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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

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
When unsure what level of protection
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
Electrical wiring should not be located near a water source
Use fiberglass ladders in place of metal

Recognize if knob and tube wiring is present and take special precautions
Follow NFPA 70E 2012 guidelines for arc flash hazards

2.0100.1e - 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](image1.png)  ![Best Practice](image2.png)

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

**Before**

Workers should be aware of work required and dress appropriately

**After**

Ensure workers have proper protective equipment for work environment

---

### 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
After

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

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

In confined spaces, use a ventilator

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

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.
New GHS/MSDS labeling is clear and concise—workers should be familiar with how to read new Safety Data Sheets.

Workers should be trained on how to wear PPE, be provided with proper PPE, and know when to use it.

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
Keep workers comfortable with hydration and cool vests

Provide fresh and moving air when working in hot confined spaces

2.0100.1n - Fire safety

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
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

**Best Practice**
In homes built before 1978, test paint before beginning renovation or assume presence of lead

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

**Materials:**
1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris

EPA RRP certification required to conduct Lead Paint assessment.

1. Clean tools and sample site to prevent contamination
2. Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers
3. Break capsule and shake to mix reagents. Swab sample site for 30 seconds
Check swab for reaction Red indicates lead positive. White is lead negative.

If negative, verify validity of test with provided calibration card

Lead in calibration card should test positive and turn spot red

Record test results to maintain documentation

**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

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

**Best Practice**
If asbestos is suspected, call an EPA-accredited professional.
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 MSDS for materials used and know where to locate MSDS 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
In homes built before 1978, test paint before beginning renovation or assume presence of lead

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

Materials:
1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris

EPA RRP certification required to conduct Lead Paint assessment.
Clean tools and sample site to prevent contamination

Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers

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

Check swab for reaction

Red indicates lead positive. White is lead negative.

If negative, verify validity of test with provided calibration card

Lead in calibration card should test positive and turn spot red

Record test results to maintain documentation
2.0103.1 - Combustion Worker Safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

2.0103.1a - Worker safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
All worker safety specifications in Global Worker Safety section will be followed

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

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
Before
STOP WORK if CO levels measure above 35ppm!!

Tools:
1. CO meter

After
Install carbon monoxide alarm if none are found.

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

**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

Notify occupant of any leaks
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 and more information at thermost-recycle.org

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
Unsure
Suspicious pipe insulation may contain asbestos

Best Practice
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

Unsafe
When working with refrigerants, short sleeves are inappropriate

Safe
Workers should dress appropriately for working with refrigerant and be aware of any addition risks in their surroundings

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.

**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

**Best Practice**
All CO issues found during initial audit should be mitigated before work begins

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

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**2.0103.2g - Sealant**

**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

**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

Best Practice

Call a certified professional
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

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.

Allow testing solution to sit on newly repaired pipe joint for 10min. Confirm repair and remove flag.

2.0107.2b - Electrical hazards

Desired Outcome:
Site properly prepared for upgrade

Specification(s):
Electrical hazards will be eliminated and inspected in accordance with NFPA 70 National Electric Code

Objective(s):
Ensure site is safe and ready for upgrade

2.0107.2c - Mold

Desired Outcome:
Site properly prepared for upgrade
Specification(s):
Appropriate remediation will be completed before upgrade

Objective(s):
Ensure site is safe and ready for upgrade

2.0107.2d - Plumbing and water leaks

Desired Outcome:
Site properly prepared for upgrade

Specification(s):
Plumbing leaks will be repaired before crawl space upgrade in accordance with the IRC

Objective(s):
Prepare site for upgrade

2.0107.2e - Pest and termite work

Desired Outcome:
Site properly prepared for upgrade

Specification(s):
Pest and termite treatment will be completed before crawl space upgrade and inspected in accordance with the IRC

Objective(s):
Prepare site for upgrade

2.0107.2f - Structural repairs, modifications

Desired Outcome:
Site properly prepared for upgrade

Specification(s):
Structural repairs and modifications will be inspected and completed before crawl space upgrade in accordance with the IRC

Objective(s):
Prepare site for upgrade

2.0107.2g - Appliance and heating, ventilation, and air conditioning (HVAC) system repairs and change outs

Desired Outcome:
Site properly prepared for upgrade

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

Objective(s):
Prepare site for upgrade

2.0107.2h - Correctable standing water

Desired Outcome:
Site properly prepared for upgrade

Specification(s):
Passive drains or sump pumps will be used to remove standing water

Objective(s):
Prepare site for upgrade

2.0107.2i - Non-correctable standing water

Desired Outcome:
Site properly prepared for upgrade

Specification(s):
Spaces with non-correctable standing water will not be considered for a closed crawl space

Objective(s):
Prevent possible damage to house
2.0107.3 - 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

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

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

Rake up and clear away trash and overgrowth.
2.0107.3b - Debris disposal

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

Specification(s):
Debris will be properly disposed of according to type and jurisdiction

Objective(s):
Protect environment from damage
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

In cases of replacement, ensure new appliance is safe and sized properly
When a simple filter cleaning or replacement will help, make it happen.

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

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

Keep occupant apprised of any health or safety concerns.

2.0201.1b - 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

Before Fuel lines should be inspected for leakage

After If leaks are found, notify occupant immediately to facilitate repair

Tools:
1. Gas sniffer
2. Spray bottle

Materials:
1. Bubble solution

Inspect exterior gas and oil lines for leaks and damage

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

2.0201.1c - 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 ventilation 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 ventilation systems for damage

Inspect ventilation systems for disconnected pipes

Inspect ventilation 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 per BPI 1200 standards.

**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
Follow BPI 1200 standards to determine the largest negative pressure. Test for spillage if required.

Tools:
1. Manometer
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

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

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

Image 3: For homes with two permanent horizontal duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in² per 2,000 Btu/h (1,100 mm²/kW) of total input rating of all appliances
2.0201.2b - 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

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**Before**
Damaged combustion appliances beyond repair should be replaced

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

- Two-pipe 90% efficiency furnaces are viable replacement appliances
- Direct vent combustion appliances are also viable replacements
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

**Tools:**
1. Drill

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

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

**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
Unsafe solid fuel burning appliances should be replaced

New appliances should be UL-listed and EPA-certified

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

Locate data plate to find out appliance ratings

Check appliance rating plates for EPA and UL markings (or CSA, ETL, or WH markings)
2.0201.3 - Vented Combustion Appliance Safety Testing

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

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**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

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

Missouri Technical Standards require spillage testing for both warm and cold vents limited to 2
minutes.

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

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

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

**Tools:**
1. Combustion analyzer with probe
CO levels cannot exceed 200ppm, or 400ppm air-free CO

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

Test undiluted flue gases in natural draft water heaters--check local codes before drilling

Test accessible exhaust outlets for direct-vent appliances

Test accessible exhaust outlets for power-vented appliances

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

Tools:

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

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

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

Tools:
1. Smoke pencil
2. Timer

Missouri Technical Standards limit testing for spillage on both warm and cold vents to two minutes.
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. B-vent adjustable 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

Tools:
1. Smoke pencil
2. Timer

2.0203.2d - Required combustion air

Desired Outcome:
Flue gasses successfully removed from the house

Specification(s):
The minimum required volume will be 50 cubic feet per 1,000 Btu /h in accordance with IRC and authority having jurisdiction.

Exception: Existing appliances that have passed combustion safety testing per BPI 1200 are deemed to have sufficient combustion air.

Objective(s):
Determine if existing conditions meet the combustion air calculation
Best Practice

If measured volume is less than 50cuft per 1000Btuh, additional combustion air is needed.

Tools:
1. Measuring tape
2. Calculator

Measure the CAZ width. Measure the CAZ length. Measure the CAZ height.

2.0203.2e - Additional combustion air (if action is required)

Desired Outcome:
Flue gases successfully removed from the house

Specification(s):
Additional combustion air will be provided in accordance with IRC or other authority having jurisdiction

Objective(s):
Ensure adequate combustion air for operation of the appliance
Before
Combustion appliance in a confined space

After
Additional combustion air supplied by high and low vents

Tools:
1. Drywall saw
2. Drill
3. Tin snips
4. Tape measure

Materials:
1. Metal ducts

2.0203.2e - Additional combustion air (if action is required)
2.0203.4 - Occupant Education

Desired Outcome:
Ensure persistence of resident safety

2.0203.4a - Occupant health and safety

Desired Outcome:
Ensure persistence of resident safety

Specification(s):
All homes will have a functioning CO alarm

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

Objective(s):
Ensure occupant health and safety

Ensure indoor CO levels do not exceed outdoor CO levels

**Best Practice**
ALL houses must have carbon monoxide detectors installed near sleeping areas

**Best Practice**
Compare indoor and outdoor CO levels. If case of elevated indoor CO levels, locate the source and fix the problem

**Tools:**
1. Combustion analyzer with probe
2. Personal CO monitor
Test all combustion appliances for coexhaust and check against appropriate action levels for appliance type. Do not forget to test gas ovens as a potential source of CO -- check results against action levels. If combustion appliances are source of elevated CO levels, repair or replace as necessary.

Could CO infiltration be coming from outdoor sources? Air seal and weatherstrip to minimize outdoor pollutants.

### 2.0203.4b - Occupant education

**Desired Outcome:**
Ensure persistence of resident safety

**Specification(s):**
Occupants will be educated on the operation and maintenance of the CO alarm.

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

Occupant will be provided information regarding the health effects and risk of high CO concentrations; EPA provides possible expanded actions and offers client education information in an appendix to the protocols.
Objective(s):
Ensure occupant can operate and maintain installations
Inform occupant regarding possible CO hazards

Best Practice
Review CO alarm maintenance with occupant

Best Practice
Provide occupant with information about CO sources, risks, and symptoms
2.0301.1 - Smoke Alarm

Desired Outcome:
Properly installed smoke alarms

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

2.0301.1a - Smoke alarm (hardwired)

Desired Outcome:
Properly installed smoke alarms

Specification(s):
When installing hardwired smoke alarms, it will be listed and labeled in accordance with UL 217 and installed in accordance with the IRC or as required by the authority having jurisdiction

Objective(s):
Ensure proper installation

2.0301.1b - Smoke alarm (battery operated)

Desired Outcome:
Properly installed smoke alarms

Specification(s):
When installing battery operated smoke alarms, it will be installed in accordance with manufacturer specifications

Objective(s):
Ensure proper installation
2.0301.2 - Carbon Monoxide Alarm or Monitor

**Desired Outcome:**
Properly installed CO alarms or monitors

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

2.0301.2a - CO detection and warning equipment (hardwired)

**Desired Outcome:**
Properly installed CO alarms or monitors

**Specification(s):**
Hardwired CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 or as required by the authority having jurisdiction

Installation will be accomplished by a licensed electrician when required by the authority having jurisdiction

**Objective(s):**
Ensure proper installation

2.0301.2b - CO detection and warning equipment (battery operated)

**Desired Outcome:**
Properly installed CO alarms or monitors

**Specification(s):**
Battery-operated CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction

**Objective(s):**
Ensure proper installation
2.0403.1 - Vented Crawl Spaces—Ground Moisture Barrier

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

2.0403.1a - Material Integrity

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

**Specification(s):**
Care will be taken to prevent punctures during installation

**Objective(s):**
Protect ground moisture barrier from damage during other crawl space work

2.0403.1b - 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
Uncovered crawl space floors can cause moisture damage

After

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

Materials:
1. Plastic sheeting (at least 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, able to withstand puncture and last 10 yrs

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

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <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 6mil)
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 and must last at least 10 years

**Tools:**

1. Stapler
2. Drill

**Materials:**

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

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After

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

Seams can be taped to prevent water leakage

Ballast or fasteners can hold barrier in place securely

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Health and Safety > Moisture > Vapor Barriers

2.0403.1e - Fastening

Missouri Department of Natural Resources
Division of Energy
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

2.0403.2a - Material Integrity

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

Specification(s):
Care will be taken to prevent punctures during installation

Objective(s):
Protect ground moisture barrier from damage during other crawl space work

2.0403.2b - 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
Uncovered crawl space floors can lead to moisture issues

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

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

2.0403.2c - 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
Best Practice

Barrier must be at least 6 mil, able to withstand puncture and last 10 yrs

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

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <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).

2.0403.2d - 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
Before Ground moisture barriers help keep moisture from permeating floor

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

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

Materials:
1. Ballast
2. Plastic sheeting (at least 6mil)
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

Tools:
1. Utility knife

Tools:
1. Utility knife

Tape wall seams and press to ensure airtight bonding of adhesive

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

2.0403.2g - Air barrier, ground moisture barrier penetrations, including fastener penetrations

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

Specification(s):
A durable sealant, compatible with the air barrier and ground moisture barrier, will be used

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

Objective(s):
Maintain continuous air barrier and ground moisture barrier

2.0403.2h - Drainage

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

**Specification(s):**
The air barrier and ground moisture barrier will not interfere with the established drainage pattern

**Objective(s):**
Ensure proper drainage

2.0403.2i - Drainage points

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

**Specification(s):**
Interior drainage collection points will be accessible from above and below the air barrier and ground moisture barrier

**Objective(s):**
Remove water above and below the air barrier and ground moisture barrier
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.

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

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

Objective(s):  
Ensure occupant safety

Preserve the integrity and safety of the house

Knob and tube wiring should be identified before work begins

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

Desired Outcome:

2.0601.1 - Knob and Tube Wiring

2.0601.1a - Knob and tube identification

2.0601.1b - Live wire testing
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

---

**Tools:**
1. Non-contact wire tester

---

**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

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

After
Dams should be installed to hold back loose fill insulation

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

Materials:
1. Plywood
2. Drywall
3. Fasteners

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

Verify that wiring is safe to work around

Damming should extend above installed height of insulation

With dams in place, insulation can begin

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.

---

**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.
| 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

Best Practice
Crawlspace access points will have highly-visible, securely-fastened, and durable signage to alert occupant and workers

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

**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

Alert those entering the crawl space never to store hazardous materials

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

3.1001.1a - Pre-inspection

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

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

Repairs will be completed before work

Objective(s):
Repair moisture-related issues

3.1001.1b - Backing and infill

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

Specification(s):
Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the hole

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

Objective(s):
Minimize hole size to ensure successful use of sealant

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

Ensure sealant does not fall out
3.1001.1c - Sealant selection

**Desired Outcome:**
Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

**Specification(s):**
- Sealants will be compatible with their intended surfaces
- Sealants will allow for differential expansion and contraction between dissimilar materials
- Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction

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

3.1001.1d - 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

**Objective(s):**
- Prevent a fire hazard

Local codes will be referenced
Gaps around combustion exhaust flues need to be sealed

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

1. Prepare work area by removing any insulation and debris
2. Use high-temperature caulking (600F min)
3. Apply first ring of caulking to match shape of opening
4.  
5.  
6.  
Apply second ring of caulking to size and shape of rigid material

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

Fasten rigid material to cover penetration and seal against flue with caulk
3.1001.2 - 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

Investigate under insulation in chases to verify they are undamaged

Water damage in chase due to hole to the outside
Tools:
1. flashlight
2. headlamp
3. hammer
4. prybar
5. circular saw
6. reciprocating saw
7. borescope
8. mirror

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

3.1001.2b - 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
Before Unsealed standard chases covered with drywall can be leakage points

After The air barrier is be maintained by capping chases with rigid material

Tools:
1. Drill/screwdriver
2. Caulk gun

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

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

---

 Paneled drop soffits typically are more combustible than plain drywall

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

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

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

EPS or bead-board are not acceptable materials.
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.

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

**After**
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.
Chases need to be capped and sealed to prevent leakage

Chase is sealed along all cracks, gaps, and penetrations

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

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

Always wear protective gloves when working with sealants.

Chase has been capped but needs to be sealed

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

Cap is sealed

---

**3.1001.2f - 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

Chases need to be capped and sealed to prevent leakage

Chase is sealed along all cracks, gaps, and penetrations

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

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

Always wear gloves when working with sealant.

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

Extend seal along adjacent framing
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

3.1001.3a - Pre-inspection

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

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

Repairs will be completed before work begins

**Objective(s):**
Repair moisture-related issues

3.1001.3b - 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

**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

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

Tools:
1. Spray foam gun
2. Caulk gun

Materials:
1. Spray foam (SPF)
2. Caulk

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

For rigid material applications, sealant should be applied to framing

When using SPF to bridge cavity, extend SPF along joist and adjacent framing
3.1003.1 - 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:**

3.1003.1a - Pre-inspection

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

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

Repairs will be completed before work begins

**Objective(s):**
Repair moisture-related issues

3.1003.1b - 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
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. 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

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

After
- 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
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

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

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

Before
Damage to an older ceiling reveals the new ceiling below

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

3.1003.2a - Pre-inspection

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

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

Repairs will be completed before work begins

**Objective(s):**
Repair moisture-related issues

3.1003.2b - Sealing methods

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

**Specification(s):**
Ceiling or roof and wall air and thermal barriers will be connected with a rigid airtight connection around the perimeter

OR

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

OR
Intermediate framing will be used to support air and thermal barrier

OR

Rigid airtight thermal barrier will be installed at the roof sheathing

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

**Objective(s):**
Prevent air leakage from dropped ceiling to attic

### 3.1003.2c - 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
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.
Dropped soffits need to be capped and sealed to prevent leakage

No gaps should remain after sealant is applied

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

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

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

**Tools:**
1. Caulk gun
2. Spray foam 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 sealant is applied along adjacent framing

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

Additional sealant should fill in all remaining gaps after cap has been set
3.1003.3 - Above Closets and Tubs

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

Note:

3.1003.3a - Pre-inspection

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

Specification(s):
An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):
Repair moisture-related issues

3.1003.3b - 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
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

**Tools:**
1. Drill
2. Saw
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
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

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

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

Uninsulated soffits can cause leakage to and from unconditioned spaces

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

### 3.1003.3e - 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

---

**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. Caulk sealant
2. Spray foam

---

Missouri Department of Natural Resources
Division of Energy
Apply sealant to surrounding surfaces before setting cap in place.

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

Additional sealant should fill in all remaining gaps after cap has been set.
3.1003.4 - Dropped Ceilings

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

3.1003.4a - Pre-inspection

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

Specification(s):
An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit.

Repairs will be completed before work begins.

Objective(s):
Repair moisture-related issues

3.1003.4b - 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 installed in line with the ceiling level.

Material will be cut to fit and fastened as required.

OR

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

OR

Wall below openings will be dense packed.
OR

Wall below openings will be bridged and sealed with SPF

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

**Objective(s):**
Prevent air leakage from dropped ceiling to attic

### 3.1003.4c - 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
Create bracing to support spans larger than 24", either from above or below. When supporting from above, apply adhesive between drywall and bracing. Bracing can be screwed to drywall before capping chase.

Ensure new bracing is secure by using screws to fasten to joist. Once chase is capped, it is now ready to be sealed along framing.

3.1003.4d - 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.
Before
Dropped soffits need to be capped and sealed to prevent leakage

After
No gaps should remain after spray foam is applied

Tools:
1. Spray foam gun
2. Caulk gun

Materials:
1. Spray foam
2. Caulk sealant

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

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

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

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

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

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:

3.1003.6a - Pre-inspection

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

Specification(s):
An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

Objective(s):
Repair moisture-related issues

3.1003.6b - 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
Accessible drop soffits should be sealed to prevent heat gain/loss

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
Air Sealing > Attics > Dropped Ceilings and Soffits 3.1003.6d - Option 2: leave soffit outside (seal at bottom or side)

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 be faced with rigid material, fastened and sealed

3.1003.6e - Soffits containing non-IC rated recessed lights

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

Specification(s):
Insulation will be kept at least 3" away from the top and side of any fixtures

If dropped soffit is to be filled with insulation, then a sealed rigid barrier enclosure will be installed to maintain a 3" clearance around the entire fixture

Top of rigid barrier enclosure will be sealed with non-insulating rigid material (e.g., gypsum or equivalent perm rating and R-value)

Objective(s):
Prevent light fixture from overheating

Bring light fixture inside of the air barrier
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

**Best Practice**
In homes built before 1978, test paint before beginning renovation

**Tools:**
1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera
EPA RRP certification required to conduct Lead Paint assessment.

Clean tools and sample site to prevent contamination

Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers

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

Check swab for reaction Red indicates lead positive. White is lead negative.

If negative, verify validity of test with provided calibration card

Lead in calibration card should test positive and turn spot red

Record test results to maintain documentation

3.1201.1b - Weather stripping

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

**Specification(s):**
Existing weather stripping and sash sealant will be removed

Surface where the sill meets the sash will be cleaned

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

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

**Objective(s):**
Form a complete seal from the outer edge of the sash to the jamb

Maintain operability of the window

---

**3.1201.1c - Sash locks**

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

**Specification(s):**
Locks will be installed so that the rails of the upper and lower sashes are flush and in full contact

No gaps will be visible between the two sashes

Locks will be installed to achieve compression of the two sashes

**Objective(s):**
Form a secure connection between the two sashes

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**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
3.1201.1e - Sash replacement

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

**Specification(s):**
Lower sash will have the same bevel on the bottom rail as the sill

Sash will be water-sealed and primed

**Objective(s):**
Ensure sash remains in a fixed position when open or partially open

Maintain operability of the window

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

3.1201.1f - Adjust stops

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

**Specification(s):**
 Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window

**Objective(s):**
Form a complete seal between the jamb, sash, and stop
Maintain operability of the window

### 3.1201.1g - Replace stops

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

#### Specification(s):
Stops will be installed to keep the window securely in place

Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window

#### Objective(s):
Form a complete seal between the jamb, sash, and stop

Maintain operability of the window
3.1201.2 - Single-Unit Window and Fixed Frame with Wood Sash

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

Note:

3.1201.2a - 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 RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

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

Best Practice
In homes built before 1978, test paint before beginning renovation
Tools:
1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

1. Clean tools and sample site to prevent contamination
2. Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers
3. Break capsule and shake to mix reagents. Swab sample site for 30 seconds
4. Check swab for reaction
5. Red indicates lead positive. White is lead negative
6. If negative, verify validity of test with provided calibration card
3.1201.2b - Operable windows

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

**Specification(s):**
All egress windows will be operable as required by local codes

**Objective(s):**
Maintain operability of egress windows

3.1201.2c - Air infiltration

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

**Specification(s):**
Details that reduce air infiltration will be repaired, replaced, sealed, or installed (e.g., new latch for meeting rail connection, pulley seals, rope caulking for other cracks, interior storm windows)

State Energy Conservation Code or local code requirements for air leakage should be met (whichever is more stringent)

**Objective(s):**
Reduce air infiltration

3.1201.2d - Water infiltration

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

**Specification(s):**
Details that reduce water infiltration will be repaired, replaced, or installed (e.g., replace missing glazing compound on sash, exterior caulking, exterior storm windows)

**Objective(s):**
Reduce water infiltration
3.1201.2e - Occupant education and maintenance

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

**Specification(s):**
Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain window

**Objective(s):**
Ensure long-term weather tightness
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

Best Practice
In homes built before 1978, test paint before beginning renovation

Tools:
1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera
EPA RRP certification required to conduct Lead Paint assessment.

1. Clean tools and sample site to prevent contamination
2. Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers
3. Break capsules and shake to mix reagents. Swab sample site for 30 seconds
4. Check swab for reaction
5. Red indicates lead positive. White is lead negative
6. If negative, verify validity of test with provided calibration card
7. Lead in calibration card should test positive and turn spot red
8. Record test results to maintain documentation

3.1201.3b - 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

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

**After**
With proper adjustment, doors should hang true and minimize leakage

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

**Materials:**
1. Shims

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
Daylight visible under exterior doors indicate water can leak in

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

Tools:
1. Caulk gun
2. Screwdriver
3. Pry bar

Materials:
1. Caulk sealant

Adjust threshold to minimize gap and keep water out
Caulk along threshold from inside and outside to prevent water infiltration
3.1201.3e - Occupant education and maintenance

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

**Specification(s):**
Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain weather stripping and caulk around door and trim

**Objective(s):**
Ensure long-term weather tightness
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

![Best Practice]

In homes built before 1978, test paint before beginning renovation

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

EPA RRP certification required to conduct Lead Paint assessment.
Clean tools and sample site to prevent contamination

Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers

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

Check swab for reaction

Red indicates lead positive. White is lead negative

If negative, verify validity of test with provided calibration card

Lead in calibration card should test positive and turn spot red

Record test results to maintain documentation

**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

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

**Materials:**
1. Tape

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

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

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

1. Always wear heavy work gloves when working with glass
2. Cut through caulk bead and glazing to ease removal
3. Remove old putty and glazing to expose metal points holding glass in place
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

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

**Materials:**
1. Sand paper
2. Cleaning solution
3. Rags

Remove all debris from sash either by sand paper, knife, or chisel
Mount new glass onto a clean surface

With points and glass removed, measure opening for replacement pane
Cut replacement glass 1/8" smaller than measured opening
Debris in the sash can cause new glass to seal improperly. Check closely to remove all pieces of broken glass and debris. With sash cleaned, glass will fit properly and glazing will seal.

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
Before
With sash prepared, installation of new pane can begin

After
Replacement glass should be securely fixed with points and glazing

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

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

Always wear heavy work gloves when working with glass. See also 2.0100.1b for Hand Protection.
Use shims to center glass while installing push points

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

Secure pane in place with tape to hold until glazing sets
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

**Best Practice**
In homes built before 1978, test paint before beginning renovation

**Tools:**
1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera
EPA RRP certification required to conduct Lead Paint assessment.

1. Clean tools and sample site to prevent contamination

2. Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers

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

4. Check swab for reaction

5. Red indicates lead positive. White is lead negative

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

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

8. Record test results to maintain documentation

3.1202.2b - 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

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

**Materials:**
1. Tape

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

broken glass with failed repairs needs to be replaced

**In Progress**
After larger pieces are removed, the sash still needs preparation

Always wear heavy work gloves when working with glass.
With pins and glass 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

In Progress

Remove all debris, glazing tape, and glass from sash.

Sash surface must be clean before mounting new glass.
Tools:
1. Chisel
2. Utility knife

Materials:
1. Cleaning solution
2. Rags

Debris in the sash can cause new glass to seal improperly
Check closely to remove and collect all broken glass and debris
With sash cleaned, glass will fit properly and glazing will seal

3.1202.2d - New glass installation

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

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

Best Practice
In homes built before 1978, test paint before beginning renovation

Tools:
1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera
EPA RRP certification required to conduct Lead Paint assessment.

1. Clean tools and sample site to prevent contamination
2. Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers
3. Break capsules and shake to mix reagents. Swab sample site for 30 seconds
4. Check swab for reaction
5. Red indicates lead positive. White is lead negative
6. If negative, verify validity of test with provided calibration card
7. Lead in calibration card should test positive and turn spot red
8. Record test results to maintain documentation

3.1203.1b - 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

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

Wood double-hung window

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

Remove sashes and balances (tracks). Remove sash cords and pry pulleys out of the jamb in older units
Scrape loose paint and thoroughly clean opening

### 3.1203.1c - 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

**Before**
Window opening ready to receive replacement window

**After**
Replacement window installed, with stop molding replaced and caulked
Tools:
1. Utility knife
2. Hammer
3. Sharp-bladed prybar
4. Nail set punch
5. Cordless driver/drill
6. Caulking gun
7. HEPA vacuum (for lead-based paint work)

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

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

**Best Practice**
In homes built before 1978, test paint before beginning renovation
Tools:
1. Note: Mask must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

EPA RRP certification required to conduct Lead Paint assessment.

Clean tools and sample site to prevent contamination

Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers

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

Check swab for reaction

Red indicates lead positive. White is lead negative

If negative, verify validity of test with provided calibration card
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

Tools:
1. Pry bar
2. Utility knife
3. Drill

Materials:
1. Window and door flashing
Single pane window needs to be replaced with double pane

Cut through caulk at stops to break seal

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

Remove interior trim

Remove exterior trim

Remove exterior fasteners to free window

Remove window from rough opening

Clean rough opening to remove old caulk and debris

Install flashing along sides and bottom of rough opening

**3.1203.2c - Replacement unit preparation**

**Desired Outcome:**
Replacement window provides weather tight fit; improved energy efficiency performance of fenestration
3.1203.2d - Replacement window installation

**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

**Tools:**
1. Tape measure
2. Utility knife

**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.

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

Before
Single pane window is being removed to install double pane unit.

After
Double pane unit installed with trim in place.

Install flashing to manufacturer specs
Flanges have been folded out to allow Fasten window flange securely around
and industry standards for easy installation 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

Missouri Department of Natural Resources
Division of Energy
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

(before) Gaps around floor penetrations, such as plumbing, HVAC, and electrical

(after) Gaps should be sealed to maintain air barrier

Tools:
1. Headlamp

Materials:
1. Backer rod
2. Sealant
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 caulk
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

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

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

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

Sprayfoam can be used to seal the hole and hold mesh in place.
3.1501.1 - 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

![Before](image1.png)
Penetrations between the garage and house can leak hazardous fumes

![After](image2.png)
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

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

**After**
Sealed ductwork connections help prevent leakage.

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

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.

— Before

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

— After

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

**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

Missouri Department of Natural Resources
Division of Energy
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

Before
Daylight visible under door to garage indicates leakage

After
Door sweep, with weatherstripping, will minimize air exchange with garage
Tools:
1. Caulk gun
2. Screwdriver
3. Utility knife
4. Hacksaw
5. Saw
6. Tape measure
7. Drill
8. Planer

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

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

CO alarms will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms and must be installed by the end of work the first day.

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

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
Occupants should never run vehicles in a closed garage.

Occupants should not light combustibles inside garages.

Speak with occupant about hazards of using gas appliances in the garage.
3.1601.3 - 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

Before

After

Ducts should not be allowed to droop and drag, adding distance to run
Properly supported ducts minimize heat loss and and maximize duct run
**Tools:**
1. Metal snips
2. Utility knife
3. Drill
4. Stapler

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

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**BAD:** Make sure supports DO NOT compress insulation or duct

**Flex ducts should have supports no less than every 4 feet**

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

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

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

**Metal wire should be at least 12 gauge and galvanized**
3.1602.1 - Air Sealing Duct System

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

3.1602.1a - New component to new component sealant selection

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

**Specification(s):**
Any closure system used will be in accordance with IRC Chapter 16

**Objective(s):**
Ensure effectiveness of air sealing system

3.1602.1b - New 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 fiberglass mesh and mastic

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

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

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

**Objective(s):**
Eliminate air leakage into or out of ducts and plenums

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

Reinforce seal
Support mastic and fiberglass mesh during curing

3.1602.1c - 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

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

After Sealed ductwork connections help prevent leakage
Materials:

1. Mastic
2. Fiberglass mesh tape

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

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

Materials:
1. Mastic
2. Mesh tape
Remove grill to expose duct boot and gaps

Wet the edges of the drywall to ensure a good bond

Cut mesh tape to fit around duct boot and cover gaps

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

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
Before

Locate unsealed ducts constructed from building cavities

After

Return plenum lined with fiberglass duct board and sealed with mastic

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

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

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

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

From NFPA 90B 4.3.1.1: "Duct coverings, duct linings, and tapes used in duct systems shall have a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84 or ANSI/UL 723..."
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

**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
Before

Uncovered filter slots are a point of leakage

After

Filter slots should be covered
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

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.

**Tools:**

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

**Materials:**

1. XPS
2. Drywall
3. Fire-resistant caulk
4. Fasteners
Do NOT use EPS in air returns due to proximity to combustion appliances

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

3.1602.5c - 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
Before
Non-IC rated recessed light fixtures should be dammed from insulation

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

Tools:
1. Utility knife
2. Tape measure

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

Box should be constructed with clearances in mind
Sealed box should be constructed of fire-rated drywall
OR non-IC 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
Non-IC rated recessed lights create excess heat and are a fire risk

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

Tools:
1. Utility knife
2. Caulk gun

Materials:
1. Drywall

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

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

---

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

**Materials:**
1. Fire-rated silicone caulk
2. UL-181 mastic
3. Spray foam
4.1001.2 - 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

Unsure Wiring
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

**Tools:**
1. Non-contact wire tester

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
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

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

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

Knob & tube wiring radiates heat and cannot be insulated over

Before insulation, wiring should be dammed or disabled and replaced
NEC guidelines and local jurisdictions often closely prescribe the treatment of knob & tube wiring. Check your local codes.

1. If electrician determines wiring is safe and keeps it active, isolate wires
2. To isolate, dams higher than intended insulation depth should be installed
3. Warning of knob & tube should be posted at all entrances to related spaces
4. Warning signs should encourage the use of certified electrician for repairs
5. Some jurisdictions require warning signs in Spanish as well
6. If knob & tube can be replaced, all existent k&t should be disabled
7. Many electricians will remove exposed wires to prevent reactivation
8. Modern wiring should replace all knob & tube

CAUTION!
Live Knob & Tube wiring present!

CUIDADO!
Cableado eléctrico con aisladores ceramicos vivo!

En Inglés: knob & tube wiring

Síes necesario realizar alguna reparación, ponerse en electricista certificado.

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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

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

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

After
Chimneys and flues should be dammed to prevent fire
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 and flues 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
To prevent fire hazards, flues, chimneys, and light fixtures require dams.

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

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

Baffles installed in vented attics to allow airflow past insulation

Insulation should not block vented eaves
Allow a standard two inch gap for air flow through eave

Baffles should be securely fastened to prevent movement over time

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

Baffles also hold insulation from falling into eave
4.1003.3 - 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

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

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

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
Before

Knee walls often need sealing and insulation

After

Knee wall is prepped for dense pack insulation

Tools:

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

Materials:

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

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

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4.1004.1a - Backing
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

Before
Top plate is missing from knee wall

After
New top plate is sealed to adjacent framing
Tools:
1. Spray foam gun
2. Caulk gun
3. Tape measure
4. Utility knife
5. Drill
6. Saw

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

Top plate has been cut and fit to size
Top plate has been sealed to adjacent framing
Bottom plate is also missing. Space is measured so XPS can be cut

Bottom plate is cut to size
Bottom plate is placed in line with interior air barrier
Bottom plate is also sealed to surrounding joist and framing

4.1004.2b - 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

After
Properly fit insulation filling full volume of stud bay

Tools:
1. Utility knife
2. Tape measure

Materials:
1. Fiberglass batts

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.

**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

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

Pry up flooring to access floor cavities
Check cavity for electrical junctions and penetrations
If electrical junctions are found, they should be enclosed and flagged
Air seal any penetrations

---

**4.1005.1b - 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
Before

Accessible attic floors should be air sealed and insulated

After

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
  Todd McVicker
  Missouri Department of Natural Resources
• 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
Before
Accessible attic floors should be air sealed and insulated

After
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.

When missing, bottom plates must be installed under knee walls. New bottom plates complete air barrier and hold insulation in place.
4.1005.2c - Installation

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

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

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

4.1005.3a - Preparation

Desired Outcome:
Insulation controls heat transfer through ceiling

Specification(s):
Existing insulation will be in contact with the air barrier prior to installing additional insulation on top

Objective(s):
Ensure proper performance of insulation

4.1005.3b - Installation

Desired Outcome:
Insulation controls heat transfer through ceiling

Specification(s):
If the top of the existing insulation is below the top of the framing, new batts will be installed parallel with framing members
If the top of the existing insulation is above the top of the framing, new batts will be installed perpendicular to framing members

Objective(s):
Ensure uniform depth of insulation in continuous contact with existing insulation
Eliminate voids and gaps

4.1005.3c - Insulation

Desired Outcome:
Insulation controls heat transfer through ceiling

**Specification(s):**
Batts 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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### 4.1005.3d - Safety

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

**Specification(s):**
Insulation will not be allowed on top of non-IC rated can light boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources

**Objective(s):**
Prevent a fire hazard

---

### 4.1005.3e - 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

After
Provide occupant with documentation of and about insulation installed

Best Practice
Documentation should include insulation material and r-value
4.1005.4 - Accessible Floors—Loose Fill Over Existing Insulation

Desired Outcome:
Insulation controls heat transfer through ceiling

4.1005.4a - Preparation

Desired Outcome:
Insulation controls heat transfer through ceiling

Specification(s):
Existing insulation will be in contact with the air barrier prior to installing additional insulation on top

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

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

Open electrical junction boxes will have covers installed

Insulation dams and enclosures will be installed as required

Objective(s):
Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing

Prevent an electrical hazard

4.1005.4b - Installation

Desired Outcome:
Insulation controls heat transfer through ceiling

Specification(s):
The correct depth and number of bags will be blown in accordance with manufacturer specifications

Insulation will be installed to prescribed R-value
Objective(s):
Insulate to prescribed R-value

4.1005.4c - Safety

Desired Outcome:
Insulation controls heat transfer through ceiling

Specification(s):
Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources

Objective(s):
Prevent a fire hazard

4.1005.4d - 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
Written documentation of insulation type and efficiency will be provided

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

This finished garage below a bonus room is an unconditioned space.

Rigid material forms an air barrier located under the bonus room stem wall.
Snap chalk lines to keep access cuts clean and easy to repair

Cut through garage ceiling to access joist cavities below bonus room

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

Measure joist cavity depth

Measure joist cavity width

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

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

Rigid block will hold the insulation in place under the bonus room above

**4.1005.5b - 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
Blow insulation into cavities to density appropriate for chosen material

Close cavities with access panel cut out at the beginning

Cut small test holes in cavities to verify specified density has been met

Set up blower door and depressurize bonus room to -50pa wrt outside

With blower door running, chemical smoke should not draw into test holes

Tape and spackle access panel and test holes to repair garage ceiling

**4.1005.5c - 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

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

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**Before**
Insulation needs to be dammed to keep from falling through during operation

**After**
Insulated pull-down stairs cover installed to prevent air leakage
Tools:
1. Tape measure
2. Drill
3. Saw
4. Caulk gun

Materials:
1. Caulk sealant
2. Lumber
3. XPS
4. Pre-fabricated stairwell cover

Stairs and hatch should both be insulated to match final R-value of attic when structurally allowable

**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
Unsealed pull-down stairs leads to air leakage to and from the attic

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

Before
Uninsulated attic hatches and access panels weaken the thermal envelope

After
Hatch cover or panel access door should match r-value of attic insulation
Materials:

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

Create hatch cover that matches r-value of surrounding insulation

Build dam to hold back attic insulation and hold cover in place tightly

Weatherstrip underside of hatch cover to create tight seal

Alternate installation for vertical access panel to attic

4.1006.2b - 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

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

![Before](image3.png) ![After](image4.png)
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

![Before]
Unsealed and uninsulated attic hatches and access doors allow leakage

![After]
Rigid insulation on back of new hatch cover attached firmly and squarely to allow for air-tight fit

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

**Materials:**
1. XPS
2. Adhesive

**Steps:**
1. Apply foam tape to "warm side" face of attic hatch
2. Ensure an air tight seal by making sure foam tape has no gaps
3. Apply strong adhesive to "cold-side" of hatch
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

4.1088.3a - 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

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

Insulated, air sealed skylight well

**Before**

**After**

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

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

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

Skylight well

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

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

After
Sealed penetrations offer leakage protection and keep insulation in place

Tools:
1. Caulk gun

Materials:
1. Backer rod
2. Spray foam
3. Caulk
4.1102.1b - 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
Before
Open walls should be insulated

After
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

**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

Tools:
1. Hands
2. Eyes

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

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**Best Practice**

Documentation should include insulation material and r-value

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**After**

Provide occupant with documentation of and about insulation installed
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

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
Make accurate count of insulation bags to be installed

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

**Tools:**

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

**Materials:**

1. cellulose or fiberglass insulation (any fiberglass material used must be specifically approved for air flow resistance by the manufacturer)
2. wooden, plastic, or foam plugs to fill installation holes
3. piece of fiberglass batt or towel to stop insulation from blowing out around the hose

State of Missouri DOE variance 1/29/18: Dense-pack insulation density will be verified by bag count, core sampling or with diagnostic methods such as infrared camera or chemical smoke with blower door at 50 Pascals of pressure difference.

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

Installer shall provide a dated insulation receipt showing coverage area, R-value, and thickness

Obtain a dated insulation receipt showing coverage area, R-value, and thickness from the installer.
4.1103.2 - 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

Cavities missing insulation allow greater heat transfer than insulated ones

Either from inside or outside, using IR camera to locate cavities for fill
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

**Tools:**
1. Caulk gun

**Materials:**
1. Caulk
2. Backer rod
3. Fire-block, when necessary

---

Before
Unsealed penetrations should be sealed to ensure insulation stays in place

After
Once air barrier has been preserved by sealing, insulation can begin

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

**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

State of Missouri DOE variance 1/29/18: Dense-pack insulation density will be verified by bag count, core sampling or with diagnostic methods such as infrared camera or chemical smoke with blower door at 50 Pascals of pressure difference.
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

![Before](image1)

Uninsulated exterior wall cavities to be insulated

![After](image2)

Reduced temperature difference indicating insulated wall cavities

**Tools:**
1. Infrared camera

![Depressurize house](image3)

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

![Inspect](image4)

Inspect for voids and low density areas

![Reduced temperature](image5)

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**
Exterior holes will be weather barrier patched and interior holes will be coated and patched to match original interior

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

**Tools:**

1. Utility knife
2. Tape measure

**Materials:**

1. Kraft-faced fiberglass batts to work order specifications

Order and install insulation as called for in Work Order.

If precise r-value cannot be purchased, choose option with greater r-value.

Install kraft-faced batts with paper against subfloor.

Ensure batts are in full contact with subfloor and remain uncompressed.
4.1301.1c - 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

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

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

Before
Fiberglass batts should not be hanging away from subfloor

After
"Lightning rods" or twine can be used to hold batts in contact

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

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**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

**Tools:**

1. Utility knife
2. Insulation machine

**Materials:**

1. Loose fill fiberglass or cellulose

---

**In Progress**

With netting in place, insulation can begin

**After**

Cavities filled to manufacturer specs to achieve prescribed r-value

**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**
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

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation
4.1301.3 - 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

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.
Locate gaps around penetrations for plumbing, electrical, etc.

Fill gaps greater than 1/4 inch with backer rod or spray foam

Caulk smaller gaps and to hold backer rod in place

4.1301.3b - 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

Uninsulated floors over unconditioned spaces are an energy drain

Rigid barriers provide air sealing and create cavities for insulation

Before

After
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
Remember to seal along sills as well

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

Before
Once rigid barrier is sealed, insulation can be blown in

After

Tools:
1. Insulation machine
2. Caulk gun

Materials:
1. Loose fill insulation
2. Caulk

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

Loose fill cavities created by rigid

Once filled to prescribed density,
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

**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 small gaps and to hold backer rod in place

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

Uninsulated floors over unconditioned spaces are an energy drain

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
Remember to caulk along sills

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
Dense pack insulation into floor
When filled to specified density and r-
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

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

After
Cavity has been blocked, sealed, and insulated. Rigid air barrier is hidden behind insulation in this photo
Tools:
1. tape measure
2. utility knife
3. flashlight
4. caulking gun
5. foam gun

Materials:
1. rigid air barrier (plywood, OSB, drywall, rigid foam board)
2. caulk or foam sealant
3. dense-pack cellulose or fiberglass insulation
4. batt insulation
5. two-part spray polyurethane foam (optional)

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

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

Before
Cavities are open and subfloor of conditioned space above is uninsulated.

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

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

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

Cavities have been insulated but are still exposed.

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

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

4.1301.5e - Occupant education
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.
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

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

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

Batts should not hang away from subfloor

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

Unfaced fiberglass batts can be attractive housing for pests

Rigid barrier allows for air sealing and protects batt insulation
**Tools:**
1. Utility knife
2. Saw
3. Drill
4. Tape measure
5. Caulk gun

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

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

Remember to seal along sills

---

**4.1301.6e - 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

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

### 4.1301.7b - 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

Uninsulated floors over unconditioned spaces are an energy drain

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 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

Fill cavities formed by rigid barrier

Once cavities have been filled to
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

**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.
4.1301.8b - 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

Uninsulated floors over unconditioned spaces are an energy drain

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
Remember to seal along sills

**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

Blown in insulation to density and r-

Once cavity is filled, prepare plug to
than insulation hose value specified by work order 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</th>
<th>Continuous Rigid Insulation, Interior or Exterior</th>
<th>Interior Cavity Insulation</th>
</tr>
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<tbody>
<tr>
<td>Zone 1</td>
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<td>0</td>
</tr>
<tr>
<td>Zone 2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zone 3</td>
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<td>Zone 5 and marine 4</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Zone 6-8</td>
<td>16</td>
<td>19</td>
</tr>
</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
Both kraft-face and drywall create air barrier, but batts are absorbent

4.1402.2c - Vapor permeability

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

**Specification(s):**
When absorbent insulation materials are installed, assembly will remain vapor semi-impermeable to the interior in all climate zones except Zone 7

**Objective(s):**
Provide drying potential to the basement
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.

### 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

**Tools:**
1. Putty knife

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

Unsealed joints and connections need to be sealed to prevent health risks. Sealed ductwork connections help prevent leakage.
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

Materials holding insulation in place should not compress or kink duct

Durable materials can be attached without compressing insulation
Tools:
1. Scissors
2. Metal snips

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

4.1601.2d - 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

Before
Unsecured and sealed insulation around ducts is useless

After
All seams should be sealed with UL-181 duct tape to preserve vapor barrier

Tools:
1. Utility knife

Materials:
1. UL-181 tape
2. R-8 duct insulation with vapor barrier
5.3003.1 - 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

Best Practice
Thoroughly inspect all heating and cooling equipment for safe operation and locate data plate to record information

Best Practice
Record model information about heating and cooling equipment to ensure proper maintenance
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. If 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

**After**
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 is typically 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
Locate nozzles on oil-fired water heaters and furnaces

Best Practice
Verify that nozzle size is appropriate for model by consulting flow chart

Tools:
1. Calipers
2. Nozzle Sizing Capacity Chart

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

**Tools:**
1. Smoke testing pump

**Materials:**
1. Filter paper

**Best Practice**
Smoke tests determine if oil-fired appliances burn cleanly by testing soot

Verify oil-fired furnaces and water heaters are operating safely
Place filter paper in testing pump and draw air through paper

Remove paper and verify draw was successful by checking for soot

Compare level of soot deposit against smoke chart. A rating of 0 is ideal

Appliances with ratings of 3 or higher should be cleaned and tuned

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
In Progress

Test flue gases to determine steady state efficiency

After

Test 10-15min after firing, when appliance is at steady state. Reading should be within manufacturer's tolerances

Tools:
1. Combustion analyzer with probe
2. Drill

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
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.
Oil-fired appliances require an appropriate level of air mixed with the oil

The percentage of Excess Air (EA) should be within manufacturer specs

**Tools:**
1. Combustion analyzer with probe
2. Drill

**5.3003.2j - 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

**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
- Damper
- Roof jack support
- Water line
- Water valve
- Electrical
- Pads
- Motor
- Fan

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

Objective(s):
Ensure all components function properly
Assess wear and tear on various parts of evaporative cooler

Pads have deposits and are shrunken from age. Replace

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
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

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

After
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

Occupants with evaporative coolers should be alerted to proper maintenance

Best Practice
Communicate professionally with occupant to provide information and support

Review properly and timely evaporative cooler maintenance

Explanation 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

Tools:
1. Hacksaw
2. Crimper

Materials:
1. Pex piping and angles
2. PVC piping and angles
3. Purple primer
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

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

A float switch should be installed to prevent overflow and damage

### 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
Before

HVAC equipment that drains upward through a roof cannot drain naturally

After

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

State of Missouri DOE variance 1/29/18: Gas pressure testing will be completed by a certified HVAC professional on new Gas HVAC installs and all Gas unit clean and tunes.

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

5.303.14c - 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
In Progress

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

Tools:
1. Metal snips
2. Drill

Materials:
1. Metal duct piping
2. Fasteners

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

Duct is the same size as the outlet and makes shortest run possible

See also ASHRAE 62.2-2016.
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

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

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

**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

Metal ducts should be supported at 10 feet or less with wire or metal strap

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

Metal wire should be at least 12 gauge and galvanized

### 6.6002.1d - 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

**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

---

Before
Fan duct is disconnected and venting into the attic space.

After
Fan has been vented with sealed, insulated duct material.

Apply mastic to the connection fitting
Snug duct liner onto connection fitting
Use tie band and tensioner to secure liner to connection fitting
Apply mastic to fan connection

Using mechanical fasteners, secure connection fitting to fan connection

Snug insulation to fan housing and strap into place

Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum

PVC-to-PVC connections should use PVC primer and cement

Sealants should be UL181-M or UL181B-M listed

**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 - Terminations

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

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\(\text{"} \)), mark to cut hole

Hole should be no more than 1/4\(\text{"} \) larger than termination fitting diameter

Verify hole size is correct before installation

### 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

Before
Termination is not mechanically fastened, or sealed appropriately.

After
Termination fitting is secure, and duct is sealed to termination.
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
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

Before
Exhaust terminations without screens are an invitation to pest intrusion

After
Screen mesh should be between 1/4" and 1/2" in either direction

6.6002.2f - 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
Before
Kitchen exhaust vents should not be made from highly combustible materials

After
This roof-mounted kitchen exhaust fan is galvanized steel--heat resistant
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

Tools:
1. Tape measure
2. Saw

Before
Determine size to cut hole by measuring fan assembly and ducting

After
A snug fit should be ensured to minimize weatherproofing required
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

6.6003.3b - 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
Before
Incorrect: disconnected ground, no wire nuts on splices, no clamp on wires passing through junction box

After
Fan junction box with cover installed

Tools:
1. Wire strippers
2. Utility knife or cable ripper
3. Screwdriver
4. Non-contact voltage tester
5. Lineman's pliers

Materials:
1. Ground wire crimp sleeves
2. Non-metallic sheathed wire (Type NM-B) e.g., Romex ®
3. Plastic junction box and cover plate
4. Wire nuts
5. Cable staples
6. Clamp-type cable connectors

Follow manufacturer's specifications and applicable codes when wiring newly installed equipment.

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 an 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
Apply sealant behind termination cap, taking care to apply sealant to all edges.

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

---

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

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.
Attach a the hose to a T connection on channels A & B with the manometer set to measure exhaust fan flow. With manometer properly set up, prepare to test air flow. Fans must meet minimum CFM requirements according to ASHRAE 62.2-2016.

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

#### Tools:
1. Manometer

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Before: Installing new ventilation can cause imbalances within the house

After: Test to assure that combustion appliances do not spill during "Worst Case" depressurization
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

Before
Dryer is vented outside, but with the incorrect material.

After
Dryer is vented outdoors, with correct material. Run is as short and straight as possible ensuring maximum flow.

Tools:
1. metal trimmers
2. drill

Materials:
1. metal flex duct
2. dryer vent kit
3. hose clamps

1. Disconnect existing vent pipe from termination. If hose clamp is installed, save for reuse.
2. Disconnect existing vent pipe from dryer.
3. Attach approved vent material to termination vent. Termination vent may need to be trimmed.
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 to ensure new ventilation isn't causing unsafe conditions.

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

Install make-up air, such as a passive inlet vent, or other pressure relief.

After mitigation, verify that depressurization limit is not being exceeded.
6.6005.1e - 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.

6.6005.2a - Wiring

Desired Outcome:
Kitchen range fan installed to specification

Specification(s):
Wiring will be installed in accordance with local regulations or the IRC in the absence of such regulations or where those regulations are not as stringent as the IRC

Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes

Objective(s):
Prevent an electrical hazard

6.6005.2b - 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 ventilating device

Objective(s):
Remove cooking contaminants from the house

Preserve integrity of building envelope
6.605.2c - 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
Exhaust duct should be smooth-walled and in as short a run as possible

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.

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

Before
Kitchen fans should exhaust to the exterior, not just recirculate air

After
Exhaust fans should have backdraft dampers
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
Before
Kitchen exhaust fans can cause combustion appliances to depressurize

After
Test to assure that combustion appliances do not spill during "Worst Case" depressurization

Tools:
1. Manometer

6.6005.2g - Occupant education

Desired Outcome:
Kitchen range fan installed to specification

Specification(s):
Occupant will be instructed to keep grease filters and termination fitting clean

Objective(s):
Effectively move air from kitchen range to outdoors
6.6201.2 - 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

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

After
Passive door vents and individual room returns are two possibilities
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.

7.8102.2a - Hazardous material removal

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

**Specification(s):**
Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified

Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator

Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)

**Objective(s):**
Remediate health hazards using EPA-certified contractors

7.8102.2b - Equipment removal

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

**Specification(s):**
Accepted industry procedures and practices will be followed to:

- Remove old water heater and associated components in accordance with IRC or authority having jurisdiction
• Seal any unused chimney openings and penetrations in accordance with IRC or authority having jurisdiction
• Remove unused oil tank, lines, valves, and associated equipment in accordance with IRC or authority having jurisdiction

All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards

Objective(s):
Ensure the safety of the workers and occupants
Preserve integrity of the building
Remove old equipment in a timely and efficient manner

7.8102.2c - New equipment installation

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

Specification(s):
New water heater and associated components will be installed to accepted industry standards, in accordance with the IRC and manufacturer specifications

The system will be installed to be freeze resistant
Any existing water leaks will be repaired before installation begins
Any penetrations to the exterior of the home created by the installation of the equipment will be sealed

Objective(s):
Ensure the safety of the workers and occupants
Preserve integrity of the building
Remove old equipment in a timely and efficient manner
**7.8102.2d - Emergency drain pan**

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

**Specification(s):**
An emergency drain pan and drain line shall be installed in accordance with the IRC

**Objective(s):**
Collect and safely dispose of water escaping from the storage tank

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**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

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**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.

Missouri Technical Standards state: "A potable water expansion tank will be installed on the cold..."
water side in accordance with the AHJ"

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

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

Water heaters should be not capped off at t&p valve  
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.
GOOD: T&P discharge should be piped within 6" of the floor or to outdoors

BAD: T&P discharge should flow with gravity and be observable

BAD: T&P discharge should not be piped into drainage system

7.8102.2g - Dielectric unions

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

Specification(s):
Dielectric unions will be installed in accordance with the IRC, authority having jurisdiction, and according to manufacturer specifications

Objective(s):
Break the stray voltage electrical circuit through the storage tank

7.8102.2h - Backflow prevention

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

Specification(s):
Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes

Objective(s):
Protect water supply from contamination
7.8102.2i - Thermal efficiency

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

**Specification(s):**
If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications

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

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

Combustible pipe insulation must maintain a minimum clearance of 6" from gas water heater draft hood and/or single wall metal pipe. Clearance from vent such as "B" vent should be maintained per vent manufacturer's specifications

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

**Objective(s):**
Reduce standby loss from near tank piping and storage tank

Ensure insulation does not make contact with flue gas venting

7.8102.2j - Fuel supply

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

**Specification(s):**
Electric or fossil fuel supply components will be installed to accepted industry standards as per NFPA 31 and 54, or NFPA 70 National Electric Code (NEC) for electric components, or authority having jurisdiction

**Objective(s):**
Provide sufficient fuel to the water heater, burner, or element
**7.8102.2k - 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](image1.png) **Unsafe**
Water heaters producing water over 120 degrees raise heating costs

![Safe](image2.png) **Safe**
Water heaters should produce water under 120 degrees to prevent scalding

**Tools:**
1. Thermometer

![Image 3](image3.png)

1. Test temperature of hot water at faucets in house
2. Hot water temperatures should not exceed 120 degrees Fahrenheit
3. Adjust water heater settings and insulate as needed
7.8102.2l - Commissioning of system

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

**Specification(s):**
The following will be checked once the system has been filled and purged:

- Safety controls
- Combustion safety and efficiency
- Operational controls
- Fuel and water leaks
- Local code requirements

Commissioning will be in compliance with manufacturer specifications and relevant industry standards

**Objective(s):**
Ensure safe system function

Keep cost of ownership as low as possible

7.8102.2m - Occupant safety

**Desired Outcome:**
Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of owner
Ownership

**Specification(s):**
Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction.

Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels.

**Objective(s):**
Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate.

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7.8102.2n - Occupant education

**Desired Outcome:**
Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership.

**Specification(s):**
Completed work will be reviewed.

Occupants will be educated on the safe and efficient operation and maintenance of the system, including:

- Adjustment of water temperature and target temperature in accordance with local code
- Periodic drain and flush
- Expansion tank and backflow preventer (no occupant maintenance required)
- Periodic inspection, maintenance, or replacement

**Objective(s):**
Ensure occupant is informed of the safe, efficient operation and maintenance of the system.
7.8103.1 - 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

Before
Complete combustion safety testing to ensure healthy, safe work environment

After
When completed work, retest to verify home is still healthy and safe
Tools:
1. Personal CO monitor
2. Combustion analyzer with probe
3. Manometer
4. Smoke pencil

Materials:
1. CO alarm
2. Fasteners

See also SWS 2.0201.1a-2.0299.1i for all Combustion Safety details and SWS 2.0100.1d for General Electrical Safety.

7.8103.1c - 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

Standard water heaters have built-in insulation ranging from R-7 to R-20.

Best Practice
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
Data plate should still be accessible after wrapping
Both hot and cold water pipes should be insulated to R-3 for first 6ft

7.8103.1e - 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 not be 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.

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