



# Retrofitting Montana



*Weatherization  
Works*

**Standard Work Specifications**

**Field Guide for**

**Single-Family Homes**

**created by**

# Montana DPHHS



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## 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

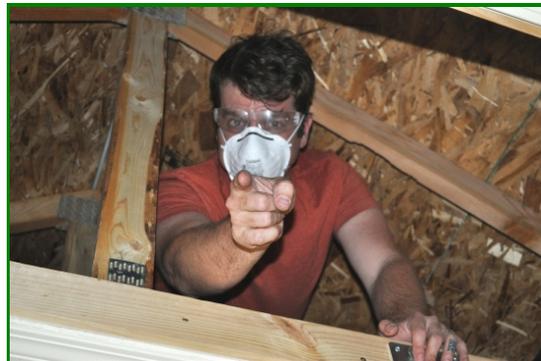
### Objective(s):

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**

Retrofits can have multiple different respiratory protection requirements

Almost all hazards in weatherization are particles (e.g. Lead, Dust, Viruses, Bacteria, Insulation, etc.). The proper protection for these hazards is a 100-level filter (P100, R100, or N100 which will be pink/purple in color).

For chemical hazards, it is recommended that a stacked cartridge be used at a minimum. This stacked cartridge will have a particulate filter on the outside with one of the following cartridges on the inside: Organic vapor, Mixed-gas, or Acid Gas.

Positive Air Purifying Respirators (PAPR) are allowable for use in the program and have an excellent Assigned Protection Factor (APF).

## 2.0100.1c - Respiratory protection



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



For two-component spray insulation, stacked respirator cartridges should be used



All respiratory protection will be fit tested at least annually to the individual. (Including N95 filtering face pieces)



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 should be inspected closely for electrical safety before work begins

## 2.0100.1d - Electrical safety



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



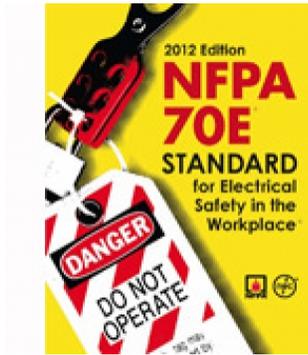
Electrical wiring should not be located near a water source



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

Protective clothing also includes: Eye, Hearing, Head, and Foot Protection.

**Eyes** - When an eye hazard is present, safety glasses stamped with the Z87 Standard must be worn. Flip-down faceshields are not a substitute and do not offer similar protection. Full-face respirators may or may not meet the Z87 Standard, look for the stamp before using.

**Hearing** - When sounds exceed 85db, hearing protection is required (examples of common tools listed below). To select proper hearing protection, read the the Noise Reduction Rating (NRR) printed on the package and divide the number by two. Subtract that number from the decibels produced by the tool to determine if you are below the 85db standard.

- Drill - 98 db
- Circular saw - 102 db
- Miter saw - 103 db
- Hammer drill - 114 db

- Belt sander - 94 db

Head Protection - If an overhead bump-hazard is present (e.g. nails in an attic) a "Bump Cap" is recommended, but not required. If a worker is working below another worker, or if a Struck-by hazard is present (e.g. tools or debris falling from above) a hard hat is required.

Foot Protection - Closed-toe shoes are required for weatherization work.

## 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



Locate all access and egress points of confined spaces before entering

## 2.0100.1g - Confined space safety



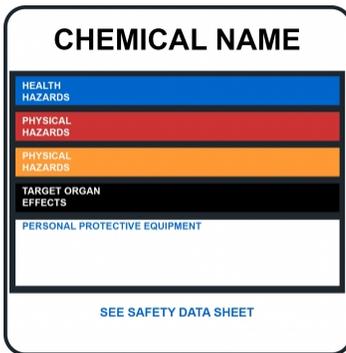
Perform visual inspection of confined spaces before beginning work



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

## 2.0100.1j

### 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

## 2.0100.1m

### 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

Do what is needed to avoid heat and thermal stress. This may include:

- Frequent breaks
- Hydration
- Ventilation
- Shade

## 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

Observe OSHA 29CFR 1926.1101 abatement protocol when asbestos is suspected.

Whenever vermiculite insulation is discovered during the initial inspection of a dwelling to be weatherized, no blower door testing or any other weatherization measures should be performed until the vermiculite has been tested for the presence of asbestos. If asbestos levels in the vermiculite

have been determined to be present, or if the agency is assuming the presence of asbestos without testing, the weatherization of the dwelling must be deferred until the vermiculite has been removed by a certified asbestos abatement contractor and an Air Clearance Exam has been performed on the dwelling to ensure that there is no asbestos present in the ambient air that would be a health and safety risk.

When the dwelling is deferred for weatherization, the agency must provide the occupants/owner with a copy of the DPHHS-EAP-023 'Notice of Dangerous Conditions.'

## 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

Carbon monoxide levels in the ambient air around the technician must be monitored throughout all combustion safety tests.

If ambient CO levels exceed 35 ppm at any time:

- Stop work immediately
- Evacuate everyone from the residence
- Notify a qualified technician to immediately fix the problem

## 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

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

## 2.0105.1c - Raw fuel



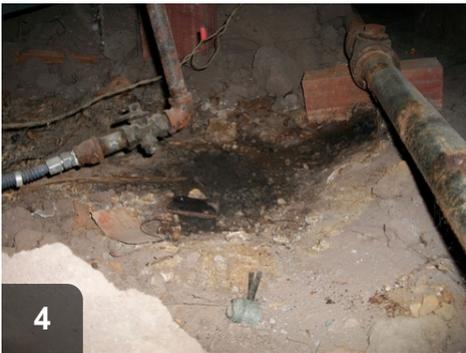
Check all raw fuel lines for leaks



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

Paraphrased from 40 CFR 273.14: A universal waste mercury-containing thermostat or container containing only universal waste mercury-containing thermostats should be labeled or marked clearly with any of the following phrases: "Universal Waste-Mercury Thermostat(s)," "Waste Mercury Thermostat(s)," or "Used Mercury Thermostat(s)." \*\*Contact [thermostat-recycle.org](http://thermostat-recycle.org) or [earth911.org](http://earth911.org) for recycling options.

MT Crews are to replace and properly dispose of mercury thermostats

Contact the Montana Weatherization Training Center for information on mercury thermostat disposal programs

## 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



Suspicious pipe insulation may contain asbestos



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

If thermal system insulation (TSI) is suspected to be an asbestos-containing material (ACM), no blower door testing or any other weatherization measures should be performed until the insulation has been tested for the presence of serpentine asbestos. If asbestos levels in TSI have been determined to contain asbestos in excess of one percent (1%), or if the agency assumes that the TCI contains serpentine asbestos in excess of one percent (1%), the weatherization of the dwelling must be deferred until the ACM has been removed by a certified asbestos abatement contractor and an Air Clearance Exam has been performed on the dwelling to ensure that there is no asbestos present in the ambient air that would be a health and safety risk.

When the dwelling is deferred for weatherization, the agency must provide the occupants/owner with a copy of the DPHHS-EAP-023 'Notice of Dangerous Conditions.'

## 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

## 2.0111.2a

### 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

## 2.0111.3a

### Desired Outcome:

Clean, safe, and easily accessible crawl space created

### Specification(s):

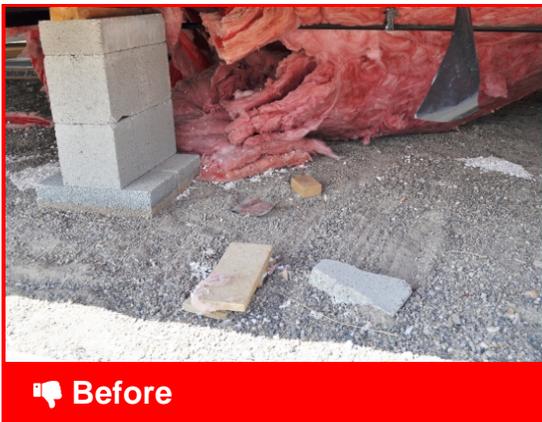
Under-floor grade will be removed of all vegetation and organic material

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

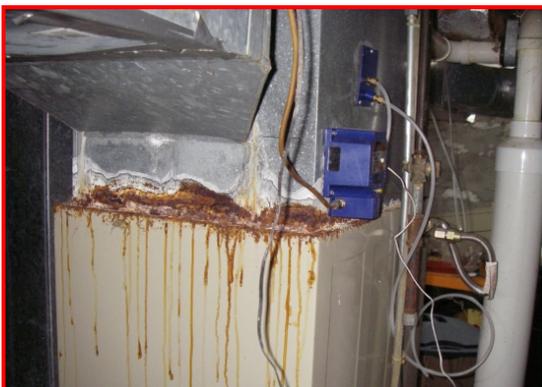
Determine if combustion and dilution air is adequate for proper combustion and venting of all equipment within the CAZ

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

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 piping system will be repaired or replaced and retested.

## 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):

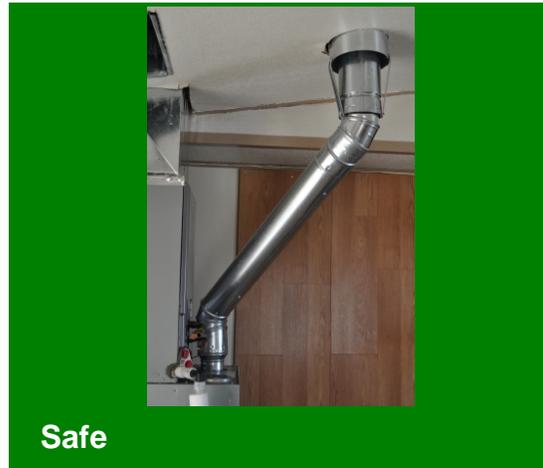
Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards

### Objective(s):

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



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



**Safe**  
Properly vented appliances make a house healthier and more efficient

Proper slope is 1/4" rise per foot of run.

## 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

This standard applies to NATURAL DRAFT appliances only.

## 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

This standard applies to NATURAL DRAFT appliances only.

## 2.0201.1e - Depressurization test



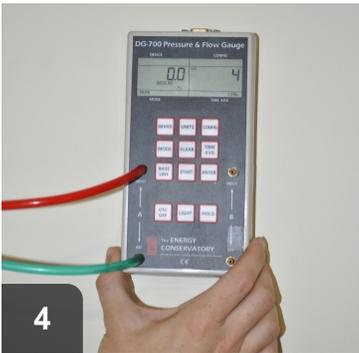
1 Place manometer reference hose to exterior of house



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

This standard applies to NATURAL DRAFT appliances only.



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)

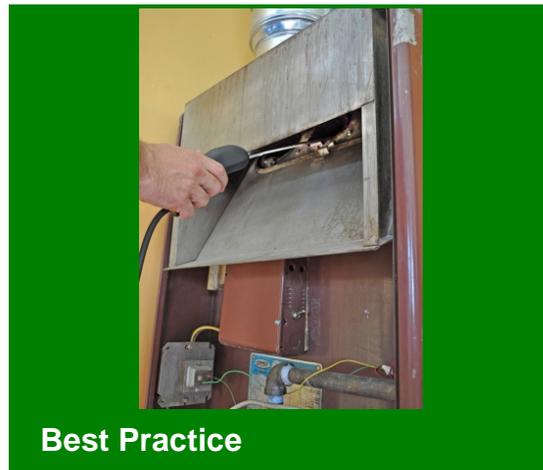
If the outlet of the exhaust is accessible, include a CO test on all sealed-combustion, direct vent, and power-vented appliances (without atmospheric chimneys)

### Objective(s):

Measure CO and report excessive levels



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

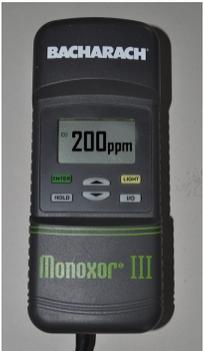


Test CO levels in undiluted flue gases and exhaust outlets, when accessible

### 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



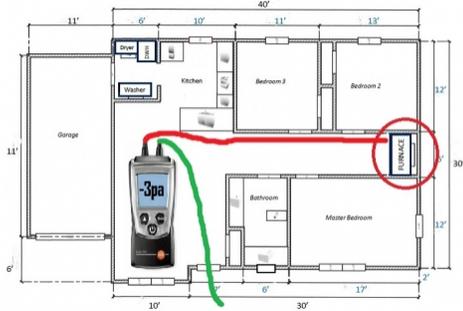
Conduct spillage and depressurization testing at the end of the work day

### Tools:

1. Manometer
2. Smoke pencil
3. Timer

This standard applies to NATURAL DRAFT appliances only.

## 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 smoke pencil



Test for spillage on all sides of draft diverter



Complete spillage testing on all combustion appliances



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):**

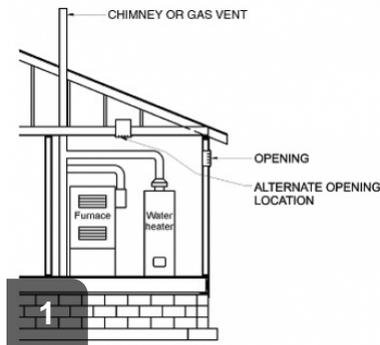
Prevent combustion byproducts from entering the house

Image 1: For homes with one permanent opening, see 2012 IRC: G2407.6.2 (304.6.2): a minimum free area of 1 in<sup>2</sup> per 3,000 Btu/h (734 mm<sup>2</sup>/kW) of total input rating of all appliances

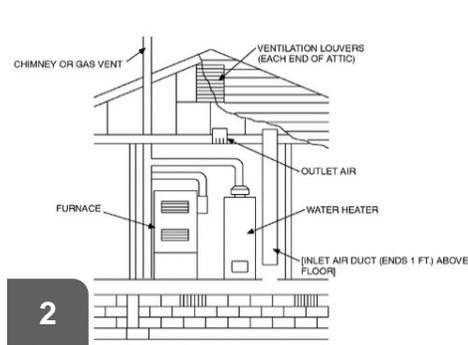
Image 2: For homes with two permanent vertical duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in<sup>2</sup> per 4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating of all appliances

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 in<sup>2</sup> per 2,000 Btu/h (1,100 mm<sup>2</sup>/kW) of total input rating of all appliances

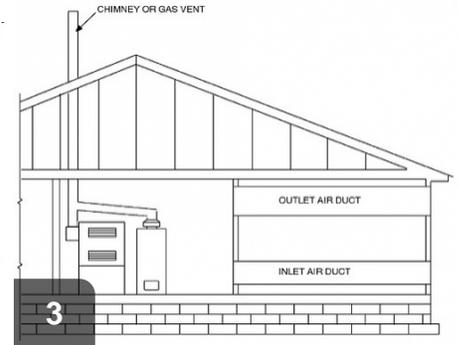
## 2.0201.2a - Outside combustion make-up air



min free area of 1 sqin per 3,000 Btu/h  
(734 mm<sup>2</sup>/kW) of total input rating



min free area of 1 sqin per 4,000 Btu/h  
(550 mm<sup>2</sup>/kW) of total input rating



min free area of 1 sqin per 2,000 Btu/h  
(1100 mm<sup>2</sup>/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



#### Best Practice

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

If CO is measured at or above 800 ppm following a tune, the agency needs to provide the occupant/owner with a copy of the DPHHS-EAP-023 'Notice of Dangerous Conditions.'

## 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 solid fuel burning appliances should be replaced



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)

## 2.0203.2a

### Desired Outcome:

Flue gasses successfully removed from the house

### Specification(s):

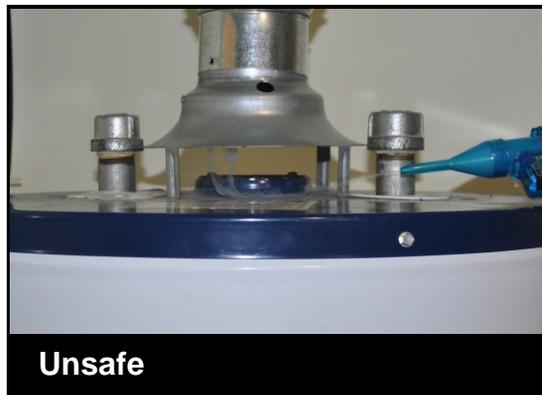
If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate

### 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

## 2.0203.2c

### 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



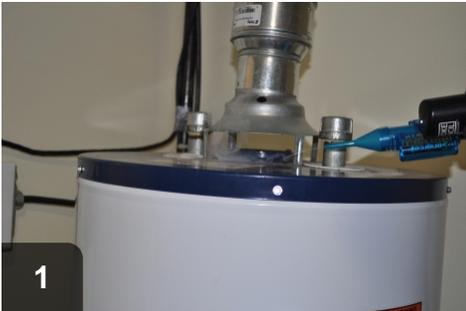
**After**

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

## 2.0299.1a

### 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

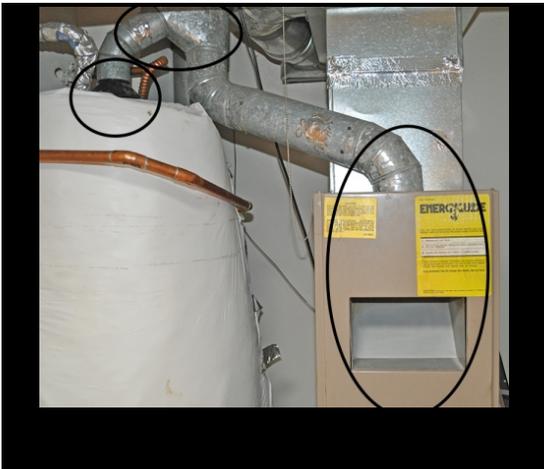
### Specification(s):

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

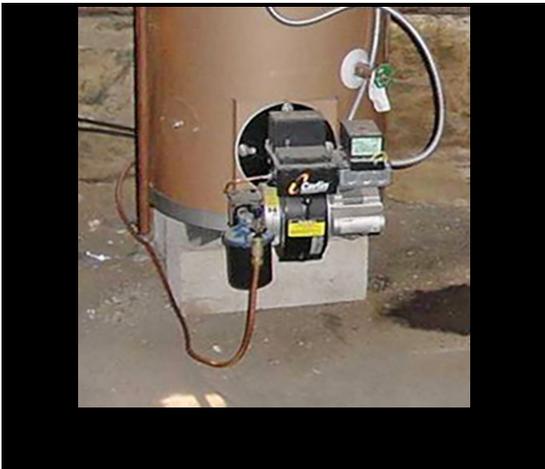
### Specification(s):

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:

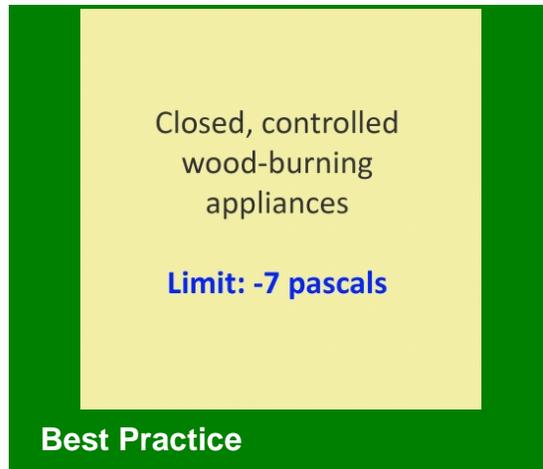
- Limit -7 pascals

### Objective(s):

Ensure appliances meet manufacturer's certified negative pressure tolerance rating



Wood-burning stove



### 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:

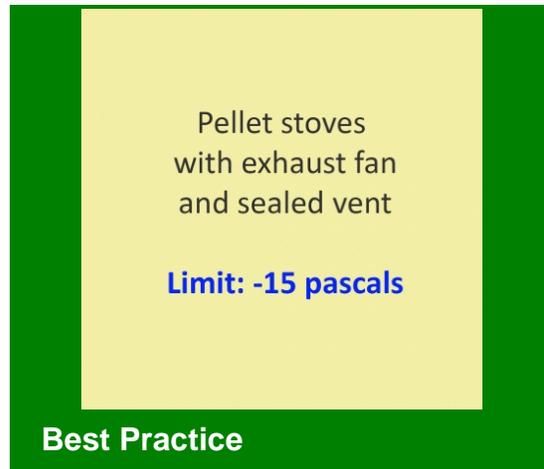
- Limit -15 pascals

### 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

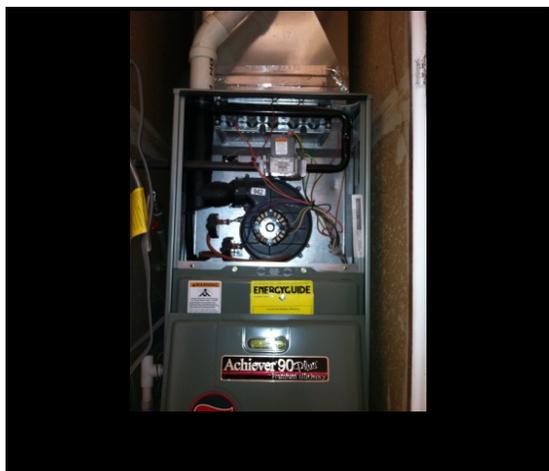
### Specification(s):

Manufacturer's certified negative pressure tolerance rating:

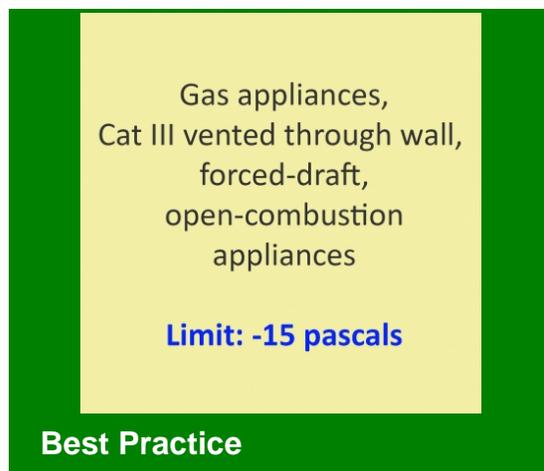
- Limit -15 pascals

### 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:

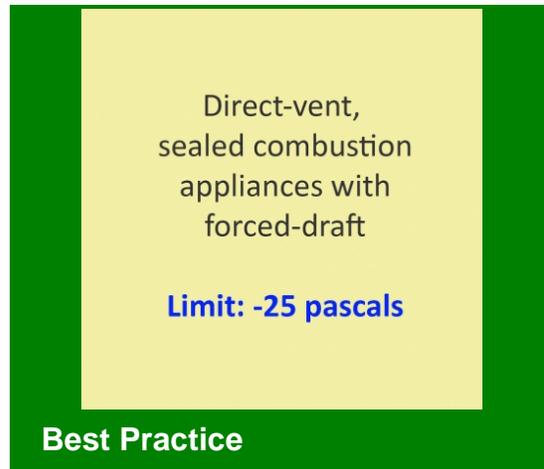
- Limit -25 pascals

### 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



Paraphrased from 2012 IRC R314: Smoke alarms will receive their primary power form the building wiring when such wiring is served from a commercial source, and when primary power is interrupted, will receive power from a battery. Wiring will be permanent and without a disconnecting switch other than those required for overcurrent protection. Smoke alarms will be installed in the following locations: 1. In each sleeping room; 2. Outside each separate sleeping area in the immediate vicinity of the bedrooms; 3. On each additional story of the dwelling, including basements and habitable attics. Per WPN 14-01, compliance with NFPA 72 is also required.

## 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):

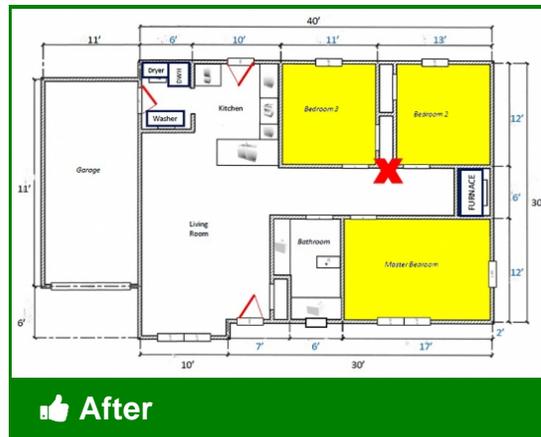
Hardwired CO detection or warning equipment will be installed in accordance with ASHRAE 62.2 or as required by the authority having jurisdiction

### 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)



1

Mount alarm to wall close to bedrooms



2

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.

## 2.0403.1b

### 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

If immovable debris is present, work for this measure will be deferred.

A ground moisture barrier will not be installed if it interferes with the established drainage pattern (e.g. seasonal drainage) as per 2.0403.2h

A ground moisture barrier will not be installed if the audit determines that there is no moisture issue present for the home and the barrier serves no health and safety need.

## 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:  $\leq 0.1$  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



 Before

Ground moisture barriers help keep moisture from permeating floor.



 After

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

## 2.0403.2b

### 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):

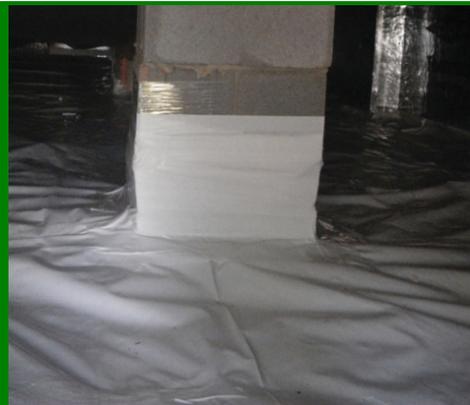
Reduce ground moisture entering the crawl space

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 4 mil)
2. Furring strips
3. Fasteners

If immovable debris is present, work for this measure will be deferred.

A ground moisture barrier will not be installed if it interferes with the established drainage pattern (e.g. seasonal drainage) as per 2.0403.2h

A ground moisture barrier will not be installed if the audit determines that there is no moisture issue present for the home and the barrier serves no health and safety need.

## 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

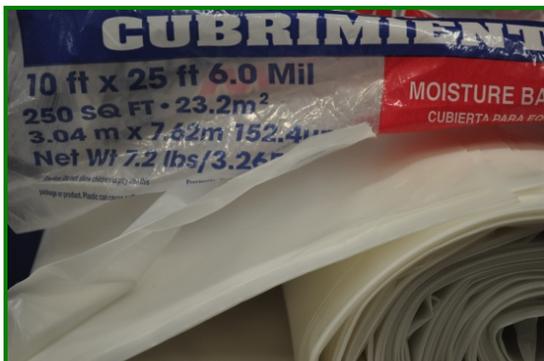
A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745

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 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:  $\leq 0.1$  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 4mil)
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

## 2.0601.1a

### 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

The State of Montana does not allow for the use of weatherization funds to rewire a house due to the presence of knob and tube electrical wiring.

## 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



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



**After**  
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

As knob and tube wiring is not part of the weatherization program in Montana (aside from avoiding direct contact of weatherization materials), the state does not require a licensed electrician to inspect and certify the electrical system prior to Wx work. A licensed electrician must be employed to satisfy this standard if knob and tube wiring is being touched by any material or worker.



## 2.0601.1c - Isolation and protection



1

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



2

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



3

Warning sign should remind to contact certified electrician for repairs



4

Many jurisdictions require a sign in Spanish as well



5

Damming should extend above installed height of insulation



6

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

As knob and tube wiring is not part of the weatherization program in Montana (aside from avoiding direct contact of weatherization materials), the state does not require a licensed electrician to inspect and certify the electrical system prior to Wx work. A licensed electrician must be employed to satisfy this standard if knob and tube wiring is being touched by any material or worker.

## 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

#### Caution, do not damage:

If Damaged, the following must be repaired immediately:

If repairs are needed, contact:

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

## 3.1001.1d

### 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

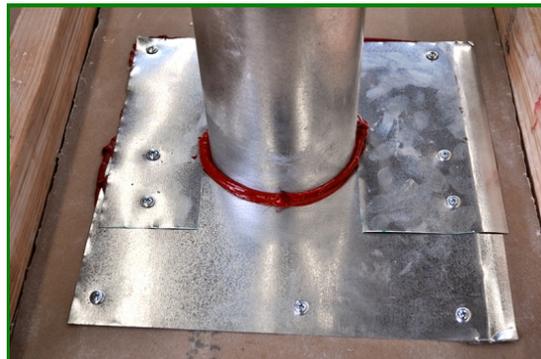
### Objective(s):

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



Prepare work area by removing any insulation and debris



Use high-temperature caulk (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

## 3.1001.2b

### 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

If the material is visible from the interior living space of the house, every attempt should be made to match the aesthetic qualities of the original structure.

Material will meet the flame and smoke spread indexes as required in 2012 IRC R302.9

### 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.

If the material is visible from the interior living space of the house, every attempt should be made to match the aesthetic qualities of the original structure.

### 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):

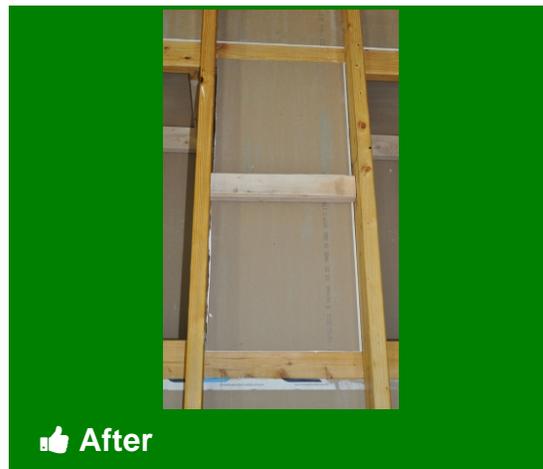
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

### 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

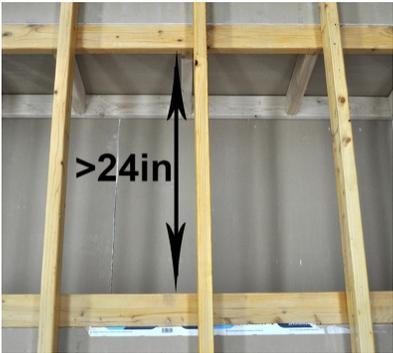
### Tools:

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:

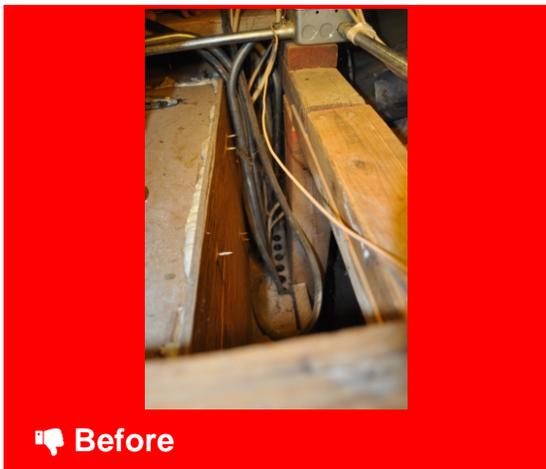
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

### 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, eyewear, and appropriate respiratory protection when working with sealants.

The use of rigid materials is not enough to provide an adequate seal around a capped penetration or chase. Sealants must be used and effectiveness checked using a blower door and smoke device.

### 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 and must be checked

## 3.1001.2f

### Desired Outcome:

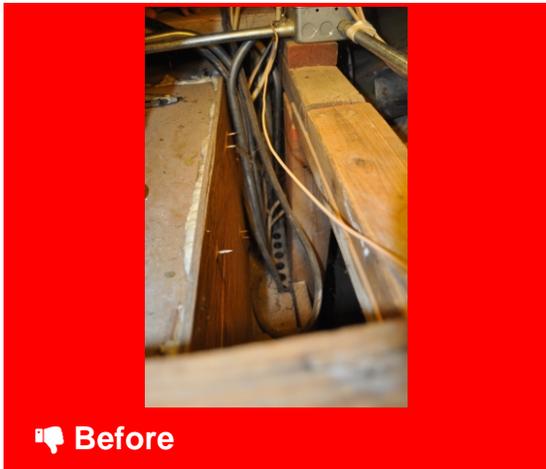
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

### 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 protective gloves, eyewear, and appropriate respiratory protection when working with sealants.

Pay attention to air sealing opportunities in framing adjacent to capped chase or penetration. Use approved sealants in these areas.

### 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

## 3.1001.3b

### 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



Wall cavities are open to attic



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

It is preferred that balloon framed cavities are dense packed, capped, and sealed.

Spray foam includes the use of 1-part foam canisters. Sealant options are selected by the agency, provided they are approved DOE materials.

Confirmation of proper air sealing, using a blower door and smoke device, is required.

### 3.1001.3b - Sealing methods



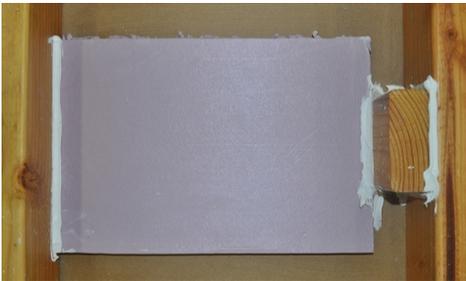
Option 1: Dense pack cavities through wood cap fastened in place



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):

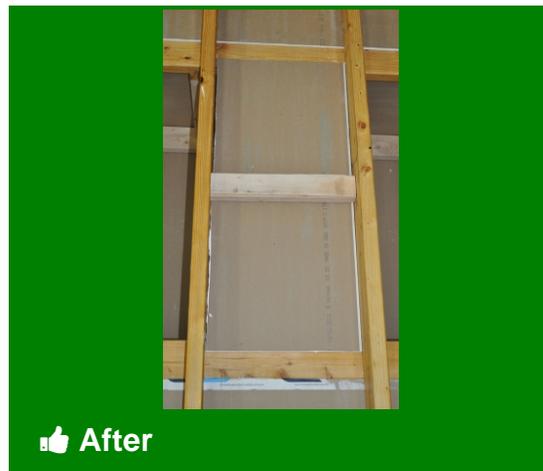
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

### 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

Balloon framing will rarely have spans greater than 24 inches. However, if these spans exist, support is required.

### 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

### Tools:

1. Spray foam gun
2. Caulk gun



All edges of the cap should be sealed to surrounding surfaces

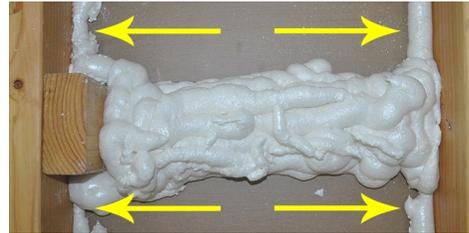
### Materials:

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



**After**

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

### Tools:

1. Spray foam gun
2. Caulk gun

### Materials:

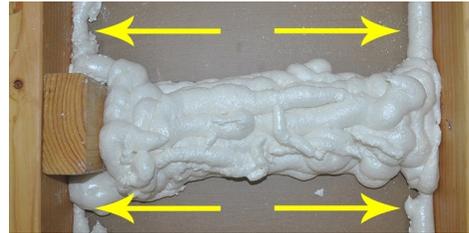
1. Spray foam (SPF)
2. Caulk

All framing adjacent to the capped balloon framed cavity must be sealed completely and tested using a blower door and smoking device.

### 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

## 3.1003.1b

### 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):

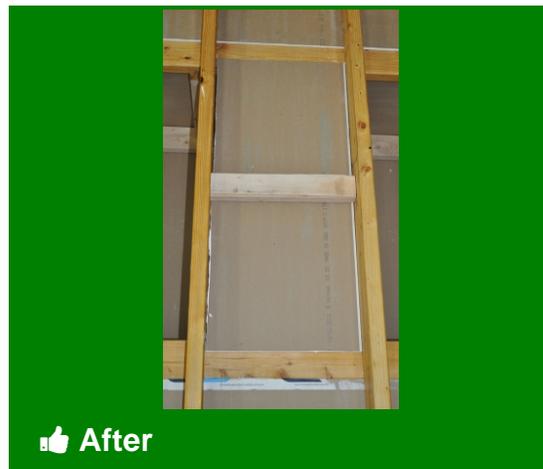
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

### 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

Large holes in an existing ceiling may require additional support if spans are 24 inches or greater.

### 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



1 Apply sealant to surrounding surfaces before setting cap in place



2 Sealant should extend along joists and into seams at top plates



3 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

## 3.1003.2c

### Desired Outcome:

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

### Specification(s):

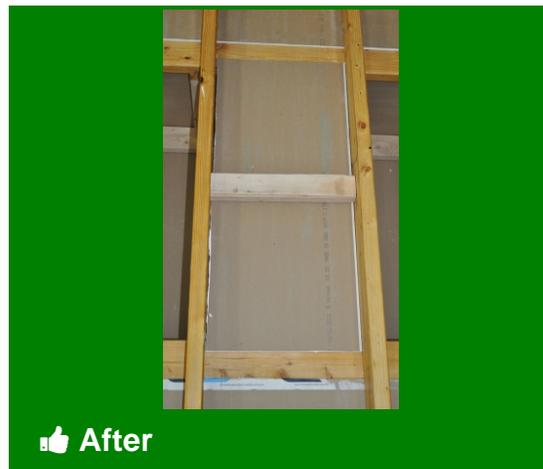
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

### 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

In this case, support is required from above and the addition of blocking is necessary.

### 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



1

Apply sealant to 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

## 3.1003.2e

### 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

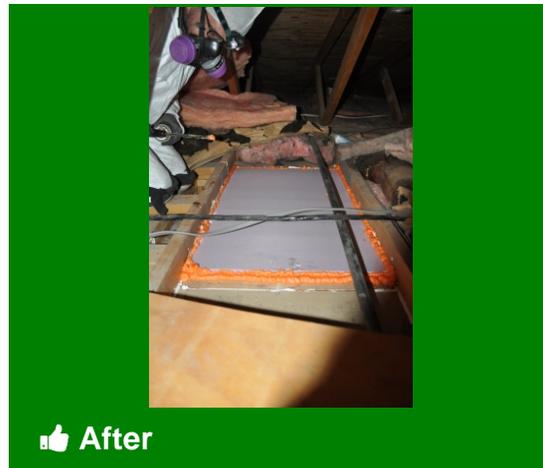
All remaining gaps at the top of the chase will be sealed

### Objective(s):

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



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. 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

## 3.1003.3b

### 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

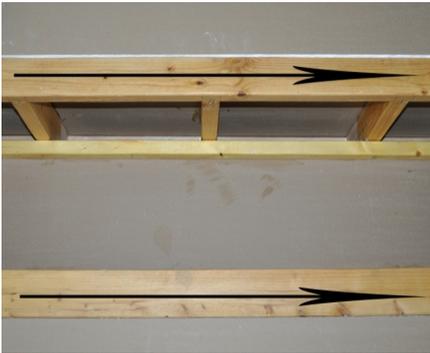
**Tools:**

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):

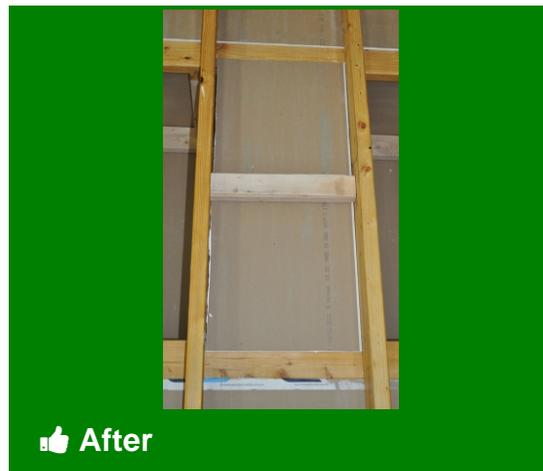
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

### 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



Uninsulated soffits can cause leakage to and from unconditioned spaces



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



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

## 3.1003.3e

### 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

## 3.1003.4c

### 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

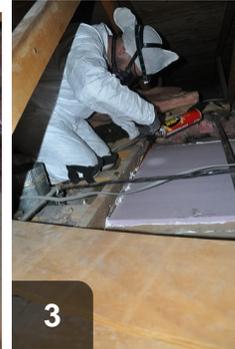
### 3.1003.4d - Joint seal



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

## 3.1003.4e

### 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



**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. 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

## 3.1003.6b

### 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

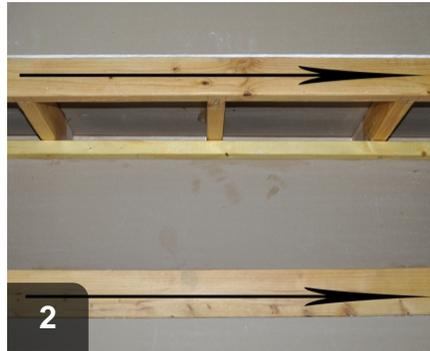
### Materials:

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

## 3.1003.6d

### Desired Outcome:

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

### Specification(s):

Each stud bay will be spanned with rigid material will be cut to fit and fastened as required

OR

Backing at each stud bay will be provided and will be sealed

OR

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

OR

A sealed rigid barrier will be installed at all transitions

### Objective(s):

Prevent air leakage from wall to soffit

Reduce opening to what can be sealed with sealant

Ensure soffit is outside of the thermal boundary



 Before

Wall cavities are open to attic and heat transfer due to dropped soffit



 After

Wall cavities capped and air-sealed in one of a variety of options

**Tools:**

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

**Materials:**

1. XPS
2. Drywall
3. Plywood
4. Lumber
5. Fasteners
6. Caulk
7. Spray foam
8. Dense packable insulation
9. Poly-wrapped insulation

### 3.1003.6d - Option 2: leave soffit outside (seal at bottom or side)



Clear work area of insulation and debris



Option 1: Span each stud bay with rigid material at level of soffit



Option 2: Backing used to fill bays and sealed with spray foam



Option 3: Stud bay will faced with rigid material, fastened and sealed

## 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

## 3.1201.1d

### Desired Outcome:

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

### Specification(s):

Beveled sill will be flush with interior wall and sloped to the exterior

Seams will be continuously and completely sealed with sealant to the jambs and to the frame

Sill will be water-sealed and primed

### Objective(s):

Form a complete seal from the bottom of the lower sash to the sill

Maintain operability of the window

Allow for drainage to the exterior



Rot in and under a window sill is often a sign of a bigger problem



Once repaired, this window is less leaky and better supported

### Tools:

1. Saw
2. Drill
3. Pry bar
4. Sander
5. Caulk gun

### Materials:

1. Lumber or metal sill
2. Caulk
3. Fasteners
4. Flashing

## 3.1201.1d - Replacement sills



Remove sill to determine full extent of rot and necessary repairs



Once rotted materials are cut away, determine sizing of new materials



Cut new materials flush to surrounding surfaces and pitch toward exterior



For exterior repairs, replace flashing



Set new sill, then replace and prime trim

## 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 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

## 3.1201.3a

### 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 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

## 3.1201.3b

### Desired Outcome:

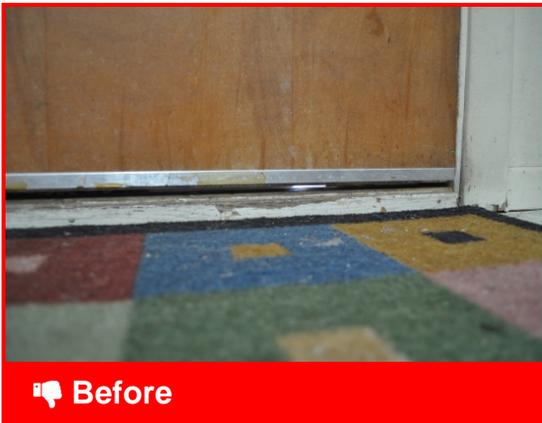
Doors operable and weather tight

### 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
3. Level

### Materials:

1. Shims

## 3.1201.3b - Door operation and fit



1  
After examining how door hangs, remove door from hinges



2  
Adjust hinge plates to bring door back into true



3  
Adjust strike plate to allow for secure and smooth operation



4  
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. HEPA vacuum
5. Tape measure

### Materials:

1. Tape

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

If the lead test is positive for lead, a heat gun or open flame will not be used to soften glazing for removal.

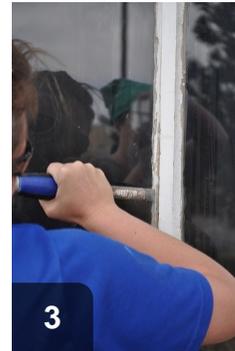
## 3.1202.1b - Broken glass removal



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):

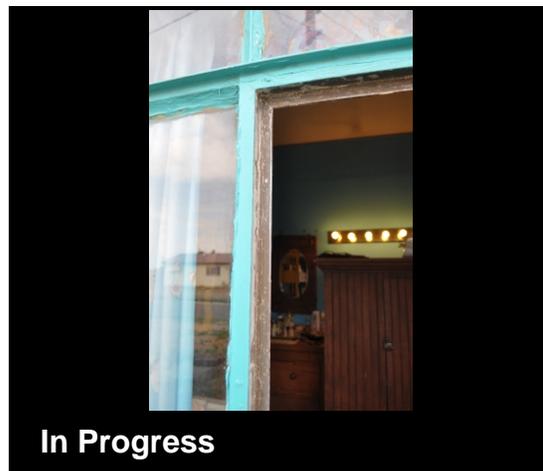
Opening will be cleaned

### 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



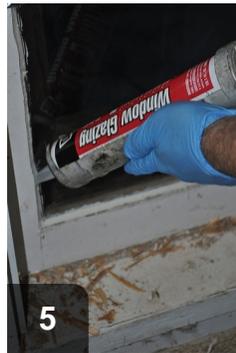
2 With broken glass removed, measure opening for replacement glass



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

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### 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



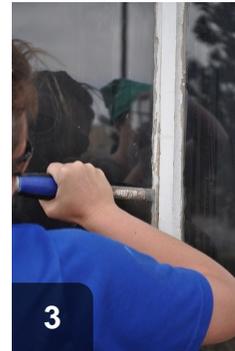
1

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

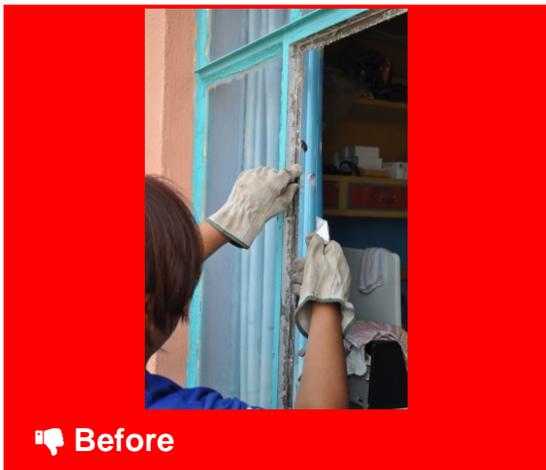
### Specification(s):

Opening will be cleaned

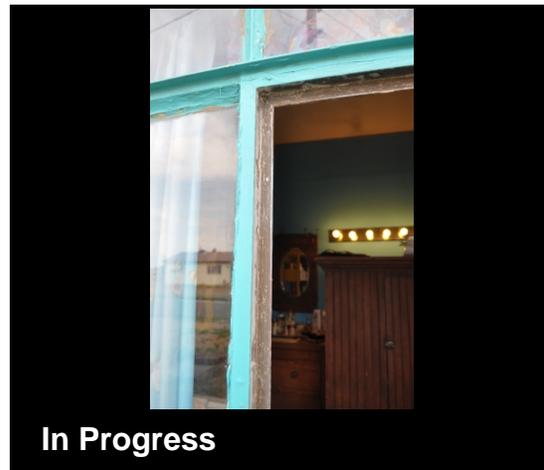
Glazing tape will be removed or replaced

### 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



Debris in the sash can cause new glass to seal improperly



Check closely to remove and collect all broken glass and debris



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):

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.

### 3.1203.1a - 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

## 3.1203.2a

### Desired Outcome:

Replacement window provides weather tight fit; 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.

### 3.1203.2a - 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

## 3.1203.2b

### Desired Outcome:

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

### Specification(s):

Replacement window will be laid out with trim

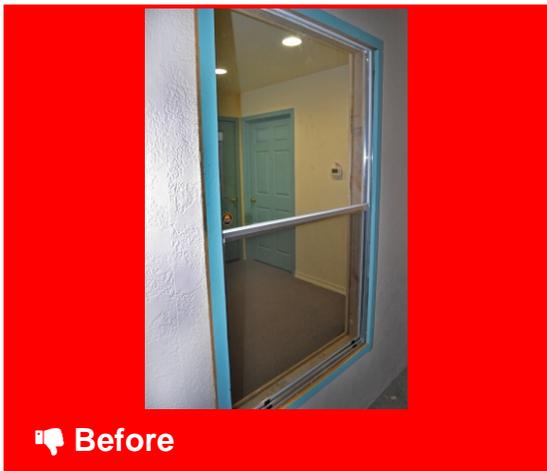
Exterior trim will be removed or exterior siding will be cut back to fit new window with trim

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



Single pane window needs to be replaced with double pane



Cut through caulk at stops to break seal



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



Remove interior trim



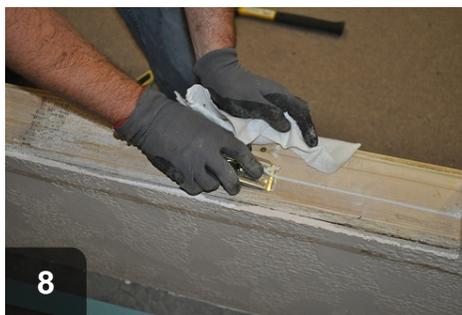
Remove exterior trim



Remove exterior fasteners to free window



Remove window from rough opening



Clean rough opening to remove old caulk and debris



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

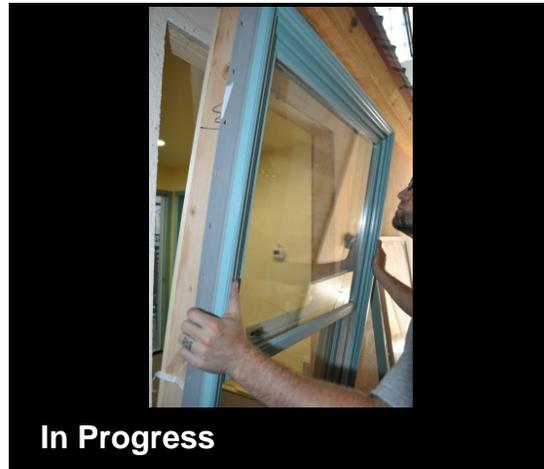
### Objective(s):

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):

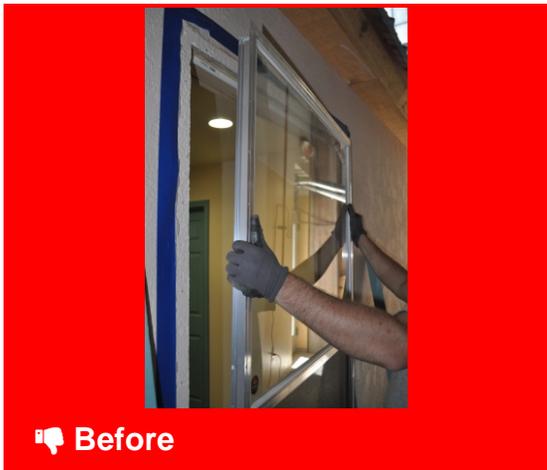
Replacement windows will be installed in accordance with manufacturer specifications and will be integrated with flashing

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

### Objective(s):

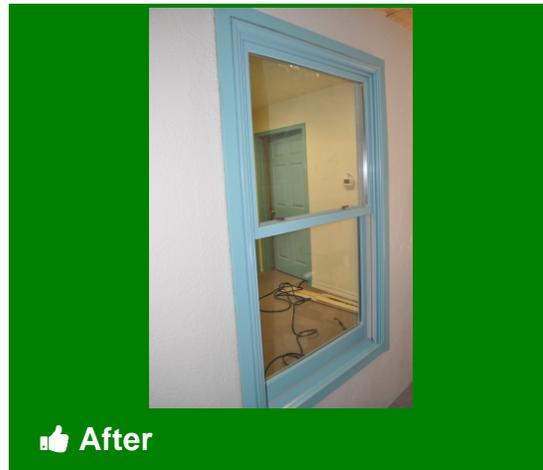
Ensure replacement window operates properly

Ensure replacement window is weather tight



 Before

Single pane window is being removed to install double pane unit



 After

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



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



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

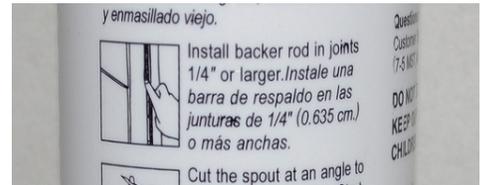
### 3.1402.1b - Sealant selection



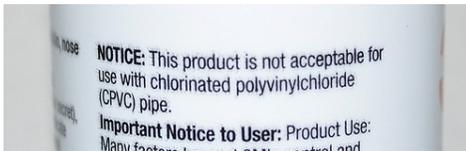
Caulking can be used to span gaps up to 1/4 inch



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



1 Prepare work area by removing any insulation and debris



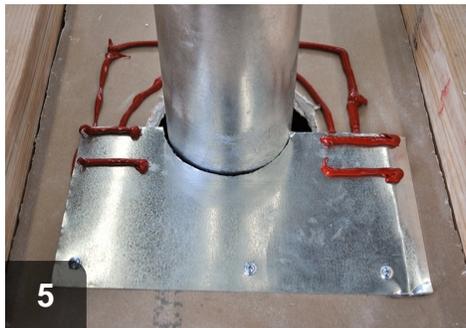
2 Use high-temperature caulking (600F min)



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

## 3.1402.3a

### Desired Outcome:

Well-sealed exterior wall prevents leakage and pests

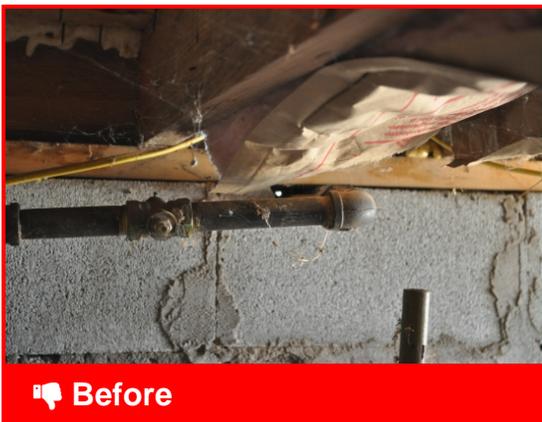
### Specification(s):

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

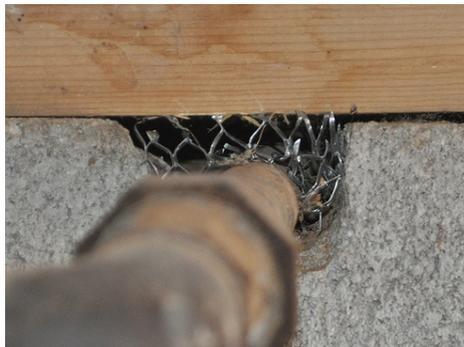
### Materials:

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

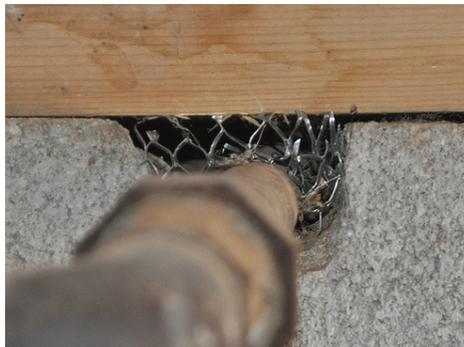
### Materials:

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



 Before

Penetrations between the garage and house can leak hazardous fumes



 After

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.

### Tools:

1. Utility knife
2. Putty knife
3. Disposable brush

### Materials:

1. Mesh tape
2. Mastic
3. Cleaning solvent

## 3.1501.1b - Ductwork



1 Prepare work area by assessing any safety concerns, verifying fasteners/strapping, and cleaning all joints with solvent.



2 Wrap joint with fiberglass mesh tape.



3 Apply UL 181 mastic to seal joint.

## 3.1501.1c

### Desired Outcome:

Openings from garage sealed to prevent leakage

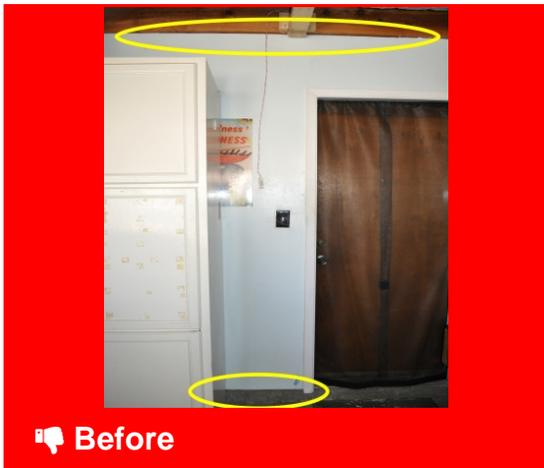
### Specification(s):

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

### Materials:

1. Sprayfoam
2. Fire-block caulk



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

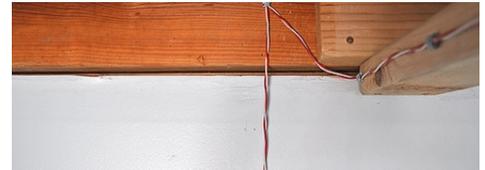
### 3.1501.1c - Cracks



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



 Before

Daylight visible under door to garage indicates leakage



 After

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:

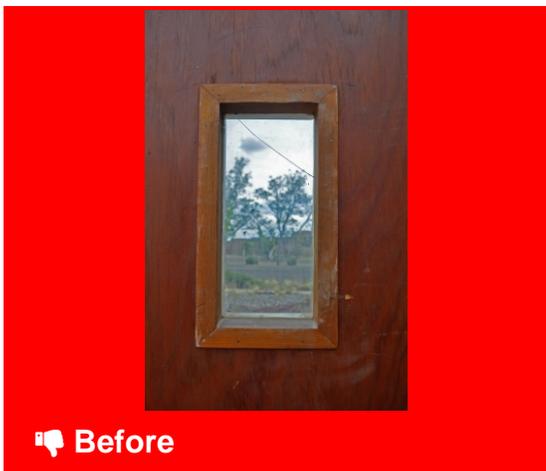
Openings from garage sealed to prevent leakage

### Specification(s):

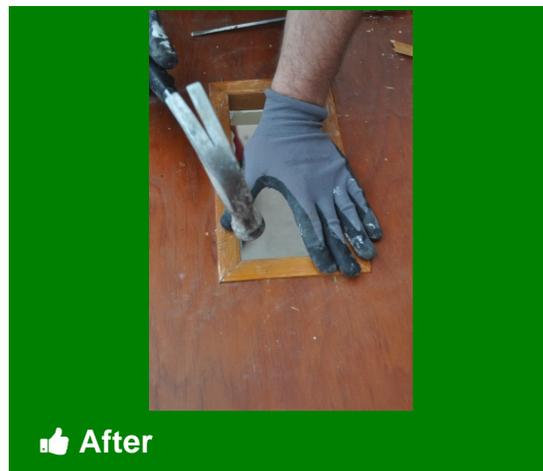
Broken glass panes in doors will be replaced, pointed, and glazed where needed

### 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:

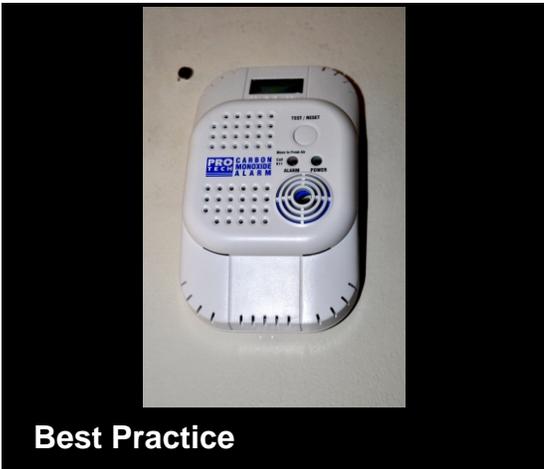
Openings from garage sealed to prevent leakage

### Specification(s):

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

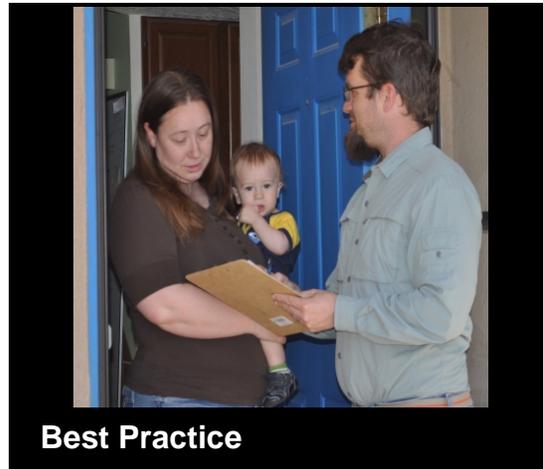
### Objective(s):

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

## 3.1602.1c

### 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

**Tools:**

1. Utility knife
2. Putty knife
3. Disposable brush

**Materials:**

1. Mastic
2. Fiberglass mesh tape
3. Cleaning solvent

### 3.1602.1c - Existing component to existing component



Prepare work area by assessing any safety concerns, verifying fasteners/strapping, and cleaning all joints with solvent.



Wrap joint with fiberglass mesh tape



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

## 3.1602.4c

### Desired Outcome:

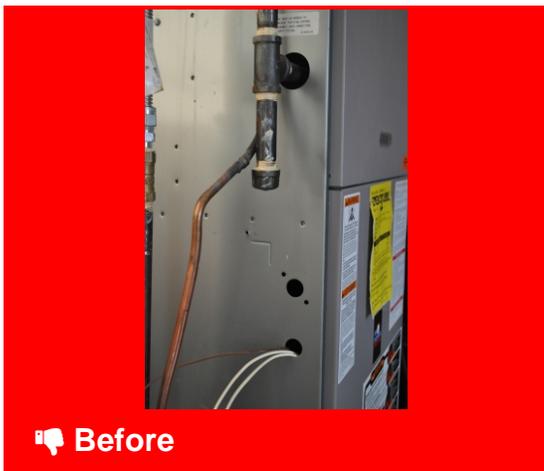
Ducts and plenums sealed to prevent leakage

### Specification(s):

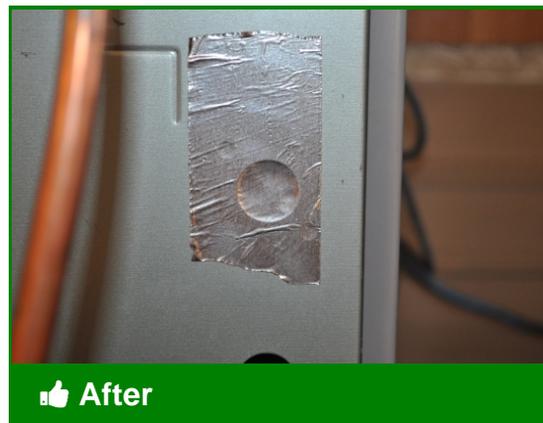
Joints will be closed and cracks and holes not needed for proper function of unit will be sealed using removable sealant (e.g., foil tape) or in accordance with the original equipment manufacturer directions (if available)

### 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



Unnecessary holes in the air handler cabinet should be sealed



Removable foil tape should be used to seal



Fully cover holes with tape to seal completely

## 3.1602.4d

### Desired Outcome:

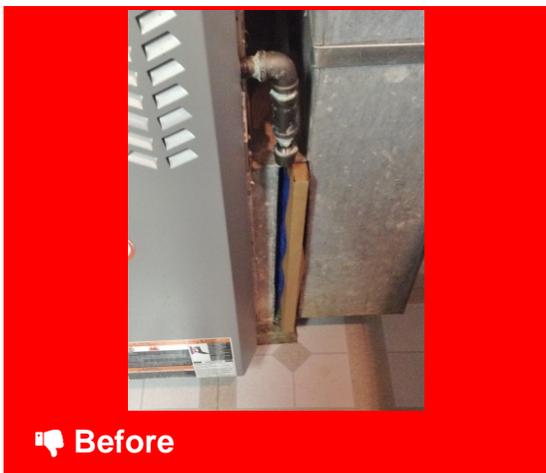
Ducts and plenums sealed to prevent leakage

### Specification(s):

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

### Objective(s):

Reduce air leakage while maintaining accessibility



## 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



**Before**

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



**In Progress**

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

### Tools:

1. HEPA vacuum

A HEPA vacuum is used to prevent airborne particulate that may be a health and safety hazard to the worker or to the occupant.

An N95 filtering face piece or a P100 APR will be used by the worker.

## 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

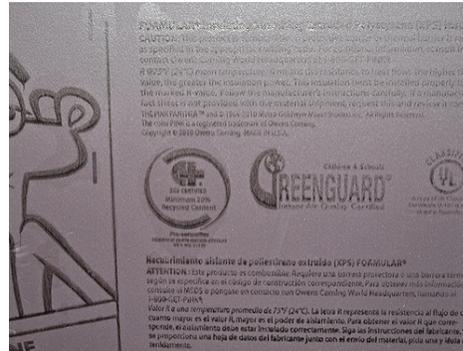
### Materials:

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

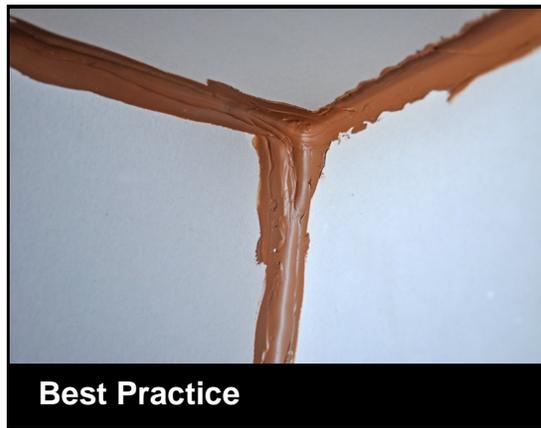
### Objective(s):

Select permanent sealant

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



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



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:**

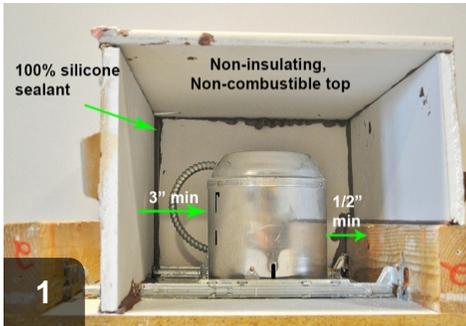
1. 5/8" fire-rated drywall
2. Fire-rated caulk sealant

Please note the change that materials must be fire-rated, but no longer must be 0.007" sheet metal.

5/8" fire code gypsum is faster, safer to work with, and easier to airseal.

Attempting to airseal by caulking directly around a non-IC light is ineffective and unallowable.

## 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

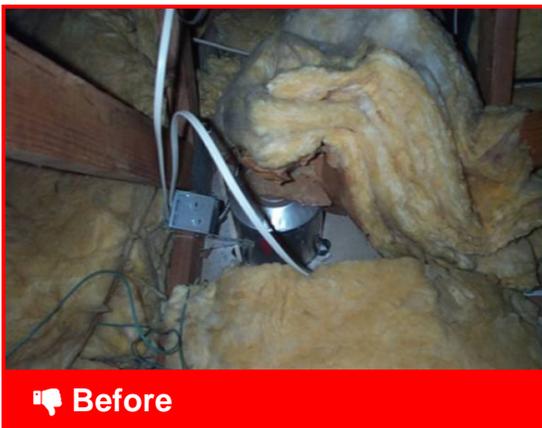
### Specification(s):

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):

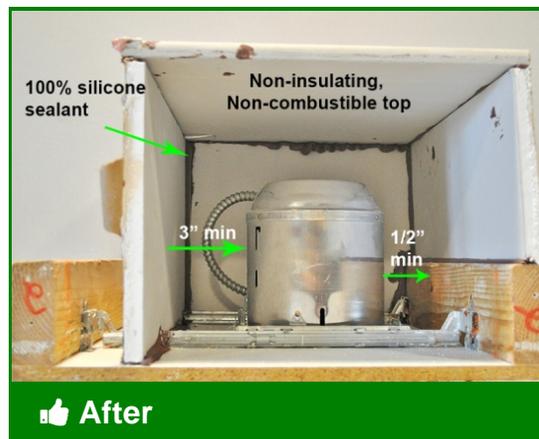
The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast

### 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):

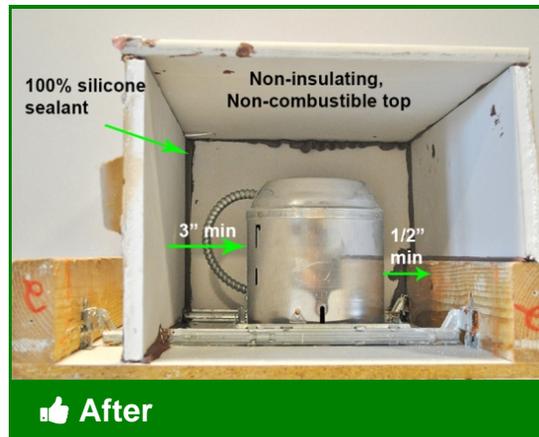
Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only

### Objective(s):

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



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



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



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



👎 Before

Knob & tube wiring radiates heat and cannot be insulated over



👍 After

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

Note: The SWS, MT Standards, and the NEC do not allow bridging over or under knob and tube wiring to facilitate insulation.

If the damming required is too extensive, insulation measures will not be applied until the knob and tube wiring is replaced or rendered inoperable by a licensed electrician.

Per MT Department of Labor and Industry, a Journeyman electrician may perform the inspection if he/she consults with a master electrician on the project.

As knob and tube wiring is not part of the weatherization program in Montana (aside from avoiding direct contact of weatherization materials), the state does not require a licensed electrician to inspect and certify the electrical system prior to damming for insulation.

# 4.1001.2c - Isolate or replace



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



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



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



4 Warning signs should encourage the use of certified electrician for repairs



5 Some jurisdictions require warning signs in Spanish as well



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



7 Many electricians will removed exposed wires to prevent reactivation



8 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

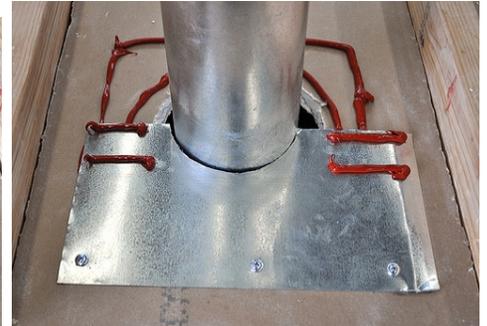
### 4.1001.3a - Verify attic prep



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:

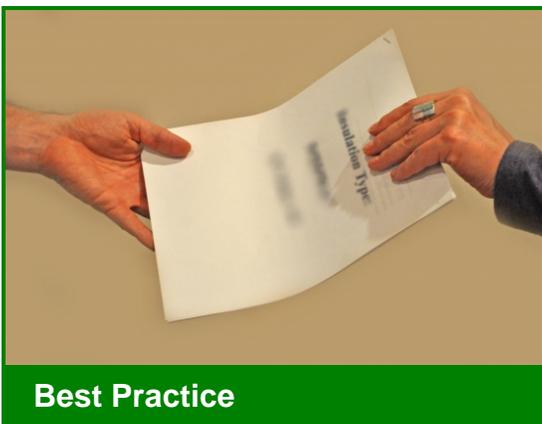
Combustible materials kept away from combustion sources

### Specification(s):

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

### Objective(s):

Provide occupant with documentation of installation

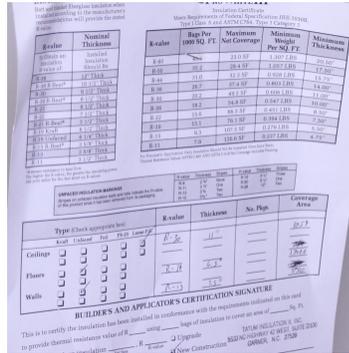


Provide occupant with documentation of and about insulation installed

# 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):

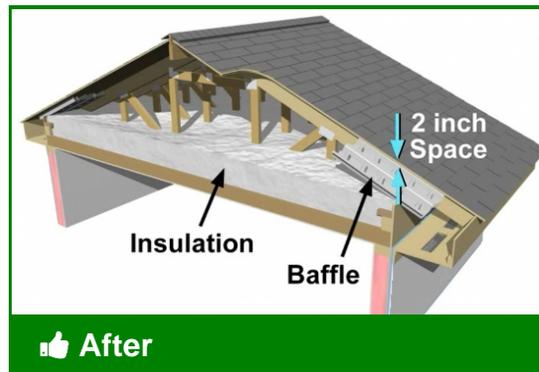
Ensure insulation R-value is not reduced

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



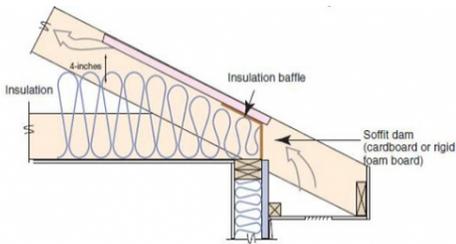
Allow a standard two inch gap for air flow through eave



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. Appropriate patching material

Although uncommon for Montana, we do occasionally work on homes requiring this practice.

The amount of venting required is as follows:

1 sq foot to every 300 sq feet of ceiling area if a vapor barrier is present.

1 sq foot to every 150 sq feet of ceiling area if a vapor barrier is not present.

## 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

If moisture is a potential concern, loose fill fiberglass insulation will be used instead of cellulose.

## 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



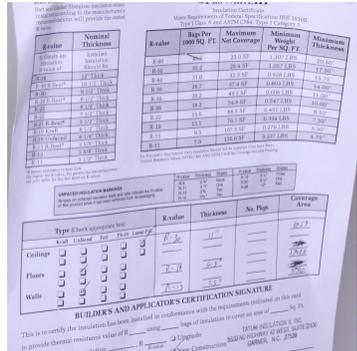
### Best Practice

Provide occupant with documentation of and about insulation installed

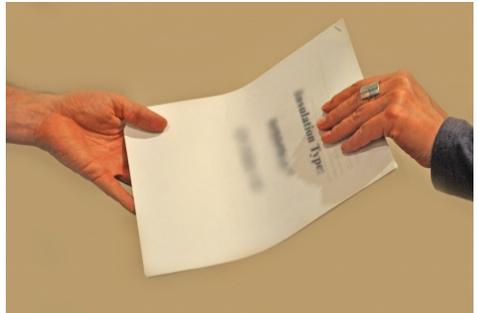
# 4.1003.3c - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 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):

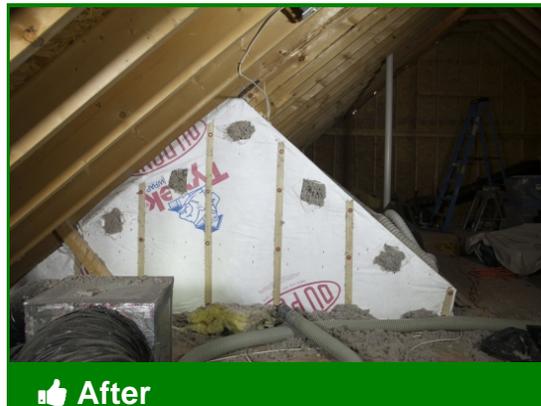
Eliminate misalignment of existing insulation

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



As a cold climate, kraft-face should face the inside, the living area of the building.



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
3. Foil-faced rigid board

## 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

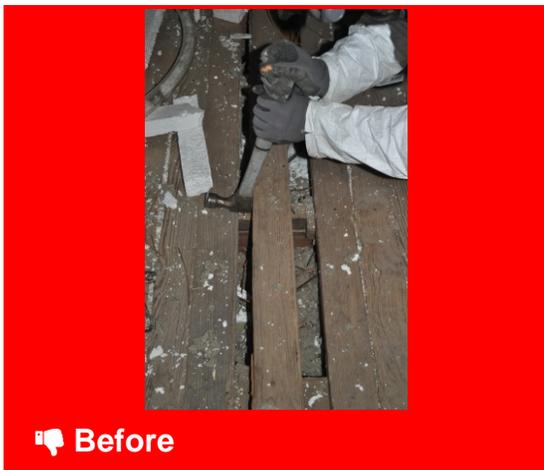
Open electrical junction boxes will have covers installed

### Objective(s):

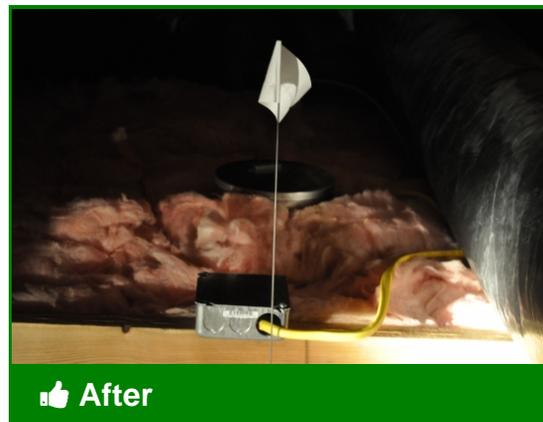
Access the workspace

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
2. Other marking materials

If safety conditions exist, dam around the hazard.

## 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

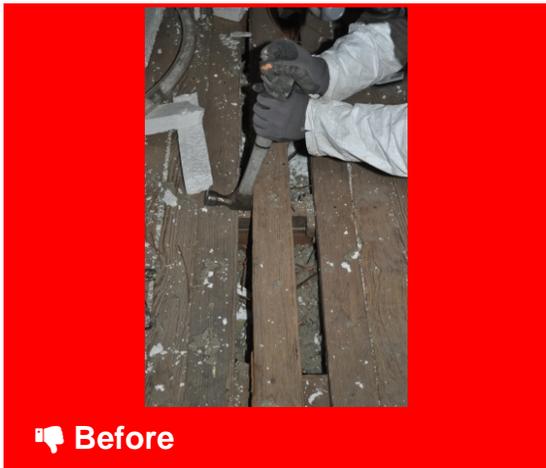
### Specification(s):

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



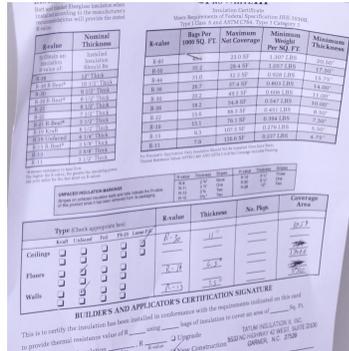
### Best Practice

Provide occupant with the MT Client Education Form

# 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

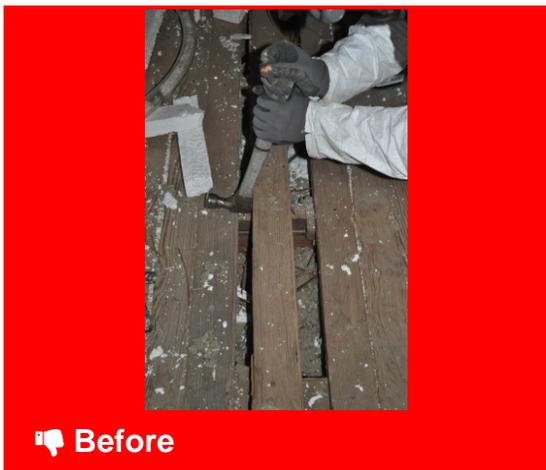
### Objective(s):

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



When missing, bottom plates must be installed under knee walls



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

Air sealing will be verified using a blower door and smoke device prior to installing insulation.

## 4.1005.2b - Air barrier



1 Measure floor cavity for new bottom plate



2 Cut rigid material, such as XPS, to size to snugly fit into cavity



3 Align block with air barrier of conditioned space



4 Air seal around new bottom plate with spray foam or caulking

## 4.1005.2c

### Desired Outcome:

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

### Specification(s):

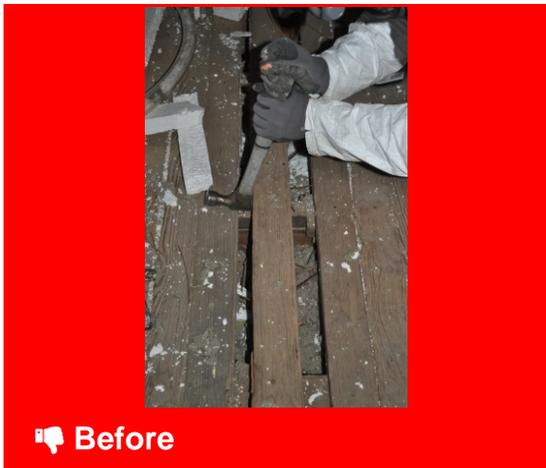
All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value

### Objective(s):

Reduce heating and air conditioning costs

Improve comfort

Minimize noise



**Before**

Accessible attic floor should be air sealed and insulated



**After**

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

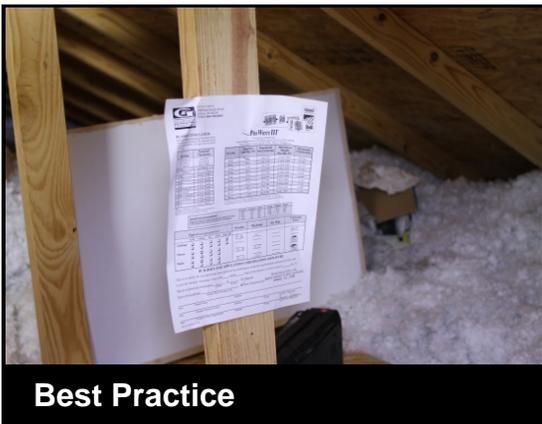
## Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

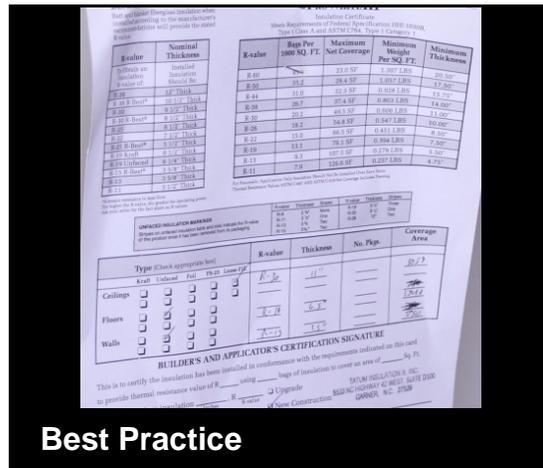
Ensure ability to match bags required for total area completed

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.

## 4.1005.3e

### Desired Outcome:

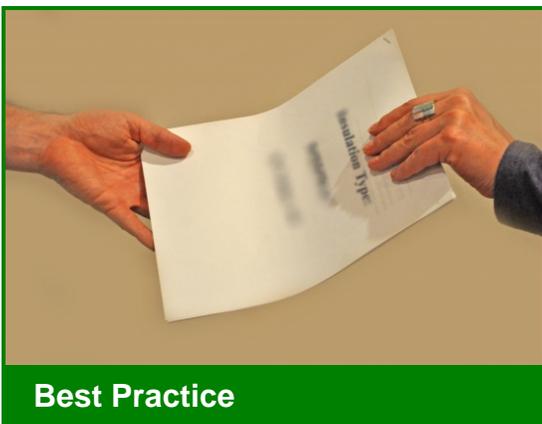
Insulation controls heat transfer through ceiling

### Specification(s):

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

### Objective(s):

Provide occupant with documentation of installation



Provide occupant with documentation of and about insulation installed



# 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

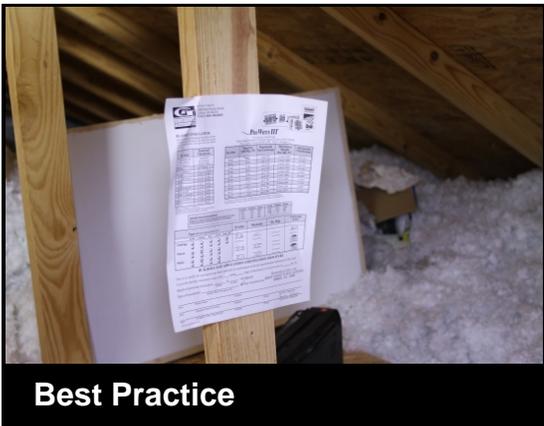
## Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

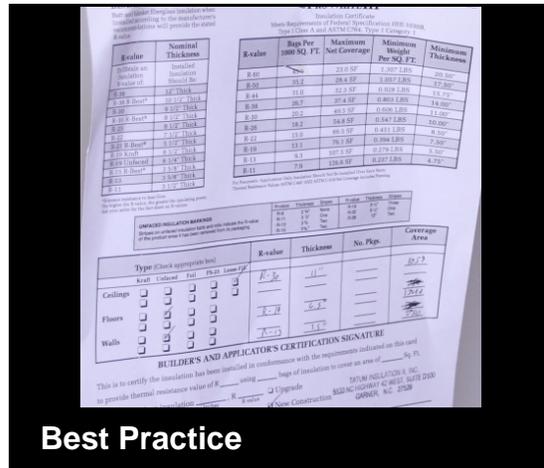
Ensure ability to match bags required for total area completed

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:

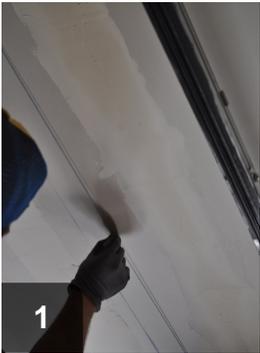
1. Drywall saw
2. Utility knife
3. Tape measure
4. Straight edge

### Materials:

1. XPS or other rigid material

Air sealing will be verified using a blower door and smoke device prior to installing insulation.

## 4.1005.5a - Air barrier



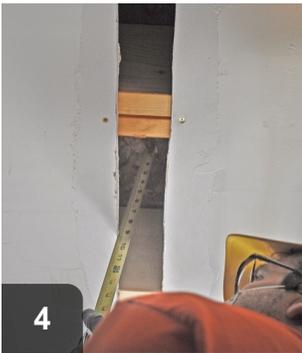
1 Snap chalk lines to keep access cuts clean and easy to repair



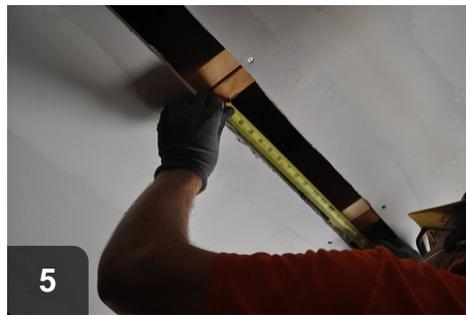
2 Cut through garage ceiling to access joist cavities below bonus room



3 The rigid block should be placed in line with the stem wall above



4 Measure joist cavity depth



5 Measure joist cavity width



6 Cut XPS, or other rigid material, to measured size of joist cavity



7 Rigid block should fit snugly into joist cavity to prevent insulation leaks



8 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

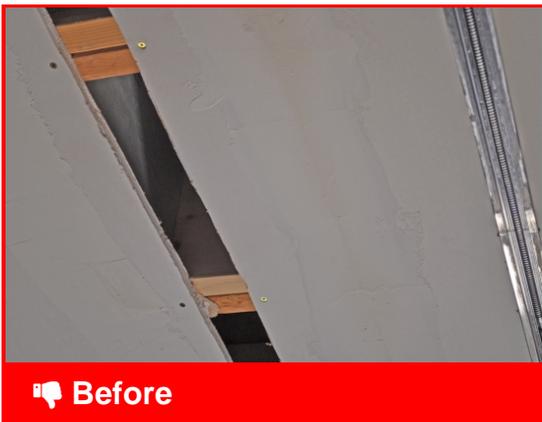
The number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

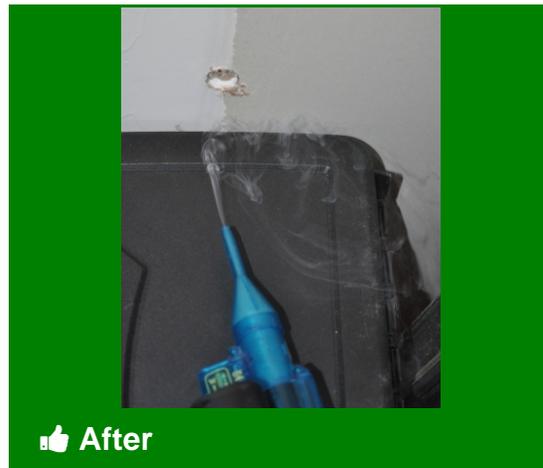
### Objective(s):

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

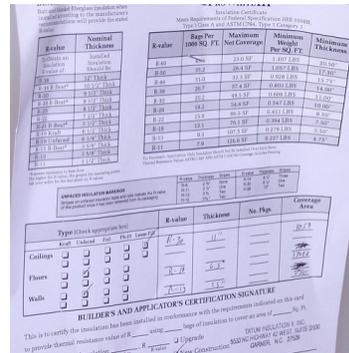
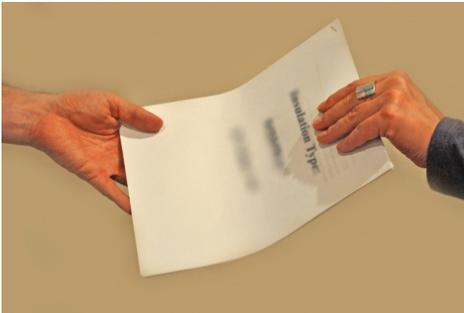
Comply with 16 CFR 460.17



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. XPS
5. 3/4" Lumber

## 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



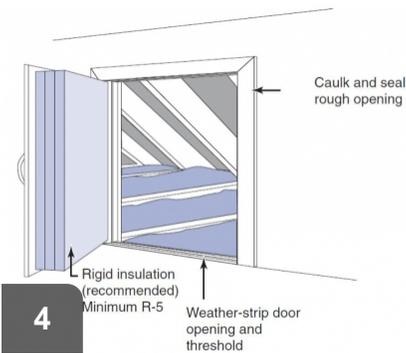
Create hatch cover that matches R-value of surrounding insulation



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

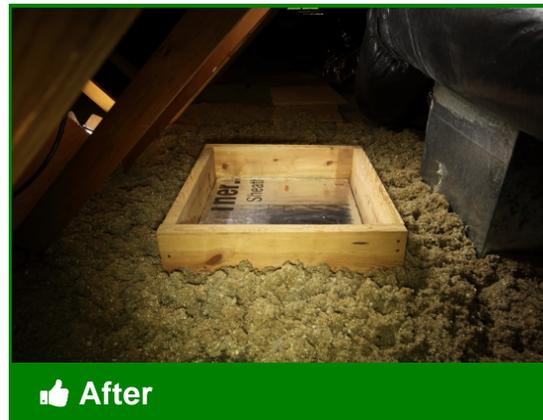
The measure must include a protective baffle or insulation barrier

### 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):

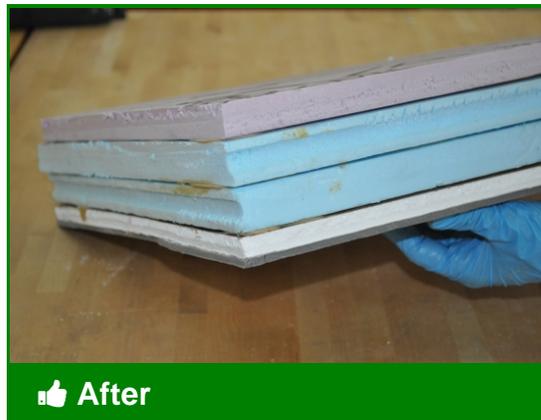
Insulation will be permanently attached and in complete contact with the air barrier

### Objective(s):

Insulate to prescribed R-value



Unsealed and uninsulated attic hatches and access doors allow leakage



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

## 4.1088.3c

### 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:

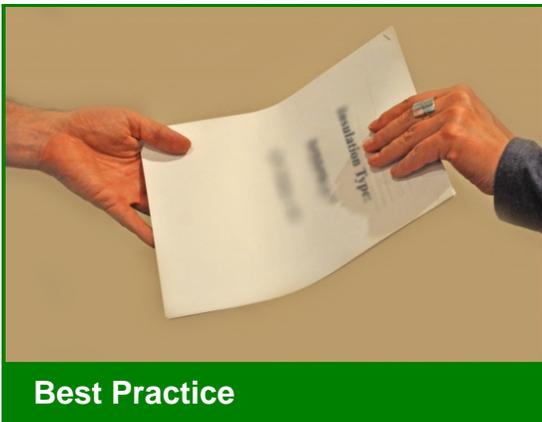
- Insulation type
- Coverage area
- R-value
- Installed thickness and settled thickness (settled thickness required for loose-fill only)
- Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

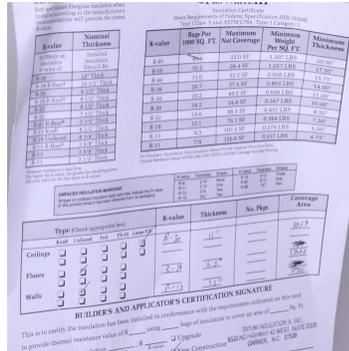


Provide occupant with documentation of and about insulation installed

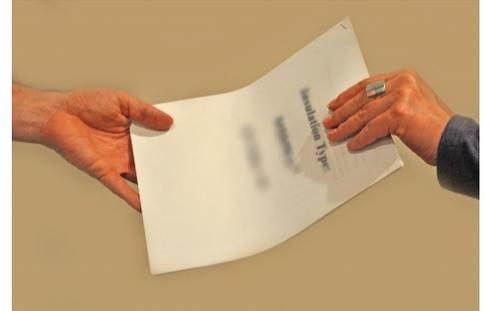
# 4.1088.3c - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1102.1a

### 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

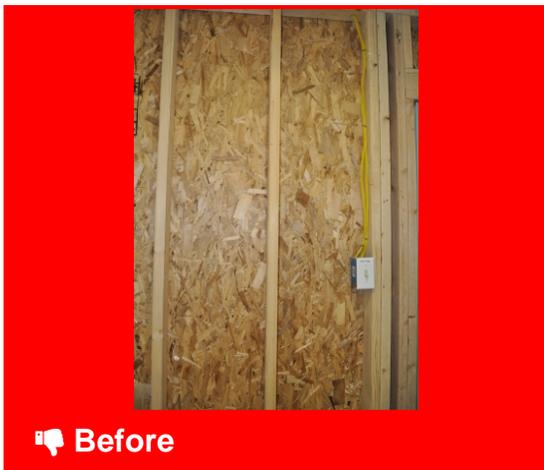
### Specification(s):

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

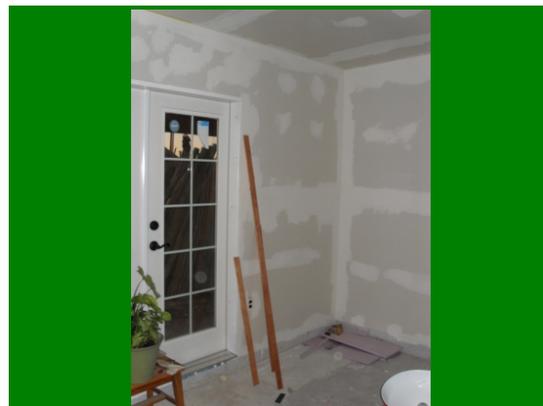
### Objective(s):

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
3. Blower door
4. IR camera

Best practice is to use a blower door and IR camera to verify proper installation

## 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:

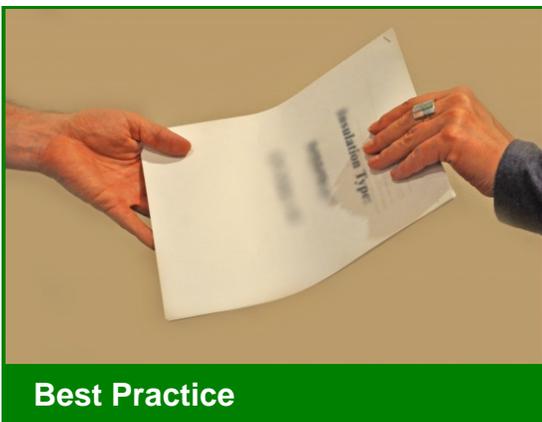
- Insulation type
- Coverage area
- R-value
- Installed thickness and settled thickness (settled thickness required for loose-fill only)
- Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

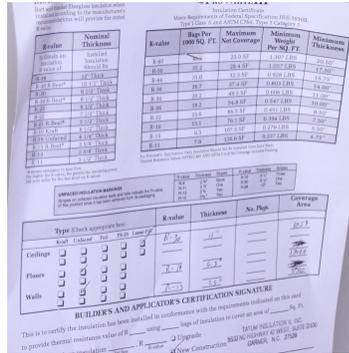


Provide occupant with documentation of and about insulation installed

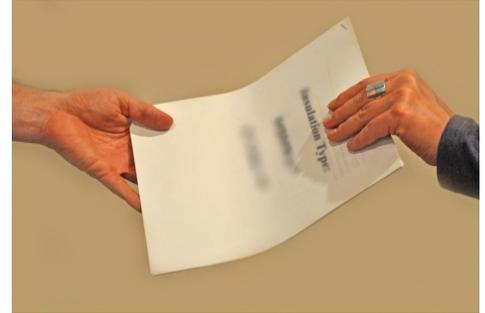
# 4.1102.1d - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1103.2a

### 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

e.g. Above and below windows, fire breaks, etc.

## 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

## 4.1103.2d

### 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
2. Borescope

When an IR camera is not available, cavities will be inspected using a borescope. Use of an IR camera is a much better practice and preferred.

## 4.1103.2d - Quality assurance



1  
Depressurize house (if safe) to -50pa wrt outside



2  
Inspect for voids and low density areas



3  
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):

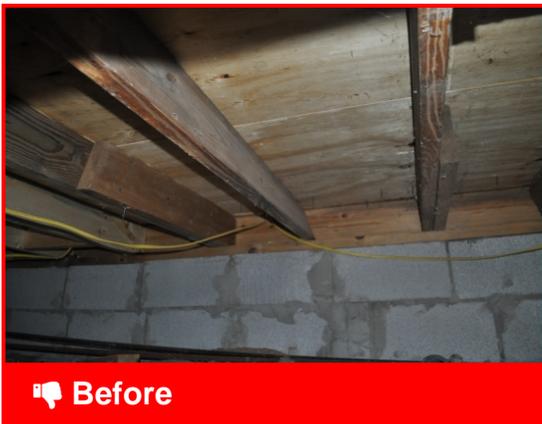
Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to subfloor

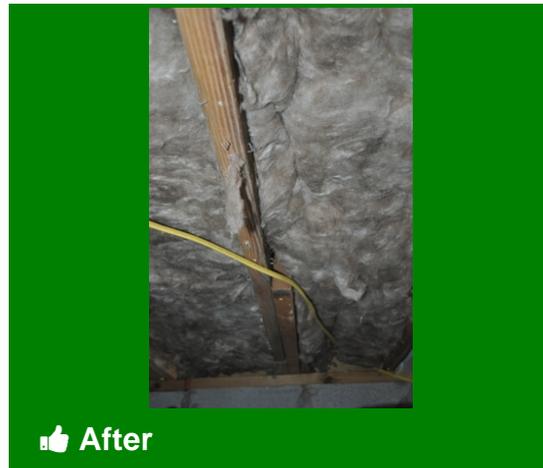
Insulation will be installed to prescribed R-value

### 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:

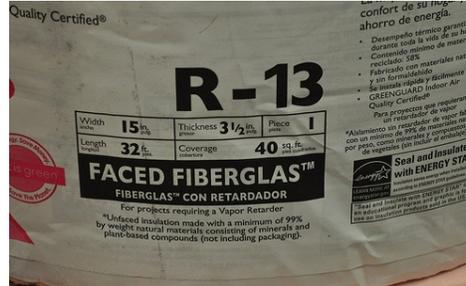
1. Kraft-faced fiberglass batts to work order specifications

# 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



Stays or twine can be used to hold batts in contact

### Tools:

1. Utility knife
2. Drill
3. Staple gun

### Materials:

1. Stays
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



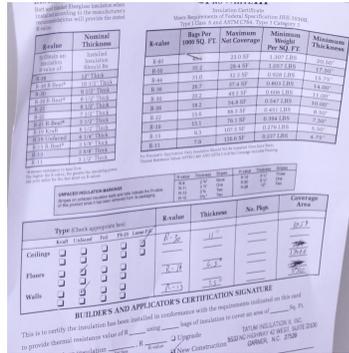
### Best Practice

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

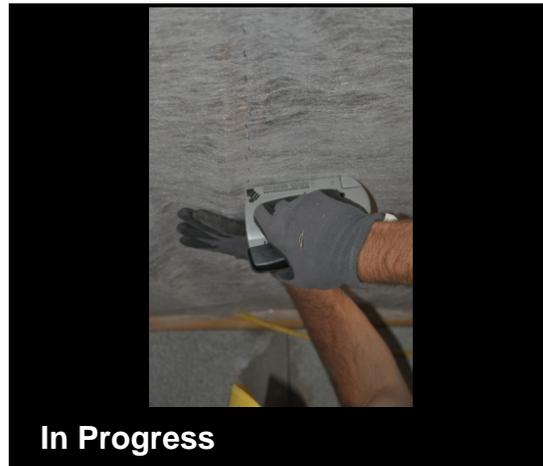
### Objective(s):

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



Secure netting across each joist to create separate cavities



Secure netting across sills to prevent leakage of insulation



Keep netting taut while stapling to prevent wrinkles and leakage



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

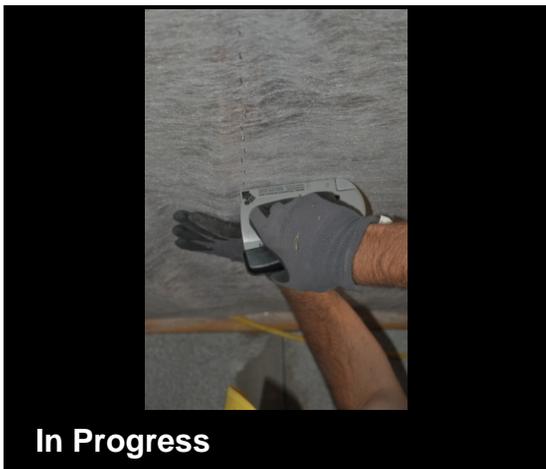
Insulation will be installed to prescribed R-value

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

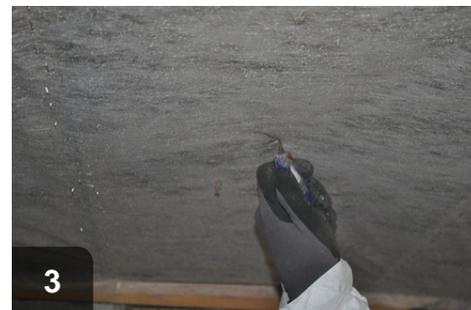
### Materials:

1. Loose fill fiberglass

# 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 Liene la maq  
Mezcla Natur  
3 Soplar al font  
el Valor-R des

Nature Blend Loose Fill Formula				Coverage Chart for Thermal Acoustical Application			
# Bags @ 50 lb	Total Volume (cubic feet)	Nominal Depth (inches)	No. Inches (100 cubic ft. per 100 cubic ft.)		2" x 8", 16" o.c.		
			Depth (inches)	Volume (cu. ft.)	Depth (inches)	Volume (cu. ft.)	
13	4.4	4.0	17.4	0.38	15.8	0.35	
18	6.1	5.5	27.9	0.61	25.5	0.56	
22	8.8	6.2	33.2	0.73	30.5	0.67	
26	7.8	7.0	38.6	0.85	35.6	0.87	
30	11.4	10.3	62.5	1.40	44.6	1.70	
36	14.6	15.1	85.0	1.90	49.6	2.00	
42	17.7	15.9	101.9	2.24	58.6	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

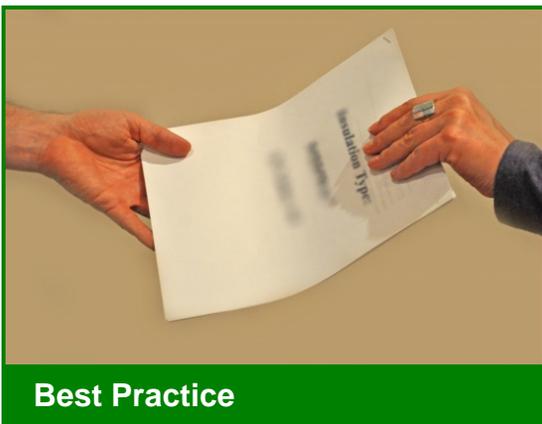
### Objective(s):

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

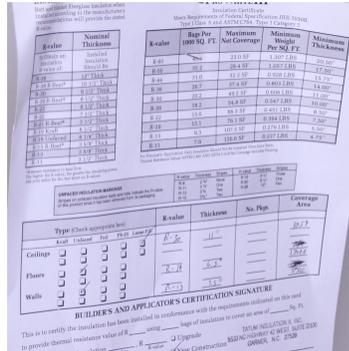


Provide occupant with documentation of and about insulation installed

# 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

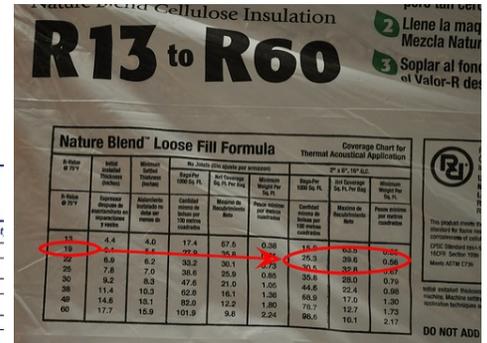


Make sure to wear proper PPE when working with insulation

**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



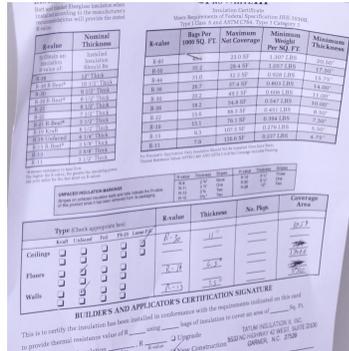
### Best Practice

Provide occupant with documentation of and about insulation installed

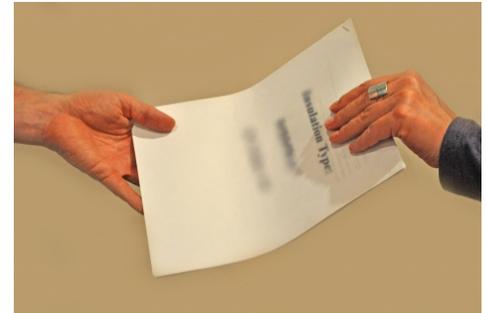
# 4.1301.3d - Occupant education



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 <sup>3</sup>	lb/ft <sup>2</sup>	bags	ft <sup>2</sup> /bag
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 2x)	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	0.700	22.3	42.8
15.4	1.8	2.2	0.778	20.7	45.9
15.5	1.8	2.4	0.833	19.1	52.4
15.6	1.8	2.6	0.889	17.5	57.1
15.7	1.8	2.8	0.944	16.0	62.5
15.8	1.8	3.0	1.000	14.6	68.5
15.9	1.8	3.2	1.056	13.3	75.2
16.0	1.8	3.4	1.111	12.1	82.7
16.1	1.8	3.6	1.167	11.0	91.1

The coverage per bag shown in the above chart is for the unfilled area (portion 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



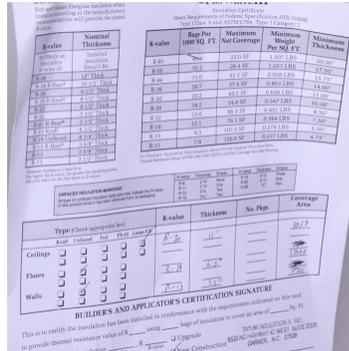
### Best Practice

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

## 4.1301.5c

### 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



 Before

Insulation should be secured to prevent drooping or movement



 After

Stays or twine should keep full contact with the subfloor

### Tools:

1. Utility knife
2. Drill
3. Staple gun

### Materials:

1. Stays
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

## 4.1301.5e

### 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



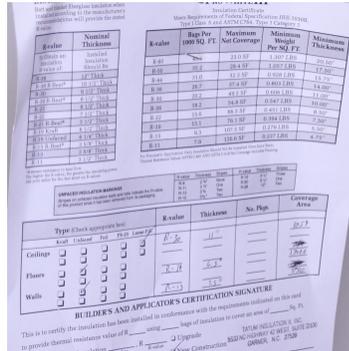
### Best Practice

Provide occupant with documentation of and about insulation installed

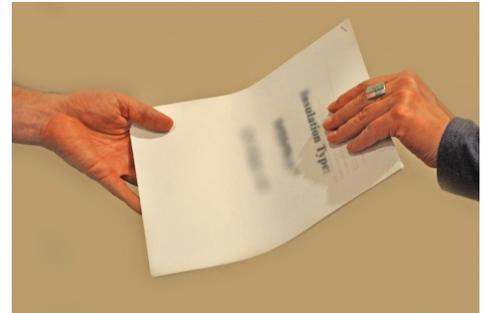
# 4.1301.5e - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1301.6a

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing between house and crawl space 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.

## 4.1301.6a - Subfloor preparation



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

## 4.1301.6b

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

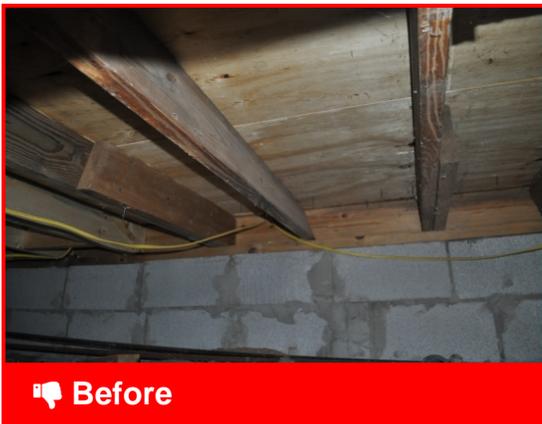
Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to subfloor

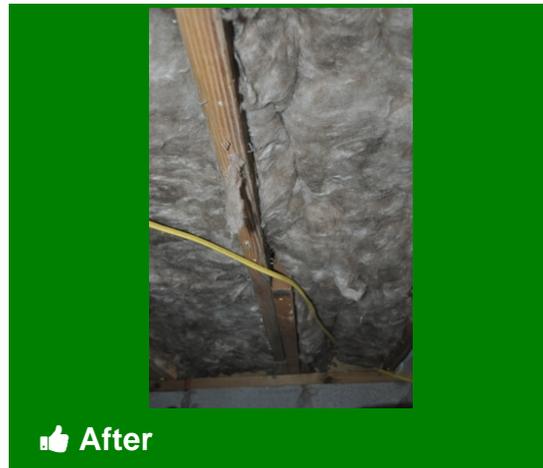
Insulation will be installed to prescribed R-value

### 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. Drill

### Materials:

1. Kraft-faced fiberglass batts to work order specifications
2. Rigid barrier -- drywall, plywood, XPS
3. Fasteners

# 4.1301.6b - 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

## 4.1301.6c

### Desired Outcome:

Consistent, uniform thermal barrier 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



Batts should not hang away from subfloor



Stays or twine should be used to maintain contact

### Tools:

1. Utility knife
2. Drill
3. Staple gun

### Materials:

1. Stays
2. Twine
3. Fasteners

## 4.1301.6c - Secure batts



Batts should be in full contact with subfloor without being compressed



Twine fastened across bays in a zig-zag pattern can also be used

## 4.1301.6d

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

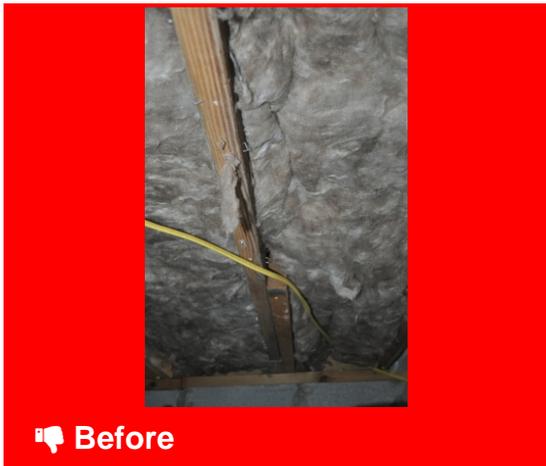
### Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly

Seams and penetrations will be sealed

### Objective(s):

Protect insulation



Unfaced fiberglass batts can be attractive housing for pests



Rigid barrier allows for air sealing and protects batt insulation

### Tools:

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

### Materials:

1. Rigid material - drywall, XPS, plywood
2. Caulk
3. Fasteners

## 4.1301.6d - Rigid air barrier



Fasten rigid barrier, aligning seams with joists when possible



Seal all seams with caulk to prevent leakage



Pay particular attention to complex joints



Remember to seal along sills

## 4.1301.6e

### Desired Outcome:

Consistent, uniform thermal barrier 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



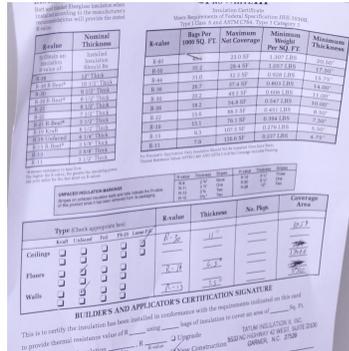
### Best Practice

Provide occupant with documentation of and about insulation installed

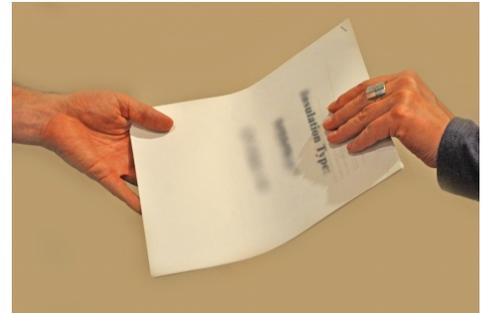
# 4.1301.6e - Occupant education



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1301.7a

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing between house and crawl space will be completed before insulating

### Objective(s):

Prevent air 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.

## 4.1301.7a - Subfloor preparation



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

## 4.1301.7b

### Desired Outcome:

Consistent, uniform thermal barrier 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 while creating 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

## 4.1301.7b - Rigid air barrier



Fasten rigid barrier, aligning seams with joists when possible



Seal all seams to prevent leakage



Pay particular attention to complex joints



Remember to caulk along sills

## 4.1301.7c

### Desired Outcome:

Consistent, uniform thermal barrier 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 has been sealed, insulation can be blown in



 After

After insulating, restore rigid barrier to prevent leakage

### Tools:

1. Insulation machine
2. Caulk gun

### Materials:

1. Loose fill insulation
2. Caulk

# 4.1301.7c - Installation

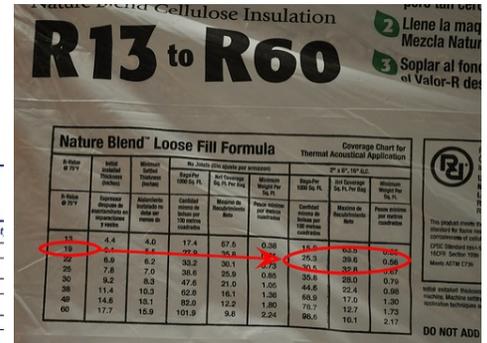


Always wear proper PPE when working with insulation

### 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	
2	Labor	Floor Insulation - Loose-fill + Rigid Barrier - R-19	SqFt	1180	\$0.35	\$413.00	
3	Miscellaneous Su	Floor Insulation - Loose-fill + Rigid Barrier - R-19	Each	1	\$100.00	\$100.00	

Purchase and install insulation to r-value specified on Work Order



Check manufacturer specs to ensure proper installation and density



Drill hole in rigid barrier slightly larger than insulation hose



Fill cavities formed by rigid barrier with loose fill insulation



Once cavities have been filled to specified r-value, prepare plug



Seal rigid barrier to prevent leakage

## 4.1301.7d

### Desired Outcome:

Consistent, uniform thermal barrier 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



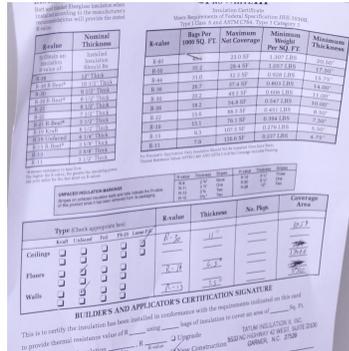
### Best Practice

Provide occupant with documentation of and about insulation installed

# 4.1301.7d - 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

## 4.1301.8a

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing between house and crawl space will be completed before insulating

### Objective(s):

Prevent air leakage



 Before

Gaps around penetrations can cause air leakage and negate insulation



 After

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.

## 4.1301.8a - Subfloor preparation



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

## 4.1301.8b

### Desired Outcome:

Consistent, uniform thermal barrier 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 while creating 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

## 4.1301.8b - Rigid air barrier



Fasten rigid barrier, aligning seams with joists when possible



Seal all seams with caulk to prevent leakage



Pay particular attention to complex seams



Remember to seal along sills

## 4.1301.8c

### Desired Outcome:

Consistent, uniform thermal barrier 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 has been sealed, insulation can be blown in



**After**

Rigid barrier should be sealed after insulating to maintain air barrier

### Tools:

1. Insulation machine
2. Caulk gun

### Materials:

1. Dense packable insulation
2. Caulk

# 4.1301.8c - 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	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	

Purchase and install insulation as per Work Order

**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 <sup>3</sup>	lb/ft <sup>2</sup>	Bags	Sq. Ft.
14.0	1.5	0.25	17.5	57.1	51.4
15.0	3.0	0.50	18.4	54.3	46.0
15.1	(nominal 2x)	2.2	0.62	21.4	42.8
15.2	2.4	0.70	22.3	45.0	38.4
15.3	1.8	0.75	23.2	43.1	34.1
22.8	5.0	2.0	0.87	20.9	27.7
22.9	(nominal 2x)	2.2	1.00	18.0	23.9
23.0	2.4	1.10	20.7	19.3	21.3
24.1	2.0	1.25	25.0	16.0	18.2

The coverage per bag shown in the above chart is for the unfurled area (surface 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.

Check manufacturer specifications to install properly



Drill hole in rigid barrier slightly larger than insulation hose



Blown in insulation to density and r-value specified by work order



Once cavity is filled, prepare plug to reseal rigid barrier



Securely seal plug into rigid barrier to prevent leakage

## 4.1301.8d

### Desired Outcome:

Consistent, uniform thermal barrier 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



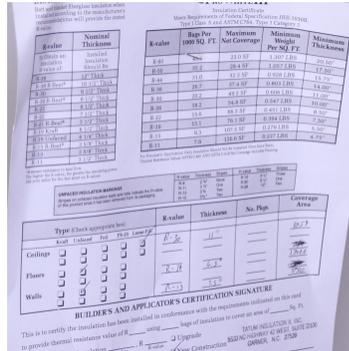
### Best Practice

Provide occupant with documentation of and about insulation installed

# 4.1301.8d - 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

## 4.1402.2a

### 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

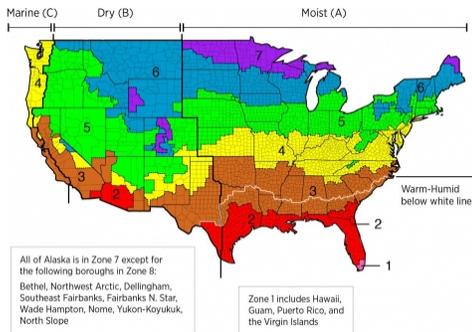
### Materials:

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:  $\leq 0.1$  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



Montana is in Climate Zone 6

## 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



Ducts can be buried in loose fill insulation because Montana is relatively dry

## 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

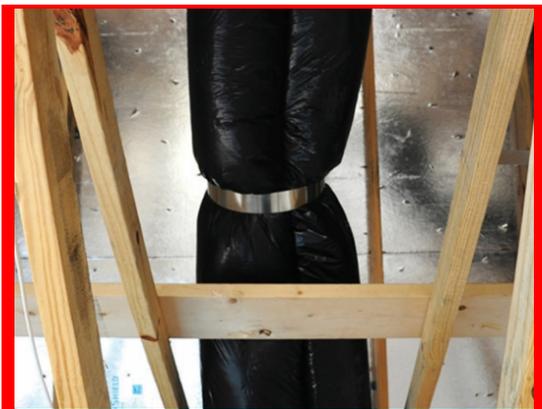
### Specification(s):

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

## 5.3003.2a

### 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

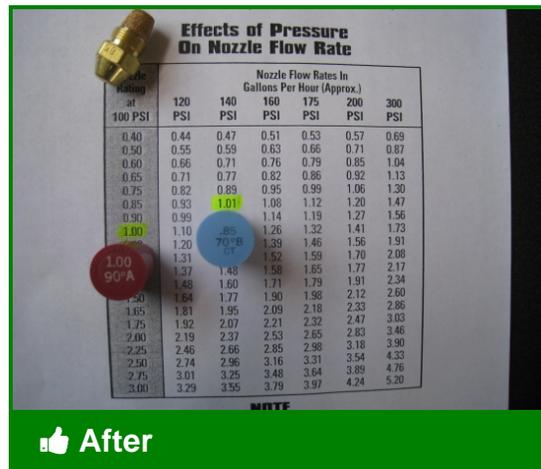
Ensure equipment operates safely

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

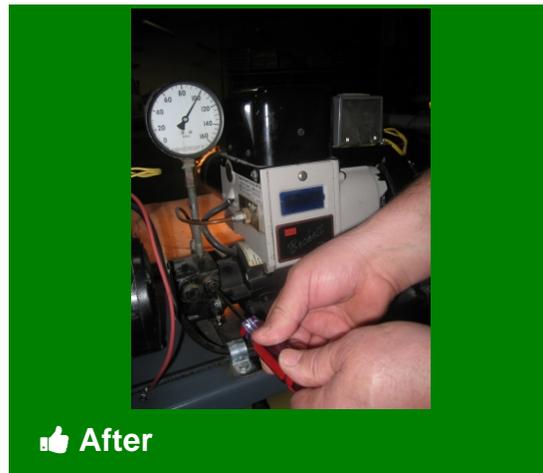
Ensure equipment operates safely

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

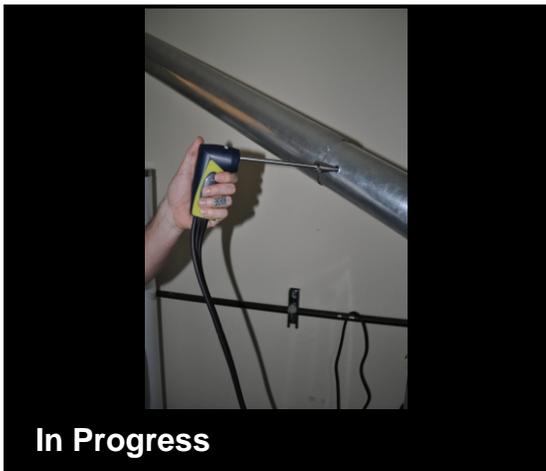
### Objective(s):

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



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

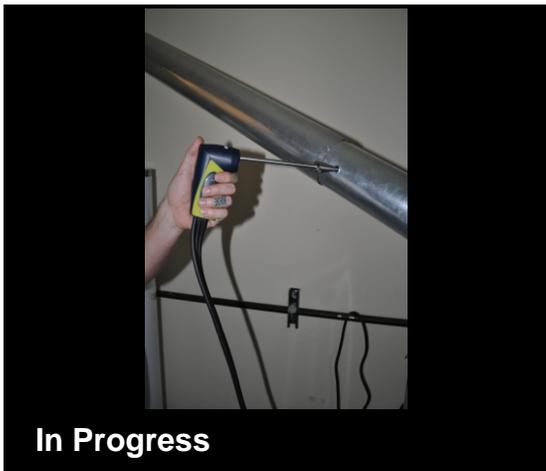
### Objective(s):

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

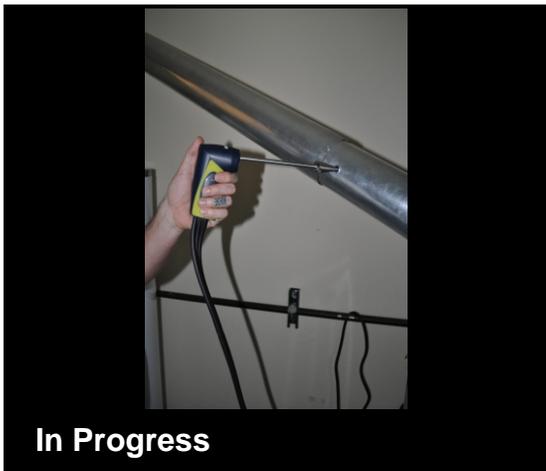
### Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



**In Progress**

Verify oil-fired appliances are burning safely by testing CO<sub>2</sub> and O<sub>2</sub> levels



**After**

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 CO<sub>2</sub> produced by an oil-fired appliance.

O<sub>2</sub> levels in the atmosphere are at a constant 20.9% at sea level. Because Montana is well above sea level, our O<sub>2</sub> levels are below that. For example, O<sub>2</sub> levels at 4,000' are approximately 17.9%. O<sub>2</sub> readings in appliances vary due to O<sub>2</sub> 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

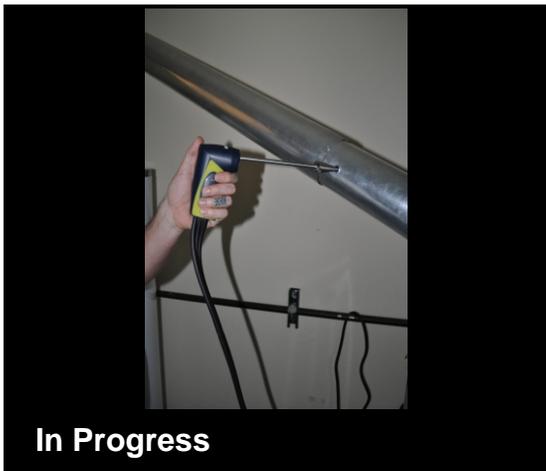
### Objective(s):

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)

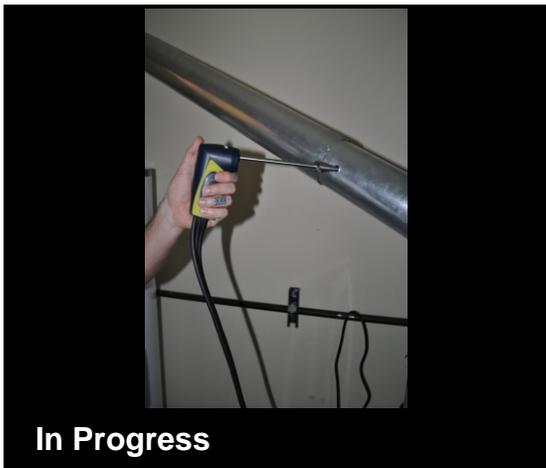
### Objective(s):

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



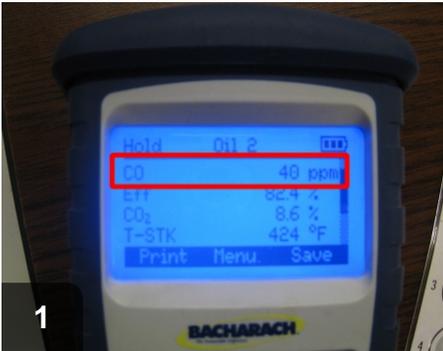
After

CO should measure less than 200ppm

### Tools:

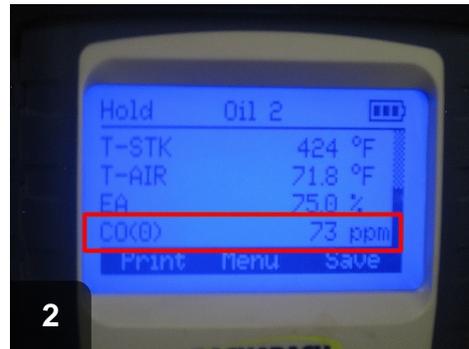
1. Combustion analyzer with probe
2. Drill

## 5.3003.2h - CO in flue gas



1

CO should measure less than 200ppm



2

Air-free CO, or CO(0), should be less than 400ppm

## 5.3003.8a

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### Specification(s):

The following system elements will be assessed:

- Pump
- Pan
- Spider
- Float
- Damper
- Roof jack support
- Water line
- Water valve
- Electrical
- Pads
- Motor
- Fan

Elements will be repaired or replaced as needed in accordance with manufacturer instructions

### Objective(s):

Ensure all components function properly



Assess wear and tear on various parts of evaporative cooler



Pads have deposits and are shrunken from age. Replace

The State of Montana does NOT include evaporative coolers in the Wx Assistance Program.

## 5.3003.8a - Assessment and diagnosis



Pump needs to be cleaned of calcium deposits



Pan has calcium deposits as well but still holds water



Check spider, which distributes water to pads, for cracks and leaks



The float, attached to the water valve, shows no signs of cracking



The damper needs to be opened at the beginning of summer



The roof jack shows some signs of cracking and should be resealed



Water line is in tact and not leaking



Water valve has signs of deposits, but isn't leaking



Motor and electrical are in good working order

## 5.3003.8b

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### Specification(s):

Calcium deposits will be removed

Pads will be replaced

Any additional repairs or replacements will be made as necessary in accordance with manufacturer's instructions

### Objective(s):

Protect the potable water supply from cross-contamination

Ensure evaporative cooler functions properly



Old swamp cooler pad on left needs replacement due to calcium depositing



Pads have been replaced; calcium deposits have been removed. Ready to run

### Tools:

1. Large vessel

### Materials:

1. Scrub pads
2. Distilled white vinegar

See also SWS 2.0100.1f and 2.0100.1i for Health & Safety measures.

The State of Montana does NOT include evaporative coolers in the Wx Assistance Program.

## 5.3003.8b - Repair and maintenance



When working on a roof, always be sure to wear a fall-protection harness and proper PPE



Use vinegar both as a soak and on scrub pads to remove calcium deposits



Scrub calcium deposits off all surfaces, including trickle trough



Exterior deposits should also be cleaned. Can you tell which part is clean?



Measure and cut, if necessary, new pads designed for use in swamp coolers



Reinstall new pads, held in place with metal bracketing

## 5.3003.8c

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### Specification(s):

A regular service schedule will be recommended to occupant

Issues regarding multiple systems running will be discussed with occupant

### Objective(s):

Ensure the occupant understands basic operation and the importance of regular maintenance



Occupants with evaporative coolers should be alerted to proper maintenance



### Best Practice

Communicate professionally with occupant to provide information and support

The State of Montana does NOT include evaporative coolers in the Wx Assistance Program.

## 5.3003.8c - Occupant education

Standard Evaporative Cooler Maintenance	
Spring (Start-Up)	
Clean Pump	
Clean Spider Nozzles and Drip Trough	
Oil Blower and Motor Bearings - DO NOT Over Oil	
Change Pads	
Check Belt Condition and Tension (3/4" deflection @ 3lb. Force)	
Check water bleed-off and clear any clogs	
Remove damper/baffle (if present)	
Plug in motor and pump	
Turn-on/Reconnect Electricity	
Mid-season Checks	
Clean/Replace Pads - depends on water quality	
Winter Shut Down	
Turn-off/Disconnect Electricity	
Drain Water (pan and all lines)	
Unplug motor and pump	
Insert damper/baffle (if equipped)	
Cover unit	



Review properly and timely evaporative cooler maintenance

Explain evaporative and refrigerative cooling should not be run together

## 5.3003.10a

### Desired Outcome:

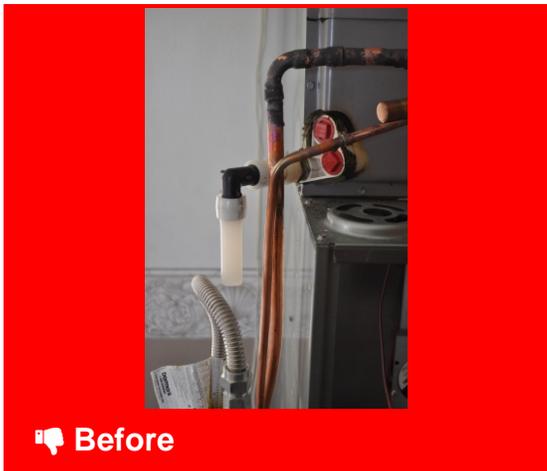
Equipment and condensate drain operate as designed

### 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):

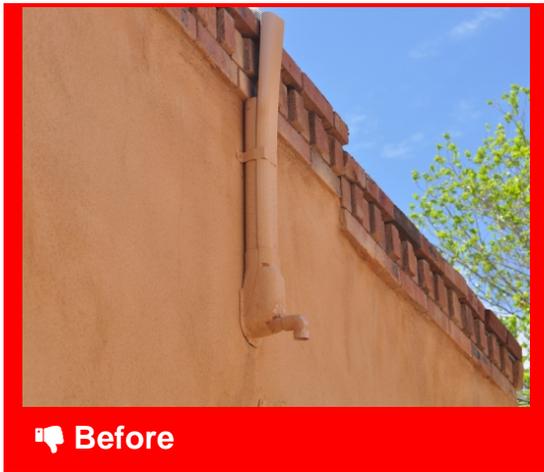
Condensate drain pumps will be installed when condensate cannot be drained by gravity

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

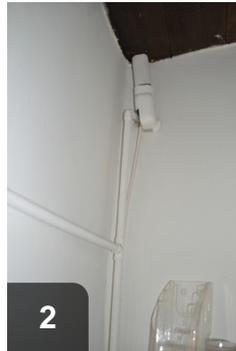


For non-gravity draining systems, a pump is necessary

## 5.3003.10d - Pumps



HVAC unit may be mounted to a wall that cannot be penetrated for various reasons.



Instead, unit is drained by utilizing a pipe and pump in the next room



The pump is connected directly into the sewage system

## 5.3003.10g

### 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

## 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



Duct work for exhaust fans should be short, smooth, and not pinch down



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



Uninsulated ducts in unconditioned spaces are an energy drain



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. Montana Code requires a minimum of R-8 insulation surrounding exhaust ducts.

## 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



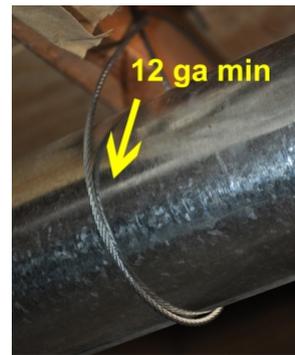
Support straps should be at least 1 1/2 inches wide



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

## 6.6002.2a

### 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

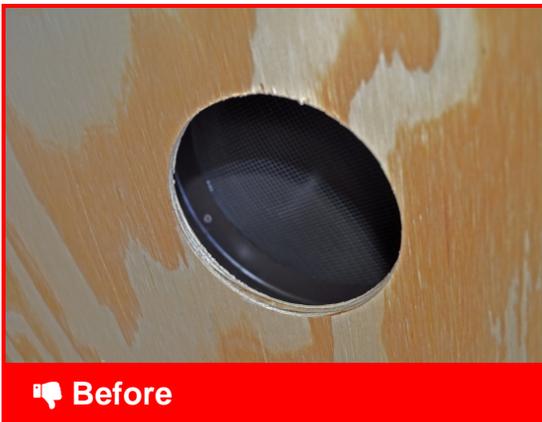
Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable

### Objective(s):

Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation



Termination fittings with no collar are to be avoided



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

## 6.6002.2d

### 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):

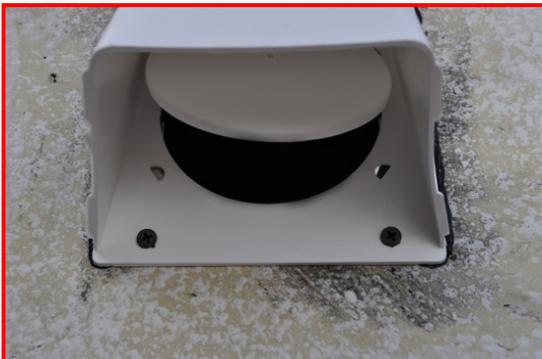
Screen material with no less than 1/4" and no greater than 1/2" hole size in any direction will be used

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

Terminations will not be installed in or near soffit vents.

## 6.6002.2g

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

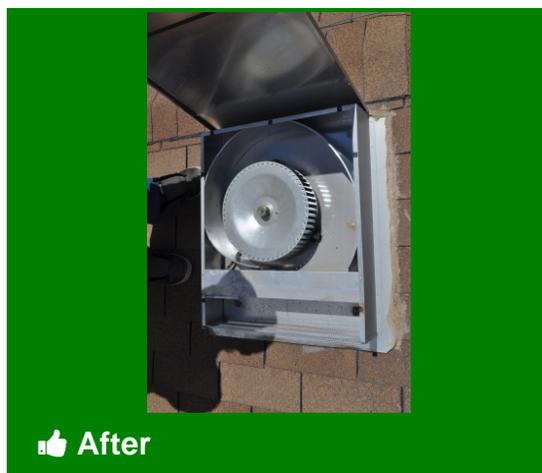
Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust

### 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

## 6.6003.3a

### 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



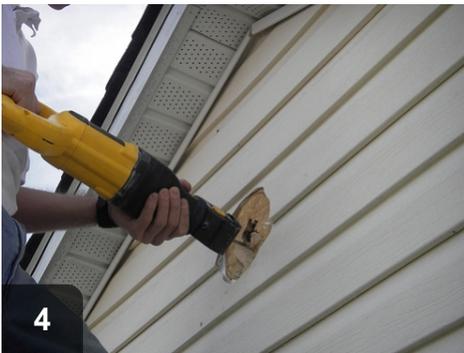
Measure the termination fitting to determine proper hole diameter (in this case, 4")



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

## 6.6003.3e

### Desired Outcome:

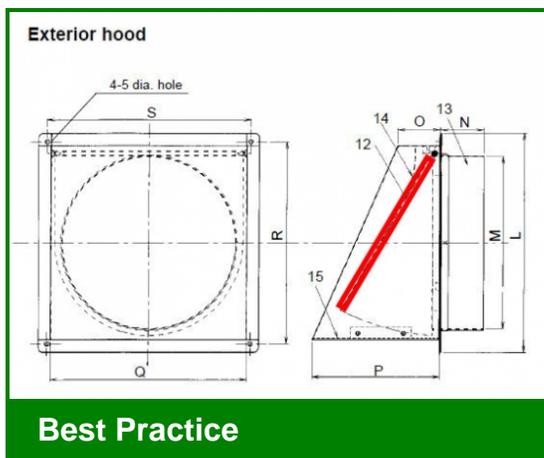
Through the wall fans installed to specification

### 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

## 6.6003.3j

### Desired Outcome:

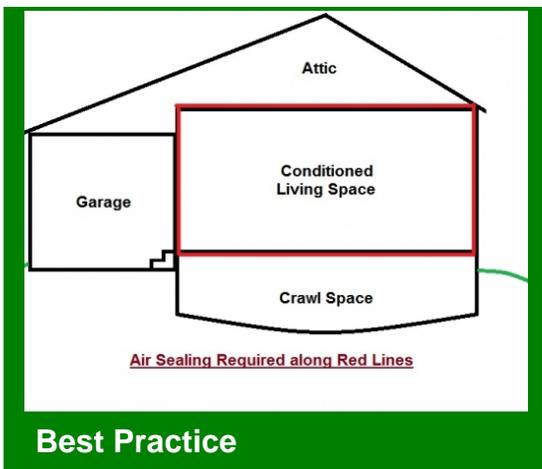
Through the wall fans installed to specification

### 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



**Before**

Installing new ventilation can cause imbalances within the house



**After**

Test that depressurization limit is not being exceeded by new ventilation

### Tools:

1. Manometer
2. Smoke Pencil

See SWS 2.0299.1a-i for CAZ depressurization limits.

Completion must include a 2-minute spillage test to confirm proper draft.

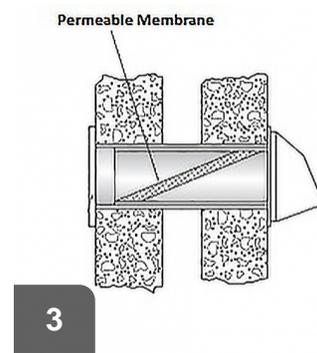
## 6.6003.3k - Combustion safety



1 Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



2 If depressurization limit is exceeded, mitigate to eliminate safety risk



3 Mitigate safety risk with make-up air or other pressure relief



4 After mitigation, verify that depressurization limits are not being exceeded and perform a 2-minute spillage test.

## 6.6005.1b

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

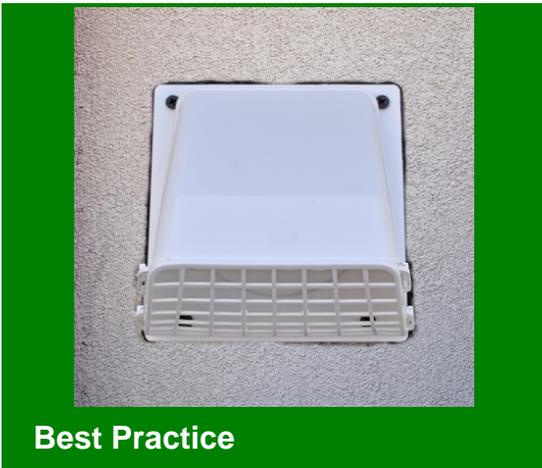
Termination fitting manufactured for use with dryers will be installed

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

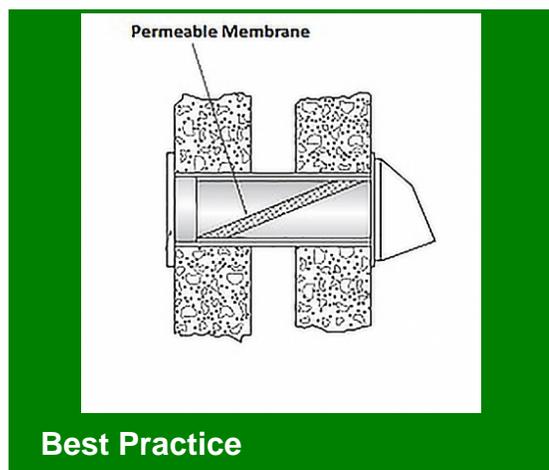
### Specification(s):

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



Test to verify combustion appliances are within depressurization limits

### Tools:

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits

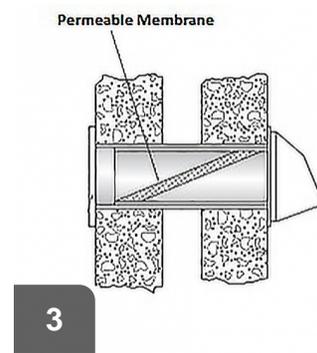
## 6.6005.1d - Combustion safety



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)

## 6.6005.2b

### Desired Outcome:

Kitchen range fan installed to specification

### Specification(s):

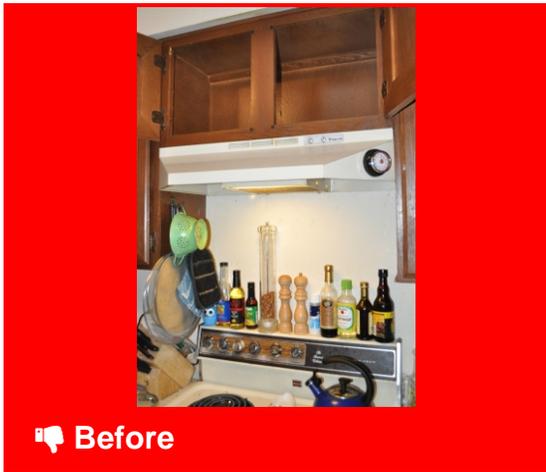
Kitchen range fans will be vented to the outdoors

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:**

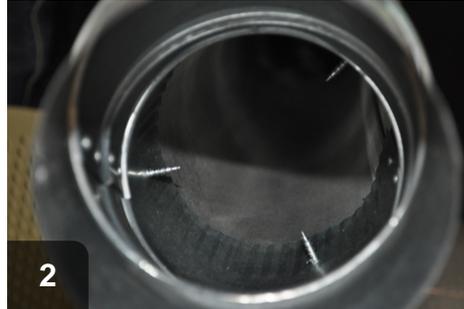
1. Round metal ducting
2. Mastic
3. Fiberglass mesh tape
4. Fasteners

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

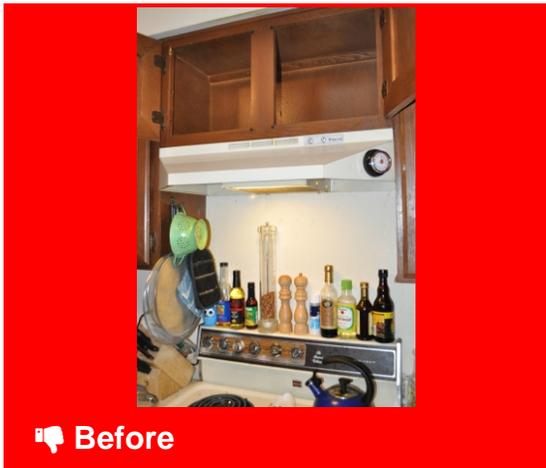
### Specification(s):

Termination fitting will be installed including a backdraft damper, as described in termination fitting detail

### Objective(s):

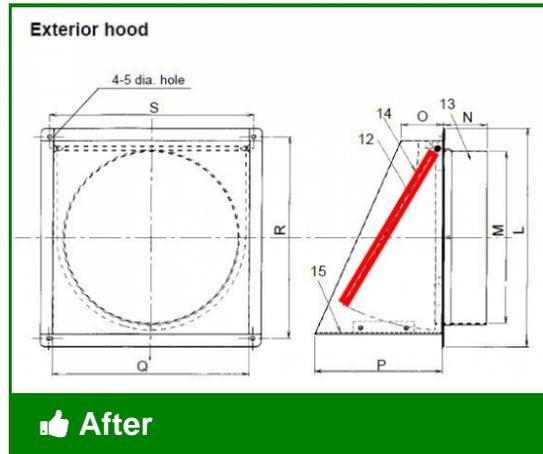
Ensure safe operation of combustion appliances

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

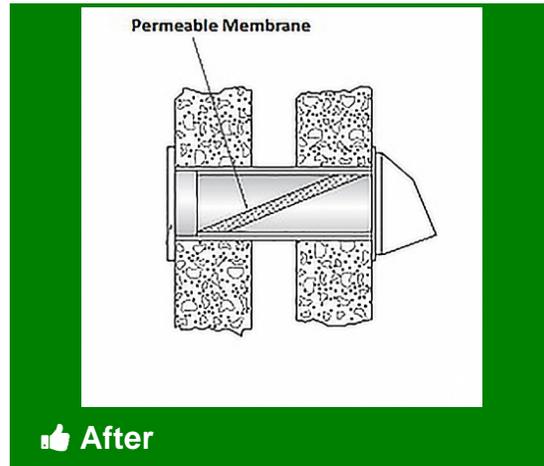
### Objective(s):

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

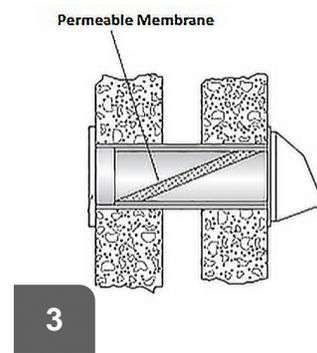
## 6.6005.2f - Combustion safety



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

## 6.6201.2a

### 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



If reading is >+/-3pa, interior ventilation needs to be installed



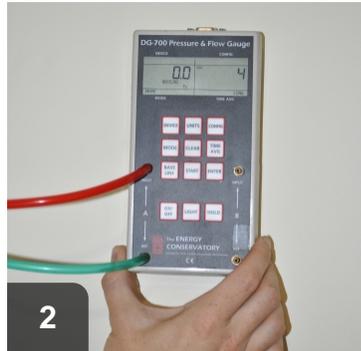
Passive door vents and individual room returns are two possibilities

## 6.6201.2a - Balancing pressure



1

With interior doors open, put reference hose to exterior



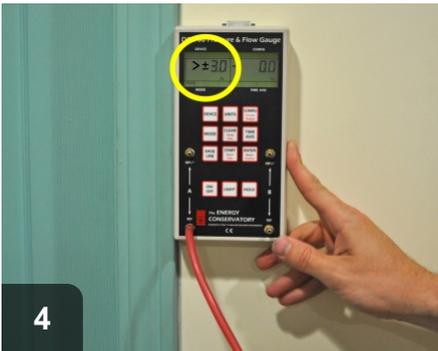
2

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

## 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

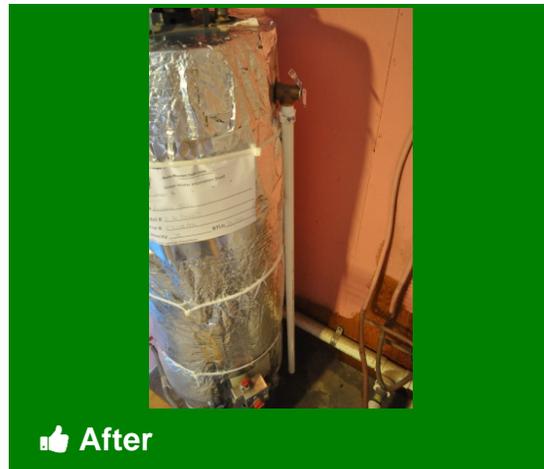
### Objective(s):

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

## 7.8102.2k

### 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



Test temperature of hot water at faucets in house



Hot water temperatures should not exceed 120 degrees Fahrenheit



Adjust water heater settings and insulate as needed



After adjustment and insulation, retest to verify temp is under 120 degrees

## 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.

## 7.8103.1c

### 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

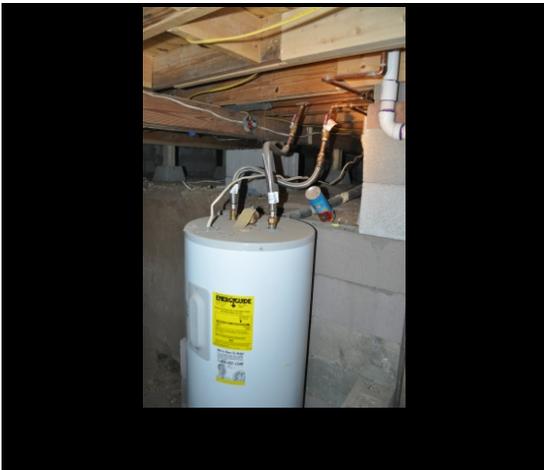
Added insulation will not obstruct the unit's draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates

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

Water heaters are not to be wrapped if appropriate insulation is already present or if manufacturer specifications prohibit wrapping.



## 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

## 7.8103.1e

### Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

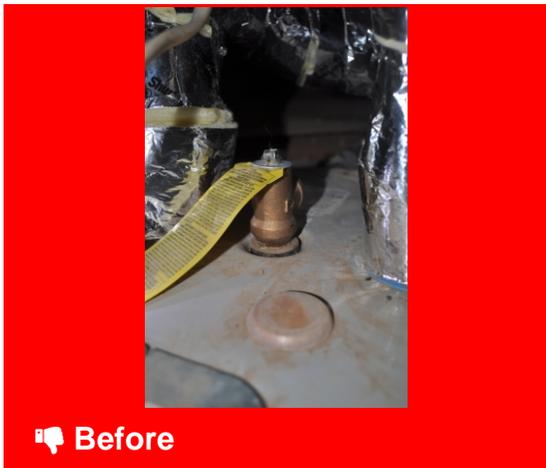
### Specification(s):

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

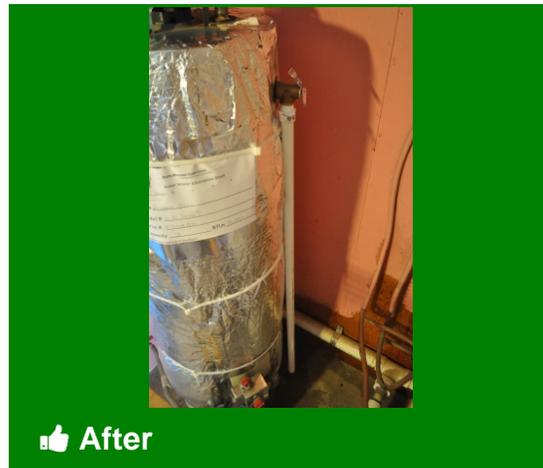
### Objective(s):

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.

## 7.8103.1e - 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