greater than the fitting will be cut to accommodate termination fitting

Objective(s):

Allow for ease of weatherproofing



 Before

Exhaust fans need exterior ventilation, often through roofs and walls



 After

Hole should be no more than 1/4" larger than termination fitting diameter

Tools:

1. Hole saw
2. Drill
3. Tape measure

6.6002.2a - Hole in building shell



1
Locate the center of your vent hole by drilling from inside through roof



2
Measure the termination fitting to determine proper hole saw diameter



3
Based on termination fitting size (in this case, 4"), mark to cut hole



4
Hole should be no more than 1/4" larger than termination fitting diameter



5
Verify hole size is correct before installation

6.6002.2b

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

A termination fitting with an integrated collar will be used

Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used

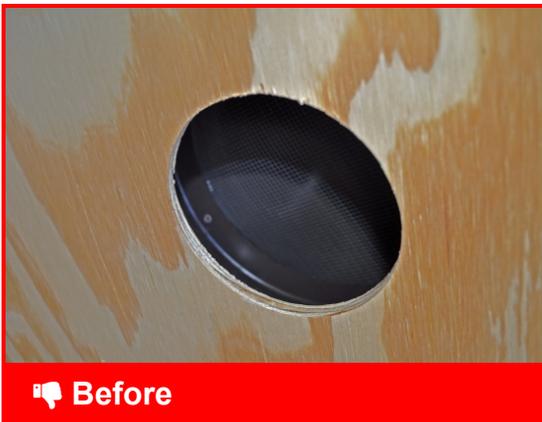
Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable

Objective(s):

Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation



Before

Termination fittings with no collar are to be avoided



After

Properly sized ducts with snug connections to collared fittings last longer

Tools:

1. Drill

Materials:

1. Fasteners

6.6002.2b - Termination fitting



BAD: Termination fittings without collars should be avoided



Termination fittings with collars should be used for exhaust ventilation



Collared fittings extend through the roof to fasten securely with duct

6.6002.2c

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

Duct will be connected and sealed to termination fitting as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Fasteners will not inhibit damper operation

Objective(s):

Effectively move the required volume of air to the outside

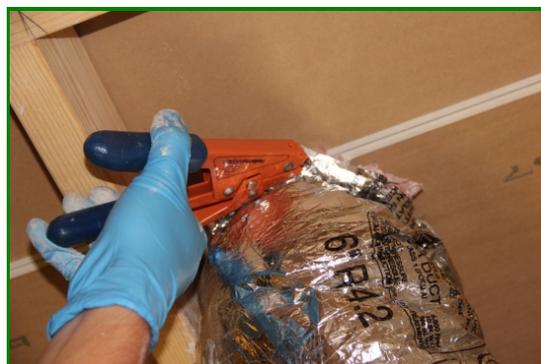
Preserve integrity of the building envelope

Ensure durable installation



 Before

Termination is not mechanically fastened, or sealed appropriately.



 After

Termination fitting is secure, and duct is sealed to termination.

Tools:

1. wire cutter
2. chip brush
3. zip tie tension tool
4. utility knife

Materials:

1. insulated flex duct with liner
2. UL 181 sealant
3. zip tie straps
4. PVC primer
5. PVC cement

6.6002.2c - Duct to termination connection



1 With other end of the duct connected to the fan, cut duct to desired length.



2 Apply mastic to termination fitting.



3 Fit duct liner on to termination fitting.



4 With duct liner in place, use the zip tie tension tool to secure the liner to the fitting.



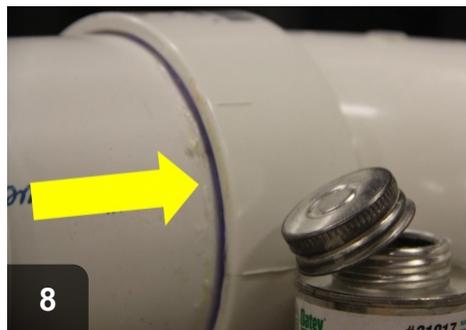
5 With liner secured and zip tie trimmed, you are ready to pull the insulation to cover the fitting.



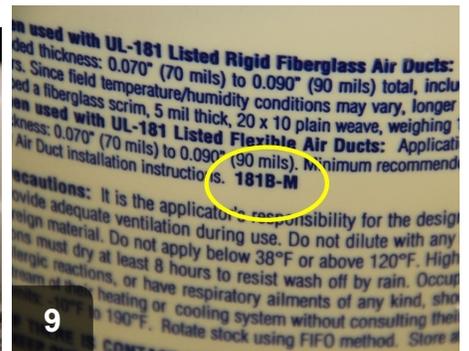
6 Ensure termination damper functions as intended.



7 Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum.



8 PVC-to-PVC connections should use PVC primer and cement.



9 Sealants should be UL181-M or UL181B-M listed.

6.6002.2d

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Installation will not inhibit damper operation

Manufacturer specifications will be followed

Objective(s):

Preserve integrity of the building envelope

Ensure a weather tight and durable termination installation

Ensure unrestricted air flow



 Before

Holes for termination fitting need to be sealed to weatherproof



 After

Termination installation should follow shingling to deter water penetration

Tools:

1. Hole saw
2. Caulk gun
3. Drill

Materials:

1. Fasteners
2. Caulk

6.6002.2d - Weatherproof installation



Termination fitting is installed to repel water and sealed

6.6002.2e

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

Screen material with no less than 1/4" and no greater than 1/2" hole size in any direction will be used

Installation will not inhibit damper operation or restrict air flow

Objective(s):

Prevent pest entry

Ensure proper air flow



 Before

Exhaust terminations without screens are an invitation to pest intrusion



 After

Screen mesh should be between 1/4" and 1/2" in either direction

6.6002.2f

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

Terminations will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors.

Terminations will be installed:

- A minimum of 3' away from any property line
- A minimum of 3' away from operable opening to houses
- A minimum of 10' away from mechanical intake
- As required by authority having jurisdiction

Objective(s):

Prevent exhaust from reentering house



Exhaust vent has been improperly mounted too close to mechanical vent



Exhaust vent was properly mounted over 3ft from door, window, and deed line

Tools:

1. Measuring tape
2. Hole saw
3. Drill

6.6002.2g

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust

Objective(s):

Prevent a fire hazard



Kitchen exhaust vents should not be made from highly combustible materials



This roof-mounted kitchen exhaust fan is galvanized steel--heat resistant

6.6002.3a

Desired Outcome:

Exhaust grille location optimizes either primary or local ventilation

Specification(s):

Fan intake grille will be installed in a central location within the main body of the house

Ensure it is accessible for filter change and cleaning

Objective(s):

Provide whole house air exchange

6.6002.3b

Desired Outcome:

Exhaust grille location optimizes either primary or local ventilation

Specification(s):

Fan intake grille will be installed in the space where odor, moisture vapor, or other contaminants are generated

Objective(s):

Remove contaminated air at the source

6.6003.1a

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

A hole no greater than a 1/4" greater than the assembly will be cut to accommodate fan assembly

Objective(s):

Minimize repair work

Ensure a secure installation

6.6003.1b

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

Objective(s):

Prevent an electrical hazard

6.6003.1c

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Fan outlet will be oriented toward the final termination location

Fan will be oriented so the equivalent length of the duct run is as short as possible

Fan will be mounted securely in accordance with manufacturer specifications

Objective(s):

Ensure short duct run to achieve optimum air flow

Ensure a secure installation

Ensure fan housing does not shake, rattle, or hum when operating

6.6003.1d

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

A backdraft damper will be installed between the outlet side of the fan and the exterior

Objective(s):

Prevent reverse air flow when the fan is off

6.6003.1e

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Duct-to-fan outlet will be connected and sealed as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened according to manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Objective(s):

Exhaust to outside

6.6003.1f

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Gaps and holes in fan housing will be sealed with caulk or other sealants in accordance with manufacturer recommendations

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

Objective(s):

Prevent air leakage through fan housing

Ensure a permanent seal

Prevent a fire hazard

6.6003.1g

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

Objective(s):

Prevent air leakage between house and fan

6.6003.1h

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Air flows in cubic feet per minute (CFM) will be measured and adjusted to meet the whole house upgrade design requirements

Objective(s):

Exhaust sufficient air from desired locations to outside

6.6003.1i

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)

Objective(s):

Ensure occupant health and safety

6.6003.1j

Desired Outcome:

Surface-mounted ducted fans installed to specification

Specification(s):

Pressure effects will be assessed and corrected on all combustion appliances

Objective(s):

Ensure safe operation of combustion appliances

6.6003.3a

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

A hole no greater than a 1/4 inch greater than the assembly will be cut to accommodate fan assembly

Objective(s):

Allow for ease of weatherproofing



 Before

Determine size to cut hole by measuring fan assembly and ducting



 After

A snug fit should be ensured to minimize weatherproofing required

Tools:

1. Tape measure
2. Saw

6.6003.3a - Hole in building shell



Measure the termination fitting to determine proper hole diameter (in this case, 4")



Hole should be no more than 1/4" larger than assembly diameter



Clear wall surface and mark hole size 1/4" larger than termination fitting



Since opening is larger than most hole saws, precision cutting is important

6.6003.3a

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

A hole no greater than a 1/4 inch greater than the assembly will be cut to accommodate fan assembly

Objective(s):

Allow for ease of weatherproofing



Measure the vent size to compare to opening. 1/4" gap or less is desired.



Hole size allows sufficient room for vent installation and proper sealing.

Tools:

1. saw
2. prybar
3. goggles
4. gloves
5. measuring tape

6.6003.3b

Desired Outcome:

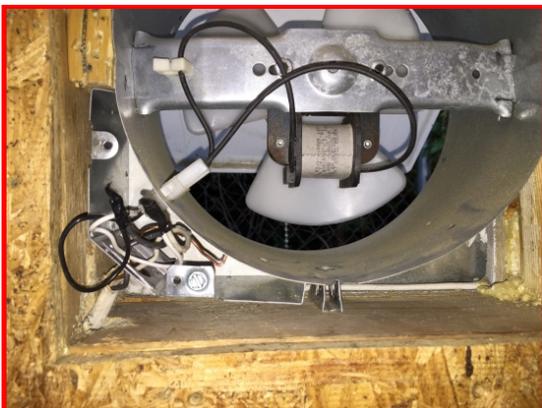
Through the wall fans installed to specification

Specification(s):

Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

Objective(s):

Prevent an electrical hazard



👎 Before

Incorrect: disconnected ground, no wire nuts on splices, no clamp on wires passing through junction box



👍 After

Fan junction box with cover installed

Tools:

1. Wire strippers
2. Utility knife or cable ripper
3. Screwdriver
4. Non-contact voltage tester
5. Lineman's pliers

Materials:

1. Ground wire crimp sleeves
2. Non-metallic sheathed wire (Type NM-B) e.g., Romex ®
3. Plastic junction box and cover plate
4. Wire nuts
5. Cable staples
6. Clamp-type cable connectors

Follow manufacturer's specifications and applicable codes when wiring newly installed equipment.

6.6003.3b - Wiring



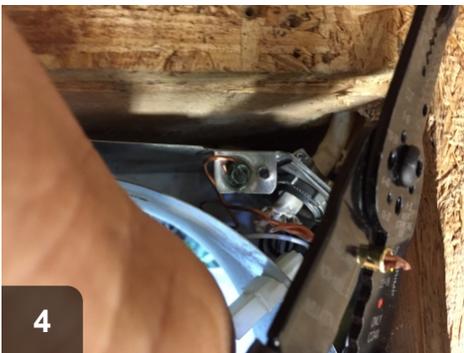
Inspect for: proper ground, wire nuts on splices, clamps on wiring where it enters junction box, cover installed on box



Install clamp on wiring into junction box



Install wire nuts on splices



Use crimp sleeves to connect ground wires



Tuck wiring into place



Reinstall cover on junction box

6.6003.3c

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

Fan outlet will be oriented toward the final termination location

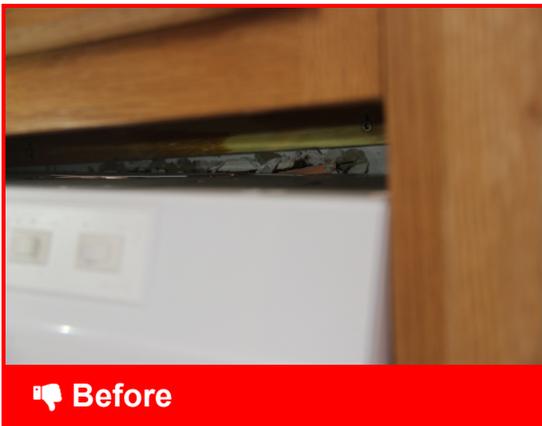
Fan will be oriented so the equivalent length of the duct run is as short as possible

Fan will be mounted securely according to manufacturer specifications

Objective(s):

Install mounting fan securely

Ensure fan housing does not shake, rattle, or hum when operating



Improperly aligned fan



Fan is mounted securely with the termination outlet lined up.

Tools:

1. drill
2. drill bits

Materials:

1. fasteners

6.6003.3c - Fan mounting



Fan is not properly supported, resulting in a improper alignment with the termination location.



Line the fan up so the outlet lines up with the termination.



Install the fan using factory mounting holes, ensuring a tight fit and quiet operation.

6.6003.3d

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Termination fitting installation will not inhibit damper operation

Manufacturer specifications will be followed

Objective(s):

Preserve integrity of the building envelope

Ensure a weather tight and durable installation

Ensure unrestricted air flow



Best Practice

Apply sealant behind termination cap, taking care to apply sealant to all edges.



Best Practice

Termination is sealed and securely attached to the wall.

Tools:

1. caulk gun
2. drill
3. drill bits
4. reciprocating saw
5. drywall saw or utility knife

Materials:

1. weatherproof termination kit with pest screen
2. caulk or equivalent sealant
3. mechanical fasteners

6.6003.3d - Weatherproof installation



1
Clean existing sealant to ensure proper adhesion to the surface.



2
Once area around the termination opening is cleaned, apply sealant to all four sides of the opening.



3
Install screws through the sealant, which will tighten the fitting and squeeze out excess sealant.



4
Wipe away excess sealant for a clean look.



5
Ensure damper swings open freely, and closes with a tight fit.

6.6003.3e

Desired Outcome:

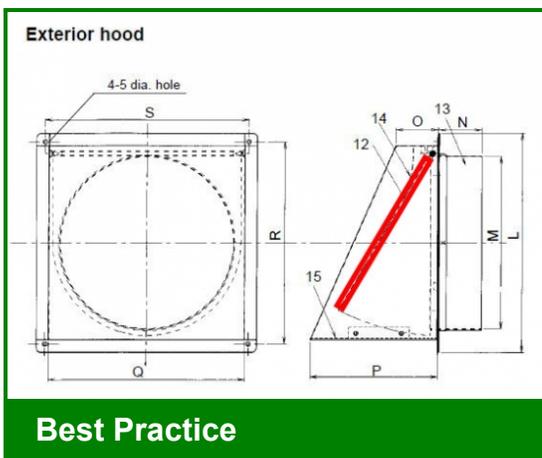
Through the wall fans installed to specification

Specification(s):

A backdraft damper will be installed between the outlet side of the fan and the exterior

Objective(s):

Prevent reverse air flow when the fan is off



Damper should be installed to maintain exterior air barrier

6.6003.3f

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

Objective(s):

Prevent air leakage through fan housing

Ensure a permanent seal to the building air barrier



Best Practice

Sealant should be waterproof and adhere to the desired surfaces.



Best Practice

Seal unused holes in the fan housing.

Tools:

1. caulk gun

Materials:

1. weatherproof, code approved caulk

6.6003.3g

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

Objective(s):

Prevent air leakage around intake housing

Prevent a fire hazard



Best Practice

Sealant should be waterproof and adhere to desired surfaces.



Best Practice

Sealant should be applied to the fan housing where it comes in contact with the exterior wall.

Tools:

1. caulk gun

Materials:

1. code approved caulk

6.6003.3h

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local code

Exception: If system operates continuously, fan housing need not be insulated

Objective(s):

Preserve integrity of the duct system

6.6003.3i

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

Air flows in CFM will be measured and adjusted to meet the design requirements

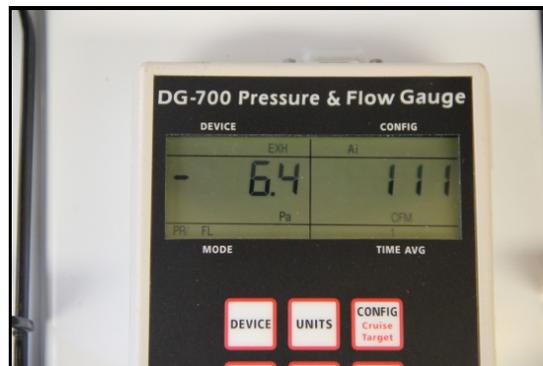
Objective(s):

Exhaust sufficient air from desired locations to outside



Best Practice

Using a digital manometer, exhaust flow meter and fabricated cover, measure the fan flow.



Best Practice

Air flow should be within acceptable limits for the location of the fan.

Tools:

1. exhaust fan flow meter
2. manometer

Materials:

1. a fabricated cover for fans larger than the flow meter

6.6003.3i - Air flow



1 The exhaust fan flow meter won't fit most range hoods. A fabricated cover is needed.



2 A fabricated cover can be used so long as the opening is smaller than the meter itself and larger than the E1 opening.



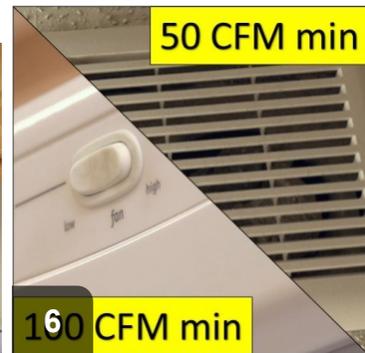
3 Attach a pressure hose to the exhaust fan flow meter.



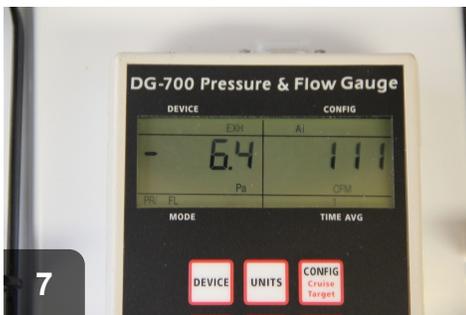
4 Attach a the hose to a T connection on channels A & B with the manometer set to measure exhaust fan flow.



5 With manometer properly set up, prepare to test air flow



Fans must pull the required CFM according to ASHRAE.



7 With the manometer Mode set to PR/FL, Device set to EXH, and Config set to E1, this fan pulls 111 CFM.

6.6003.3j

Desired Outcome:

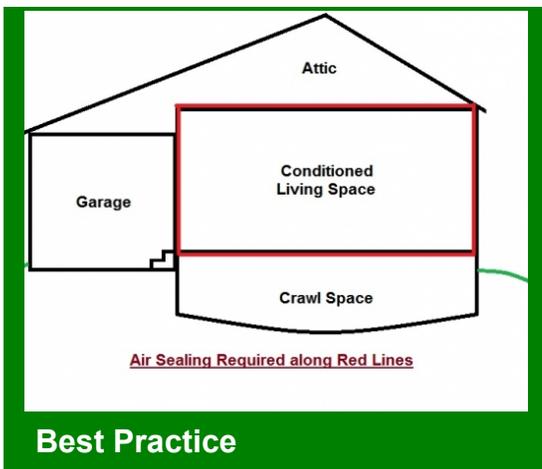
Through the wall fans installed to specification

Specification(s):

Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)

Objective(s):

Ensure occupant health and safety



The barrier between conditioned and unconditioned spaces should be sealed

See also SWS 3.1501.1 Air Sealing Garage Penetrations.

6.6003.3k

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

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

Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

Objective(s):

Ensure safe operation of combustion appliances



Installing new ventilation can cause imbalances within the house



Test that depressurization limit is not being exceeded by new ventilation

Tools:

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits

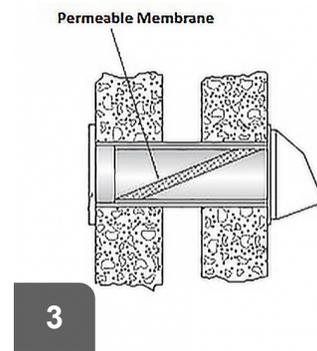
6.6003.3k - Combustion safety



Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



If depressurization limit is exceeded, mitigate to eliminate safety risk



Mitigate safety risk with make-up air or other pressure relief



After mitigation, verify that depressurization limits are not being exceeded

6.6005.1a

Desired Outcome:

Dryer air exhausted efficiently and safely

Specification(s):

Clothes dryers will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors

As short a run as practical of rigid sheet metal or semi-rigid sheet metal venting material will be used in accordance with manufacturer specifications

Dryer ducts exceeding 35' in duct equivalent length will have a dryer booster fan installed

Plastic venting material will not be used

Uninsulated clothes dryer duct will not pass through unconditioned spaces such as attics and crawl spaces

Ducts will be connected and sealed as follows:

- UL listed foil type or semi-rigid sheet metal to rigid metal will be fastened with clamp
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

In addition:

- Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used
- Condensing dryers will be plumbed to a drain

Objective(s):

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside

**Before**

Dryer is vented outside, but with the incorrect material.

**After**

Dryer is vented outdoors, with correct material. Run is as short and straight as possible ensuring maximum flow.

Tools:

1. metal trimmers
2. drill

Materials:

1. metal flex duct
2. dryer vent kit
3. hose clamps

6.6005.1a - Clothes dryer ducting



1 Disconnect existing vent pipe from termination. If hose clamp is installed, save for reuse.



2 Disconnect existing vent pipe from dryer.



3 Attach approved vent material to termination vent. Termination vent may need to be trimmed.



4 Trim metal vent to ensure the run is as short and straight as possible.



5 Connect vent pipe to dryer.



6 Dryer vents to outdoors, and exhaust damper is functional.



7 For vent runs >35 feet, a booster fan is required.



8 Duct runs outside of conditioned space must be insulated and properly supported.

6.6005.1b

Desired Outcome:

Dryer air exhausted efficiently and safely

Specification(s):

Termination fitting manufactured for use with dryers will be installed

A backdraft damper will be included, as described in termination fitting detail

Objective(s):

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



Best Practice

Termination fittings for dryers should have backdraft dampers

6.6005.1b - Termination fitting



Most modern dryer vents have a built-in backdraft damper

To minimize pest intrusion, mesh >1/4" square can be used (see 6.6002.2e)

6.6005.1c

Desired Outcome:

Dryer air exhausted efficiently and safely

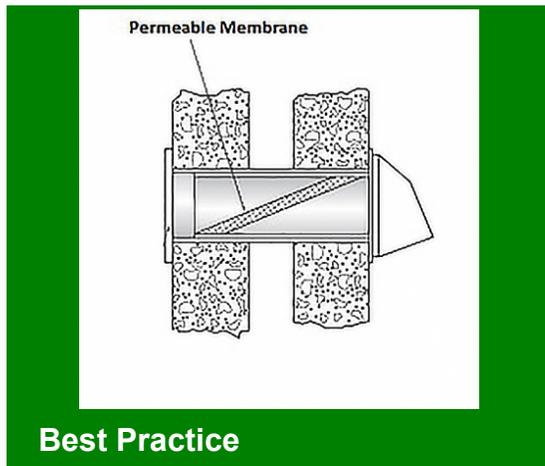
Specification(s):

Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction

Objective(s):

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



A passive inlet vent can provide make-up air for dryer exhaust

Tools:

1. Drill
2. Hole saw
3. Caulk gun

Materials:

1. Caulk sealant
2. Fasteners

6.6005.1d

Desired Outcome:

Dryer air exhausted efficiently and safely

Specification(s):

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

Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety



Appliance exhaust, such as that for a dryer, can cause depressurization



After

Test to verify combustion appliances are within depressurization limits

Tools:

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits

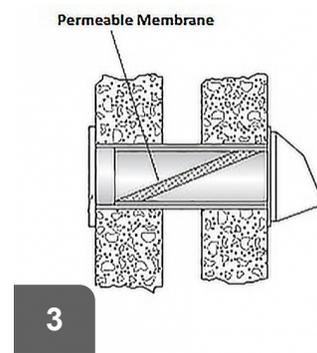
6.6005.1d - Combustion safety



Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



If depressurization limit is exceeded, mitigate to eliminate safety risk



Install make-up air, such as a passive inlet vent, or other pressure relief



After mitigation, verify that depressurization limit is not being exceeded

6.6005.1e

Desired Outcome:

Dryer air exhausted efficiently and safely

Specification(s):

Occupant will be instructed to keep lint filter and termination fitting clean

Occupant will be instructed to keep dryer booster fan clean, if present

Occupant will be instructed on clothes dryer operation safety including information on items that must not be placed in the clothes dryer (items with any oil or other flammable liquid on it, foam, rubber, plastic or other heat-sensitive fabric, glass fiber materials)

Objective(s):

Effectively move air from clothes dryer to outside



Unsafe

Neglect of clothes dryer maintenance can cause fire hazards



Best Practice

Occupants should be taught to clean lint filters and termination fittings

6.6005.1e - Occupant education



In homes with booster fans, occupant should know location and how to clean



Occupants should be taught never to put flammable articles in dryer (in this case, oily rags)

6.6005.2a

Desired Outcome:

Kitchen range fan installed to specification

Specification(s):

Wiring will be installed in accordance with local regulations or the 2012 IRC in the absence of such regulations or where those regulations are not as stringent as the 2012 IRC

Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes

Objective(s):

Prevent an electrical hazard

6.6005.2b

Desired Outcome:

Kitchen range fan installed to specification

Specification(s):

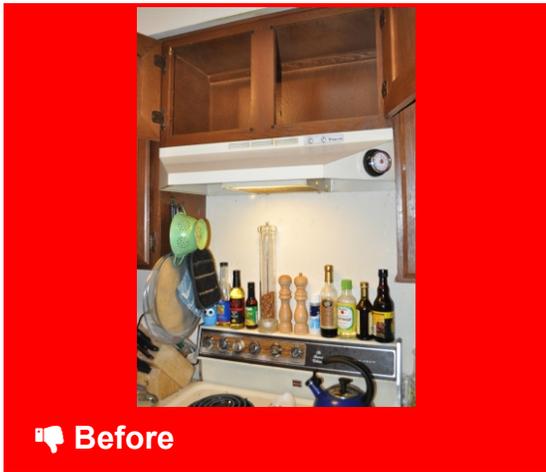
Kitchen range fans will be vented to the outdoors

Recirculating fans will not be used as a ventilating device

Objective(s):

Remove cooking contaminants from the house

Preserve integrity of building envelope



Recirculating fans over ranges do not actually remove contaminants



Daylight visible through dampered kitchen exhaust proves venting access

6.6005.2c

Desired Outcome:

Kitchen range fan installed to specification

Specification(s):

Kitchen range fans will be ducted to the outdoors

As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications

Ducting will be connected and sealed as follows:

- Metal-to-metal will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- For down-draft exhaust systems, PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Objective(s):

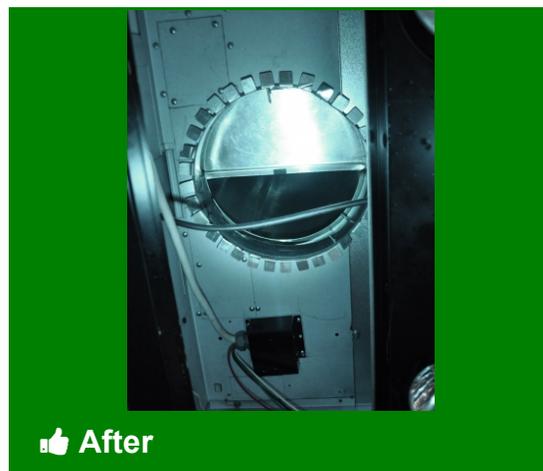
Preserve integrity of building envelope

Effectively move air from range to outside



 Before

Exhaust duct should be smooth-walled and in as short a run as possible



 After

Daylight visible through dampered kitchen exhaust proves outside access

Tools:

1. Drill
2. Putty knife
3. Tape measure
4. Metal snips
5. Saw

Materials:

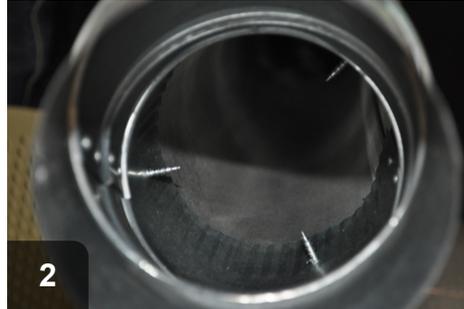
1. Round metal ducting
2. Mastic
3. Fiberglass mesh tape
4. Fasteners

See also 6.6002.1d. Note: Only smooth-wall metal duct will be used, except for down-draft exhaust systems where PVC is acceptable as well. Flex duct is NOT acceptable for kitchen fan exhaust application.

6.6005.2c - Fan ducting



1
Duct run should be as smooth and short as possible



2
Duct should be fastened securely with three evenly-spaced screws



3
Then joints should be secured with fiberglass tape



4
Finally, joint should be secured with UL-181 mastic

6.6005.2d

Desired Outcome:

Kitchen range fan installed to specification

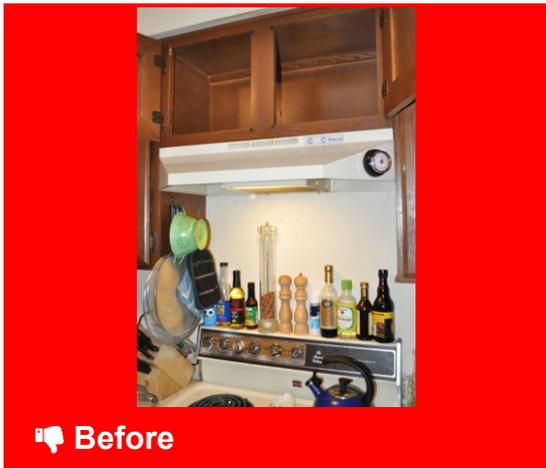
Specification(s):

Termination fitting will be installed including a backdraft damper, as described in termination fitting detail

Objective(s):

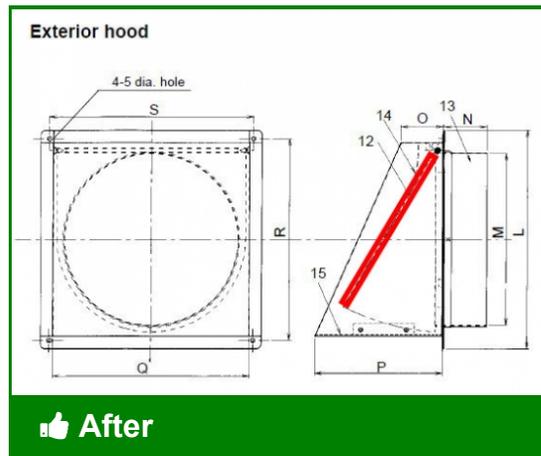
Ensure safe operation of combustion appliances

Ensure occupant health and safety



Before

Kitchen fans should exhaust to the exterior, not just recirculate air



After

Exhaust fans should have backdraft dampers

6.6005.2d - Termination fitting



Backdraft damper on roof mounted exhaust fan



An interior backdraft damper can also be installed for good measure

6.6005.2e

Desired Outcome:

Kitchen range fan installed to specification

Specification(s):

Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction

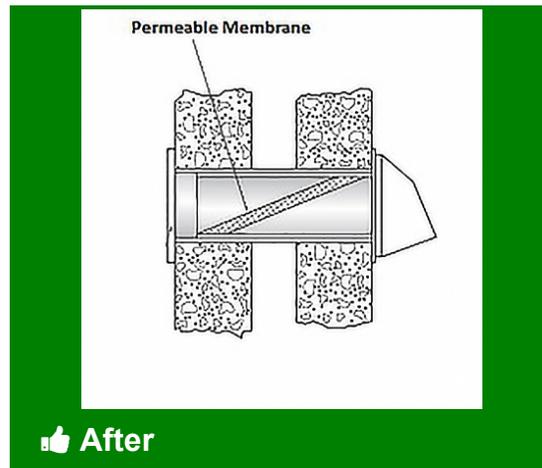
Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety



If kitchen exhaust is venting at more than 200 cfm, provide make-up air



A passive inlet vent can provide make-up air for kitchen exhaust

Tools:

1. Drill
2. Hole saw
3. Caulk gun

Materials:

1. Caulk sealant
2. Fasteners

6.6005.2f

Desired Outcome:

Kitchen range fan installed to specification

Specification(s):

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

Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety



 Before

Kitchen exhaust fans can cause combustion appliances to depressurize



 After

Test that combustion appliances are operating within depressurization limit

Tools:

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits

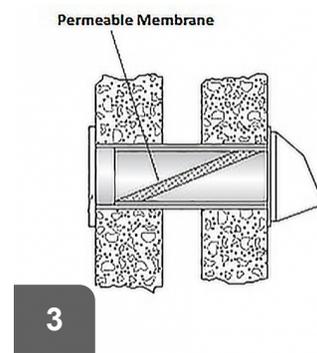
6.6005.2f - Combustion safety



1 Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



2 If appliances exceed depressurization limit, mitigate to reduce risk



3 Install a source of make-up air, such as a passive inlet vent



4 After mitigation, verify that depressurization limits are not being exceeded

6.6005.2g

Desired Outcome:

Kitchen range fan installed to specification

Specification(s):

Occupant will be instructed to keep grease filters and termination fitting clean

Objective(s):

Effectively move air from kitchen range to outdoors

6.6201.2a

Desired Outcome:

Air circulates freely between rooms

Specification(s):

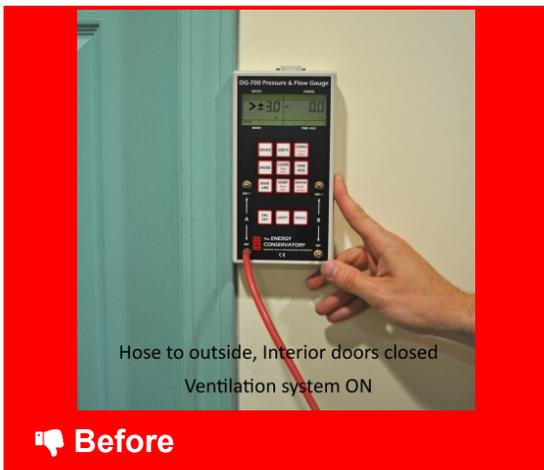
An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)

No room will exceed +/- 3 pascals with reference to the outdoors with all interior doors closed and ventilation systems running

Objective(s):

Ensure free flow of air between rooms

Preserve integrity of the building envelope



Before

If reading is >+/-3pa, interior ventilation needs to be installed



After

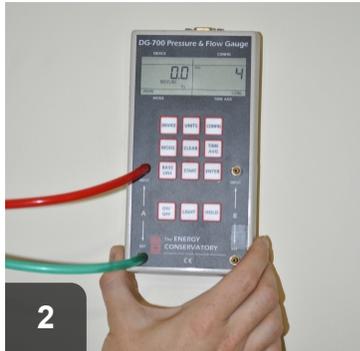
Passive door vents and individual room returns are two possibilities

6.6201.2a - Balancing pressure



1

With interior doors open, put reference hose to exterior



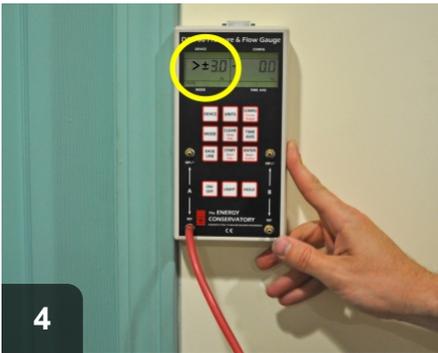
2

Take baseline reading



3

Turn on exhaust fans and close interior doors



4

With hose under door, check pressure again. Readings $> \pm 3\text{pa}$ are no good and require interior ventilation

6.6202.1a

Desired Outcome:

Fan controls support ventilation strategy

Specification(s):

Controls will be used that can meet the following conditions:

- Run fan continuously or intermittently depending upon the intended schedule of operation
- Operate fan to produce the intended flow for each intended flow setting

Objective(s):

Deliver intended air exchange

Ensure fan controls meet intended ventilation strategy

6.6202.1b

Desired Outcome:

Fan controls support ventilation strategy

Specification(s):

Controls will be used that meet the following conditions:

- Run fan continuously or intermittently depending on the intended schedule of operation
- Run fan for intended time for timed operation
- Operate fan to produce the intended flow for each intended flow setting

Objective(s):

Deliver intended air exchange

Ensure fan controls meet intended ventilation strategy

6.6202.1c

Desired Outcome:

Fan controls support ventilation strategy

Specification(s):

Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

Objective(s):

Prevent an electrical hazard

Ensure fan controls meet intended ventilation strategy

6.6202.1d

Desired Outcome:

Fan controls support ventilation strategy

Specification(s):

A labeled switch for manual override will be included for the ventilation system

Objective(s):

Ensure fan controls meet intended ventilation strategy

6.6202.1e

Desired Outcome:

Fan controls support ventilation strategy

Specification(s):

A system operation guide designed for occupants (non-professionals) will be provided to explain how and why to operate system

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

Objective(s):

Educate occupants about system operation and importance

Deliver intended air exchange

7.8102.1a

Desired Outcome:

Safe, reliable, and efficient hot water source selected that meets occupant needs at lowest possible cost of ownership and operation

Specification(s):

Equipment will provide sufficient, affordable, safe, and healthy hot water for the occupant in accordance with 2012 IRC P2801

Potential for solar hot water heating or other renewable energy systems will be assessed in selecting the hot water equipment

Potential for health and safety hazards (e.g., backdrafting, flame rollout, obstructions) will be assessed in selecting equipment and the cost of remedying such problems will be included in any cost and benefit calculations

If a combustion based system is selected, it will be either direct vented or power vented, and ENERGY STAR® qualified or an Energy Factor (EF) of 0.58 or higher

If combustion equipment is selected, a low nitrogen oxide burner will be included

Equipment will be functional at high efficiency under all load conditions

Standby losses will be reduced to maximum potential

Fuel type will be selected based on affordability to occupant

Equipment will be freeze resistant or installed in a conditioned space

Efficiency of equipment will be maintained throughout life of system

Occupant control of hot water temperature will be provided on the equipment

The following will be determined from the occupant:

- Lifestyle
- Current and future needs
- Space considerations
- Fuel options
- Health and safety considerations
- Appliance options

- Maintenance and operation costs
- Return on investment concerns

Objective(s):

Save energy and water

Protect the environment

Identify appliance options based on the needs and wants of the occupant

7.8102.1b

Desired Outcome:

Safe, reliable, and efficient hot water source selected that meets occupant needs at lowest possible cost of ownership and operation

Specification(s):

Water heater will be selected based on performance requirements of the occupant, available fuel sources, energy efficiency, and total life cycle cost

In very cold climates, on-demand water heaters will be sized to meet the demand of water flow at very low water intake temperatures

When evaluating an existing thermal solar water heating system, a solar expert should be consulted

The proper installation and maintenance of solar hot water systems is provided in the Uniform Solar Energy Code (USEC) and 2012 IRC Chapter 23

Objective(s):

Ensure equipment meets the occupant's expectations while providing efficient energy and water use

7.8102.2a

Desired Outcome:

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

Specification(s):

Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified

Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator

Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)

Objective(s):

Remediate health hazards using EPA-certified contractors

7.8102.2b

Desired Outcome:

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

Specification(s):

Accepted industry procedures and practices will be followed to:

- Remove old water heater and associated components in accordance with 2012 IRC R105.1 or authority having jurisdiction
- Seal any unused chimney openings and penetrations in accordance with 2012 IRC N1102.4.1.1 or authority having jurisdiction
- Remove unused oil tank, lines, valves, and associated equipment in accordance with 2012 IRC M2201.7 or authority having jurisdiction

All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards

Objective(s):

Ensure the safety of the workers and occupants

Preserve integrity of the building

Remove old equipment in a timely and efficient manner

7.8102.2c

Desired Outcome:

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

Specification(s):

New water heater and associated components will be installed to accepted industry standards, in accordance with the 2012 IRC and manufacturer specifications

The system will be installed to be freeze resistant

Any existing water leaks will be repaired before installation begins

Any penetrations to the exterior of the home created by the installation of the equipment will be sealed

Objective(s):

Ensure the safety of the workers and occupants

Preserve integrity of the building

Remove old equipment in a timely and efficient manner

7.8102.2d

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 $\frac{3}{4}$ " drainline 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

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

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

GOOD: Expansion tank is installed on both cold sides

Appropriate licensing for installer required.

7.8102.2f

Desired Outcome:

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

Specification(s):

Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC

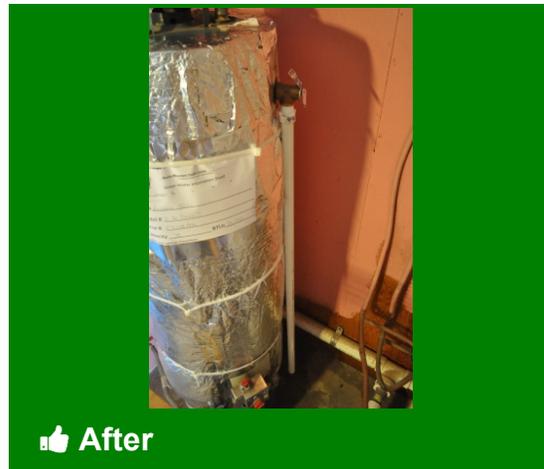
Objective(s):

Discharge excessive energy (pressure or temperature) from storage tank to safe location



Before

Water heaters should be not capped off at t&p valve



After

T&P discharge should be piped to a safe and observable location

Tools:

1. Pipe wrench
2. Hacksaw

Materials:

1. PVC
2. Plumber's epoxy

Check local jurisdictional codes. Paraphrased from 2012 IRC P2803.6.1: Temperature and pressure relief valve discharge pipes should not be connected to drainage system. T&P discharge pipes should be a clean line without valve or tee, flowing with gravity to an observable and safe location that cannot cause personal injury or structural damage -- the floor, an existing drain pan, a waste receptor, or to the outdoors. Pipe should not terminate more than 6" from floor, pan or waste receptor.

7.8102.2f - Temperature and pressure relief valve



GOOD: T&P discharge should be piped within 6" of the floor or to outdoors



BAD: T&P discharge should flow with gravity and be observable



BAD: T&P discharge should not be piped into drainage system

7.8102.2g

Desired Outcome:

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

Specification(s):

Dielectric unions will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications

Objective(s):

Break the stray voltage electrical circuit through the storage tank

7.8102.2h

Desired Outcome:

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

Specification(s):

Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes

Objective(s):

Protect water supply from contamination

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

7.8102.2j

Desired Outcome:

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

Specification(s):

Electric or fossil fuel supply components will be installed to accepted industry standards as per NFPA 31 and 54, or NFPA 70 National Electric Code (NEC) for electric components, or authority having jurisdiction

Objective(s):

Provide sufficient fuel to the water heater, burner, or element

7.8102.2k

Desired Outcome:

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

Specification(s):

Discharge temperature will be set not to exceed 120° or as prescribed by local code

Objective(s):

Ensure safe hot water supply temperature to fixtures



Unsafe

Water heaters producing water over 120 degrees raise heating costs



Safe

Water heaters should produce water under 120 degrees to prevent scalding

Tools:

1. Thermometer

7.8102.2k - Discharge temperature



1 Test temperature of hot water at faucets in house



2 Hot water temperatures should not exceed 120 degrees Fahrenheit



3 Adjust water heater settings and insulate as needed



4 After adjustment and insulation, retest to verify temp is under 120 degrees

7.8102.2I

Desired Outcome:

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

Specification(s):

The following will be checked once the system has been filled and purged:

- Safety controls
- Combustion safety and efficiency
- Operational controls
- Fuel and water leaks
- Local code requirements

Commissioning will be in compliance with manufacturer specifications and relevant industry standards

Objective(s):

Ensure safe system function

Keep cost of ownership as low as possible

7.8102.2m

Desired Outcome:

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

Specification(s):

Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction

Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels

Objective(s):

Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate

7.8102.2n

Desired Outcome:

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

Specification(s):

Completed work will be reviewed

Occupants will be educated on the safe and efficient operation and maintenance of the system, including:

- Adjustment of water temperature and target temperature in accordance with local code
- Periodic drain and flush
- Expansion tank and backflow preventer (no occupant maintenance required)
- Periodic inspection, maintenance, or replacement

Objective(s):

Ensure occupant is informed of the safe, efficient operation and maintenance of the system

7.8103.1a

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice

Electrical components will be verified to comply with NEC (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)

Objective(s):

Identify potential health and safety issues



Complete combustion safety testing to ensure healthy, safe work environment



When completed work, retest to verify home is still healthy and safe

Tools:

1. Personal CO monitor
2. Combustion analyzer with probe
3. Manometer
4. Smoke pencil

Materials:

1. CO alarm
2. Fasteners

See also SWS 2.0201.1a-2.0299.1i for all Combustion Safety details and SWS 2.0100.1d for General Electrical Safety.

7.8103.1b

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Inspection will be conducted to show compliance with the 2012 IRC, including but not limited to:

- Water or fuel leaks
- Damaged wiring
- Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence)
- Corrosion (e.g., rust, mineral deposits)
- General condition of components

Objective(s):

Determine needed repairs or maintenance

7.8103.1c

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Water heater storage tanks shall have a minimum R-value of R-24, unless the SIR to add insulation is less than 1.0

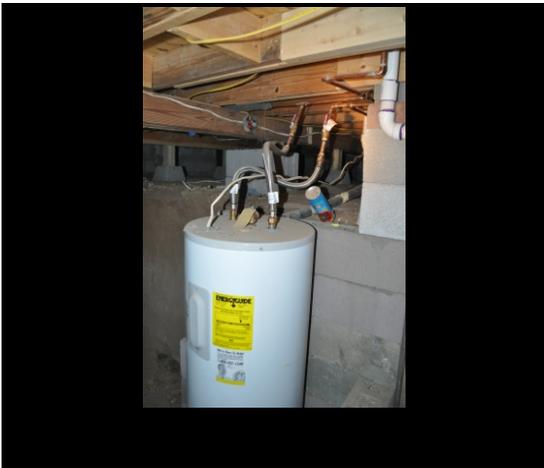
Added insulation will not obstruct the unit's draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates

The first 6' of inlet and outlet piping will be insulated in accordance with 2012 IRC N1103.4.2 or local requirements, whichever is greater

Objective(s):

Reduce standby losses from near tank piping and storage tank

Ensure insulation does not make contact with flue gas venting



Standard water heaters have built-in insulation ranging from R-7 to R-20.



Storage-type water heaters should be wrapped to bring total value to R-24

Tools:

1. Utility knife

Materials:

1. Pipe wrap
2. Water heater blanket
3. Foil tape
4. Long zip ties

7.8103.1c - Thermal efficiency



Check occupant's water heater model to see what r-value is built-in



Blanket does not obstruct draft diverter or plumbing pipes and elements



Wrap does not obstruct ventilation, thermostat access plate, hi-limit switch, or fuel line



Data plate should still be accessible after wrapping



Both hot and cold water pipes should be insulated to R-3 for first 6ft

7.8103.1d

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

A potable water expansion tank will be installed on the cold water side

Tanks that leak or have excessive corrosion will be replaced

A direct connection with no valves from the expansion tank to the storage tank will be installed

Connection will be properly supported with strapping

An expansion tank drain will be included in non-bladder tanks

Tank will be installed to accepted industry standards, in accordance with the 2012 IRC and according to manufacturer specifications

Tanks that are completely full of water will be drained and refilled before being replaced or repaired

Expansion tanks with bladders will have air charged to the manufacturer pressure requirements while water is not present in the tank

Bladder tanks with water inside of the air bladder will be replaced in accordance with manufacturer specifications

Objective(s):

Absorb water expansion of the system

Virginia WAP will only address expansion tanks only when existing DHW tanks warrant replacement and/or the unit requires an expansion tank where required by local code.

7.8103.1e

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC

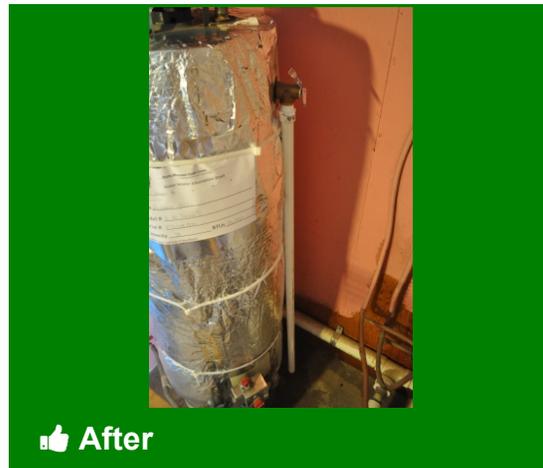
Objective(s):

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After

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Materials:

1. PVC
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Check local jurisdictional codes. Paraphrased from 2012 IRC P2803.6.1: Temperature and pressure relief valve discharge pipes should not be connected to drainage system. T&P discharge pipes should be a clean line without valve or tee, flowing with gravity to an observable and safe location that cannot cause personal injury or structural damage -- the floor, an existing drain pan, a waste receptor, or to the outdoors. Pipe should not terminate more than 6" from floor, pan or waste receptor.

7.8103.1e - Temperature and pressure relief valve



GOOD: T&P discharge should be piped within 6" of the floor or to outdoors



BAD: T&P discharge should flow with gravity and be observable



BAD: T&P discharge should not be piped into drainage system

7.8103.1f

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Occupants will be advised to keep records of all maintenance done to their system

Copies of or access to installation and operation manuals will be provided

Objective(s):

Provide a history of system installation and maintenance to improve chance of successful future maintenance or repair

7.8103.1g

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction

Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels

Objective(s):

Ensure occupant life safety

Inform occupant regarding possible CO hazards

7.8103.1h

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Completed work will be reviewed

Occupants will be educated on the safe and efficient operation and maintenance of the system, including:

- Adjustment of water temperature and target temperature in accordance with local code
- Periodic drain and flush
- Periodic inspection, maintenance, or replacement of anode rod

Objective(s):

Ensure occupant is informed of the safe, efficient operation and maintenance of the system