Retrofitting Oklahoma - 2018 SF

Standard Work Specifications

Field Guide for

Single-Family Homes

created by

Oklahoma Department of Commerce
2 Health and Safety

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2.0100 Safe Work Practices

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2.0100.1 - Global Worker Safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

2.0100.1a - Prevention through design

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

Objective(s):
Prevent worker injuries
Reduce risk exposure to toxic substances and physical hazards

2.0100.1b - Hand protection

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 hazards
2.0100.1c - Respiratory protection

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 MSDS for respiratory protection requirements

OSHA 1910.134 shall be followed for the implementation of a respiratory protection program
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

All crew members must be fit tested for a respirator. Medical surveillance (i.e. pulmonary function test and blood lead level) must also be completed for each crew member being fitted for a respirator.

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

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

All P-100s should be fitted to the individual worker
When working with high-pressure spray foam, use a Supplied Air Respirator.

When unsure what level of protection is necessary, check the Safety Data Sheets (SDS) for the materials to be used.

2.0100.1d - Electrical safety

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
Unsafe
Inspect house for unsafe electrical situations

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

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

Use fiberglass ladders in place of metal

Electrical wiring should not be located near a water source

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

Follow NFPA 70E 2012 guidelines for arc flash hazards

2.0100.1e - Carbon monoxide (CO)

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

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

**Best Practice**
Install carbon monoxide alarms

**Tools:**
1. CO meter

**2.0100.1f - Personal Protective Equipment**

**Desired Outcome:**
Work completed safely without injury or hazardous exposure

**Specification(s):**
MSDS and OSHA regulations will be consulted for equipment and protective clothing would be worn if contaminants are present (e.g., insulation materials)

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
Provide eye protection

2.0100.1g - Confined space safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Spaces with limited ingress and egress and restricted work area will be considered confined space

Access and egress points will be located before beginning work

Inspection will be conducted for hazards, such as damaged or exposed electrical conductors, mold, sewage effluent, friable asbestos or fiberglass, pests, and other potential hazards

Adequate ventilation will be provided

Use of toxic material will be reduced

Objective(s):
Prevent build-up of toxic or flammable contaminants
Reduce risk to the workers in the confined space
Provide adequate access and egress points
Prevent electrical shock
Locate all access and egress points of confined spaces before entering

Perform visual inspection of confined spaces before beginning work

Check for frayed or worn electrical wires

In confined spaces, use a ventilator

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

2.0100.1h - Power tool safety

**Desired Outcome:**
Work completed safely without injury or hazardous exposure
**Specification(s):**
Power tools will be inspected and used in accordance with manufacturer specifications and OSHA regulations to eliminate hazards such as those associated with missing ground prongs, ungrounded circuits, misuse of power tools, noise, and improper or defective cords or extension cords. All tools must be maintained in proper operating condition with all guards securely in place.

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

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

**Objective(s):**
- Prevent power tool injuries
- Prevent buildup of toxic or flammable contaminants

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**2.0100.1i - Chemical safety**

**Desired Outcome:**
Work completed safely without injury or hazardous exposure

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

Appropriate personal protective equipment (PPE) will be provided.

Workers will be trained on how to use PPE.

Workers will be expected to always use appropriate PPE during work.

**Objective(s):**
- Prevent worker exposure to toxic substances
2.0100.1j - Ergonomic safety

**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

Tools:
1. Hard hats
2. Knee pads
3. Bump caps

2.0100.1k - Hand tool safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Hand tools will be maintained in safe working order and used for intended purpose

Objective(s):
Prevent injuries

2.0100.1l - Slips, trips, and falls

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Caution will be used around power cords, hoses, tarps, and plastic sheeting

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

When scaffolding is used, manufacturer set-up procedures will be followed

Appropriate footwear and clothing will be worn

Objective(s):
Prevent injuries due to slips, trips, and falls

2.0100.1m - Thermal stress

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Ensure staff is aware of risks during extreme weather including the symptoms of heat stroke, heat exhaustion, and hypothermia

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

Tools:
1. Cool vests
2. Ventilator

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

DO NOT HESITATE to call 911 in potential cases of heat stroke or hypothermia
Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply)
Use of flammable material will be reduced and fire-rated materials will be used

Objective(s):
Prevent a fire hazard

Unsafe
Fire hazards should be removed from the work area with the permission and/or assistance of the homeowner

Best Practice
Set combustion appliances to off or pilot to minimize risk of fire
2.0100.1o - Asbestos-containing materials (ACM)

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

If suspected ACM is in good condition, do not disturb

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

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

When working around ACM, do not:

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

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

Objective(s):
Protect workers and occupants from potential asbestos hazards
Before

If materials that may contain asbestos are found in the home, do not disturb the material or run blower door.

Best Practice

If asbestos is suspected, call an EPA-accredited professional.

Materials:

1. Containment shroud
2. Caution tape

Do not disturb ACM by vacuuming, dusting, or sweeping.

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

2.0100.1p - Lead paint assessment

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):

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

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

Objective(s):
Protect workers and occupants from potential lead hazards

Tools:
1. EPA-recognized test kits with manufacturer's instructions
2. Kit-specific supplies as required in the manufacturer's instructions
3. Manufacturer-provided test verification card with lead-based paint layer
4. Digital camera (optional)
5. Painted wood surface with no lead-based paint layer
6. Test Kit Documentation Form
7. Participant Progress Log
8. Pen or Pencil
9. EPA Vacuum with attachments (for cleanup after sampling)

Materials:
1. Disposable plastic drop cloth 2’ x 2’
2. Tape (duct, painters, and masking)
3. Non-latex disposable gloves
4. Disposable shoe covers
5. Disposable wet cleaning wipes
6. Heavy duty garbage bags
7. Numbered index cards (optional)

EPA RRP certification required to conduct Lead Paint assessment.

Step 1: Read the manufacturer's instructions

Step 2: Write required information and observations about the test location on the Test Kit Documentation Form (Form 42).

Step 3: (Optional) Secure a small disposable plastic drop cloth (2 ft x 2 ft) on the floor beneath the test location with masking tape.

Step 4: Put on disposable non-latex gloves and shoe covers.
Step 5: Follow the manufacturer’s instructions for use of the test kit to conduct the test. Perform one test on the test card provided by the manufacturer, to observe a positive test result; conduct one test of a painted wood surface with no lead-based paint layer, to observe a negative test result.

Step 6: Use one wet cleaning wipe to remove residual chemicals left on the surface tested. Use a second cleaning wipe to remove any visible debris or dust on the floor beneath the sample collection area and place the used cleaning wipe in the trash bag.

Step 7: Check documentation for completeness and note the result of the testing on the Test Kit Documentation Form (Form 42).

Step 8: (Optional) Number the test location in sequence on the Test Kit Documentation Form (Form 42) then select the corresponding numbered index card and tape it next to the test location with masking tape and take a picture of the numbered test location to photo-document conduct and possibly the result of the test.

Set up interior containment

Properly post signage

Put down plastic sheeting 10’ in all directions

Barrier tape should be placed at 20’ from the house

Cover all plants

Wear proper respiratory protection -- the P100 filtered respirator
Wear additional PPE -- Tyvek coveralls with hoodie, booties, and nitrile gloves

2.0100.1q - Site security

**Desired Outcome:**
Work completed safely without injury or hazardous exposure

**Specification(s):**
Work site will be secured to prevent unauthorized entry

Temporarily disconnected equipment will be locked up and tagged out

All loose or unbagged trash and unused materials will be removed from work site daily

**Objective(s):**
Protect the occupant from exposure to potential hazards

2.0100.1r - Crawl space safety

**Desired Outcome:**
Work completed safely without injury or hazardous exposure

**Specification(s):**
The source of all contaminants (e.g., sewage, dead animals, needles) will be corrected, repaired, or removed before performing inspections that require complete access to the crawl space

If appropriate, the contaminant will be neutralized and/or a protective barrier will be installed in the area

**Objective(s):**
Ensure work safety
Prevent worker exposure to hazards

2.0102.1 - Insulation Worker Safety

Desired Outcome:
Work is completed safely without injury or hazardous exposure

2.0102.1a - Worker safety

Desired Outcome:
Work is completed safely without injury or hazardous exposure

Specification(s):
Worker safety specifications will be followed in accordance with SWS 2.0100 Global Worker Safety

Objective(s):
Prevent injury

Minimize exposure to health and safety hazards

2.0102.1b - Asbestos containing materials (ACM)

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

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

If suspected ACM is in good condition, do not disturb

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

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

When working around ACM, do not:

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

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

**Objective(s):**

Protect workers and occupants from potential asbestos hazards.

---

**Materials:**

1. Containment shroud
2. Caution tape
Do not disturb ACM by drilling, sanding, scraping, sawing, etc.

Do not disturb ACM by vacuuming, dusting, or sweeping

### 2.0102.1c - Materials

**Desired Outcome:**
Work is completed safely without injury or hazardous exposure

**Specification(s):**
All materials will be handled in accordance with manufacturer specifications or material safety data sheets (MSDS) standards

**Objective(s):**
Eliminate hazards associated with incorrect, defective, or improperly used or installed materials

**Best Practice**
Workers should be familiar with Safety Data Sheets for materials used and know where to locate SDS in case of emergency

**New Safety Data Sheet and GHS label formatting is easier to quickly interpret**
2.0102.1d - Lead paint assessment

**Desired Outcome:**
Work is completed safely without injury or hazardous exposure

**Specification(s):**
Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise

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

**Objective(s):**
Protect worker and occupant from potential lead hazards

---

**Best Practice**
Lead Check -- EPA-approved Lead Paint test kit

**Best Practice**
D-Lead -- EPA-approved Lead Paint test kit
Tools:
1. EPA-recognized test kits with manufacturer's instructions
2. Kit-specific supplies as required in the manufacturer's instructions
3. Manufacturer-provided test verification card with lead-based paint layer
4. Digital camera (optional)
5. Painted wood surface with no lead-based paint layer
6. Test Kit Documentation Form
7. Participant Progress Log
8. Pen or Pencil
9. EPA Vacuum with attachments (for cleanup after sampling)

Materials:
1. Disposable plastic drop cloth 2' x 2'
2. Tape (duct, painters, and masking)
3. Non-latex disposable gloves
4. Disposable shoe covers
5. Disposable wet cleaning wipes
6. Heavy duty garbage bags
7. Numbered index cards (optional)

EPA RRP certification required to conduct Lead Paint assessment.

Step 1: Read the manufacturer's instructions

Step 2: Write required information and observations about the test location on the Test Kit Documentation Form (Form 42).

Step 3: (Optional) Secure a small disposable plastic drop cloth (2 ft x 2 ft) on the floor beneath the test location with masking tape.

Step 4: Put on disposable non-latex gloves and shoe covers.

Step 5: Follow the manufacturer's instructions for use of the test kit to conduct the test. Perform one test on the test card provided by the manufacturer, to observe a positive test result; conduct one test of a painted wood surface with no lead-based paint layer, to observe a negative test result.

Step 6: Use one wet cleaning wipe to remove residual chemicals left on the surface tested. Use a second cleaning wipe to remove any visible debris or dust on the floor beneath the sample collection area and place the used cleaning wipe in the trash bag.

Step 7: Check documentation for completeness and note the result of the testing on the Test Kit Documentation Form (Form 42).

Step 8: (Optional) Number the test location in sequence on the Test Kit Documentation Form (Form 42) then select the corresponding numbered index card and tape it next to the test location with masking tape and take a picture of the numbered test location to photo-document conduct and possibly the result of the test.
Set up interior containment

Properly post signage

Put down plastic sheeting 10' in all directions

Barrier tape should be placed at 20' from the house

Cover all plants

Wear proper respiratory protection -- the P100 filtered respirator

Wear additional PPE -- Tyvek coveralls with hoodie, booties, and nitrile gloves

2.0103.1 - Combustion Worker Safety

Desired Outcome:
Work completed safely without injury or hazardous exposure
2.0103.1b - Carbon monoxide (CO)

**Desired Outcome:**
Work completed safely without injury or hazardous exposure

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

**Objective(s):**
Protect worker and occupant health

STOP WORK if CO levels measure above 35ppm!!

Install carbon monoxide alarm if none are found.

**Tools:**
1. CO meter

2.0103.1c - Raw fuel

**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
Fuel leaks need to be repaired by appropriate professional

Notify occupant of any leaks

**Tools:**

1. Gas sniffer
2. Bubble solution

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
2.0103.2 - Heating and Cooling Worker Safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

2.0103.2a - Worker safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Follow all worker safety specifications in SWS 2.0100 Global Worker Safety section

Objective(s):
Prevent injury
Minimize exposure to health and safety hazards

2.0103.2b - Mercury

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 worker and occupant from mercury exposure
Unsafe

Mercury thermostats should be replaced and disposed of properly

Bad Practice

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 or earth911.org for recycling options.

2.0103.2c - Asbestos

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Suspected asbestos hazards will be identified in furnaces (e.g., gaskets), wood stoves, zonal heating devices, electrical wiring insulation, boilers, and pipe insulation and corrected in accordance with EPA guidance

Workers will take precautionary measures to avoid exposure

Objective(s):
Protect worker and occupant from asbestos exposure
Suspicious pipe insulation may contain asbestos

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

If exposure to ACM cannot be avoided, workers must wear P-100 masks and proper PPE to avoid ingestion or contamination.

2.0103.2d - Personal protective equipment (PPE)

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Workers will wear personal protective equipment (PPE) as needed to protect themselves against exposure to hazards (e.g., pests, sewage, flooded duct work, mold, chemicals, scat, viruses)

Long sleeves and long pants should be worn as additional protection from liquid nitrogen and other hazardous materials

Objective(s):
Protect worker from exposure to hazards
Protect worker from skin contact with liquid nitrogen

2.0103.2e - Combustible gas detection

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Worker will check for presence of combustible gas leaks before work begins
Leaks will be repaired before work is performed

Objective(s):
Protect worker and occupant from exposure to hazards

Unsafe
Fuel leaks need to be repaired

Safe
Repairs need to be tested and verified that they no longer leak

Tools:
1. Combustible 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 piping system will be repaired or replaced and retested.
Fuel leaks discovered during initial audit should be flagged for repair.

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

Repeatedly test repair site for leakage over a 10 minute period.

Then allow testing solution to sit on newly repaired pipe joint for 10 minutes.

Confirm repair and remove flag.

### 2.0103.2f - Carbon monoxide (CO)

**Desired Outcome:**
Work completed safely without injury or hazardous exposure

**Specification(s):**
Workers will check for presence of ambient CO before and during work

CO issues will be addressed before work is performed or continued

**Objective(s):**
Protect worker and occupant from exposure to hazards
Best Practice

Workers will monitor CO levels throughout work day, wearing a personal CO detector at all times.

Personal CO detectors should be calibrated outside in fresh, open air before entering a home.

If at any point CO levels exceed 35ppm, work must stop immediately and the home must be evacuated.

Best Practice

All CO issues found during initial audit should be mitigated before work begins.

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Pipes will be sealed by a certified professional with an approved fastening process and sealant in accordance with manufacturer specifications (International Fuel Gas Code)

Gas lines will be leak free when tested with an electronic combustible gas leak detector and verified with bubble solution

OR

Gas lines will be leak free when tested by a standing pressure test that meets the approval of the
local code

**Objective(s):**
Install gas lines with no leaks

![Best Practice]
Call a licensed professional for gas line installations and repairs.

![Best Practice]
Test any new gas line connections with combustible gas detector, and verify lack of leaks with testing solution.

**Tools:**
1. Combustible gas detector
2. Testing solution

### 2.0103.2h - Safety devices

**Desired Outcome:**
Work completed safely without injury or hazardous exposure

**Specification(s):**
A secondary LP safety detector system (valve, exhaust fan, alarm light) will be installed by a certified professional for propane piping installed below grade

When installing new equipment, a shut off valves will be installed by a certified professional at each gas appliance (ANSI Z21.15)

**Objective(s):**
Detect accumulation of dangerous levels of propane in below-grade areas

Isolate appliances from the rest of the system for emergencies, removal, or repairs
2.0107.2 - Basements and Crawl Spaces—Pre-Work Qualifications

Desired Outcome:
Site properly prepared for upgrade

2.0107.2a - Fuel leaks

Desired Outcome:
Site properly prepared for upgrade

Specification(s):
Fuel leaks will be repaired and inspected in accordance with the 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 piping system will be repaired or replaced and retested.

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
2.0107.3 - Basements and Crawl Spaces—Debris Removal

Desired Outcome:
Clean, safe, and easily accessible crawl space created

2.0107.3a - Debris removal

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

After
Rake up and clear away trash and overgrowth.

Tools:
1. Rake
2. Shop vacuum
3. PPE

2.0201.1 - Combustion Appliance Zone (CAZ) Testing

Desired Outcome:
Accurate information about appliance safe operation is gathered

2.0201.1a - Assessment

Desired Outcome:
Accurate information about appliance safe operation is gathered

Specification(s):
Emergency problems (e.g., ambient gas levels greater than 10% Lower Explosion Limit (LEL), ambient CO levels that exceed 70 ppm) will be communicated clearly and immediately to the customer, the home shall be evacuated, and appropriate personnel (e.g.: HVAC technician, utility, emergency services) shall be contacted.

Significant problems (e.g., gas leak less than 10% LEL, ambient CO levels that exceed 35 ppm but less than 70 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested

Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance
Objective(s):
Ensure system does not have potentially fatal problems

Unsafe combustion appliances indicate need for repair or replacement

Unsafe

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

Oklahoma does not allow test drilling through double walled pipe (B-vent) or PVC.

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

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

Keep occupant apprised of any health or safety concerns
In cases of replacement, ensure new appliance is safe and sized properly.

2.0201.1b - Fuel leak detection

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

Tools:
1. Gas sniffer
2. Spray bottle

Materials:
1. Bubble solution
2.0201.1c - Venting

**Desired Outcome:**
Accurate information about appliance safe operation is gathered

**Specification(s):**
For oil systems that require a draft regulator, the presence and operability of it (that draft regulator) will be verified and tested

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

**Objective(s):**
Determine if a regulator is present and working

Determine whether vent system is in good condition and installed properly
Unsafe
If venting system puts occupants at risk, it needs immediate attention

Safe
Properly vented appliances make a house healthier and more efficient

Determine if a draft regulator is installed and working
Inspect venting systems for damage
Inspect venting systems for disconnected pipes
Inspect venting systems for inadequate slope
Inspect for missing draft diverter

2.0201.1d - Base pressure test

Desired Outcome:
Accurate information about appliance safe operation is gathered

**Specification(s):**
Baseline pressure for naturally drafting vented appliances 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

**Best Practice**
Natural conditions—Winter set-up, Exhaust fans off, Interior doors open

**Tools:**
1. Manometer

**2.0201.1e - Depressurization test**

**Desired Outcome:**
Accurate information about appliance safe operation is gathered

**Specification(s):**
CAZ depressurization testing will be administered for all atmospherically vented appliances located inside the pressure boundary.

Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof; the test will be done to determine the largest negative pressure per BPI Standard 1200.

**Objective(s):**
Determine worst-case depressurization in combustion zone due mechanical system fans
Best Practice

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

Tools:

1. Manometer

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

Check reading against the Depressurization Limits table. If reading is less negative than allowable limit, all is well.

2.0201.2 - Combustion Safety - Make-up Air

Desired Outcome:
Buildup of dangerous combustion byproducts in the living space prevented

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

2.0201.2a - Outside combustion make-up air

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 IRC for the type of appliance installed

Objective(s):
Prevent combustion byproducts from entering the house

Please see "Combustion Air Calculation Sheet" in Appendix.

2.0201.2b - New appliances

Desired Outcome:
Buildup of dangerous combustion byproducts in the living space prevented

**Specification(s):**
If replacing appliances, a sealed-combustion, direct-vent appliance will be installed if possible. New appliances will be installed in accordance with manufacturer specifications, the IRC and additional applicable codes

**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

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Two-pipe 90% efficiency furnaces are viable replacement appliances

Direct vent combustion appliances are also viable replacements

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**2.0201.2c - CO detection and warning equipment**

**Desired Outcome:**
Buildup of dangerous combustion byproducts in the living space prevented

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

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

**Objective(s):**
Alert occupant to CO exposure

---

**Best Practice**
Carbon Monoxide alarms should be installed according to local codes

**Best Practice**
Alarms should be mounted within 15ft of the bedrooms--such as the one marked in red

**Tools:**
1. Drill

**Materials:**
1. CO alarm
   2. Fasteners

In Oklahoma, alarms should be mounted within 15 feet of the bedrooms.

---

**2.0201.2d - Gas ovens**

**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 225 ppm as measured

**Objective(s):**
Ensure clean burn of gas ovens
Unsafe

If air-free CO reading exceeds 225ppm, order a clean and tune

Best Practice

Test gas oven for carbon monoxide using a combustion gas analyzer

Tools:

1. Combustion analyzer with probe

2.0201.2e - Gas range burners

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, an irregular pattern, or if burners are visibly dirty, corroded, or bent

Objective(s):
Ensure clean burn and operation of gas range burners

Before

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

After

A properly operating gas range burner should have an even blue flame
Gas ranges should be cleaned and tuned if improper operation is evident

2.0201.2f - Solid fuel burning appliances

**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

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.
2.0201.3 - Vented Combustion Appliance Safety Testing

**Desired Outcome:**
Accurate information about appliance safe operation is gathered

2.0201.3a - Spillage Test

**Desired Outcome:**
Accurate information about appliance safe operation is gathered

**Specification(s):**
In conditions with largest negative pressure as determined from Detail 2.0201.1e:

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

If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate

**Objective(s):**
Detect excessive spillage of combustion gases
Unsafe
Test natural draft furnace or water heater for spillage in excess of 2 min.

**Tools:**
1. Smoke pencil
2. Timer

Spillage test should be performed under worst case depressurization.

**2.0201.3b - Carbon monoxide (CO) test in appliance vent**

**Desired Outcome:**
Accurate information about appliance safe operation is gathered.

**Specification(s):**
CO will be tested for in undiluted flue gases of combustion appliances.

In conditions with largest negative pressure as determined from Detail 2.0201.1e:

If CO levels exceed 400 ppm air-free measurement in furnaces, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications).

If CO levels exceed 200 ppm air-free measurement in water heaters or room heaters, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications).

**Objective(s):**
Measure CO and report excessive levels.
**Best Practice**
Test CO levels in undiluted flue gases and exhaust outlets, when accessible

**Best Practice**
Refer to ANSI/BPI 1200-S-2017 Standard Practice for Basic Analysis of Buildings action levels table in Appendix

**Tools:**

1. Combustion analyzer with probe

Test undiluted flue gases in induced-draft furnaces--check local codes before drilling

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
2.0201.3c - Final test out

**Desired Outcome:**
Accurate information about appliance safe operation is gathered

**Specification(s):**
Final combustion testing will be conducted at project completion to ensure compliance with the above specifications

**Objective(s):**
Ensure safe operation of combustion appliance within the whole house system after any repair project

**Tools:**
1. Manometer
2. Smoke pencil
3. Timer
4. Combustion analyzer with probe

**Unsafe**
Conduct spillage and depressurization testing at the end of the work day
Run depressurization test at the end of the work day
Complete spillage test using chemical smoke pencil
Test for spillage on all sides of draft diverter

Complete spillage testing on all combustion appliances
Complete carbon monoxide testing using a CO detector or combustion analyzer

**2.0202.1 - Unvented Space Heaters: Propane, Natural Gas, and Kerosene Heaters**

**Desired Outcome:**
Elimination of combustion byproducts

**2.0202.1a - Removal**

**Desired Outcome:**
Elimination of combustion byproducts

**Specification(s):**
With the occupant's permission, unvented heaters will be removed, except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2
Units that are not being operated in compliance with ANSI Z21.11.2 should be removed before the retrofit but may remain until a replacement heating system is in place.

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

**Objective(s):**
Eliminate sources of combustion byproduct within a living space.

---

### 2.0202.1a - Removal

**Desired Outcome:**
Elimination of combustion byproducts

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

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

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

**Objective(s):**
Eliminate sources of combustion byproduct within a living space.

---

### 2.0202.1b - Occupant education

**Desired Outcome:**
Elimination of combustion byproducts

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

**Objective(s):**
Inform occupant about possible hazards associated with combustion byproducts and moisture.
2.0202.1b - Occupant education

Desired Outcome:
Elimination of combustion byproducts

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

Objective(s):
Inform occupant about possible hazards associated with combustion byproducts and moisture

2.0203.2 - Combustion Flue Gas—Orphaned Water Heaters

Desired Outcome:
Flue gasses successfully removed from the house

2.0203.2a - Spillage testing

Desired Outcome:
Flue gasses successfully removed from the house

Specification(s):
If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate

If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate

Objective(s):
Detect excessive spillage of combustion gases
Unsafe Orphaned water heaters have oversized flues after a furnace is removed.

Tools:
1. Smoke pencil

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

Desired Outcome:
Flue gasses successfully removed from the house

Specification(s):
A chimney liner will be installed in accordance with the IRC or applicable NFPA standard

Objective(s):
Allow water heater to vent properly
Prevent damage to the chimney
Tools:
1. hammer drill
2. disposable brushes
3. tin snips
4. 5/16" nut driver
5. pulling cone
6. rope
7. caulking gun
8. tape measure
9. 4 1/2" angle grinder with metal cutoff wheel

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

Connect chimney liner to appliance in accordance with applicable codes.

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

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

Measure and mark the flexible chimney liner at 4 inches above the chimney
Cut the flexible chimney liner to length Install top plate over opening and attach it to the liner Fasten the rain cap to the chimney liner

Seal around penetrations in chimney with refractory (furnace) cement Connect appliance vent to the chimney liner Use refractory (furnace) cement to seal metal water heater or furnace vents to the masonry chimney

2.0203.2c - Retesting spillage

**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 with a warm vent
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

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

2.0403.1 - Vented Crawl Spaces—Ground Moisture Barrier

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

2.0403.1b - Coverage

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

Specification(s):
A ground moisture barrier that covers the exposed crawl space floor will be installed

**Objective(s):**
Reduce ground moisture entering the crawl space

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

**2.0403.1c - Material specification**

**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 6 mil and able to withstand puncture

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

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of ≤0.1 (which translates to 6mil or thicker). From 2007 IRC definition of vapor retarders: Class I: ≤ 0.1 perm (called impermeable), Class II: 0.1 to 1.0 perm (called semi-impermeable), Class III: 1.0 perm to 10 perms (called semi-permeable).

2.0403.1d - Overlap seams

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

Specification(s):
When seams exist, they will be overlapped a minimum of 12" using reverse or upslope lapping technique

Objective(s):
Keep water under the liner

Reduce the likelihood of damage at seams
Ground moisture barriers help keep moisture from permeating floor.

**Before**

**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 6 mil)
3. Furring strips
4. Seam tape - moisture resistant

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 - Fastening**

**Desired Outcome:**
Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

**Specification(s):**
When ground moisture barrier is installed on sloping ground, may be exposed to wind, or accessed for routine maintenance or storage it will be fastened to ground with durable fasteners or ballast(s)

**Objective(s):**
Prevent movement of the ground moisture barrier
Before Fastening of moisture barrier is required

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

**Tools:**
1. Stapler
2. Drill

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

Seams can be taped to prevent water leakage

Ballast or fasteners can hold barrier in place securely

### 2.0403.2 - Closed Crawl Spaces—Ground Moisture Barriers

**Desired Outcome:**
Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

### 2.0403.2b - Coverage

**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 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

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

2.0403.2c - Material specification

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, 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.

![Plastic Sheet Image]

**Best Practice**
Barrier must be at least 6 mil and able to withstand puncture.

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

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

**2.0403.2d - Overlap seams**

**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

Tools:
1. Stapler
2. Utility knife
3. Drill

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

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 - Fastening**

**Desired Outcome:**
Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

**Specification(s):**
When ground moisture barrier is installed on sloping ground, or accessed for routine maintenance or storage it will be fastened to ground with durable fasteners or ballast(s)

**Objective(s):**
Prevent movement and uplift of the air barrier and ground moisture barrier

Before

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

After

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

**Tools:**
1. Drill
2. Stapler

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

**2.0403.2f - Sealing seams**

**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

Tape wall seams and press to ensure airtight bonding of adhesive
Tape (overlapped) floor seams to prevent movement and water leakage

2.0601.1 - Knob and Tube Wiring

Desired Outcome:
Live unsafe wiring identified and brought to local codes

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.
2.0601.1a - Knob and tube identification

**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

---

2.0601.1b - Live wire testing

**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

Voltage drop and voltage detection testing are allowed.

2.0601.1c - Isolation and protection

Desired Outcome:
Live unsafe wiring identified and brought to local codes

Specification(s):
Proper clearance will be maintained around live knob and tube as required by the National Electrical Code (NEC) or authority having jurisdiction

When required, 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
Live knob & tube wiring may get hot and should not be insulated over.

**Before**

**After**

Dams should be installed to hold back loose fill insulation.

**Tools:**

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

**Materials:**

1. Plywood
2. Drywall
3. Fasteners

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

- Have a certified electrician verify that wiring is safe to work around.
- A sign should be posted at all entrances to warn of knob & tube wiring.
- Warning sign should remind to contact certified electrician for repairs.

**CAUTION!**

Live Knob & Tube wiring present!

If repairs are needed, please contact a certified electrician.
2.0601.1d - Replacement

**Desired Outcome:**
Live unsafe wiring identified and brought to local codes

**Specification(s):**
Wiring will be replaced with new appropriate wiring in accordance with the NEC National Electrical Code and local codes

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

**Objective(s):**
Ensure occupant safety

Preserve the integrity and safety of the house
Before

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

After

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

Tools:

1. Non-contact wire tester

Materials:

1. Romex as needed

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

In Oklahoma, repairs are allowed as an incidental repair, provided the repair meets the definition and requirements of an incidental repair.

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

2.0701.2 - Crawl Space Information Sign

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

**Note:**

2.0701.2a - Sign specifications

**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 - Sign content**

**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

Tools:
1. Printer
2. Staple gun

Materials:
1. Paper
2. Laminant
3. Staples

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

Hacer la señal en español también

2.0701.2c - Hazard warning

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

**Best Practice**

Mount sign where anyone entering the crawl space can see it

**Tools:**
1. Staple gun
2. Printer

**Materials:**
1. Paper
2. Laminant
3. Staples

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

Alert those entering the crawl space never to store hazardous materials

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

Hacer la señal en español también

### 3.1001.1 - Penetrations and Chases

**Desired Outcome:**
Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space
3.1001.1d - High temperature application

**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
3.1001.2 - Chase Capping

**Desired Outcome:**
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

3.1001.2a - Pre-inspection

**Desired Outcome:**
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

**Specification(s):**
An inspection will be conducted for mold, water leaks, and water damage before sealing a chase

Repairs will be completed before work begins
Objective(s):
Repair moisture-related issues

Before
Investigate under insulation in chases to verify they are undamaged

Before
Water damage in chase due to hole to the outside

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

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

Locate and expose chases to prepare for inspection and capping/sealing
Clear away insulation and debris to allow inspection
Carefully investigate areas with high potential for water leaks
3.1001.2b - Standard chase (interior walls covered with drywall or plaster)

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

Tools:
1. Drill/screwdriver
2. Caulk gun

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

Unsealed standard chases covered with drywall can be leakage points

The air barrier is be maintained by capping chases with rigid material
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 - Non-standard chase (interior walls covered with wood or paneling)

**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 IRC

**Objective(s):**
Prevent a fire hazard
Before
Paneled drop soffits typically are more combustible than plain drywall

After
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.

Sealing with drywall reduces overall combustibility of paneled chases
Sealing with XPS also reduces overall combustibility of paneled chases

3.1001.2d - Support

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

**Tools:**
1. Drill
2. Saw
3. Tape measure

**Materials:**
1. Lumber
2. Drywall
3. Fasteners

---

Support should prevent cap from sagging or moving

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 - Joint seal

**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

**Tools:**
1. Spray foam gun
2. Caulk gun

**Materials:**
1. Spray foam
2. Caulk

Before
Before Chases need to be capped and sealed to prevent leakage

After
Chase is sealed along all cracks, gaps, and penetrations
Always wear protective gloves when working with sealants.

3.1001.2f - Adjacent framing

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

Before
Chases need to be capped and sealed to prevent leakage

After
Chase is sealed along all cracks, gaps, and penetrations

Tools:
1. Spray foam gun
2. Caulk gun

Materials:
1. Spray foam
2. Caulk

Always wear gloves when working with sealant.
3.1001.3 - Walls Open to Attic—Balloon Framing and Double Walls

**Desired Outcome:**
Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

3.1001.3b - Sealing methods

**Desired Outcome:**
Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**
Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

**OR**

Wall below openings will be dense packed

**OR**

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

Sealants will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference
Objective(s):
Prevent air leakage from wall cavity to attic

Before
Wall cavities are open to attic

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

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

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

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
3.1001.3c - Support

**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

Before
Spans greater than 24 inches require additional bracing before capping

After
Support should prevent cap from sagging or moving
**Tools:**
1. Saw
2. Drill
3. Tape measure

**Materials:**
1. Lumber
2. Drywall
3. Fasteners

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 - Joint seal

**Desired Outcome:**
Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space.

**Specification(s):**
Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections.

**Objective(s):**
Provide airtight, durable seal that does not move, bend, or sag.
Before Balloon framing needs to be capped and sealed to prevent leakage

Tools:
1. Spray foam gun
2. Caulk gun

Materials:
1. Spray foam
2. Caulk

After All edges of the cap should be sealed to surrounding surfaces

For rigid material applications, extend sealant along all seams

Extend sealant or SPF along joist to seal all gaps

3.1001.3e - Adjacent framing

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

For rigid material applications, sealant should be applied to framing
When using SPF to bridge cavity, extend SPF along joist and adjacent framing

3.1003.1 - New Ceiling Below Original—Old Ceiling Intact or Repairable

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

Note:
3.1003.1b - Sealing methods

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

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 - Support

**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

---

**Tools:**
1. Saw
2. Drill
3. Tape measure

**Materials:**
1. Lumber
2. Drywall
3. Fasteners

---

Spans greater than 24 inches require additional bracing before capping

Support should prevent cap from sagging or moving
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 - Joint seal

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

Apply sealant to surrounding surfaces before setting cap in place

Sealant should extend along joists and into seams at top plates

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

3.1003.1e - Adjacent framing

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

**Tools:**
1. Caulk gun
2. Spray foam gun

**Materials:**
1. Spray foam
2. Caulk sealant

Caulk along all joists before setting cap

Use sealant to fill all remaining gaps

### 3.1003.2 - Ceiling Leaks Not Repairable—No Air Barrier Above

**Desired Outcome:**
Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Note:**

### 3.1003.2c - Support

**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

![Before and After Images]

**Tools:**
1. Drill
2. Saw
3. Tape measure

**Materials:**
1. Lumber
2. Drywall
3. Fasteners

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 - Joint seal

**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

---

**Tools:**
1. Caulk gun
2. Spray foam gun

**Materials:**
1. Spray foam
2. Caulk

---

Dropped soffits need to be capped and sealed to prevent leakage

No gaps should remain after sealant is applied
Apply sealant to surrounding surfaces before setting cap in place
Sealant should extend along surround joist and into seams at top plates
Once cap is set, apply sealant to remaining gaps and along all seams

3.1003.2e - Adjacent framing

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

Specification(s):
All remaining gaps will be sealed at the top of the dropped ceiling

OR

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

Objective(s):
Provide airtight framing from one finished side of the dropped ceiling to the other

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

After
No gaps should remain after sealant is applied along adjacent framing
Tools:
1. Caulk gun
2. Spray foam gun

Materials:
1. Spray foam
2. Caulk sealant

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

3.1003.3 - Above Closets and Tubs

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

Note:

3.1003.3b - Above closets and tubs

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

**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

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

Capped soffits minimize leakage to and from unconditioned spaces
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 - Support**

**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

![Before](image1.png) ![After](image2.png)

**Before**
Spans greater than 24 inches require additional bracing before capping

**After**
Support should prevent cap from sagging or moving

**Tools:**
1. Drill
2. Saw
3. Tape measure

**Materials:**
1. Lumber
2. Drywall
3. Fasteners

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
3.1003.3d - Joint seal

**Desired Outcome:**
Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space.

**Specification(s):**
Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections.

**Objective(s):**
Provide airtight, durable seal that does not move, bend, or sag.

**Before**
Uninsulated soffits can cause leakage to and from unconditioned spaces.

**After**
No gaps should remain after spray foam is applied.

**Tools:**
1. Caulk gun
2. Spray foam gun

**Materials:**
1. Caulk
2. Spray foam
3.1003.3e - Adjacent framing

**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

**Tools:**
1. Caulk gun
2. Spray foam gun

**Materials:**
1. Caulk sealant
2. Spray foam

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

Dropped soffits need to be capped and sealed to prevent leakage

No gaps should remain after sealant is applied along adjacent framing
3.1003.4 - Dropped Ceilings

**Desired Outcome:**
Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

3.1003.4c - Support

**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.

**Tools:**
1. Saw  
2. Drill  
3. Tape measure

**Materials:**
1. Lumber  
2. Drywall  
3. Fasteners

Support should prevent cap from sagging or moving.

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 to be sealed along framing

3.1003.4d - Joint seal

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

Tools:
1. Spray foam gun
2. Caulk gun

Materials:
1. Spray foam
2. Caulk sealant

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

After
No gaps should remain after spray foam is applied
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 - Adjacent framing

**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

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

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

3.1003.6 - Dropped Soffits

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

Note:

3.1003.6b - Soffit general

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

**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

Before

Standard soffits are often open to the attic and uninsulated

After

Rigid material encloses the soffit into the conditioned living space

Tools:
1. Drill/screwdriver
2. Caulk gun

Materials:
1. Drywall
2. Sealant

1. Soffits open to the attic need to be sealed to maintain air barrier
2. Apply sealant along top plates
3. Cap soffit with rigid material, such as drywall, cut to size
4. Fasten cap with screws to set sealant
5. Insulate over now-capped soffit
and create air barrier

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

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

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

3.1201.1 - Double-Hung Wood Windows

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

3.1201.1a - Lead paint assessment

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
See SWS 2.0100.1p
for Lead Paint
Assessment

3.1201.1d - Replacement sills

**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

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.
3.1201.3 - Exterior Doors

**Desired Outcome:**
Doors operable and weather tight

**Note:**

3.1201.3a - Lead paint assessment

**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

See SWS 2.0100.1p for Lead Paint Assessment

3.1201.3b - Door operation and fit

**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

**Tools:**
1. Screwdriver
2. Planer

**Materials:**
1. Shims

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

With proper adjustment, doors should hang true and minimize leakage

After examining how door hangs, remove door from hinges

Adjust hinge plates to bring door back into true

Adjust strike plate to allow for secure and smooth operation
3.1201.3c - Air infiltration

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

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 - Water infiltration

**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](image1)
Daylight visible under exterior doors indicate water can leak in

![After](image2)
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

Adjust threshold to minimize gap and keep water out

Caulk along threshold from inside and outside to prevent water infiltration
3.1202.1 - Fixed Frame with Wood Sash—Older House

Desired Outcome:
Glass complete and intact; improved energy efficiency performance of fenestration

3.1202.1a - Lead paint assessment

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

See SWS 2.0100.1p for Lead Paint Assessment

3.1202.1b - Broken glass removal

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

**Before**
Broken glass with failed repairs needs to be replaced

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

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

**Materials:**
1. Tape

Always wear heavy work gloves when clearing broken glass. See also 2.0100.1b for Hand Protection.

**Cut through caulk bead and glazing to ease removal**

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

**With gloves on, clear away broken glass and clean sash of debris**
After all debris has been removed, measure opening for replacement pane.

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

3.1202.1c - Sash preparation

 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


3.1202.1d - New glass installation

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
Air Sealing > Windows and Doors > Repairing/Replacing Cracked and Broken Glass

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

Wear heavy work gloves when clearing away broken glass or working with cut glass. See also 2.0100.1b for Hand Protection.
3.1202.2 - Single-Unit Window, Mounted on Rough Opening—Newer House

Desired Outcome:
Glass complete and intact; improved energy efficiency performance of fenestration

3.1202.2a - Lead paint assessment

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
3.1202.2b - Broken glass removal

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

See SWS 2.0100.1p for Lead Paint Assessment

3.1202.2b - Broken glass removal

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 vaccuum
5. Tape measure

**Materials:**

1. Tape

Wear heavy work gloves when clearing away broken glass. See also 2.0100.1b for Hand Protection.

**Cut through caulk or glazing to simplify removal**

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

**With gloves on, clear away broken glass and clean sash of debris**

**After all debris has been removed, measure opening for replacement pane**

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

---

**3.1202.2c - Opening preparation**

**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

**Tools:**
1. Chisel
2. Utility knife

**Materials:**
1. Cleaning solution
2. Rags

**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

<Before>
With sash prepared, new pane installation can begin

<After>
Replaced glass should be held in place while glazing sets

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

**Materials:**
1. Trim

Wear heavy work gloves when clearing broken glass or working with cut glass. See also 2.0100.1b for Hand Protection.
Wear heavy gloves to clear away broken glass as well as when working with cut glass

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

Cut replacement glass 1/8" smaller than measured opening

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

Apply window glazing to air seal new pane

### 3.1203.1 - Replacement Window in Existing Window Frame

**Desired Outcome:**
Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

### 3.1203.1a - Lead paint assessment

**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

**3.1203.1b - Opening preparation**

**Desired Outcome:**
Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

**Specification(s):**
Interior stops, sashes, parting strips, and pulleys will be removed

Opening will be cleaned

**Objective(s):**
Provide a clean opening for replacement window unit

See SWS 2.0100.1p for Lead Paint Assessment
Before Wooden window still in opening

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

In Progress Wood window with sashes removed before replacement

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

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

Scrape loose paint and thoroughly clean opening

3.1203.1c - Replacement window installation

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

Specification(s):
Replacement window will be installed in accordance with manufacturer specifications, ensuring that the exterior stops are caulked
Objective(s):
Ensure replacement window operates properly

Ensure replacement window has a weather tight fit

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

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

Prepare and clean opening before installing new window

Check opening for plumb, level, and square

Measure diagonally both ways across opening. If measurements are equal, the opening is square
Apply caulk to stop molding and install the new window in accordance with manufacturer's instructions.

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

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

Caulk new window to existing stop molding.

Reinstall and caulk interior stop molding.

Completed installation.

3.1203.2 - Single-Unit Window, Mounted on Rough Opening—Newer House

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

Note:

3.1203.2a - Lead paint assessment

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

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**See SWS 2.0100.1p for Lead Paint Assessment**

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### 3.1203.2b - Opening preparation

**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
Single pane window in newer home

Before

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

Air Sealing > Windows and Doors > Replacement

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
3.1203.2c - Replacement unit preparation

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" rough opening depth

Measure rough opening depth to determine best method of installation

Clean old sealant off exterior surface to allow for flange installation

Install unit following appropriate detail for rough opening and unit depth

3.1203.2d - Replacement window installation

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

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.

**3.1402.1 - Crawl Spaces—Sealing Floor Penetrations**

**Desired Outcome:**
Air leakage prevented and indoor air quality protected

**Note:**

**3.1402.1a - Backing and infill**

**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

**Tools:**
1. Headlamp

**Materials:**
1. Backer rod
2. Sealant

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 - Sealant selection

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
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 - High temperature application

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
Before

Gaps around floor penetrations allow air and moisture movement

After

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

Prepare work area by removing any insulation and debris

Use high-temperature caulking (600°F 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
3.1402.3 - Closed Crawl Spaces—Air Sealing Exterior Wall

Desired Outcome:
Well-sealed exterior wall prevents leakage and pests

3.1402.3a - Seal penetrations

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

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

Materials:
1. Caulk
2. Sprayfoam
3. Metal mesh
4. Fasteners
3.1402.3b - Pest exclusion

**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

**Tools:**
1. Caulk gun
2. Sprayfoam gun
3. Metal snips
4. Drill

**Materials:**
1. Caulk
2. Sprayfoam
3. Metal mesh
4. Rigid backing
3.1501.1 - Penetrations, Cracks, and Doors Between Garage and House

Desired Outcome:
Openings from garage sealed to prevent leakage

3.1501.1a - Penetrations

Desired Outcome:
Openings from garage sealed to prevent leakage

Specification(s):
All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed

Objective(s):
Prevent air leakage and pollutant entry
Penetrations between the garage and house can leak hazardous fumes.

Seal penetrations to minimize risks and air leakage.

**Materials:**
1. Backer Rod
2. Caulk
3. Spray foam

**3.1501.1b - Ductwork**

**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

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

Sealed ductwork connections help prevent leakage.
Materials:
1. Mesh tape
2. Mastic

Prepare work area by assessing any safety concerns. Wrap joint with fiberglass mesh tape. Apply UL 181 mastic to seal joint.

3.1501.1c - Cracks

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

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

Before

After

Air sealing reduces pollutant entry, but does not diminish fire resistance
3.1501.1d - Garage to house door

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

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

Daylight visible under door to garage indicates leakage

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

 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

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

After
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

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 - Carbon monoxide (CO) alarm

 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

Every home will have a digital CO alarm. CO alarms should be installed one per floor and near sleeping areas.
3.1501.1g - Occupant education

**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

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**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

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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

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3.1601.3 - Support

**Desired Outcome:**
Ducts and plenums properly supported

3.1601.3a - Support (applies to all duct types)

**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

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

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

After
Properly supported ducts minimize heat loss and and maximize duct run
3.1602.1 - Air Sealing Duct System

 Desired Outcome:
Ducts and plenums sealed to prevent leakage

3.1602.1c - Existing component to existing component

 Desired Outcome:
Ducts and plenums sealed to prevent leakage

Specification(s):
Seams, cracks, joints, holes, and penetrations less than ¼” will be sealed using UL 181 fiber-embedded mastic

Seams, cracks, joints, holes, and penetrations between ¼” and ¾” will be sealed in two stages:
* They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing* They will be sealed using fiberglass mesh and mastic

Seams, cracks, joints, holes, and penetrations larger than ¾" will be repaired using rigid duct material

Mastic will overlap repair joint or existing temporary tape by at least 1" on all sides

**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

---

**Materials:**

1. Mastic
2. Fiberglass mesh tape
Prepare work area by assessing any safety concerns

Wrap joint with fiberglass mesh tape

Apply UL 181 mastic to seal joint

3.1602.4 - Air Sealing System Components

Desired Outcome:
Ducts and plenums sealed to prevent leakage

3.1602.4a - Duct boot to interior surface

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 IRC

Objective(s):
Prevent air leakage

Prevent a fire hazard
Gaps around duct boots allow for leakage to and from the attic.

**Tools:**
1. Utility knife
2. Spray bottle
3. Putty knife

**Materials:**
1. Mastic
2. Mesh tape

1. Remove grill to expose duct boot and gaps
2. Wet the edges of the drywall to ensure a good bond
3. Cut mesh tape to fit around duct boot and cover gaps
4. Apply mastic over mesh tape to create heat resistant, durable bond
5. Once mastic is set, grill can be replaced and mastic should not show.
3.1602.4b - Wooden plenums and building cavities

**Desired Outcome:**
Ducts and plenums sealed to prevent leakage

**Specification(s):**
Accessible connections and joints will be made airtight using approved material

**Objective(s):**
Ensure ducts and plenums will not leak

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

**Materials:**
1. mastic
2. fiberglass duct board
3. UL 181 listed mastic tape
4. sheet metal
5. screws

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

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

From NFPA 90B 4.3.1.1: "Duct coverings, duct linings, and tapes used in duct systems shall have a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84 or ANSI/UL..."
Identify building cavities used as ducts

Seal penetrations around AC lineset and wiring

Cut and Install appropriate board material to create an airtight duct

Seal all seams and joints with duct mastic

3.1602.4c - Air handler cabinet

**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

**Materials:**

1. Foil tape

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

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**3.1602.4d - Filter slot**

**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
3.1602.5 - Return—Framed Platform

Desired Outcome:
The return duct installed to prevent air leakage

3.1602.5a - Preparation

Desired Outcome:
The return duct installed to prevent air leakage

Specification(s):
Debris and dirt will be cleaned out of the return platform

Objective(s):
Allow for the application of rigid materials and sealants
Dirty, unsealed return platform needs to be cleaned out before sealing

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

**Tools:**
1. Shop vacuum

**3.1602.5b - Infill and backing**

**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
Leakage from air return into wall cavities should be eliminated. Only materials rated for use in higher temperature areas should be used, such as drywall.

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

**Materials:**
1. Drywall
2. Fire-resistant caulk
3. Fasteners

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

### 3.1602.5c - Sealant selection

**Desired Outcome:**
The return duct installed to prevent air leakage

**Specification(s):**
Sealants will be continuous and be in accordance with IRC

**Objective(s):**
Select permanent sealant
Ensure sealant meets or exceeds the performance characteristics of the surrounding materials

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

Best Practice
Caulk sealants will be continuous

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

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

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

4.1001.1 - Non-Insulation Contact (IC) Recessed Light

Desired Outcome:
Ensure safety from fire and prevent air leakage

4.1001.1a - Air barrier system

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 IC-rated fixture or insert

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

Tools:
1. Utility knife
2. Tape measure

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

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 - Enclosure top

**Desired Outcome:**
Ensure safety from fire and prevent air leakage

**Specification(s):**
The top-fire rated enclosure material will have an R-value of 0.56 or less

The top of the enclosure will be left free of insulation

**Objective(s):**
Prevent heat build up

**Tools:**
1. Utility knife
2. Caulk gun

**Materials:**
1. Drywall

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

4.1001.1c - Clearance

**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 - Sealants and weather stripping

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.

**Before**

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

**After**

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

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

### 4.1001.2 - Knob and Tube Wiring

**Desired Outcome:**
Insulation kept away from contact with live wiring

**Note:**
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

### 4.1001.2a - Identifying knob and tube wiring

**Desired Outcome:**
Insulation kept away from contact with live wiring

**Specification(s):**
Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring

**Objective(s):**
Determine if knob and tube wiring exists
Unsafe
Identify knob and tube wiring in homes to insulate properly and safely

4.1001.2b - Testing to determine if live

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

Safe
Live wiring should be dammed or professionally disabled before insulating

Tools:
1. Non-contact wire tester

4.1001.2c - Isolate or replace

Desired Outcome:
Insulation kept away from contact with live wiring

Specification(s):
Proper clearance will be maintained around live knob and tube as required by the National Electrical Code (NEC) or authority having jurisdiction

When required, a dam that does not cover the top will be created to separate insulation from the wire path

Objective(s):
Ensure work can be completed safely

Protect occupant and house

Ensure future work can be done safely

Prevent the overheating of the wiring
Knob & tube wiring radiates heat and cannot be insulated over.

Before insulation, wiring should be dammed or disabled and replaced.

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

**Materials:**
1. Fasteners
2. Romex as needed

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

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

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

Warning of knob & tube should be posted at all entrances to related spaces.
Warning signs should encourage the use of certified electrician for repairs.

Some jurisdictions require warning signs in Spanish as well.

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

Many electricians will remove exposed wires to prevent reactivation.

Modern wiring should replace all knob & tube.

4.1001.3 - Fireplace Chimney and Combustion Flue Vents

Desired Outcome:
Combustible materials kept away from combustion sources

4.1001.3a - Verify attic prep

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

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 - Required clearance

**Desired Outcome:**
Combustible materials kept away from combustion sources

**Specification(s):**
A rigid dam having a height to ensure a 3" clearance area free of insulation or combustibles between combustion flue vent and dam, unless the flue vent is listed for a lesser clearance

**Objective(s):**
Ensure dam material does not bend, move, or sag

Prevent a fire hazard

**Tools:**
1. Metal snips

**Materials:**
1. 26-gauge steel sheeting
2. Fasteners
4.1001.3c - Safety

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](image1.png) ![After](image2.png)

Dams around flues, chimneys, and light fixtures should hold back insulation
Clear dams of any loose insulation in order to minimize risk of fire

4.1001.3d - Occupant education

Desired Outcome:
Combustible materials kept away from combustion sources

Specification(s):
Documentation of material and R-value will be provided to occupant

Objective(s):
Provide occupant with documentation of installation
Best Practice

Provide occupant with documentation of and about insulation installed.

Communicate professionally with occupant to provide information and support.

Documentation should include insulation material and r-value.

Provide occupant with copies of all documentation.

4.1001.4 - Vented Eave or Soffit Baffles

**Desired Outcome:**
Attic ventilation meets code requirements and insulation is protected from wind washing.

**Note:**

4.1001.4a - Installation

**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

**Tools:**
- 1. Stapler

**Materials:**
- 1. Baffles
- 2. Staples

**Before**
Insulation should not block vented eaves

**After**
Baffles installed in vented attics to allow air flow past insulation

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
4.1003.3 - Unvented Flat Roof with Existing Insulation

**Desired Outcome:**
Insulation reduces heat flow through unvented roof

4.1003.3a - Ventilation

**Desired Outcome:**
Insulation reduces heat flow through unvented roof

**Specification(s):**
Code compliant ventilation will be installed before insulation

**Objective(s):**
Reduce possibility of moisture issues
Unvented flat roofs should have venting installed

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

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

Materials:
1. Metal lath
2. Stucco

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 - Installation**

**Desired Outcome:**
Insulation reduces heat flow through unvented roof

**Specification(s):**
Roof cavities will be blown with loose fill insulation (or roof cavities will be dense packed with insulation) without gaps, voids, compressions, misalignments, or wind intrusions
Insulation will be installed to prescribed R-value

**Objective(s):**
Insulate to prescribed R-value

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

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

**Tools:**
1. Insulation machine

**Materials:**
1. Loose fillable or dense packable insulation

### 4.1003.3c - Occupant education

**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

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation

4.1004.1 - Preparation for Dense Packing

Desired Outcome:
Airtight cavity and insulated knee wall

4.1004.1a - Backing

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

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
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 - Installation**

**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

Attach furring strips to create pockets for dense-pack insulation

Insulation should meet manufacturer specifications for density.

### 4.1004.2 - Preparation for Batt Insulation

**Desired Outcome:**
Airtight cavity and properly insulated knee wall
4.1004.2a - Knee wall prep for batts

**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

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

**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

**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
4.1004.2b - Installation

**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

Tools:
1. Utility knife
2. Tape measure

Materials:
1. Fiberglass batts

After
Properly fit insulation filling full volume of stud bay

Where existing insulation is improperly installed, fix it
Kraft-face should go to "warm in winter" side and batt should fill bay
Batts should fill entire volume of knee wall stud bays

4.1004.2c - Backing knee wall

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

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

4.1005.1 - Accessible Floors—Batt Installation

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

4.1005.1a - Preparation

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

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**Before**
Remove flooring in attic spaces to access floor cavities and insulate

**After**
Flag electrical junctions to make future maintenance and repairs easier

**Tools:**
1. Hammer
2. Pry bar

**Materials:**
1. Flags
4.1005.1b - Installation

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

Insert fiberglass batts into floor cavities, kraft-face down
Fill entire volume of floor cavity
Once insulated, flooring should be reinstalled

### 4.1005.1c - Occupant education

**Desired Outcome:**
Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

**Specification(s):**
A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
• R-value
  **Objective(s):**
  Document job completion to contract specifications
  Confirm amount of insulation installed
  Comply with 16 CFR 460.17

  **Best Practice**
  Provide occupant with documentation of and about insulation installed

  **Communicate professionally with occupant to provide information and support**
  **Documentation should include insulation material and r-value**
  **Provide occupant with copies of all documentation**

### 4.1005.2 - Accessible Floors—Loose Fill Installation

**Desired Outcome:**
Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow
4.1005.2a - Preparation

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

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 - Air barrier

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

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

Measure floor cavity for new bottom plate
Cut rigid material, such as XPS, to size to snugly fit into cavity
Align block with air barrier of conditioned space

Before
When missing, bottom plates must be installed under knee walls

After
New bottom plates complete air barrier and hold insulation in place
Air seal around new bottom plate with spray foam

4.1005.2c - Installation

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

Specification(s):
All insulation will be installed to the minimum unsettled depth and the maximum coverage per bag to reach a consistent depth for desired R-value indicated on the manufacturer's coverage chart.

Objective(s):
Reduce heating and air conditioning costs
Improve comfort
Minimize noise

Accessible attic floor should be air sealed and insulated
Check chart on package to ensure proper insulation depth to achieve R-value
Tools:
1. Insulation machine

Materials:
1. Loose fill insulation

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 - Onsite documentation

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 specification

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
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.

**4.1005.3 - Accessible Floors—Batt Insulation Over Existing Insulation**

**Desired Outcome:**
Insulation controls heat transfer through ceiling

**4.1005.3e - Onsite documentation**

**Desired Outcome:**
Insulation controls heat transfer through ceiling

**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

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17

4.1005.4 - Accessible Floors—Loose Fill Over Existing Insulation

Desired Outcome:
Insulation controls heat transfer through ceiling

4.1005.4d - Onsite documentation

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.

### 4.1005.5 - Enclosed Bonus Room Floor Over Unconditioned Space—Dense Pack Installation

**Desired Outcome:**
A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### 4.1005.5a - Air barrier

**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

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

Materials:
1. XPS or other rigid material
2. Fasteners

Snap chalk lines to keep access cuts clean and easy to repair
Cut through garage ceiling to access joist cavities below bonus room
The rigid block should be placed in line with the stem wall above
Measure joist cavity depth

Measure joist cavity width

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

Rigid block should fit snugly into joist cavity and be fastened mechanically to prevent insulation leaks

Fastened rigid block will hold the insulation in place under the bonus room above

4.1005.5b - Fill floors

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 or to a maximum density structurally allowable
- 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 at 50 pascals of pressure difference using chemical smoke or other approved verification method by the authority having jurisdiction
Objective(s):
Eliminate voids and settling
Minimize framing cavity air flows

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

Before
With rigid block in place under bonus room stem wall, insulation can begin

After
Chemical smoke at 50pa indicates insulation is at appropriate density

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
4.1005.5c - Safety

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

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

Clear dams of any insulation or debris in order to minimize risk of fire
No insulation on top of non-insulation contact (non-IC) rated fixtures

4.1005.5d - Onsite documentation

**Desired Outcome:**
A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

**Specification(s):**
A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
- R-value

**Objective(s):**
Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17
After

Documentation of insulation installed should be provided in writing

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For all insulation except loose-fill and aluminum foil, the receipt must show the coverage area, thickness, and R-value of the insulation you installed. The receipt must be dated and signed by the installer. To figure out the R-value of the insulation, use the data that the manufacturer gives you.

Rather than posting in the insulated space, a "receipt" may be provided

Information should include insulation type, r-value, coverage area, etc.

4.1006.1 - Pull-Down Stairs

Desired Outcome:
Pull-down attic stair properly sealed and insulated

4.1006.1a - Installation

Desired Outcome:
Pull-down attic stair properly sealed and insulated
Specification(s):
Top-side of the attic enclosure 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, rigid 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

Tools:
1. Tape measure
2. Drill
3. Saw
4. Caulk gun

Materials:
1. Caulk sealant
2. Lumber
3. XPS
4. Pre-fabricated stairwell cover
Stairs and hatch should both be insulated to match r-value of attic

4.1006.1b - Sealing

**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, frictionally engaging components 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

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

4.1006.2 - Access Doors and Hatches

Desired Outcome:
Attic access door properly sealed and insulated

4.1006.2a - Installation

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, rigid 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

**Materials:**

1. XPS
2. Lumber
3. Weatherstripping
4. Fasteners

**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

Create hatch cover that matches r-
Build dam to hold back attic insulation
Weatherstrip underside of hatch cover
**4.1006.2b - Sealing**

**Desired Outcome:**
Attic access door properly sealed and insulated

**Specification(s):**
Access hatch frames will be sealed using caulk, gasket, weather-strip, 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 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

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 - Attachment

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

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Apply foam tape to "warm side" face of attic hatch

Ensure an air tight seal by making sure foam tape has no gaps

Apply strong adhesive to "cold-side" of hatch

Adhesive should ring perimeter as well as criss-crossing hatch to ensure complete attachment of insulation

Affix XPS insulation to "cold-side" of hatch with adhesive, ensuring XPS is tight and square to hatch

Repeat adhesive and XPS layers to reach maximum R-value without making hatch excessively heavy or awkward
All XPS layers should be attached firmly to one another and square to hatch

4.1088.3 - Skylights

**Desired Outcome:**
Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

4.1088.3b - Installation

**Desired Outcome:**
Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

**Specification(s):**
Insulation will be installed in accordance with manufacturer specifications and will be in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

**Objective(s):**
Insulate to prescribed R-value
Uninsulated, unsealed skylight well

Tools:
1. stapler
2. tape measure
3. utility knife
4. caulk gun
5. foam gun

Materials:
1. caulk
2. one-part foam sealant
3. insulation (fiberglass, cellulose, spray polyurethane foam, polyisocyanurate board, extruded polystyrene board, or other as needed to achieve specified R-value)
4. air barrier material (drywall, foam board, paneling, hardboard, etc.)

Air-permeable insulation such as fiberglass or cellulose should be covered with a sealed attic-side air barrier.

Carefully seal all seams and joints

Install insulation in complete contact with all sides of the cavity.
Install an attic-side air barrier. The air barrier may be constructed from rigid insulation board. Seal the attic side air barrier.

4.1088.3c - Occupant education

Desired Outcome:
Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):
A dated receipt signed by the installer will be provided that includes:

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

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17
Best Practice

Provide occupant with documentation of and about insulation installed

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation

4.1102.1 - Open-Cavity Wall Insulation—General

Desired Outcome:
Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

4.1102.1a - Sealing

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

**Tools:**
1. Caulk gun

**Materials:**
1. Backer rod
2. Spray foam
3. Caulk

Penetrations and bypasses create places where blown in insulation can leak.

Sealed penetrations offer leakage protection and keep insulation in place.

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.
4.1102.1b - Installation

**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

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Seal penetration with caulk or fire-block, as appropriate

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

Wall should be netted and insulation blow in to prescribed r-value

OR: Wall can be insulated using batts installed without gaps

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### 4.1102.1c - Pre-drywall verification

**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

Take a visual and physical inspection of insulation installation

4.1102.1d - Onsite documentation

Desired Outcome:
Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Specification(s):
A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
• R-value

• Installed thickness and settled thickness (settled thickness required for loose-fill only)

• Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

**Objective(s):**
Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

**Best Practice**
Documentation should include insulation material and r-value

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**4.1103.1 - Dense Pack Exterior Walls**

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

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**4.1103.1a - Exterior dense pack**

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**
Using fill tube or an alternative method as approved by the authority having jurisdiction, 100% of each cavity will be filled to a consistent density:
• Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density
• Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit air flow that corresponds to an air permeance value of 3.5 cfm /sq. ft. at 50 pascals, as measured using ASTM C 522, E 283, or E 2178; the number of bags installed will be confirmed and will match the number required on the coverage chart
• All holes and penetrations will be plugged and/or sealed

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

Tools:
1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape

Materials:
1. cellulose or fiberglass insulation (any fiberglass material used must be specifically approved for air flow resistance by the manufacturer)
2. wooden, plastic, or foam plugs to fill installation holes
3. piece of fiberglass batt or towel to stop insulation from blowing out around the hose
Calculate the number of bags needed and verify the number you actually install.

Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI.

Adjust the pressure with the blower controls.

Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes.

With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation.

Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density.

Check that cavities are filled and are the proper density.

Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.

Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke.

4.1103.1b - Onsite documentation

**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

**4.1103.2 - Additional Exterior Wall Cavities**

**Desired Outcome:**
Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

**4.1103.2a - Location of cavities**

**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

Tools:
1. Infrared camera
2. Drill
3. Hole saw
4. Tape measure
5. Probe

4.1103.2b - Sealing

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
4.1103.2c - Dense packing

Desired Outcome:
Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

Specification(s):
Using fill tube, 100% of each cavity will be filled to a consistent density:

- Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density
- Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit airflow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using ASTM, SITE C 522, E 283, or E 2178
- The number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation will be verified to prevent visible air movement at 50 pascals of pressure difference using chemical smoke or other approved verification method by the authority having jurisdiction

Objective(s):
Eliminate voids and settling
Minimize framing cavity air flows

Make accurate count of insulation bags to be installed

Install insulation to correct density (at least 3.5 pounds per cubic foot for cellulose, or 1.5 pounds for fiberglass)

Tools:
1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape

Calculate the number of bags needed and verify the number you actually install.

Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI.

Adjust the pressure with the blower control knobs.
Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes.

With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation.

Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density.

Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.

Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.

Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke.

### 4.1103.2d - Quality assurance

**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
## Tools:

1. Infrared camera

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

Inspect for voids and low density areas

- Reduced temperature difference indicating insulated wall cavities

---

### 4.1103.2e - Close holes

**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

**In Progress**
With insulation complete, wall needs to be patched to better-than-found

**After**
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

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.

4.1301.1 - Standard Floor System—Batt Installation

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly.

4.1301.1a - Sealing

**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

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.

4.1301.1b - Installation

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.

---

**Tools:**

1. Utility knife
2. Tape measure

**Materials:**

1. Kraft-faced fiberglass batts to work order specifications

---

Uninsulated floors above unconditioned spaces are an energy drain.

Batts should fill most of joist bay and be in full contact with subfloor.

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.
4.1301.1c - Securing batts

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**
Batts will be secured with physical fasteners

**Objective(s):**
Ensure insulation remains in contact with subfloor

Fiberglass batts should not be hanging away from subfloor

“Lightning rods” or twine can be used to hold batts in contact
**Tools:**
1. Utility knife
2. Drill
3. Staple gun

**Materials:**
1. Lightning rods
2. Twine
3. Fasteners

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 - Occupant education**

**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

Communicate professionally with occupant to provide information and support
Documentation should include insulation material and r-value
Provide occupant with copies of all documentation

4.1301.2 - Standard Floor System—Loose Fill with Netting

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

4.1301.2a - Sealing

**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

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.

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 - Netting, fabric

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

---

Uninsulated floors above unconditioned spaces are an energy drain

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

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 - Installation

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**
Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications

Insulation will be installed to prescribed R-value

Insulation will be in continuous contact with air barrier

**Objective(s):**
Insulate to prescribed R-value

Ensure a continuous thermal boundary between conditioned and unconditioned space
With netting in place, insulation can begin.

Cavities filled to manufacturer specs to achieve prescribed r-value.

**Tools:**

1. Utility knife
2. Insulation machine

**Materials:**

1. Loose fill fiberglass or cellulose

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.

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 - Occupant education

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
4.1301.3 - Standard Floor System—Loose Fill with Rigid Barrier

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

4.1301.3a - Sealing

**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
Before
Gaps around penetrations cause air leakage and negate insulation

After
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.

4.1301.3b - Rigid air barrier

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

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
4.1301.3c - Installation

**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

Once rigid barrier is sealed, insulation can be blown in
Tools:
1. Insulation machine
2. Caulk gun

Materials:
1. Loose fill insulation
2. Caulk

Make sure to wear proper PPE when working with insulation

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 - Occupant education

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
Communicate professionally with occupant to provide information and support.

Documentation should include insulation material and r-value.

Provide occupant with copies of all documentation.

**4.1301.4 - Dense Pack Floor System with Rigid Barrier**

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly.

**4.1301.4a - Sealing**

**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.
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.

4.1301.4b - Rigid air barrier

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

Securely fasten rigid barrier, aligning seams with joist when possible

Seal all seams with caulk to prevent leakage

Pay particular attention at complex joints
4.1301.4c - Installation

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

Ensure that proper PPE is worn while working with insulation

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 - Occupant education

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

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation
4.1301.5 - Cantilevered Floor—Batt Installation

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

4.1301.5a - Air barrier

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**
Air barrier will be installed between joists and sealed

Air barrier will be placed to the most interior edge of the top plate of the wall below

**Objective(s):**
Separate cantilevered floor from conditioned floor space

Allow for insulation

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![Before](image1.png)  ![After](image2.png)

Cavities are open allowing unconditioned air to communicate within the space between floors.

Cavity has been blocked, sealed, and insulated. Rigid air barrier is hidden behind insulation in this photo.
1. Stuff the cavities with fiberglass insulation as a backer, and then apply two-part spray polyurethane foam to seal the openings. 2. Cut and install drywall, plywood, OSB, or rigid foam board in each cavity, then seal around the edges with foam or caulk. 3. Install dense-pack insulation in cantilevered area, being careful to extend it inward past the supporting wall (this also accomplishes insulating the cantilevered floor area).

Install insulation at the required R-value in permanent contact with the subfloor under the cantilevered section.
4.1301.5b - Installation

**Desired Outcome:**
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**
Air barrier will be insulated between joist from top plate of the wall below to subfloor above

Cantilevered subfloor will be insulated in complete contact with the floor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to the air barrier

Insulation will be installed to prescribed R-value

**Objective(s):**
Insulate to prescribed R-value

---

**Tools:**
1. drill
2. mechanical fasteners
3. claw hammer or pry bar

**Materials:**
1. batt insulation - kraft-faced or unfaced
2. insulation supports
Cavities are open and subfloor of conditioned space above is uninsulated.

Insulation R-value to be installed matches the work order.

Here the worker is removing the kraft facing, which may be needed in some areas.

Ensure the batt is positioned correctly.

Batt insulation is installed to either fill the cavity or be properly supported to maintain contact with the subfloor.

4.1301.5c - Attachment

**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

Tools:
1. Utility knife
2. Drill
3. Staple gun

After

"Lightning rods" or twine should keep full contact with the subfloor

Materials:
1. Lightning rods
2. Twine
3. Fasteners

Batts should have full contact with subfloor without being compressed

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

4.1301.5d - Exterior soffit

Desired Outcome:
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

Specification(s):
Exterior soffit material will be installed and sealed

Objective(s):
Cover and protect insulation

Before: Cavities have been insulated but are still exposed.

After: After all accessible cavities have been air sealed and insulated, replace sheathing and siding to cover insulation.

Tools:
1. claw hammer
2. drill
3. mechanical fastners

Materials:
1. OSB/Plywood(where existing)
2. Vinyl Soffit(where existing)

Cantilevered floors should be insulated to preserve thermal boundary.

Seal off floor cavities using previously removed materials, in this case OSB and vinyl soffit.

Re-install any materials that were removed, such as OSB, J-channels, and vinyl soffit.
4.1301.5e - Occupant education

**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.

Communicate professionally with occupant to provide information and support.

Documentation should include insulation material and r-value.

Provide occupant with copies of all documentation.

4.1301.6 - Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier

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

4.1301.6a - Subfloor preparation

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

**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.

Gaps around penetrations can cause air leakage and negate insulation

Sealed penetrations maintain the air barrier

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 - Installation

**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

**Before**
Uninsulated floors above unconditioned spaces are an energy drain

**After**
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
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 - Secure batts

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
Before

Batts should not hang away from subfloor

After

"Lightning rods" or twine should be used to maintain contact

Tools:
1. Utility knife
2. Drill
3. Staple gun

Materials:
1. Lightning rods
2. Twine
3. Fasteners

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 - Rigid air barrier

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

Before
Unfaced fiberglass batts can be attractive housing for pests

After
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

Fasten rigid barrier, aligning seams with joists when possible
Seal all seams with caulk to prevent leakage
Pay particular attention to complex joints
4.1301.6e - Occupant education

**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.

Communicate professionally with occupant to provide information and support.

Documentation should include insulation material and r-value.

Provide occupant with copies of all documentation.

4.1301.7 - Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier

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

4.1301.7a - Subfloor preparation

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 Image](image1.png) **Before**
Gaps around penetrations can cause air leakage and negate insulation

![After Image](image2.png) **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.

![Backer Rod](image3.png) **Backer Rod**
Locate gaps around penetrations for plumbing, electrical, etc.

![Fill Gaps](image4.png) Fill gaps greater than 1/4 inch with backer rod or spray foam

![Caulk Smaller Gaps](image5.png) Caulk smaller gaps and to hold backer rod in place

**4.1301.7b - Rigid air barrier**

**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

---

**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

---

Uninsulated floors over unconditioned spaces are an energy drain

Rigid barriers allow for air sealing while creating cavities for insulation

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 - Installation

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

Always wear proper PPE when working with insulation.

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 - Occupant education**

**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
Communicate professionally with occupant to provide information and support. Documentation should include insulation material and r-value. Provide occupant with copies of all documentation.

4.1301.8 - Pier Construction Subfloor Installation—Dense Pack with Rigid Barrier

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

4.1301.8a - Subfloor preparation

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.

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 - Rigid air barrier**

**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

Fasten rigid barrier, aligning seams with joists when possible

Seal all seams with caulk to prevent leakage

Pay particular attention to complex seams
4.1301.8c - Installation

**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

Make sure to wear proper PPE when working with insulation

Purchase and install insulation as per Work Order

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 - Occupant education

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

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation
4.1402.2 - Basement Wall Insulation—No Groundwater Leakage

**Desired Outcome:**
Basement insulation improves thermal performance and ensures sufficient drying potential

4.1402.2a - R-value

**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

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 4, except marine</th>
<th>Zone 5 and marine 4</th>
<th>Zone 6 &amp; 8</th>
</tr>
</thead>
<tbody>
<tr>
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<td>15</td>
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<td>16</td>
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<td>20</td>
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</tbody>
</table>

**Best Practice**
Find your regional zone and insulation application to determine r-value

4.1402.2b - Air barrier

**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

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
4.1601.2 - Insulating Metal Ducts

Desired Outcome:
Lowered thermal conductance of duct system and minimized condensation on the duct system

4.1601.2a - Selection of duct insulation material

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
Uninsulated ducts in unconditioned spaces are an energy drain

Properly insulated ducts operate at much higher rates of efficiency

Ducts in unconditioned areas should have r-8 insulation with vapor barrier

OR ducts can be buried in loose fill in attic spaces in drier climates

Burying ducts is discouraged in warm coastal and hot humid regions

4.1601.2b - Duct sealing

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

Sealed ductwork connections help prevent leakage

Tools:
1. Putty knife

Materials:
1. Mesh tape
2. Mastic

Prepare work area by assessing any safety concerns
Wrap joint with fiberglass mesh tape
Apply UL 181 mastic to seal joint

4.1601.2c - Attachment of duct insulation

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

Tools:
1. Scissors
2. Metal snips

Materials:
1. Nylon twine
2. Wire
3. Tie bands

After

Durable materials can be attached without compressing insulation

4.1601.2d - Taping of the duct insulation

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
Tools:
1. Utility knife

Materials:
1. UL-181 tape
2. R-8 duct insulation with vapor barrier

5.3003.1 - Data Plate Verification

Desired Outcome:
Data for commissioning and future service work is recorded

5.3003.1a - Data plate verification

Desired Outcome:
Data for commissioning and future service work is recorded

Specification(s):
Equipment will be visually inspected

Information will be recorded from the equipment data plates indoors and outdoors where available

Objective(s):
Ensure technician has equipment data necessary for commissioning and future service work
5.3003.2 - Combustion Analysis of Oil-Fired Appliances

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail!f new installation or replacement is necessary, ANSI / ACCA 5 QI HVAC Quality Installation Specification will be followed

5.3003.2a - Oil system: filter

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Filter will be present, clean, and leak free

Objective(s):
Ensure oil filter is present and functional
Best Practice

Locate oil filter(s) on oil-fired water heaters and furnaces, and check for need of cleaning or replacement

If necessary, replace with appropriate filter and gasket

Tools:
1. Wrench

Materials:
1. Replacement oil filter
2. Gasket

Some systems have more than one filter. One filter typically is located close to fuel tank and may be outdoors.

Take note of filter model number for easy replacement

5.3003.2b - Nozzle

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Nozzle size, angle, and spray pattern will be correct for design input and within equipment firing rate of the heating system manufacturer. Position of nozzle and electrodes will be in accordance with
manufacturer specifications

Objective(s):
Ensure equipment is outfitted with the correct nozzle per manufacturer guidelines

5.3003.2c - Fuel pressure

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Measurement will be verified in accordance with manufacturer specifications

Objective(s):
Ensure correct oil pump pressure for nozzle installed and at OEM’s specified values per ACCA

5.3003.2d - Place appliance in operation

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Heating equipment will be placed in operation in accordance with applicable standards and manufacturer specifications when available.

**Objective(s):**
Prepare equipment for combustion analysis tests

Verify oil-fired furnaces and water heaters are operating safely

### 5.3003.2e - Smoke Test

**Desired Outcome:**
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**
Smoke test will be conducted before any combustion testing is completed

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):**
Determine whether equipment is operating within acceptable range according to smoke test and call for action if needed
5.3003.2f - Steady state efficiency (SSE)

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Measurement will be verified in accordance with manufacturer specifications

Objective(s):
Determine whether steady state efficiency is within manufacturer range

5.3003.2g - Net stack temperature

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Net stack temperature will be measured and verified in accordance with manufacturer specifications

Objective(s):
Determine whether net stack temperature is within manufacturer's recommended range

In Progress
Verify oil-fired appliances are not burning hotter than manufacturer specs

After
T-stack minus T-air equals net stack temperature. Check against specs
Tools:
1. Combustion analyzer with probe
2. Drill

T=temperature. T-stack minus T-air = Delta T or Net Stack Temperature.

5.3003.2h - Carbon dioxide (CO2) and oxygen (O2)

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Measurement will be verified in accordance with manufacturer specifications

Objective(s):
Verify combustion performance of equipment is within manufacturer recommended range based on CO2 and O2 readings

In Progress
Verify oil-fired appliances are burning safely by testing CO2 and O2 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 CO2 produced by an oil-fired appliance.

O2 levels in the atmosphere are at a constant 20.9%. O2 readings in appliances vary due to O2 density and the efficiency of the combustion process.
5.3003.2i - Excess combustion air

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
Excess combustion air will be calculated and shown to be in accordance with manufacturer specifications

Objective(s):
Verify combustion performance of equipment is within manufacturer recommended range based on excess combustion air readings

Tools:
1. Combustion analyzer with probe
2. Drill

5.3003.2j - CO in flue gas

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.
Specification(s):
Measure CO and recommend actions to ensure that CO in the undiluted flue gas will be less than 400 ppm air-free

Objective(s):
Ensure CO in undiluted flue gas is less than 400 ppm air-free

Test oil-fired appliances for air-free CO in the flue gases to verify safe levels

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

Tools:
1. Combustion analyzer with probe
2. Drill

5.3003.2k - Testing/inspection holes

Desired Outcome:
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

Specification(s):
All testing and inspection holes will be sealed with approved materials

Objective(s):
Ensure equipment:

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

Best Practice

Foil tape should be used to seal testing holes unless high temperature sealant is required by jurisdictional code

Materials:
1. Foil tape
2. High temperature sealant

Check jurisdictional code for approved method

5.3003.8 - Evaporative Cooler Maintenance and Repairs

Desired Outcome:
Evaporative cooler evaluated and maintained as needed

5.3003.8a - Assessment and diagnosis

Desired Outcome:
Evaporative cooler evaluated and maintained as needed

Specification(s):
The following system elements will be assessed:

• Pump
• Pan
• Spider
• Float
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

In Progress

Pads have deposits and are shrunken from age. Replace

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 - Repair and maintenance

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 2.0100.1l for Health & Safety measures.

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 - Occupant education

**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

**Best Practice**
Communicate professionally with occupant to provide information and support

Occupants with evaporative coolers should be alerted to proper maintenance

### Standard Evaporative Cooler Maintenance

<table>
<thead>
<tr>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Pump</td>
</tr>
<tr>
<td>Clean Spider Needles and Drip Trough</td>
</tr>
<tr>
<td>Oil Blower and Motor Bearings - DO NOT Over Oil</td>
</tr>
<tr>
<td>Change Pads</td>
</tr>
<tr>
<td>Check Belt Condition and Tension (1/4” deflection @ 3/8” Force)</td>
</tr>
<tr>
<td>Check water level off and drain any (hot)</td>
</tr>
<tr>
<td>Remove damp/dafts (if present)</td>
</tr>
<tr>
<td>Plug in motor and pump</td>
</tr>
<tr>
<td>Turn-on/Reconnect Electricity</td>
</tr>
</tbody>
</table>

**Mid-season Checks**

<table>
<thead>
<tr>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean/Replace Pads - depends on water quality</td>
</tr>
<tr>
<td>Winter Shut Down</td>
</tr>
</tbody>
</table>

**Turn-off/Disconnect Electricity**

<table>
<thead>
<tr>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain water (gas and lines)</td>
</tr>
<tr>
<td>Unplug motor and pump</td>
</tr>
<tr>
<td>Turn damp/dafts off (if equipped)</td>
</tr>
<tr>
<td>Cover unit</td>
</tr>
</tbody>
</table>
Review properly and timely evaporative cooler maintenance

Explain evaporative and refrigerative cooling should not be run together

5.3003.10 - Condensate Drainage of Heating and Air Conditioning Equipment

Desired Outcome:
Equipment and condensate drain operate as designed

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

5.3003.10a - Connection

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
4. PVC cement

### 5.3003.10b - Insulation

**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 - Overflow protection: upflow

**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

**5.3003.10d - Pumps**

**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.

HVAC unit is mounted to "historic" adobe wall which cannot be penetrated.

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

The pump is connected directly into the sewage system.

### 5.3003.10e - Vents and traps

**Desired Outcome:**
Equipment and condensate drain operate as designed

**Specification(s):**
Vents and traps will be installed on condensate drainlines

Trap supplied with the equipment will be used and manufacturer specifications will be followed

**Objective(s):**
Ensure condensate drain operates as designed

Ensure condensate drain does not leak air
5.3003.10f - Drain pan

Desired Outcome:
Equipment and condensate drain operate as designed

Specification(s):
Condensate from all cooling coils or evaporators shall be conveyed from the drain pan outlet to an approved place of disposal

Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than 1/8 unit vertical in 12 units horizontal (1% slope)

Condensate shall not discharge into a street, alley, or other areas where it would cause a nuisance

Objective(s):
Prevent water damage from drain system malfunction

5.3003.10g - Float switch

Desired Outcome:
Equipment and condensate drain operate as designed

Specification(s):
All secondary drain pans will have a float switch and be drained away through a drainline

Objective(s):
Prevent water overflowing the pan and draining onto the ceiling below

Float switches should be installed in drainage pans to prevent overflow
5.3003.10h - Termination

Desired Outcome:
Equipment and condensate drain operate as designed

Specification(s):
Condensate drain will be terminated in accordance with local codes

Objective(s):
Ensure condensate does not leak to the house
Ensure condensate drain does not freeze

5.3003.14 - Combustion Analysis of Gas-Fired Appliances (LP and Natural Gas)

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

5.3003.14a - Gas Pressure

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

Specification(s):
Measurement will be verified by a certified professional in accordance with fuel type and manufacturer specifications

Objective(s):
Ensure equipment:
  • Operates as designed
  • Operates safely
  • Operates efficiently
  • Is durable
5.3003.14b - Place appliance in operation

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

Specification(s):
Heating equipment will be placed in operation in accordance with applicable NFPA standards and manufacturer specifications when available

Objective(s):
Ensure equipment:

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

Best Practice
Only place appliances in operation that are installed to manufacturer specification and have passed combustion testing

5.3003.14c - Carbon dioxide (CO2) and oxygen (O2)

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

Specification(s):
Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)
Objective(s):
Ensure equipment:

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

Verify gas-fired appliances are burning safely by testing CO2 and O2 levels

Levels should be within industry standards and match manufacturer specs

Tools:
1. Combustion analyzer with probe
2. Drill

O2 levels in the atmosphere are at a constant 20.9%. O2 readings in appliances vary due to O2 density and the efficiency of the combustion process.

5.3003.14d - Carbon monoxide (CO) in flue gas

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

Specification(s):
CO in the undiluted flue gas will be less than 400 ppm air-free

Objective(s):
Ensure equipment:
• Operates as designed
• Operates safely
• Operates efficiently
• Is durable

Test undiluted flue gasses for carbon monoxide levels

Tools:
1. Combustion analyzer with probe
2. Drill

5.3003.14e - Testing/inspection holes

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

Specification(s):
All testing and inspection holes will be sealed with manufacturer approved materials

Objective(s):
Ensure equipment:

• Operates as designed
• Operates safely
• Operates efficiently
• Is durable
Best Practice
Foil tape should be used to seal testing holes unless high temperature sealant is required by jurisdictional code

Materials:
1. Foil tape
2. High temperature sealant

Check jurisdictional code for approved method of sealing

6.6002.1 - Ducts

Desired Outcome:
Installed ducts effectively move the required volume of air and prevent condensation

6.6002.1a - Duct design and configuration

Desired Outcome:
Installed ducts effectively move the required volume of air and prevent condensation

Specification(s):
Ventilation ducts will be as short, straight, and smooth as possible

Ventilation ducts will not be smaller than the connections to which they are attached

Objective(s):
Effectively move the required volume of air
Before

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

Tools:
1. Metal snips
2. Drill

Materials:
1. Metal duct piping
2. Fasteners

See also ASHRAE 62.2-2016.

After

Duct is the same size as the outlet and makes shortest run possible

6.6002.1b - Duct insulation

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 62.2-2016. Check local codes to see if R-8 is accepted level of insulation.

6.6002.1c - Duct support

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

**Before**
Ducts should not be allowed to droop or sag to maximize efficiency

**After**
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 62.2-2016.

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
6.6002.1d - Duct connections

**Desired Outcome:**
Installed ducts effectively move the required volume of air and prevent condensation

**Specification(s):**
Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws

Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic- plus-embedded-fabric systems, or tapes

Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool

PVC-to-PVC materials will be fastened with approved PVC cement

Other specialized duct fittings will be fastened in accordance with manufacturer specifications

In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

**Objective(s):**
Effectively move the required volume of air

Preserve the integrity of the duct system
Fan duct is disconnected and venting into the attic space.

**Tools:**
1. drill
2. tie band tensioner
3. brush

**Materials:**
1. tie bands
2. insulated flex duct
3. mastic
4. PVC primer
5. PVC cement

Apply mastic to the connection fitting. Snug duct liner onto connection fitting. Use zip tie and tensioner to secure liner to connection fitting.

Fan has been vented with sealed, insulated duct material.
Apply mastic to fan connection. Using mechanical fasteners, secure connection fitting to fan connection. Snug insulation to fan housing and strap into place.

Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum.

PVC-to-PVC connections should use PVC primer and cement.

Sealants should show UL181-M or UL181B-M.

6.6002.1e - Duct materials

**Desired Outcome:**
Installed ducts effectively move the required volume of air and prevent condensation

**Specification(s):**
Flexible materials will be UL 181 listed or Air Diffusion Council approved

The metal gauge of rigid kitchen fan ducting shall meet code requirements or the approval of the authority having jurisdiction.

**Objective(s):**
Effectively move the required volume of air

Preserve the integrity of the duct system
Bad Practice
Existing duct is installed incorrectly and is not UL listed

Best Practice
This flexible duct conforms to UL 181

Materials:
1. All materials should be UL 181 Listed
2. 30-gauge minimum Rigid Duct

Look for the Air Diffusion Council seal. Flex installed should meet or exceed UL181. When rigid duct is being used, its wall thickness should be 30 gauge minimum.

6.6002.2 - Terimations

Desired Outcome:
Securely installed termination fittings with unrestricted air flow

6.6002.2a - Hole in building shell

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

Exhaust fans need exterior ventilation, often through roofs and walls

Hole should be no more than 1/4" larger than termination fitting diameter

**Tools:**
1. Hole saw
2. Drill
3. Tape measure

Locate the center of your vent hole by drilling from inside through roof

Measure the termination fitting to determine proper hole saw diameter

Based on termination fitting size (in this case, 4"), mark to cut hole
6.6002.2b - Termination fitting

**Desired Outcome:**
Securely installed termination fittings with unrestricted air flow

**Specification(s):**
A termination fitting with an integrated collar will be used

Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used

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

**Objective(s):**
Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation
Before
Termination fittings with no collar are to be avoided

After
Properly sized ducts with snug connections to collared fittings last longer

Tools:
1. Drill

Materials:
1. Fasteners

BAD: Termination fittings without collars should be avoided
Termination fittings with collars should be used for exhaust ventilation
Collared fittings extend through the roof to fasten securely with duct

6.6002.2c - Duct to termination connection

Desired Outcome:
Securely installed termination fittings with unrestricted air flow

Specification(s):
Duct will be connected and sealed to termination fitting as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
• Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
• PVC-to-PVC materials will be fastened with approved PVC cement
• Other specialized duct fittings will be fastened in accordance with manufacturer specifications
• In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Fasteners will not inhibit damper operation

**Objective(s):**
Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation

**Tools:**
1. wire cutter
2. chip brush
3. zip tie tension tool
4. utility knife

**Materials:**
1. insulated flex duct with liner
2. UL 181 sealant
3. zip tie straps
4. PVC primer
5. PVC cement
With other end of the duct connected to the fan, cut duct to desired length.

Apply mastic to termination fitting.

Fit duct liner on to termination fitting.

With duct liner in place, use the zip tie tension tool to secure the liner to the fitting.

With liner secured and zip tie trimmed, you are ready to pull the insulation to cover the fitting.

Ensure termination damper functions as intended.

Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum.

PVC-to-PVC connections should use PVC primer and cement.

Sealants should be UL181-M or UL181B-M listed.

**6.6002.2d - Weatherproof installation**

**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

Tools:
1. Hole saw
2. Caulk gun
3. Drill

Materials:
1. Fasteners
2. Caulk

Before
Holes for termination fitting need to be sealed to weatherproof

After
Termination installation should follow shingling to deter water penetration
Termination fitting is installed to repel water and sealed

6.6002.2e - Pest exclusion

**Desired Outcome:**
Securely installed termination fittings with unrestricted air flow

**Specification(s):**
Screen material with no less than ¼" and no greater than ½" 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

Exhaust terminations without screens are an invitation to pest intrusion

Screen mesh should be between 1/4" and 1/2" in either direction

6.6002.2f - Termination location

**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

**Tools:**
1. Measuring tape
2. Hole saw
3. Drill

**6.6002.2g - Kitchen exhaust**

**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
6.6003.3 - Through the Wall

Desired Outcome:
Through the wall fans installed to specification

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

6.6003.3a - Hole in building shell

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

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

**Hole should be no more than 1/4" larger than assembly diameter**

**Clear wall surface and mark hole size 1/4" larger than termination fitting**

**Since opening is larger than most hole saws, precision cutting is important**
6.6003.3a - Hole in building shell

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

Tools:
1. saw
2. prybar
3. goggles
4. gloves
5. measuring tape

6.6003.3b - Wiring

Desired Outcome:
Through the wall fans installed to specification

Specification(s):
Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes
Objective(s):
Prevent an electrical hazard

Tools:
1. Wire strippers
2. Utility knife or cable ripper
3. Screwdriver
4. Non-contact voltage tester
5. Lineman's pliers

Materials:
1. Ground wire crimp sleeves
2. Non-metallic sheathed wire (Type NM-B) e.g., Romex ®
3. Plastic junction box and cover plate
4. Wire nuts
5. Cable staples
6. Clamp-type cable connectors

Follow manufacturer's specifications and applicable codes when wiring newly installed equipment.

Inspect for: proper ground, wire nuts on splices, clamps on wiring where it enters junction box, cover installed on box

Install clamp on wiring into junction box
Install wire nuts on splices
6.6003.3c - Fan mounting

**Desired Outcome:**
Through the wall fans installed to specification

**Specification(s):**
- Fan outlet will be oriented toward the final termination location
- Fan will be oriented so the equivalent length of the duct run is as short as possible
- Fan will be mounted securely according to manufacturer specifications

**Objective(s):**
- Install mounting fan securely
- Ensure fan housing does not shake, rattle, or hum when operating

**Before**
Improperly aligned fan

**After**
Fan is mounted securely with the termination outlet lined up.
**Tools:**
1. drill
2. drill bits

**Materials:**
1. fasteners

Fan is not properly supported, resulting in improper alignment with the termination location.

Line the fan up so the outlet lines up with the termination.

Install the fan using factory mounting holes, ensuring a tight fit and quiet operation.

---

**6.6003.3d - Weatherproof installation**

**Desired Outcome:**
Through the wall fans installed to specification

**Specification(s):**
- Exterior termination fitting will be flashed or weather sealed
- Water will be directed away from penetration
- Termination fitting installation will not inhibit damper operation
- Manufacturer specifications will be followed

**Objective(s):**
- Preserve integrity of the building envelope
- Ensure a weather tight and durable installation
- Ensure unrestricted air flow
Best Practice
Apply sealant behind termination cap, taking care to apply sealant to all edges.

Best Practice
Termination is sealed and securely attached to the wall.

**Tools:**
1. caulk gun
2. drill
3. drill bits
4. reciprocating saw
5. drywall saw or utility knife

**Materials:**
1. weatherproof termination kit with pest screen
2. caulk or equivalent sealant
3. mechanical fasteners

Clean existing sealant to ensure proper adhesion to the surface.

Once area around the termination opening is cleaned, apply sealant to all four sides of the opening.

Install screws through the sealant, which will tighten the fitting and squeeze out excess sealant.
Wipe away excess sealant for a clean look.
Ensure damper swings open freely, and closes with a tight fit.

6.6003.3e - Backdraft damper

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

![Exterior hood]

Best Practice
Damper should be installed to maintain exterior air barrier

6.6003.3f - Fan housing seal

Desired Outcome:
Through the wall fans installed to specification

Specification(s):
Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

Objective(s):
Prevent air leakage through fan housing
Ensure a permanent seal to the building air barrier

**Best Practice**
Sealant should be waterproof and adhere to the desired surfaces.

**Best Practice**
Seal unused holes in the fan housing.

**Tools:**
1. caulk gun

**Materials:**
1. weatherproof, code approved caulk

---

**6.6003.3g - Fan to interior surface seal**

**Desired Outcome:**
Through the wall fans installed to specification

**Specification(s):**
Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

**Objective(s):**
Prevent air leakage around intake housing

Prevent a fire hazard
Best Practice
Sealant should be waterproof and adhere to desired surfaces.

Best Practice
Sealant should be applied to the fan housing where it comes in contact with the exterior wall.

Tools:
1. caulk gun

Materials:
1. code approved caulk

6.6003.3h - Insulation

Desired Outcome:
Through the wall fans installed to specification

Specification(s):
All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local code

Exception: If system operates continuously, fan housing need not be insulated

Objective(s):
Preserve integrity of the duct system

6.6003.3i - Air flow

Desired Outcome:
Through the wall fans installed to specification

Specification(s):
Air flows in CFM will be measured and adjusted to meet the design requirements

Objective(s):
Exhaust sufficient air from desired locations to outside

Best Practice
Using a digital manometer, exhaust flow meter and fabricated cover, measure the fan flow.

Best Practice
Air flow should be within acceptable limits for the location of the fan.

Tools:
1. exhaust fan flow meter
2. manometer

Materials:
1. a fabricated cover for fans larger than the flow meter

The exhaust fan flow meter won’t fit most range hoods. A fabricated cover is needed.

A fabricated cover can be used so long as the opening is smaller than the meter itself and larger than the E1 opening.

Attach a pressure hose to the exhaust fan flow meter.

50 CFM min
150 CFM min
Attach a hose to a T connection on channels A & B with the manometer set to measure exhaust fan flow. With the manometer properly set up, prepare to test air flow. Fans must pull the required CFM according to ASHRAE.

With the manometer Mode set to PR/FL, Device set to EXH, and Config set to E1, this fan pulls 111 CFM.

6.6003.3j - Preventing air leakage caused by exhaust fans

**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

**Best Practice**
The barrier between conditioned and unconditioned spaces should be sealed
See also SWS 3.1501.1 Air Sealing Garage Penetrations.

### 6.6003.3k - Combustion safety

**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

![Image: Before - Installing new ventilation can cause imbalances within the house](image1)

![Image: After - Test that depressurization limit is not being exceeded by new ventilation](image2)

**Tools:**
1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits
Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions

If depressurization limit is exceeded, mitigate to eliminate safety risk

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

After mitigation, verify that depressurization limits are not being exceeded

**6.6005.1 - Clothes Dryer**

**Desired Outcome:**
Dryer air exhausted efficiently and safely

**6.6005.1a - Clothes dryer ducting**

**Desired Outcome:**
Dryer air exhausted efficiently and safely

**Specification(s):**
Clothes dryers will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors

As short a run as practical of rigid sheet metal or semi-rigid sheet metal venting material will be
used in accordance with manufacturer specifications

Dryer ducts exceeding 35' in duct equivalent length will have a dryer booster fan installed

Plastic venting material will not be used

Uninsulated clothes dryer duct will not pass through unconditioned spaces such as attics and crawl spaces, except where allowed by the authority having jurisdiction

Ducts will be connected and sealed as follows:

- UL listed foil type or semi-rigid sheet metal to rigid metal will be fastened with clamp
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

In addition:

- Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used
- Condensing dryers will be plumbed to a drain

Objective(s):
Preserve integrity of building envelope

Effectively move air from clothes dryer to outside

Dryer is vented outside, but with the incorrect material.

Dryer is vented outdoors, with correct material. Run is as short and straight as possible ensuring maximum flow.
Tools:
1. metal trimmers
2. drill

Materials:
1. metal flex duct
2. dryer vent kit
3. hose clamps

If passing through unvented spaces, the ducting will be insulated to an R-8.

Disconnect existing vent pipe from dryer.

Attach approved vent material to termination vent. Termination vent may need to be trimmed.

Trim metal vent to ensure the run is as short and straight as possible.

Connect vent pipe to dryer.

Dryer vents to outdoors, and exhaust damper is functional.

For vent runs >35 feet, a booster fan is required.

Duct runs outside of conditioned space must be insulated and properly supported.
6.6005.1b - Termination fitting

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

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 - Make-up air

Desired Outcome:
Dryer air exhausted efficiently and safely

Specification(s):
If natural draft combustion appliances are present and if worst-case CAZ and/or other performance based testing is conducted and indicates a need for make-up air, make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

If natural draft combustion appliances are present and if no performance based testing is conducted, make-up air will be provided prescriptively 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

Best Practice
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 - Combustion safety

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

Run depressurization testing on house  If depressurization limit is exceeded, Install make-up air, such as a passive
to ensure new ventilation isn't causing unsafe conditions
mitigate to eliminate safety risk inlet vent, or other pressure relief

After mitigation, verify that depressurization limit is not being exceeded

6.6005.1e - Occupant education

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

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)

6.6005.2 - Kitchen Range

Desired Outcome:
Kitchen range fan installed to specification

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

6.6005.2b - Fan venting

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 venting device

**Objective(s):**
Remove cooking contaminants from the house
Preserve integrity of building envelope

**Before**
Recirculating fans over ranges do not actually remove contaminants

**After**
Daylight visible through dampered kitchen exhaust proves venting access

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**6.6005.2c - Fan ducting**

**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.

Ducts must be insulated to R-8.
Duct run should be as smooth and short as possible

Duct should be fastened securely with three evenly-spaced screws

Then joints should be secured with fiberglass tape

Finally, joint should be secured with UL-181 mastic

6.6005.2d - Termination fitting

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
Kitchen fans should exhaust to the exterior, not just recirculate air.

Exhaust fans should have backdraft dampers.

Backdraft damper on roof mounted exhaust fan. An interior backdraft damper can also be installed for good measure.

6.6005.2e - Make-up air

Desired Outcome:
Kitchen range fan installed to specification.

Specification(s):
If natural draft combustion appliances are present and if worst-case CAZ and/or other performance based testing is conducted and indicates a need for make-up air, make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

If natural draft combustion appliances are present and if no performance based testing is conducted, make-up air will be provided prescriptively 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

Before
If kitchen exhaust is venting at more than 200 cfm, provide make-up air

After
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 - Combustion safety

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
Kitchen exhaust fans can cause combustion appliances to depressurize

Test that combustion appliances are operating within depressurization limit

**Tools:**

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits

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

If appliances exceed depressurization limit, mitigate to reduce risk

Install a source of make-up air, such as a passive inlet vent

After mitigation, verify that depressurization limits are not being exceeded.
6.6201.2 - Primary Ventilation Air Flow between Rooms

**Desired Outcome:**
Air circulates freely between rooms

6.6201.2a - Balancing pressure

**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 common area 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
With interior doors open, put reference hose to exterior

Take baseline reading

Turn on exhaust fans and close interior doors

With hose under door, check pressure again. Readings >±3pa are no good and require interior ventilation

7.8003.1 - Lighting Upgrade

Desired Outcome:
Energy used for lighting reduced while maintaining adequate and safe lighting levels

7.8003.1a - Daylighting

Desired Outcome:
Energy used for lighting reduced while maintaining adequate and safe lighting levels

Specification(s):
Window coverings (e.g., blinds, shades, movable insulation) will be replaced or maneuvered to maximize useful daylight where appropriate

Active and passive day lighting will be properly oriented, designed, and installed where appropriate
Objective(s):
Reduce energy use without negative consequences (e.g., glare, unintentional heating)

7.8003.1b - Selection

Desired Outcome:
Energy used for lighting reduced while maintaining adequate and safe lighting levels

Specification(s):
All bulbs, fixtures, and controls will be appropriate for the intended application (e.g., enclosed, orientation, dimmable, potential for breakage, indoor, and outdoor)

All bulbs, fixtures, and controls will be selected to provide the brightness and light quality required in that application (e.g., task lighting, trip-and-fall hazards, nightlights)

Selected equipment should have the highest level of efficiency within a technology [e.g., compact fluorescent lamp (CFL), LED]

All bulbs, fixtures, and controls will be ENERGY STAR® rated where applicable

When possible, bulbs, fixtures, and controls will be selected that will facilitate the use of future lighting technologies (e.g., LEDs)

When incandescent bulbs cannot be replaced or when occupant chooses not to replace, a dimmer will be selected

Light/lamp wattage should not exceed rated wattage of fixture

Bulb replacements will be chosen based on expected durability, light quality, and lifetime energy use of the bulb

Controls to turn off lights when not needed (e.g., no one in room) will be provided

All bulbs, fixtures, and controls will be UL-approved and installed in accordance with local code(s) and NFPA 70 National Electric Code

Fluorescent light ballasts containing polychlorinated biphenyls (PCBs) will be replaced in accordance with the EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades

Objective(s):
Provide improved lighting quality at lower energy use
Select equipment that will not be an unnecessary barrier to future technologies

Avoid inferior products and unsatisfied occupants

DOE has granted Oklahoma approval to use LEDs in addition to CFLs as of June 14, 2017

7.8102.2 - Storage-Type Appliance

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

Note:
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

7.8102.2e - Expansion tank

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

Specification(s):
Expansion tanks will be installed where required and in accordance with the AHJ

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 - Temperature and pressure relief valve

**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 IRC and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with IRC

**Objective(s):**
Discharge excessive energy (pressure or temperature) from storage tank to safe 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.
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 - Discharge temperature

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
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

7.8103.1 - Storage-Type Appliance

**Desired Outcome:**
Safe, reliable, and efficient operation of the appliance maintained

**Note:**
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

7.8103.1a - Health and safety

**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

**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 - Thermal efficiency**

**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 IRC 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

**Best Practice**
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

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
7.8103.1e - Temperature and pressure relief valve

*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 IRC and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with 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.
## Ambient CO

<table>
<thead>
<tr>
<th>CO Level</th>
<th>Action</th>
</tr>
</thead>
</table>
| 9ppm - 35ppm | *Advise homeowner/occupant of elevated levels of ambient CO.  
*Open all Windows and doors.  
*Where it appears that the source of CO is a permanently installed appliance, the homeowner/occupant shall be advised to contact a qualified professional. |
| 36ppm - 69ppm | *Immediately terminate inspection until ambient CO levels are under 35ppm. *(Oklahoma Specific)*  
*Advise homeowner/occupant of elevated levels of ambient CO.  
*Open all Windows and doors.  
*Where it appears that the source of CO is a permanently installed appliance, the homeowner/occupant shall be advised to contact a qualified professional. |
| 70ppm | *Immediately terminate inspection, notify homeowner & occupants to evacuate building. The appropriate emergency services shall be notified from outside the home. |

### Appliance CO Action Limits

All CO measurements to be taken at 5 minutes of appliance main burner operation. ANSI/BPI CO Procedure Page 12, Table 1 Page 13

<table>
<thead>
<tr>
<th>Appliance</th>
<th>CO Action Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Burning Fireplace - Gas Log</td>
<td>400ppm or Greater Air Free</td>
</tr>
<tr>
<td>Clothes Dryer</td>
<td>400ppm or Greater Air Free</td>
</tr>
<tr>
<td>Central Heater, Floor Heater, Gravity Heater, Wall (Direct Vent)</td>
<td>400ppm or Greater Air Free</td>
</tr>
<tr>
<td>Wall Heater (BIV - duel), Vented Room Heater, Unvented Room Heater</td>
<td>200ppm or Greater Air Free</td>
</tr>
<tr>
<td>Water Heater</td>
<td>200ppm or Greater Air Free</td>
</tr>
<tr>
<td>Gas Fireplace with Gas Log</td>
<td>25 ppm or Greater As Measured</td>
</tr>
<tr>
<td>Oven/Broiler at Steady State</td>
<td>225 ppm or Greater As Measured</td>
</tr>
<tr>
<td>Stove Top Burners - <em>(Oklahoma Specific)</em></td>
<td>35 ppm as measured (ODOC)</td>
</tr>
</tbody>
</table>

### Spillage

ANSI/BPI Spillage Procedure Page 12, Annex D Action Levels Page 42

- Cold Vent Testing - **Furnace Only** *(Water Heater must be tested via Warm Vent)* - Spillage shall be assessed at 5 minutes of main burner operation.
- Warm Vent Testing - Water Heater &/or Furnace: Spillage shall be assessed at 2 minutes of main burner operation.

### Multiple combustion appliances sharing chimney or venting system

ANSI/BPI Spillage Procedure Page 12

Starting with lowest BTUh first, upon completion of spillage & CO testing of 1st appliance, place the next largest BTUh combustion appliance in operation while the first appliance is still firing. Do not wait for the chimney to cool. **Retest the first appliance for spillage** when the second appliance has reached 2 minutes of main burner operation. Test the second appliance for spillage immediately thereafter.

### Test Result:

<table>
<thead>
<tr>
<th>Spillage</th>
<th>Action Required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greatest CAZ Depressurization occurs <strong>with Air Handler ON:</strong></td>
<td>Determine if leaky ducts or other HVAC imbalances are cause of spillage. If so, recommend system repairs that will reduce CAZ depressurization.</td>
</tr>
<tr>
<td>Greatest CAZ Depressurization <strong>w/CAZ door closed, but alleviated w/CAZ door open:</strong></td>
<td>Recommend measures to improve air transfer between CAZ &amp; core of house.</td>
</tr>
<tr>
<td>IF the cause of spillage has been traced to <strong>excessive mechanical ventilation:</strong></td>
<td>Verify that sufficient combustion air is available or recommend further evaluation/service of venting/combustion air by qualified professional.</td>
</tr>
<tr>
<td>Both Spillage and Excessive CO are present:</td>
<td>In addition to specific above recommendations, recommend appliance be shut down until it can be serviced by a qualified professional.</td>
</tr>
</tbody>
</table>