Georgia Weatherization Assistance Program
Single Family Field Guide
June 2018

Weatherization Works

Standard Work Specifications Field Guide for

Single-Family Homes

created by the

Georgia Environmental Finance Authority
Summary

The Georgia Weatherization Assistance Program (WAP) Single Family Field Guide was developed to align with the U.S. Department of Energy (DOE) Standard Work Specifications (SWS) for Single Family Home Energy Upgrades and to support and promote high quality work. This guide was created through a collaborative effort between Southface Energy Institute, Santa Fe Community College, and other participating DOE Weatherization Training Centers. It includes text and photo guides to assist Retrofit Installer Technicians, Crew Leaders, Energy Auditors, and Quality Control Inspectors with effectively performing the tasks required by the WAP. All sections in this Field Guide follow the requirements set forth by the SWS. All tasks and methods outlined in this Field Guide define measure installation and diagnostic testing best practices that should be followed throughout the state.

Codes and Standards

While the SWS and Georgia Weatherization Single Family Field Guide will help identify the desired outcomes of energy efficiency measures in a weatherization or home energy upgrade project, they are not a replacement for the codes and/or technical standards mandated by a particular jurisdiction. State, local, or municipal code or ordinance has legal precedence and users should obtain copies of the applicable codes and standards for their jurisdiction before performing the work.
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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.

2.0100.1b - 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

![Unsure Image]!
GOOD: Wear nitrile gloves when handling mastic
Inspect gloves for holes and damage to minimize risk

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

OSHA regulations defined in 29 CFR 1910.134(f) require organizations requiring respirator use to 1) establish a written respirator program, 2) train all personnel in the proper use and care of their respirators, 3) have personnel medically evaluated for their fitness to wear respirators, and 4) perform annual qualitative and quantitative fit testing on each individual with their assigned respirator.

Whenever airborne contaminants are a possibility, wear an N-95 mask. For two-component spray insulation, P-100 respirators should be used. All P-100s should be fitted to the individual worker.

When working with high pressure spray foam, use a Supplied Air. When unsure what level of protection is necessary, check the SDS.
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

Inspects 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

**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

From OSHA.gov: "Many workplaces contain areas that are considered "confined spaces" because while they are not necessarily designed for people, they are large enough for workers to enter and perform certain jobs. A confined space also has limited or restricted means for entry or exit and is not designed for continuous occupancy."


Perform visual inspection of confined spaces before beginning work

Check for frayed or worn electrical wires

In confined spaces, use a ventilator

Check GHS labels and Safety Data
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


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.

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

Keep workers comfortable with hydration and cool vests.
2.0103.1 - Combustion Worker Safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

2.0103.1b - Carbon monoxide (CO)

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

Objective(s):
Protect worker and occupant health

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

After
Install carbon monoxide alarm if none are found.

Tools:
1. CO meter

2.0103.1c - Raw fuel

Desired Outcome:
Work completed safely without injury or hazardous exposure
Specification(s):
Raw fuel leaks will be monitored for before entering building spaces
If leaks are found, testing will be discontinued and condition reported to occupant immediately

Objective(s):
Protect worker and occupant health

Tools:
1. Combustible gas detector
2. Spray bottle

Materials:
1. Noncorrosive leak detection fluid

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

Notify occupant.

leakage--bubble solution
2.0106.1 - Material Selection, Labeling, and Material Safety Data Sheets (MSDSs)

Desired Outcome:
Occupant and worker risk from hazardous materials minimized

2.0106.1a - Material selection

Desired Outcome:
Occupant and worker risk from hazardous materials minimized

Specification(s):
Materials that do not create long-term health risks for occupants and workers will be used

Objective(s):
Improve indoor air quality in the living space

2.0106.1b - Material labels

Desired Outcome:
Occupant and worker risk from hazardous materials minimized

Specification(s):
Manufacturer specifications will be followed

Objective(s):
Reduce risk of exposure to harmful substances

Follow safety procedures

2.0106.1c - Material Safety Data Sheets (MSDSs)

Desired Outcome:
Occupant and worker risk from hazardous materials minimized

Specification(s):
MSDSs will be provided onsite and available during all work
Objective(s):
Assess exposure risk

Prepare a response in case of emergency
2.0107.2 - 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.
2.0107.3 - 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

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

After
Rake up and clear away trash and overgrowth.
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

Follow this process for all homes with combustion appliances:
• If the gas supplier has shut off and locked the gas valve at the meter or the propane storage tank is empty, and the client states they are not and will not be using the appliance(s), then the client will need to remove the appliance(s) or disable them by disconnecting and capping off the gas line.
• Since no combustion safety testing was performed, there will be no liability issue if the client later restores fuel to the appliance(s).
• If the client refuses to have the system disabled, defer the home.
• If it appears that the client intends to restore the fuel supply and return the combustion appliance(s) to service, defer the home until combustion safety testing can be performed on them.
• Document everything in writing and obtain a client signature to acknowledge the conditions.

Assess existing combustion appliances for damage and replace when necessary
When a simple filter cleaning or replacement will help, make it happen
Ensure there is adequate make-up air -- combustion air inlet in closet
Stop the misuse of combustion appliances -- camp heater in bedroom
Keep occupant apprised of any health or safety concerns

2.0201.1b - Fuel leak detection

Desired Outcome:
Accurate information about appliance safe operation is gathered

**Specification(s):**
Inspect and test for gas or oil leakage at connections of natural gas, propane piping, or oil systems

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

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

**Objective(s):**
Detect fuel gas leaks

Determine and report need for repair

**Tools:**
1. Combustible gas detector
2. Spray bottle

**Materials:**
1. Noncorrosive leak detection fluid

Paraphrased from 2012 IRC G2417: Leakage will be located using an approved combustible gas detector, a noncorrosive leak detection fluid or an equivalent nonflammable solution. Matches, candles, open flames or other methods that could provide a source of ignition cannot be used. Where leakage or other defects are located, the affected portion of the piping system will be repaired or replaced and retested.
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 vent systems for damage
Inspect vent systems for disconnected pipes
Inspect vent 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, air handler and exhaust fans off, interior doors open

**Tools:**
1. Manometer

**2.0201.1e - Depressurization test**

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

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

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

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

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

Tools:

1. Manometer

Place manometer reference hose to exterior of house

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

Place test hose by combustion appliance

Take baseline reading

Turn on interior exhaust fans, including any clothes dryers

Is the air handler on?
Check interior doors for pressure differential either using smoke pencil or hand.

Manometer reading should not be more negative than -3pa.

If reading is within allowable limit, all is well.
2.0201.2 - Combustion Safety - Make-up Air

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

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

2.0201.2a - Outside combustion make-up air

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

Specification(s):
Where applicable, combustion air will be provided from the outside and installed in accordance with the IRC for the type of appliance installed

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

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

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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

![Image of carbon monoxide alarm]

**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

![Image of gas oven]

**Best Practice**
Alarms should be mounted near sleeping areas—such as the one marked in red

**Tools:**

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

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**Unsafe**
If CO reading as measured exceeds 225 ppm, order a clean and tune

**Best Practice**
Test gas oven for carbon monoxide using a combustion gas analyzer

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

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### 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

1. Yellow, uncontrolled flames indicate the need for a clean and tune
2. Gas ranges should be cleaned and tuned if improper operation is evident
3. Blue, even flames indicate burners are working properly

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

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

Tools:
1. Smoke pencil
2. Timer
3. Mirror
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

Tools:
1. Combustion analyzer with probe
2. Personal carbon monoxide detector

It is recommended as a best practice that technicians in the field have a dedicated CO monitoring device on their person to monitor ambient CO levels independent of the combustion analyzer.
CO levels cannot exceed 200ppm, or 400ppm air-free CO

Test undiluted flue gases in induced-draft furnaces

Test undiluted flue gases in natural draft furnaces

Test undiluted flue gases in natural draft water heaters.

Test accessible exhaust outlets for direct-vent appliances

Test accessible exhaust outlets for power-vented appliances
2.0202.1 - Unvented Space Heaters: Propane, Natural Gas, and Kerosene Heaters

Desired Outcome:
Elimination of combustion byproducts

2.0202.1a - Removal

Desired Outcome:
Elimination of combustion byproducts

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

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

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

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

2.0202.1b - Occupant education

Desired Outcome:
Elimination of combustion byproducts

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

Objective(s):
Inform occupant about possible hazards associated with combustion byproducts and moisture
2.0203.1 - Combustion Air for Natural Draft Appliances

Desired Outcome:
Sufficient air provided in the Combustion Appliance Zone (CAZ)

2.0203.1a - Required combustion air

Desired Outcome:
Sufficient air provided in the Combustion Appliance Zone (CAZ)

Specification(s):
The required volume of indoor air will be determined in accordance with IRC and authority having jurisdiction, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), IRC will be used

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

2.0203.1b - Additional combustion air (if action is required)

Desired Outcome:
Sufficient air provided in the Combustion Appliance Zone (CAZ)

Specification(s):
Additional combustion air will be provided in accordance with IRC and authority having jurisdiction when necessary to solve spillage problems

Objective(s):
Ensure adequate combustion air for operation of the appliance

2.0203.1c - Spillage testing

Desired Outcome:
Sufficient air provided in the Combustion Appliance Zone (CAZ)
**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
2.0203.2 - Combustion Flue Gas—Orphaned Water Heaters

Desired Outcome:
Flue gasses successfully removed from the house

2.0203.2a - Spillage testing

Desired Outcome:
Flue gasses successfully removed from the house

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

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

Objective(s):
Detect excessive spillage of combustion gases

Unsafe

Orphaned water heaters have oversized flues after a furnace is removed

Tools:
1. Timer or stopwatch
2. Smoke pencil
3. Mirror
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

**Materials:**
1. Flexible chimney liner
2. Elbows
3. Tees
4. Refractory cement
5. Rain cap
6. Thimble
7. Bricks
8. Mortar

Connect chimney liner to appliance in accordance with applicable codes.

1. Identify masonry chimneys being used as combustion appliance vents
2. Measure from the bottom termination to the chimney crown. Add one foot to the measurement and cut the liner to length
3. Pull the liner to the desired position with a rope and pulling cone
2.0203.2c - Retesting spillage

Desired Outcome:
Flue gasses successfully removed from the house

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

Objective(s):
Ensure appliance is not spilling longer than two minutes with a warm vent

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

After
The elimination of the oversized chimney should prevent spillage
Tools:

1. Timer or stopwatch
2. Smoke pencil
3. Mirror

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

Repipe the flue to eliminate the oversized chimney

When repairs have been completed, no spillage should occur after two minutes
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

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
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

2.0403.1b - Coverage

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

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

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

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

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

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

**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 Ground moisture barrier overlaps at seams at least 12 inches and is securely fastened to walls and ground

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

Materials:
1. Ballast
2. Plastic sheeting (at least 6 mil)
3. Furring strips
4. Seam tape - moisture resistant. Examples: Butyl tape, Gorilla tape
5. Landscape staples
6. Polyurethane construction adhesive

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

Overlap seams at least 12 inches, using a reverse shingle method on sloping ground to allow water to drain
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

Best Practice
Ground moisture barrier extends up the wall, is fastened with staples, and is held in place with ballast

Tools:
1. Stapler
2. Drill

Materials:
1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Staples
4. Landscape staples
5. Cut nails, case hardened nails, or masonry screws
Seams on walls can be taped to prevent water leakage. Use mechanical fasteners such as staples or furring strips on the walls. Use ballast or landscape staples on the ground.
2.0403.2 - Closed Crawl Spaces—Ground Moisture Barriers

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

2.0403.2b - Coverage

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

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

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

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

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

Before
Uncovered crawl space floors can lead to moisture issues

After
Ground moisture barrier should cover 100% of floor and at least 6" of walls
Materials:
1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

2.0403.2c - 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
4. Polyurethane construction adhesive
5. Landscape staples
6. Heavy duty tape such as Gorilla Tape or waterproof seam tape

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

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
Moisture barrier is fastened to sill with staples, and is weighed down with rebar as ballast.

This closed crawlspace uses spray polyurethane foam to seal vapor barrier to the wall and to seal the rim joist.

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

**Materials:**
1. 6 mil or greater polyethylene sheeting
2. Furring strips
3. Fasteners such as nails, screws, or staples for use on walls
4. Landscape staples, rebar, or bricks to hold sheeting down
5. Spray polyurethane foam may be used to seal rim joist and plastic to walls

**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, for example, butyl tape or Gorilla tape

1
Tape wall seams and press to ensure airtight bonding of adhesive

2
Tape (overlapped) floor seams to prevent movement and water leakage
2.0501.1 - Radon—Air Sealing Considerations, Basements, and Crawl spaces

Desired Outcome:
Work completed without increasing occupant exposure to radon

2.0501.1a - Radon testing and mitigation

Desired Outcome:
Work completed without increasing occupant exposure to radon

Specification(s):
Radon testing and mitigation will be done in accordance with the Environmental Protection Agency (EPA) Healthy Indoor Environment Protocols for Home Energy Upgrades

Objective(s):
Reduce potential for occupant exposure to radon
2.0601.1 - Knob and Tube Wiring

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

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

2.0601.1a - Knob and tube identification

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

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

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

Preserve the integrity and safety of the house

Knob and tube wiring should be identified before work begins

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

2.0601.1b - Live wire testing

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

**Specification(s):**
Non-contact testing method will be used to determine if wiring is live

**Objective(s):**
Protect occupant safety
Preserve the integrity and safety of the house

**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.

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

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

Warning sign should remind to contact certified electrician for repairs
Many jurisdictions require a sign in Spanish as well.

Damming should extend above installed height of insulation.

With dams in place, insulation can begin.

### 2.0601.1d - Replacement

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

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

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

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

Preserve the integrity and safety of the house.
Before knob and tube wiring may get hot and cannot be insulated over.

After if possible, knob and tube (k&t) wiring should be disabled and replaced with modern wiring.

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

**Materials:**
1. Romex as needed

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

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
2.0701.1 - Crawl Spaces—Providing New Access

**Desired Outcome:**
Access to the closed crawl space is controlled and the ground moisture barrier is protected to maintain the integrity of the system

2.0701.1a - Crawl Spaces - Providing New Access

**Desired Outcome:**
Access to the closed crawl space is controlled and the ground moisture barrier is protected to maintain the integrity of the system

**Specification(s):**
Crawl space will be accessible in accordance with IRC
Access to mechanical equipment located in the crawl space will be in accordance with IRC
Service and maintenance of the crawl space and equipment will be performed without risk of damage to the thermal barrier, air barrier, and ground moisture barrier in accordance with IRC

**Objective(s):**
Provide crawl space access
Maintain integrity of the crawl space system

2.0701.1b - Security

**Desired Outcome:**
Access to the closed crawl space is controlled and the ground moisture barrier is protected to maintain the integrity of the system

**Specification(s):**
At client's/resident's discretion, a lockable access will be provided if access is from the exterior.

**Objective(s):**
Control access and prevent intruders
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
Sign should be highly-visible, securely-fastened, and durable

2.0701.2b - Sign content

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

**Specification(s):**
Those entering the crawl space will be cautioned not to damage the air barrier, ground moisture barrier, insulation, and mechanical components specific to the crawl space type.

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

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

**Objective(s):**
Prevent damage to the crawl space after upgrade.

Educate anyone entering the crawl space.

Provide occupants with a way to contact the installer.

---

**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

PROHIBIDO: NO almacenar Materiales Inflamables o Peligrosos en este espacio

Hacer la señal en español también
3.1001.1 - Penetrations and Chases

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

3.1001.1d - High temperature application

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

Specification(s):
Only non-combustible sealant will be used in contact with chimneys, vents, and flues

Local codes will be referenced

Objective(s):
Prevent a fire hazard

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

Before
Gaps around combustion exhaust flues need to be sealed

After
Sealed penetrations and chases should utilize high-temperature materials
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
3.1001.2 - 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

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

Locate and expose chases to prepare Clear away insulation and debris to Carefully investigate areas with high

Air Sealing > Attics > Penetrations and Chases

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

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

Specification(s):
Entire opening will be spanned with rigid material

Material will be cut to fit and fastened as required

Objective(s):
Reduce opening to what can be sealed with sealant

Tools:
1. Drill/screwdriver
2. Caulk gun

Materials:
1. XPS
2. Drywall
3. Caulk
4. Sheet metal
5. OSB or plywood
Clear area of debris and insulation in preparation for work

Apply sealant all the way around opening

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

Fasten rigid material appropriately, such as with screws

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

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

**Specification(s):**
Material will be used that can be exposed to the interior of the house and meet the flame and smoke spread indexes as required in IRC

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

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

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

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

EPS or bead-board are not acceptable materials.

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

3.1001.2d - Support

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

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

Objective(s):
Ensure seal stays in place and does not sag

Spans greater than 24 inches require additional bracing before capping.

Support should prevent cap from sagging or moving.

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

Materials:
1. Lumber
2. Drywall
3. Fasteners

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

When supporting from above, apply adhesive between drywall and bracing.

Bracing can be screwed to drywall before capping chase.
3.1001.2e - Joint seal

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

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

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

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

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

3.1001.3b - 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
Wall cavities are open to attic

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

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

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

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

Spans greater than 24 inches require additional bracing before capping

Support should prevent cap from sagging or moving
Create bracing to support spans larger than 24”, either from above or below

When supporting from above, apply adhesive between drywall and bracing

Bracing can be screwed to drywall before capping chase

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

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

3.1001.3d - 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
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

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
3.1001.10 - Non-Insulation Contact (IC) Recessed Light

Desired Outcome:
Ensure safety from fire and prevent air leakage

3.1001.10a - 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 and IC- rated fixture

OR

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

Objective(s):
Prevent a fire hazard
Prevent air leakage through fixture

3.1001.10b - 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 0.5 or less

The top of the enclosure will be left free of insulation
Objective(s):
Prevent heat build up

3.1001.10c - Clearance

Desired Outcome:
Ensure safety from fire and prevent air leakage

Specification(s):
The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast

Objective(s):
Keep an air space around the fixture

3.1001.10d - 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
3.1003.1 - New Ceiling Below Original—Old Ceiling Intact or Repairable

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

Note:

3.1003.1b - Sealing methods

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

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

Material will be cut to fit and fastened as required

OR

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

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

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

Objective(s):
Prevent air leakage from dropped ceiling to attic
Before Damage to an older ceiling reveals the new ceiling below

After Rigid material sealed in place creates an air barrier

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

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

Prepare work area by removing existing insulation and debris

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

Option 1, Step 2: Cover openings with rigid material, either XPS or drywall
Option 2: Seal with rigid material along face of stud cavities

Option 3: Dense pack cavities through fastened wood plate

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

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

3.1003.1c - Support

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

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

Objective(s):
Ensure seal stays in place and does not sag
Spans greater than 24 inches require additional bracing before capping.

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

Materials:
1. Lumber
2. Drywall
3. Fasteners

Support should prevent cap from sagging or moving.

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

When supporting from above, apply adhesive between drywall and bracing.

Bracing can be screwed to drywall before capping chase.

Ensure new bracing is secure by using...

Once chase is capped, it is now ready.
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
Apply sealant to surrounding surfaces before setting cap in place

Sealant should extend along joists and into seams at top plates

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

3.1003.1e - Adjacent framing

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

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

OR

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

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

Damage to an older ceiling reveals the new ceiling below

No gaps should remain after spray foam is applied
Tools:
1. Caulk gun
2. Spray foam gun

Caulk along all joists before setting cap

Materials:
1. Spray foam
2. Caulk sealant

Use sealant to fill all remaining gaps
3.1003.2 - Ceiling Leaks Not Repairable—No Air Barrier Above

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

Note:

3.1003.2c - Support

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

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

Objective(s):
Ensure seal stays in place and does not sag.

Spans greater than 24 inches require additional bracing before capping.
Support should prevent cap from sagging or moving.

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

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

Dropped soffits need to be capped and sealed to prevent leakage

After

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

---

*Dropped soffits need to be capped and sealed to prevent leakage*  
*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:

3.1003.3b - 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
Before

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

After

Capped soffits minimize leakage to and from unconditioned spaces

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

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

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
Spans greater than 24 inches require additional bracing before capping.

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

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

Support should prevent cap from sagging or moving.

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

When supporting from above, apply adhesive between drywall and bracing.

Bracing can be screwed to drywall before capping chase.

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

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

---

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

**After**
No gaps should remain after spray foam is applied
3.1003.3e - Adjacent framing

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

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

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

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

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

3.1003.4c - 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

Before

After

Spans greater than 24 inches require additional bracing before capping
Support should prevent cap from sagging or moving
Create bracing to support spans larger than 24", either from above or below. When supporting from above, apply adhesive between drywall and bracing. Bracing can be screwed to drywall before capping chase.

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

3.1003.4d - 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:

3.1003.6b - 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

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 are 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

Tools:
1. Drill/screwdriver
2. Caulk gun

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

3.1003.6d - 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.
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

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

**Materials:**
1. XPS
2. Drywall
3. Plywood
4. Lumber
5. Fasteners
6. Caulk
7. Spray foam
8. Dense packable insulation
9. Poly-wrapped insulation
Clear work area of insulation and debris

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

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

Option 3: Stud bay will faced with rigid material, fastened and sealed
3.1005.1 - Tongue and Groove Ceilings

**Desired Outcome:**
Tongue and groove ceilings sealed to prevent air leakage and moisture movement between the attic and conditioned space

**Note:**

3.1005.1a - Pre-inspection

**Desired Outcome:**
Tongue and groove ceilings 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 tongue and groove ceiling

Repairs will be completed before work

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

3.1005.1b - Backing

**Desired Outcome:**
Tongue and groove ceilings sealed to prevent air leakage and moisture movement between the attic and conditioned space

**Specification(s):**
Backing will be installed behind tongue and groove ceilings

**Objective(s):**
Prevent air leakage and allow for sealants

3.1005.1c - Sealant selection

**Desired Outcome:**
Tongue and groove ceilings sealed to prevent air leakage and moisture movement between the attic and conditioned space
and conditioned space

**Specification(s):**
Sealants will be compatible with their intended surfaces
Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction
No sealant will be allowed to be visible in the living space

**Objective(s):**
Select permanent sealant
Ensure sealant meets or exceeds the performance characteristics of the surrounding materials
Ensure ceiling remains aesthetically pleasing
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.

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

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

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

**Materials:**
1. Lumber or metal sill
2. Caulk
3. Fasteners
4. Flashing
Remove sill to determine full extent of rot and necessary repairs

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

Cut new materials flush to surrounding surfaces and pitch toward exterior

For exterior repairs, replace flashing

Set new sill, then replace and prime trim
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.

Clean tools and sample site to prevent contamination

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

Record test results to maintain
positive and turn spot red  documentation
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](image)

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. 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.

### Desired Outcome:
Doors operable and weather tight
Specification(s):
Door will be adjusted to properly fit the jamb and allow for ease of operation (e.g., hinge replacement, re-plane door, door strike adjustment)

Objective(s):
Ensure proper operation of the door

Tools:
1. Screwdriver
2. Planer

Materials:
1. Shims

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

1. After examining how door hangs, remove door from hinges
2. Adjust hinge plates to bring door back into true
3. Adjust strike plate to allow for secure and smooth operation
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

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

**Materials:**
1. Caulk sealant

---

Daylight visible under exterior doors indicate water can leak in

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

Adjust threshold to minimize gap and keep water out

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

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

3.1202.1a - Lead paint assessment

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

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

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

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

**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

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

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

**Materials:**
1. Tape

When handling glass, wear heavy work gloves. 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

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Wear heavy work gloves when handling glass

Cut through caulk bead and glazing to ease removal

Remove old putty and glazing to expose metal points holding glass in place
With points and glass removed, measure opening for replacement pane.

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

3.1202.1c - Sash preparation

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

Specification(s):
Opening will be cleaned

Objective(s):
Prepare opening for new glass

Tools:
1. Chisel
2. Utility knife

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

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

After
Replacement glass should be securely fixed with points and glazing

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

Wear heavy work gloves when handling 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.

- Clean tools and sample site to prevent contamination
- 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

**3.1202.2b - 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

Wear heavy work gloves when handling glass. See also 2.0100.1b for Hand Protection.

Before
Broken glass with failed repairs needs to be replaced

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

1. Wear heavy work gloves when handling glass
2. Cut through caulk or glazing to simplify removal
3. Remove old putty and glazing from glass to expose pin nails holding 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

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

In Progress
Sash surface must be clean before mounting new glass.
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
With sash prepared, new pane installation can begin

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

Materials:
1. Trim

Wear heavy work gloves when handling glass. See also 2.0100.1b for Hand Protection.

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

Cut replacement glass 1/8" smaller than measured opening
With sash prepared, shim glass to center in opening and reinstall stops

Apply window glazing to air seal new pane

3.1202.2d - New glass installation
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. 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

Written approval from GEFA is required before replacing windows or doors.

### 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

In Progress
Installing a vinyl replacement window into a double-hung wood window jamb

**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

Written approval from GEFA is required before replacing windows or doors.

1. Using a utility knife, carefully cut the paint and caulk to remove window stops from window jambs.
2. Using a hammer and flat prybar, carefully remove the inside window stops and remove bottom sash.
3. Remove the blind stops, bottom sash, pulleys, and ropes. Clean and prepare the opening.
Apply caulk to stop molding and install the new window in accordance with manufacturer's instructions.

Follow lead safe work practices if lead based paint will be disturbed. Cover floors with plastic six feet from work area.

Wet surfaces before disturbing lead based paint.

Using a HEPA vacuum in lead based paint work areas, clean up as you work.

Dispose of all waste properly. Wrap waste and place in a dumpster.
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.

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

3.1203.2d - Replacement window installation
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 fastening 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
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

Tools:
1. Headlamp

Materials:
1. Backer rod
2. Sealant

Gaps around floor penetrations, such as plumbing, HVAC, and electrical
Gaps should be sealed to maintain air barrier
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

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

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

Before
Gaps around floor penetrations allow air and moisture movement

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

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

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

Fasten rigid material to cover penetration and seal against flue with caulk
3.1402.3 - 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
Light showing through penetration in exterior block wall

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

Tools:
1. Caulk gun
2. Spray foam 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

**Tools:**
1. Caulk gun
2. Reusable spary foam gun
3. Spray bottle (misting surfaces will improve spray foam adhesion and cure)

**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

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

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

Sealed ductwork connections help prevent leakage.

**Tools:**
1. Disposable brushes
2. Utility knife
3. Cordless driver/drill and 1/4" nut driver bits
4. Zip tie tensioning tool

**Materials:**
1. Fiberglass mesh tape
2. Mastic duct sealant
3. Zip ties
4. Zip-in pointed sheet metal screws

Fasten metal to metal joints with at least three equally spaced screw around the joint. Use fiberglass mesh tape on cracks 1/4" and larger. Apply mastic sealant at least as thick as a nickel on all seams and gores.
3.1501.1c - Cracks

Desired Outcome:
Openings from garage sealed to prevent leakage

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

All cracks in ceiling surfaces will be sealed

Objective(s):
Prevent air leakage and pollutant entry

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

Materials:
1. Sprayfoam
2. Fire-block caulk

Air sealing reduces pollutant entry, but does not diminish fire resistance
Determine which walls are shared between garage and living space

Inspect wall and ceiling for cracks and penetrations

Clear work area of obstacles and debris

Apply appropriate sealant dependent upon size of crack and location

Ensure sealant does not decrease wall's fire resistance

3.1501.1d - 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
Daylight visible under door to garage indicates leakage

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

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

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

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

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

**Tools:**

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

**Materials:**

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

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 should be installed one per floor and near sleeping areas.

3.1501.1g - Occupant education

Desired Outcome:
Openings from garage sealed to prevent leakage

Specification(s):
Occupant will be educated on need to keep door from garage to house closed and not to warm up vehicles or use any gas engine appliances or grills in the garage, even if the main door is left open
**Objective(s):**
Reduce risk of CO poisoning inside of garage and adjacent rooms

**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
3.1601.1 - Preparation and Mechanical Fastening

Desired Outcome:
Ducts and plenums properly fastened to prevent leakage

3.1601.1a - Preparation

Desired Outcome:
Ducts and plenums properly fastened to prevent leakage

Specification(s):
Type and R-value of existing duct insulation (e.g., fiberglass, stone wool, asbestos) will be identified as will the location of vapor retarders, if any

If asbestos insulation was used, it will not be disturbed; consult with an asbestos abatement expert for removal

Surrounding insulation will be cleared to expose joints being sealed

Duct surface to accept sealant will be cleaned

Insulation will be returned or replaced with equivalent R-value

Objective(s):
Gain access while maintaining insulation value

Achieve proper adhesion for airtight seal

3.1601.1b - Metal to metal

Desired Outcome:
Ducts and plenums properly fastened to prevent leakage

Specification(s):
Round ducts will be mechanically fastened to maintain alignment

Other shaped ducts will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes

Objective(s):
Ensure durable joints

3.1601.1c - Flex to metal

**Desired Outcome:**
Ducts and plenums properly fastened to prevent leakage

**Specification(s):**
Joints will be fastened with tie bands using a tie band tensioning tool

**Objective(s):**
Ensure durable joints

3.1601.1d - Duct board to duct board

**Desired Outcome:**
Ducts and plenums properly fastened to prevent leakage

**Specification(s):**
Joints will be fastened with clinch stapler

**Objective(s):**
Ensure durable joints

3.1601.1e - Flexible duct to duct board

**Desired Outcome:**
Ducts and plenums properly fastened to prevent leakage

**Specification(s):**
Metal take-off collar will be used and attached in accordance with IRC

**Objective(s):**
Ensure durable joints
3.1601.1f - Metal plenum to air handler cabinet

Desired Outcome:
Ducts and plenums properly fastened to prevent leakage

Specification(s):
Plenum will be mechanically fastened

Objective(s):
Ensure durable joints

3.1601.1g - Duct board plenum to air handler cabinet

Desired Outcome:
Ducts and plenums properly fastened to prevent leakage

Specification(s):
Termination bar or metal strip will be fastened with screws
Duct board will be installed between the screw and the termination bar

Objective(s):
Ensure durable joints

3.1601.1h - Boot to wood

Desired Outcome:
Ducts and plenums properly fastened to prevent leakage

Specification(s):
Screws or nails will be used to fasten boot to wood

Objective(s):
Ensure durable joints

3.1601.1i - Boot to gypsum

Desired Outcome:
Ducts and plenums properly fastened to prevent leakage

**Specification(s):**
Boot hanger will be fastened to adjacent framing with screws or nails

Boot will be connected to boot hanger with screws

Integral snap boots will be installed

**Objective(s):**
Ensure durable joints

### 3.1601.1j - Flex to duct board

**Desired Outcome:**
Ducts and plenums properly fastened to prevent leakage

**Specification(s):**
Take-offs will be in accordance with IRC and applicable local code

**Objective(s):**
Ensure durable joints
3.1601.2 - Duct Preparation for SPF Application

Desired Outcome:
Condition of ductwork identified and necessary repairs made in preparation for spray polyurethane foam (SPF) application

3.1601.2a - Inspection

Desired Outcome:
Condition of ductwork identified and necessary repairs made in preparation for spray polyurethane foam (SPF) application

Specification(s):
All exposed ductwork in unconditioned spaces (e.g., attics, basements, crawl spaces) will be inspected

Broken joints or large cracks, gaps, or holes will be identified

Type of ductwork (e.g., metal, duct board, flex duct) will be identified

Type and R-value of existing duct insulation (e.g., fiberglass, stone wool, asbestos) will be identified as will the location of vapor retarders, if any

If asbestos insulation was used, it will not be disturbed; consult with an asbestos abatement expert for removal

Loose fitting or damaged fiberglass or stone wool insulation will be removed using proper safety equipment

Necessary clearances for installation of SPF will be ensured

Objective(s):
Identify damaged ductwork in need of repair

Identify type and R-value of existing insulation

3.1601.2b - Repair

Desired Outcome:
Condition of ductwork identified and necessary repairs made in preparation for spray polyurethane foam (SPF) application

**Specification(s):**
Broken or missing ductwork will be repaired or replaced
All cracks, gaps, or holes greater than ¼" will be taped or sealed as feasible
Dust, dirt, and grease will be removed from exterior surfaces of ducts

**Objective(s):**
Cover openings in ducts to prevent SPF from entering the interior of the duct
Ensure surfaces of duct are clean to promote proper adhesion of SPF
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
Ducts should not be allowed to droop and drag, adding distance to run

After
Properly supported ducts minimize heat loss and and maximize duct run
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

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

### 3.1602.1c - 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

Materials:

1. Mastic
2. Fiberglass mesh tape

After

Sealed ductwork connections help prevent leakage

1. Prepare work area by assessing any safety concerns
2. Wrap joint with fiberglass mesh tape
3. Apply UL 181 mastic to seal joint
3.1602.2 - Duct Spray Polyurethane Foam (SPF) Installation

**Desired Outcome:**
Exposed ductwork in unconditioned spaces insulated and sealed

3.1602.2a - Installation

**Desired Outcome:**
Exposed ductwork in unconditioned spaces insulated and sealed

**Specification(s):**
- Insulation will be installed according to manufacturer specifications and all provisions of the IRC
- SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer
- Sufficient insulation will be applied to all joints and around all penetrations to the conditioned space through walls, floors, and ceilings
- SPF will be covered with proper fire protective coverings or coatings appropriate for location of ductwork and type of foam used and provisions of the IRC and local codes
- If ducts are used for air-conditioning, an appropriate vapor retarder will be applied on the SPF if open-cell SPF used
- If 2” or more of closed-cell SPF is used, follow manufacturer specification to determine if additional vapor retarder is needed
- The flame spread index will not be greater than 25 and the smoke-developed index is not greater than 450 at the specified installed thickness
- The foam plastic will be protected with an ignition barrier

**Objective(s):**
- Insulate and seal all exposed ductwork in unconditioned spaces
- Manage moisture condensation on ductwork that carry cooled air in warm, moist climates
- Provide adequate fire protection for exposed SPF
3.1602.3 - Proprietary Spray Application

Desired Outcome:
Ducts and plenums sealed to prevent leakage

3.1602.3a - Internal or external application

Desired Outcome:
Ducts and plenums sealed to prevent leakage

Specification(s):
Installation of sealant will be applied in accordance with manufacturer specifications as well as UL 181M, NFPA 90A, and NFPA 90B

Objective(s):
Reduce duct leakage
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
4. Reusable spray foam gun
5. Caulking gun

Materials:
1. Mastic
2. Mesh tape
3. Caulk
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
Air Sealing > Ducts > Duct Sealing

3.1602.4b - Wooden plenums and building cavities

Locate unsealed ducts constructed from building cavities

**Before**

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. screws
5. sheet metal

DO NOT use spray polyurethane foam.

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 holes and penetrations and line the duct with airtight material

Cut and install fiberglass duct board to create an airtight duct

Seal seams in duct board and site-built ducts with 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

**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
Uncovered filter slots are a point of leakage

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. Fiberglass duct board
2. Drywall
3. Fire-resistant caulk
4. Fasteners
DO NOT use EPS foam board or XPS foam board in air returns due to proximity to combustion appliances

3.1602.5c - Sealant selection

Desired Outcome:
The return duct installed to prevent air leakage

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

Objective(s):
Select permanent sealant

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

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

Best Practice
Caulk sealants will be continuous

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

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

Paraphrased from 2012 IRC R302.9: Wall and ceiling finishes will have a flame spread index of 200 or less and a smoke-developed index of 450 or less
4.1001.1 - Non-Insulation Contact (IC) Recessed Light

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

4.1001.1a - Air barrier system

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

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

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

OR

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

OR

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

OR

Air sealing measures as approved by the authority having jurisdiction

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

Prevent air leakage through fixture
Non-IC rated recessed light fixtures should be dammed from insulation

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

Tools:
1. Utility knife
2. Tape measure

Materials:
1. 5/8" fire-rated Type X drywall
2. Fire-rated caulk sealant
3. OR approved fire-rated air barrier system/material

Construct box to maintain a minimum of 3" clearance to combustible materials

Sealed box should be constructed of fire-rated drywall

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

**4.1001.1b - Enclosure top**

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

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

The top of the enclosure will be left free of insulation
Objective(s):
Prevent heat build up

Tools:
1. Utility knife
2. Caulk gun

Materials:
1. Drywall

4.1001.1c - Clearance

Desired Outcome:
Ensure safety from fire and prevent air leakage

Specification(s):
The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast

Objective(s):
Keep an air space around the fixture
Non-IC rated recessed lights produce excess heat and can be a fire risk

A 3 inch clearance should be kept from boxing materials

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

**Materials:**
1. Fire-rated sealant
2. Drywall

### 4.1001.1d - Sealants and weather stripping

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

**Specification(s):**
Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only

**Objective(s):**
To prevent air leakage, completely adhere the sealant to all surfaces to be sealed
Non-IC recessed light fixtures produce excess heat and can be a fire risk.

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

Materials:
1. Fire-rated silicone caulk
2. UL-181 mastic
3. Spray foam
4.1001.2 - Knob and Tube Wiring

 Desired Outcome:
Insulation kept away from contact with live wiring

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

4.1001.2a - Identifying knob and tube wiring

 Desired Outcome:
Insulation kept away from contact with live wiring

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

 Objective(s):
Determine if knob and tube wiring exists

Unsafe
Identify knob and tube wiring in homes to insulate properly and safely
4.1001.2b - Testing to determine if live

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

**Specification(s):**
Non-contact testing method will be used to identify live wiring

**Objective(s):**
Ensure safety of occupants, workers, and house

Plan where remediation is needed

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

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

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

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

Warning signs should encourage the use of certified electrician for repairs

Some jurisdictions require warning signs in Spanish as well

CAUTION!
Live Knob & Tube wiring present!

If repairs are needed, please contact a certified electrician.

CAUDEADO!
Cableado eléctrico con aisladores cerámicos vivo!

En Inglés: knob & tube wiring

Si es necesario realizar alguna reparación, ponerse en electricista certificado.

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

Modern wiring should replace all knob & tube

Many electricians will removed exposed wires to prevent reactivation
4.1001.3 - Fireplace Chimney and Combustion Flue Vents

Desired Outcome:
Combustible materials kept away from combustion sources

4.1001.3a - Verify attic prep

Desired Outcome:
Combustible materials kept away from combustion sources

Specification(s):
Holes, penetrations, and bypasses will be sealed

Dams will be fixed in places that maintain required clearance

Objective(s):
Prevent air leakage

Ensure insulation dams maintain clearance

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

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

Tools:
1. Metal snips
2. Caulk gun
3. Fasteners

Materials:
1. 26-gauge steel sheeting
2. High temperature caulk
3. Caulk
4. Backer rod
5. Spray foam
Gaps around flues and penetrations need to be sealed before insulating. High temperature caulk should be used for flues and chimneys. 26-gauge steel should be used to construct seals and dams on flues.

Only construct dam after sealing has been completed properly. Dammed chimneys, flues and light fixtures prevent fires.

4.1001.3b - Required clearance

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

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

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

Prevent a fire hazard.
Before
To prevent fire hazards, flues, chimneys, and light fixtures require dams

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

Tools:
1. Metal snips

Materials:
1. 26-gauge steel sheeting
2. Fasteners

4.1001.3c - Safety

Desired Outcome:
Combustible materials kept away from combustion sources

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

Objective(s):
Prevent a fire hazard

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

After
Clear dams of any loose insulation in order to minimize risk of fire
4.1001.3d - 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**
Staple insulation card in an easily viewed location in the attic

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Staple the insulation card in a prominent location in the attic
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
Allow a standard two inch gap for airflow 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
Knee walls often need sealing and 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 wall is prepped for dense pack insulation

Knee walls missing top plates need one created from rigid material

Top plate holds dense pack insulation in cavity

New top plate should be sealed to surrounding joists and studs
Bottom plates also need to be installed. Measure for size. Cut to size and attempt to install in line with air barrier above. Seal to surrounding joist.

If using house-wrap or fabric, tack in place with furring strips or staples. Drywall is also a good barrier for dense packing knee walls.

4.1004.1b - Installation

Desired Outcome:
Airtight cavity and insulated knee wall

Specification(s):
All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates.

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

Follow manufacturer's requirements for fiberglass dense pack applications.

Objective(s):
Eliminate misalignment of existing insulation
Prevent insulation from settling or moving.
Before
Existing batt insulation should be adjusted to fit properly

Attach furring strips to create pockets for dense-pack insulation

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

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

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**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

Many popular extruded polystyrene (XPS) foam insulation products meet the exemption at the bottom of the following section from the 2012 IRC, based on testing and evaluation by the ICC Evaluation Service (ICC-ES) or Underwriters Laboratories (UL). Ensure that the code conditions are met and check for the appropriate ICC-ES or UL evaluation report for the specific product and manufacturer before installing without an ignition or thermal barrier.

"R316.5.3 Attics. The thermal barrier specified in Section R316.4 is not required where all of the following apply:

1. Attic access is required by Section R807.1.
2. The space is entered only for purposes of repairs or maintenance.
3. The foam plastic insulation is protected against ignition using one of the following ignition barrier materials:
   3.1. 11/2-inch-thick (38 mm) mineral fiber insulation;"
3.2. 1/4-inch-thick (6.4 mm) wood structural panels;
3.3. 3/8-inch (9.5 mm) particleboard;
3.4. 1/4-inch (6.4 mm) hardboard;
3.5. 3/8-inch (9.5 mm) gypsum board; or
3.6. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm);
3.7. 1 1/2-inch-thick (38 mm) cellulose insulation. The above ignition barrier is not required where the foam plastic insulation has been tested in accordance with Section R316.6."
4.1004.3 - Strapping for Existing Insulation

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

Note:

4.1004.3a - 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

4.1004.3b - 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 full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions

Objective(s):
Insulate to prescribed R-value

4.1004.3c - Attachment

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

**Specification(s):**
Strapping material will have a minimum expected service life of 20 years

**Objective(s):**
Maintain alignment

---

**4.1004.3d - Occupant education**

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

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

**Objective(s):**
Provide occupant with documentation of installation
4.1004.4 - Knee Wall Without Framing

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

4.1004.4a - 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

4.1004.4b - Flat cavity present

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

**Specification(s):**
Gap between framing and existing air barrier will be insulated

**Objective(s):**
Create a flat insulated surface

4.1004.4c - Installation

**Desired Outcome:**
Consistent uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value
**Specification(s):**
A rigid insulated sheathing will be mechanically fastened to code required R-value
Seams will be sealed

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

### 4.1004.4d - 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:

- Coverage area
- Thickness
- R-value

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

Confirm amount of insulation installed

Comply with 16 CFR 460.17
4.1005.1 - 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
Accessible attic floors should be air sealed and insulated

**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

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**4.1005.1c - Occupant education**

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

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

- Coverage area
- Thickness
• R-value

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

Confirm amount of insulation installed

Comply with 16 CFR 460.17

**Best Practice**
Document the thickness and R-value of the installed insulation

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation
4.1005.2 - Accessible Floors—Loose Fill Installation

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

4.1005.2a - Preparation

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

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

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

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

Open electrical junctions will have covers installed

Insulation dams and enclosures will be installed as required

Objective(s):
Access the workspace

Verify uniformity of insulation material

Provide location of electrical boxes for future servicing

Prevent an electrical hazard
Accessible attic floors should be air sealed and insulated

**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.

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

**After**
New bottom plates complete air barrier and hold insulation in place.
Tools:
1. Tape measure
2. Utility knife
3. Saw
4. Drill
5. Spray foam gun
6. Caulk gun

Materials:
1. Spray foam
2. XPS
3. Drywall
4. Plywood
5. Fasteners
6. Caulk sealant

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

Before
Accessible attic floor should be air sealed and insulated

After
Check chart on package to ensure proper insulation depth to achieve R-value

Tools:
1. Insulation machine

Materials:
1. Loose fill insulation

Use depth markers to ensure insulation has reached prescribed R-value

Where flooring cannot be removed, verify insulation is meeting R-value goal

4.1005.2d - Onsite documentation

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

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

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

**Objective(s):**

Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For loose-fill, the receipt must show the coverage area, initial installed thickness, minimum settled thickness, R-value, and the number of bags used. To figure out the R-value of the insulation, use the data that the manufacturer gives you. The receipt must be dated and signed by the installer.
4.1005.3 - Accessible Floors—Batt Insulation Over Existing Insulation

Desired Outcome:
Insulation controls heat transfer through ceiling

4.1005.3e - Onsite documentation

Desired Outcome:
Insulation controls heat transfer through ceiling

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

- Coverage area
- Thickness
- R-value

Objective(s):
Document job completion to contract specifications
Confirm amount of insulation installed
Ensure ability to match bags required for total area completed
Comply with 16 CFR 460.17

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 an attic insulation card detailing thickness, type, and R-value of the newly added insulation
4.1005.4 - Accessible Floors—Loose Fill Over Existing Insulation

Desired Outcome:
Insulation controls heat transfer through ceiling

4.1005.4d - Onsite documentation

Desired Outcome:
Insulation controls heat transfer through ceiling

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

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

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17
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

 This finished garage below a bonus room is an unconditioned space

 Rigid material forms an air barrier located under the bonus room stem wall

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

 Materials:
 1. XPS or other rigid material
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

Documentation of insulation installed should be provided in writing.

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

In addition to posting an insulation information card in the insulated space, a "receipt" may be provided. Information should include insulation type, r-value, coverage area, etc.
4.1005.6 - Enclosed Attic Storage Platform Floor—Dense Pack Installation

Desired Outcome:
Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments

4.1005.6a - Fill floors

Desired Outcome:
Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments

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

4.1005.6b - Safety

Desired Outcome:
Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments

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

4.1005.6c - Onsite documentation

Desired Outcome:
Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments

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

- Coverage area
- Thickness
- R-value

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

4.1005.6d - Occupant education

Desired Outcome:
Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments

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

Objective(s):
Provide occupant with documentation of installation
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

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 r-value of attic

4.1006.1b - Sealing

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

Specification(s):
Entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space

Pull-down stair frame will be caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, frictionally engaging components or solid material that allows attic door operation

Objective(s):
Prevent air leakage
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

Uninsulated attic hatches and access panels weaken the thermal envelope

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)
Unsealed attic hatches and panel doors allow air leakage to and from attic

![After](image2)
Once sealed, air leakage at attic hatch or door should be minimized

**Materials:**
1. Weatherstripping
2. 3/4” Lumber
3. Caulk

![Image3]
Remember to seal around finish details and framing on interior

![Image4]
Build insulation dam from 3/4 inch lumber and seal around base

![Image5]
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 airtight fit

Tools:
1. Caulk gun
2. Utility knife

Materials:
1. XPS
2. Adhesive

Apply foam tape to "warm side" face of attic hatch
Ensure an air tight seal by making sure foam tape has no gaps
Apply strong adhesive to "cold-side" of hatch
Adhesive should ring perimeter as well as criss-crossing hatch to ensure complete attachment of insulation

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

Repeat adhesive and XPS layers to reach maximum R-value without making hatch excessively heavy or awkward

All XPS layers should be attached firmly to one another and square to hatch
4.1006.3 - Whole-House Fan

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

Note:

4.1006.3a - Installation

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

Specification(s):
Sides of fan insulation box assembly will be insulated to the same R-value as adjoining insulated assembly.

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

4.1006.3b - Air sealing

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

Specification(s):
Fan insulation box frame will be continuously weatherstripped to ensure a tight fit.

Objective(s):
Prevent air leakage.

4.1006.3c - Attachment

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

**Specification(s):**
Non-compressible insulation will be permanently attached in contact with fan insulation box

Appropriate adhesive or mechanical fastener will be used

**Objective(s):**
Ensure continuous alignment with air barrier

---

**4.1006.3d - Durability**

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

**Specification(s):**
Material integrity will meet a minimum expected service life of 20 years

**Objective(s):**
Ensure a minimum expected service life

---

**4.1006.3e - Occupant education**

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

**Specification(s):**
Purpose of insulation will be communicated to occupant

**Objective(s):**
Educate occupant on how to use the whole-house fan to ensure integrity of the fan insulated assembly throughout service life
4.1088.1 - Attic Ventilation

Desired Outcome:
Properly restored vents minimize moisture and ice dams

4.1088.1a - Air barrier and thermal boundary

Desired Outcome:
Properly restored vents minimize moisture and ice dams

Specification(s):
Attic ventilation will be recommended or installed if local code requires attic ventilation during weatherization or retrofits

The presence of an effective air barrier and thermal boundary between the attic and the living space must be verified and appropriate attic sealing and proper insulation is specified as part of the scope of work

Objective(s):
Ensure presence of continuous air barrier and thermal boundary

4.1088.1b - Vent type

Desired Outcome:
Properly restored vents minimize moisture and ice dams

Specification(s):
Attic vent types will be made of corrosion-resistant material for their specific location (e.g., exterior soffit, gable end, roof) and material and intended use (e.g., metal vent on metal roof)

Attic-powered ventilators will not be used

Objective(s):
Ensure vent meets proper performance characteristics for location and roofing type

4.1088.1c - Vent location

Desired Outcome:
Properly restored vents minimize moisture and ice dams

**Specification(s):**
Placement of attic vents will be considered for proper air flow and prevention of entry of wind driven rain or snow

**Objective(s):**
Encourage proper air flow
Minimize entry of wind driven rain or snow

### 4.1088.1d - Ventilation baffling

**Desired Outcome:**
Properly restored vents minimize moisture and ice dams

**Specification(s):**
Baffling for attic soffit vents will be installed to:

- Ensure proper air flow
- Prevent wind washing of insulation
- Allow maximum insulation coverage
- Ensure baffle terminates above insulation

**Objective(s):**
Ensure vent allows proper air flow without compromising insulation performance

### 4.1088.1e - Ventilation screens

**Desired Outcome:**
Properly restored vents minimize moisture and ice dams

**Specification(s):**
All attic ventilation will have screens with non-corroding wire mesh with openings of 1/16" to 1/4" to prevent pest entry (e.g., birds, bats, bees)

Existing vents that are not screened will be covered with non-corroding wire mesh with openings of 1/16" to 1/4"

Ensure net free area requirements are met
Additional vents or larger vents can be added if screen size is smaller than designated

**Objective(s):**
Prevent pest entry
4.1088.3 - Skylights

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

4.1088.3b - Installation

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

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

Insulation will be installed to prescribed R-value

Objective(s):
Insulate to prescribed R-value

Before
Uninsulated, unsealed skylight well

After
Insulated, air sealed skylight well
Insulation > Attics > Special Considerations

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

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

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

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**
Attach an insulation information card in a prominent location near the attic access
Communicate professionally with occupant to provide information and support.

Documentation should include insulation material and r-value.

Attach an insulation information card in a prominent location near the attic access.
4.1101.1 - Exterior Wall Dense Packing

**Desired Outcome:**
Walls properly prepared to receive dense pack insulation

4.1101.1a - Preparation

**Desired Outcome:**
Walls properly prepared to receive dense pack insulation

**Specification(s):**
Lead and asbestos safety procedures will be followed

Cavities will be free of hazards, intact, and able to support dense pack pressures

Drilling hazards (e.g., wiring, venting, fuel piping) will be located

Blocking will be installed around:
- All openings to inside crawl space and basement for fibrous material
- High temperature fire-rated materials
- Wiring and electrical hazards
- Heat sources

Access to exterior wall cavities will be gained, sheathing will be drilled as needed and probed to locate each cavity, wall studs, and blockers

Interior will be masked and dust controlled during drilling when accessing from interior

Electricity supply will be confirmed and will support blowing machine power demand

Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed

Hose outlet pressure will be at least 80 IWC or 2.9 psi for cellulose insulation; for other types of dense pack insulation, check manufacturer specification for blowing machine set up

**Objective(s):**
Prevent damage to house

Provide a clean work space
Provide thorough access to allow 100% coverage

Ensure proper equipment and process results in consistent density

Prevent settling and retard air flow through cavities

Protect worker and occupant health

4.1101.1b - Exterior dense pack

Desired Outcome:
Walls properly prepared to receive dense pack insulation

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

- Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot
- Loose fiber glass material will be installed and will be specifically approved for air flow resistance per manufacturer's specifications

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

Insulation density will be verified by bag count, core sampling, or infrared camera with the blower door at 50 pascals to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Objective(s):
Eliminate voids and settling

Minimize framing cavity air flows
4.1101.2 - Exterior Wall Insulating Sheathing

Desired Outcome:
Wall cladding removed and replaced to expose wall sheathing for installation of insulating wall sheathing

4.1101.2a - Wall cladding removal

Desired Outcome:
Wall cladding removed and replaced to expose wall sheathing for installation of insulating wall sheathing

Specification(s):
Existing cladding will be removed
Lead and asbestos safety procedures will be followed

Objective(s):
Expose existing wall sheathing to prepare for installation of insulating sheathing

4.1101.2b - Wall cladding replacement

Desired Outcome:
Wall cladding removed and replaced to expose wall sheathing for installation of insulating wall sheathing

Specification(s):
New cladding will be installed in accordance with manufacturer specifications and local codes after exterior wall insulation is installed

Objective(s):
Install wall cladding correctly
Meet local codes
4.1102.1 - Open-Cavity Wall Insulation—General

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

4.1102.1a - Sealing

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

Specification(s):
Holes and penetrations will be sealed
Bypasses will be blocked and sealed

Objective(s):
Prevent air leakage

Tools:
1. Caulk gun

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

**4.1102.1d - Onsite documentation**

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

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

• Coverage area

• R-value

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

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

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

Confirm amount of insulation installed

Comply with 16 CFR 460.17

**Best Practice**
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


4.1103.1 - 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

4.1103.1b - Onsite documentation

Desired Outcome:
Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly
Specification(s):
A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
- R-value

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed Comply with 16 CFR 460.17
4.1103.2 - Additional Exterior Wall Cavities

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

4.1103.2a - Location of cavities

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

Specification(s):
Details remaining in or between completed wall sections will be located and accessed

Objective(s):
Ensure the last gaps and framing edges in the thermal boundary, roof-wall joints, floor-wall joints, etc., are found and finished

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

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

---

### 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 (if safe) to -50pa wrt outside
Inspect for voids and low density areas

Reduced temperature difference indicating insulated wall cavities

### 4.1103.2e - Close holes

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

**Specification(s):**
Installation holes will be plugged as follows:

- Exterior holes will be weather barrier patched
- Interior holes will be coated and patched to match original interior surface

All construction debris and dust will be collected and removed

**Objective(s):**
Ensure house is returned to watertight and clean condition

**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.

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.

Once drywall patches are spackled, prime and paint.
4.1103.3 - Insulated Sheathing and Insulated Siding Installation

Desired Outcome:
Properly installed insulated wall sheathing and insulated siding

4.1103.3a - Sealing

Desired Outcome:
Properly installed insulated wall sheathing and insulated siding

Specification(s):
Holes, gaps, and penetrations in existing sheathing will be sealed

Objective(s):
Prevent air leaks

4.1103.3b - Location of wall framing

Desired Outcome:
Properly installed insulated wall sheathing and insulated siding

Specification(s):
Wall studs and other framing will be located and marked

Objective(s):
Provide secure attachment of insulating sheathing

4.1103.3c - Installation

Desired Outcome:
Properly installed insulated wall sheathing and insulated siding

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):
Install insulation properly

4.1103.3d - Occupant education

Desired Outcome:
Properly installed insulated wall sheathing and insulated siding

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

• Coverage area

• Thickness

• R-value

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17
4.1301.1 - 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

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.

Tools:
1. Caulk gun

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

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiberglass batts should not be hanging away from subfloor</td>
<td>&quot;Lightning rods&quot; or twine can be used to hold batts in contact</td>
</tr>
</tbody>
</table>

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

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

Batt should be in contact with subfloor without being compressed

Twine fastened across bays in a zig-zag pattern can also be used
4.1301.1d - Occupant education

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

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

- Coverage area
- Thickness
- R-value

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

Best Practice
Provide occupant with documentation of and about insulation installed
Communicate professionally with occupant to provide information and support.

Documentation should include insulation material and r-value.

Provide occupant with copies of all documentation.
4.1301.2 - Standard Floor System—Loose Fill with Netting

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

4.1301.2a - Sealing

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

Specification(s):
Sealing the floor system will be completed before insulating

Objective(s):
Ensure airtight envelope

Prevent leakage

Before
Gaps around penetrations can cause air leakage and negate insulation

After
Sealed penetrations maintain the air barrier

Tools:
1. Caulk gun

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

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.
4.1301.2b - Netting, fabric

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

Specification(s):
When using netting or fabric, staples will be placed according to manufacturer specifications

Netting or fabric will meet local fire codes

Objective(s):
Secure insulation

Uninsulated floors above unconditioned spaces are an energy drain

Netting is secured to joists and sills to create cavities for insulation
Tools:
1. Utility knife
2. Scissors
3. Stapler

Materials:
1. Fabric netting
2. Staples

Secure netting across each joist to create separate cavities
Secure netting across sills to prevent leakage of insulation
Keep netting taut while stapling to prevent wrinkles and leakage
Staples should be kept tightly together, placed no more than 1 1/2" apart

4.1301.2c - Installation

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

Specification(s):
Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications
Insulation will be installed to prescribed R-value
Insulation will be in continuous contact with air barrier

**Objective(s):**
- Insulate to prescribed R-value
- Ensure a continuous thermal boundary between conditioned and unconditioned space

**In Progress**

With netting in place, insulation can begin

**After**

Cavities filled to manufacturer specs to achieve prescribed r-value

**Tools:**
1. Utility knife
2. Insulation machine

**Materials:**
1. Loose fill fiberglass or cellulose

Order and install insulation based on specifications in work order

Always wear proper PPE when blowing in insulation

Cut holes in each individual cavity to insert insulation machine nozzle
Ensure that hole is large enough for nozzle without allowing for outflow

Consult manufacturer specs on insulation packaging for proper installation

Blow in insulation to prescribed r-value

4.1301.2d - Occupant education

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

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

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

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17
Best Practice

Provide occupant with documentation of and about insulation installed

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

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

Gaps around penetrations cause air leakage and negate insulation
Sealed penetrations maintain the air barrier

**Tools:**
1. Caulk gun

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

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.
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
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,
rigid barrier

Plug should be sealed in place to prevent leakage

4.1301.3d - Occupant education

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

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

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

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17
Best Practice

Provide occupant with documentation of and about insulation installed.

Communicate professionally with occupant to provide information and support.

Documentation should include insulation material and r-value.

Provide occupant with copies of all documentation.
4.1301.4 - Dense Pack Floor System with Rigid Barrier

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

4.1301.4a - Sealing

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

**Specification(s):**
Sealing the floor system will be completed before insulating

**Objective(s):**
Ensure airtight envelope

Prevent leakage

![Before](before.png)

Gaps around penetrations can cause air leakage and negate insulation

![After](after.png)

Sealed penetrations maintain the air barrier

**Tools:**
1. Caulk gun

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

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.
4.1301.4b - Rigid air barrier

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

Specification(s):
A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

Seams and penetrations will be sealed

Objective(s):
Relocate air barrier

Uninsulated floors over unconditioned spaces are an energy drain

Rigid barriers allow for air sealing and create cavities for insulation
Insulation > Floors > Accessible Floors

**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

**Tools:**
1. tape measure
2. utility knife
3. flashlight

**Materials:**
1. rigid air barrier
2. sealant

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Before

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

After

Cavity as been blocked, sealed, and insulated.
Refer to 2012 IECC with Georgia State Supplements and Amendments. Local codes may be more stringent than the statewide code.

Measure cavity to determine size necessary for blocking. Measure and cut blocking to fit snugly between floor joists. Ensure the blocking is placed to the most interior edge of the top plate of the wall below.

Air seal blocking around its perimeter edges with foam or caulk. Cut batt insulation to match the size of the blocking.

4.1301.5b - 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

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Insulation will be installed to prescribed R-value

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

![Before](image1.png)  
Cavities are open and subfloor of conditioned space above is uninsulated.

![After](image2.png)  
Batt insulation is installed to either fill the cavity or be properly supported to maintain contact with the subfloor.

**Tools:**
1. drill  
2. nail gun
3. claw hammer

**Materials:**
1. batt insulation - kraft-faced or unfaced  
2. insulation supports

Refer to 2012 IECC with Georgia State Supplements and Amendments. Local codes may be more stringent than the statewide code.

Block and air seal all joist cavities in cantilevered floors above and in line with the supporting wall.

**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
Sagging, unsupported floor insulation is not in contact with the subfloor

After
Fiberglass floor insulation properly installed with wire supports

Tools:
1. Wire cutters
2. Stapler
3. Cordless driver/drill
4. Utility knife

Materials:
1. Wire insulation supports
2. (optional) 1 X 2 furring strips or insulation support netting
3. Staples

https://www.youtube.com/watch?v=b47hH7HByts

4.1301.5c - Attachment

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

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

Objective(s):
Ensure insulation remains in contact with subfloor and air barrier
Before

Insulation should be secured to prevent drooping or movement

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

After

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

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

Batts should have full contact with subfloor without being compressed

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

4.1301.5d - Exterior soffit

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

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

Objective(s):
Cover and protect insulation

Before
Cavities have been insulated but are still exposed.

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

Tools:
1. hammer
2. drill
3. nail gun
4. mechanical fasteners

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

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

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

4.1301.5e - Occupant education

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

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

• Thickness

• R-value

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17

Best Practice
Provide occupant with documentation of and about insulation installed

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation
4.1301.6 - Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier

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

4.1301.6a - Subfloor preparation

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

**Specification(s):**
Sealing between house and crawl space will be completed before insulating

**Objective(s):**
Ensure airtight envelope

Prevent leakage

![Before](before), ![After](after)

Gaps around penetrations can cause air leakage and negate insulation

Sealed penetrations maintain the air barrier

**Tools:**
1. Caulk gun

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

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.
Locate gaps around penetrations for plumbing, electrical, etc. 
Fill gaps greater than 1/4 inch with backer rod or spray foam 
Caulk smaller gaps and to hold backer rod in place

4.1301.6b - Installation

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

**Specification(s):**
Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

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

Insulation will be installed to prescribed R-value

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

Uninsulated floors above unconditioned spaces are an energy drain

After

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

Tools:

1. Utility knife
2. Drill

Materials:

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

Order and install insulation as called for in Work Order

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

Install kraft-faced batts with paper against subfloor
Ensure batts are in full contact with subfloor and remain uncompressed

4.1301.6c - Secure batts

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

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

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

Before

Batts should not hang away from subfloor

After

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

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

Materials:
1. Lightning rods
2. Twine
3. Fasteners
Batts should be in full contact with subfloor without being compressed.

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

4.1301.6d - Rigid air barrier

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

Specification(s):
A rigid air barrier will be mechanically fastened to underside of floor assembly.

Seams and penetrations will be sealed.

Objective(s):
Protect insulation.

Before
Unfaced fiberglass batts can be attractive housing for pests.

After
Rigid barrier allows for air sealing and protects batt insulation.
Insulation > Floors > Accessible Floors

4.1301.6e - Occupant education

**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
Objective(s):
Document job completion to contract specifications
Confirm amount of insulation installed
Comply with 16 CFR 460.17

- Thickness
- R-value

Best Practice
Provide occupant with documentation of and about insulation installed

Communicate professionally with occupant to provide information and support
Documentation should include insulation material and r-value
Provide occupant with copies of all documentation
4.1301.7 - Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier

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

4.1301.7a - Subfloor preparation

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

**Specification(s):**
Sealing between house and crawl space will be completed before insulating

**Objective(s):**
Prevent air leakage

![Before](image1)

Gaps around penetrations can cause air leakage and negate insulation

![After](image2)

Sealed penetrations maintain the air barrier

**Tools:**
1. Caulk gun

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

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.
4.1301.7b - 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
than insulation hose with loose fill insulation specified r-value, prepare plug

Seal rigid barrier to prevent leakage

4.1301.7d - Occupant education

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

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

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

Objective(s):
Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17
Best Practice

Provide occupant with documentation of and about insulation installed

Communicate professionally with occupant to provide information and support

Documentation should include insulation material and r-value

Provide occupant with copies of all documentation
4.1301.8 - Pier Construction Subfloor Installation—Dense Pack with Rigid Barrier

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

4.1301.8a - Subfloor preparation

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

**Specification(s):**
Sealing between house and crawl space will be completed before insulating

**Objective(s):**
Prevent air leakage

**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
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.
4.1601.1 - Insulating Flex Ducts

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

4.1601.1a - Removal of existing flexible ducting

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

**Specification(s):**
All accessible low R-value flexible ducting will be removed from premises

**Objective(s):**
Ensure installation of proper R-value ducts

4.1601.1b - Selection of new flexible ducting

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

**Specification(s):**
All flexible ducting will have a minimum of R-8

**Objective(s):**
Minimize thermal conductance of the duct system

4.1601.1c - Sizing of new flex

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

**Specification(s):**
Duct sizing procedures will be conducted when replacing flex duct

**Objective(s):**
Improve comfort in rooms
Improve fan performance

4.1601.1d - Installation of flex

Desired Outcome:
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

Specification(s):
Flexible ducts will be supported in accordance with flex duct manufacturer's directions or local codes

Objective(s):
Prevent sags, drops, or other bends that may interfere with correct air flow

4.1601.1e - Interior liner attachment

Desired Outcome:
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

Specification(s):
Interior liner of the flex-to-metal connection will be fastened with tie bands using a tie band tensioning tool or a mechanical band

Objective(s):
Create a strong, secure attachment

4.1601.1f - Sealing of interior liner

Desired Outcome:
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

Specification(s):
Systems used to seal flexible air ducts and flexible air connectors will comply with UL 181B and will be marked "181 B-FX" for pressure-sensitive tape or "181 B-M" for mastic

Objective(s):
Create an airtight connection
4.1601.1g - Attachment of exterior liner

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

**Specification(s):**
Liner will be pulled up onto the metal duct as far as possible before securing

The exterior liner of the flex duct will be fastened with tie bands using a tie band tensioning tool

**Objective(s):**
Create a strong, durable attachment

4.1601.1h - Sealing of all accessible ducts

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

**Specification(s):**
All accessible joints, seams, and connections in ductwork will be securely fastened and sealed with UL "181 B-M" compliant mastic (adhesives) or mastic-plus-embedded-fabric systems

**Objective(s):**
Minimize duct leakage

4.1601.1i - Insulation of all fittings

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

**Specification(s):**
All metal fittings including boots, elbows, and take-offs will be insulated separately using an R-11 duct wrap with vapor retarder

**Objective(s):**
Minimize thermal conductance of the duct system
4.1601.1j - Completeness of vapor barrier

**Desired Outcome:**
Lower conductive heat transfer by ducts and decreased condensation on duct vapor barrier

**Specification(s):**
Vapor retarder of all duct insulation will be taped to the flex duct using tape that complies with UL 181B and will be marked "181 B-FX" for pressure-sensitive tape or "181 B-M" for mastic

**Objective(s):**
Ensure a complete vapor barrier
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

Before
Uninsulated ducts in unconditioned spaces are an energy drain

After
Properly insulated ducts operate at much higher rates of efficiency
Ducts in unconditioned areas should have r-8 insulation with vapor barrier. OR ducts can be buried in loose fill in attic spaces in drier climates. Burying ducts is discouraged in warm coastal and hot humid regions.

### 4.1601.2b - Duct sealing

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

**Specification(s):**
All joints, seams, and connections in ductwork shall be securely fastened and sealed with UL 181 B-M mastics (adhesives) or mastic-plus-embedded-fabric systems installed in accordance with the manufacturer's instructions before insulation is applied.

**Objective(s):**
Minimize duct leakage

**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
4.1601.2d - Taping of the duct insulation

**Tools:**
1. Scissors
2. Metal snips

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

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

**Specification(s):**
Using a tape approved by the manufacturer, all seams and connection of the duct insulation will be taped

No gaps will exist between pieces of duct insulation

**Objective(s):**
Prevent gaps in the vapor barrier of the insulation

**Before**
Unsecured and sealed insulation around ducts is useless

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

**Tools:**
1. Utility knife

**Materials:**
1. UL-181 tape
2. R-8 duct insulation with vapor barrier
5.3001.1 - Load Calculation and Equipment Selection

Desired Outcome:
Equipment sized properly and operates efficiently

5.3001.1a - Load calculation

Desired Outcome:
Equipment sized properly and operates efficiently

Specification(s):
Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J (Residential Load Calculation) and manufacturer specifications

Objective(s):
Properly size equipment for load

5.3001.1b - Equipment selection

Desired Outcome:
Equipment sized properly and operates efficiently

Specification(s):
Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications

Objective(s):
Ensure equipment is able to heat, cool, and dehumidify the house

5.3001.1c - Air filtration

Desired Outcome:
Equipment sized properly and operates efficiently

Specification(s):
New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass around the filters
Objective(s):
Particle removal to protect equipment and help maintain indoor air quality
5.3001.2 - Ductwork and Termination Design

Desired Outcome:
Efficient air flow to all rooms ensured by proper ductwork

5.3001.2a - Duct design

Desired Outcome:
Efficient air flow to all rooms ensured by proper ductwork

Specification(s):
Duct design will be performed in accordance with ANSI/ACCA Manual D and manufacturer specifications

Objective(s):
Maximize air flow

5.3001.2b - Termination design

Desired Outcome:
Efficient air flow to all rooms ensured by proper ductwork

Specification(s):
Termination design will be performed in accordance with ANSI/ACCA Manual T and manufacturer specifications

Objective(s):
Maximize air flow

Ensure occupant comfort

5.3001.2c - Air filtration

Desired Outcome:
Efficient air flow to all rooms ensured by proper ductwork

Specification(s):
New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass
around the filters

**Objective(s):**
Particle removal to protect equipment and help maintain indoor air quality
5.3002.1 - Preparation for New Equipment

Desired Outcome:
Existing equipment removed safely and lawfully

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

5.3002.1a - Access

Desired Outcome:
Existing equipment removed safely and lawfully

Specification(s):
A code compliant walkway and service platform will be installed in attics, if not present
Walkway and platform will be above the level of insulation (if practical)

Objective(s):
Ensure new equipment can be installed and serviced
Maintain adequate insulation level

5.3002.1b - Utility disconnect

Desired Outcome:
Existing equipment removed safely and lawfully

Specification(s):
Electricity and fuel will be turned off prior to starting removal of old appliance

Objective(s):
Protect workers and occupants from injury

5.3002.1c - Refrigerant recovery

Desired Outcome:
Existing equipment removed safely and lawfully
**5.3002.1d - Equipment disconnection**

**Desired Outcome:**
Existing equipment removed safely and lawfully

**Specification(s):**
Refrigerant lines, plumbing, ducts, electric, control wires, vents, and fuel supply will be disconnected

**Objective(s):**
Ensure equipment can be removed

---

**5.3002.1e - Removal**

**Desired Outcome:**
Existing equipment removed safely and lawfully

**Specification(s):**
Equipment will be removed (e.g., furnace, air handler, evaporator, condensing unit)

Equipment will be removed from space without damaging property and disturbing or compressing the insulation

Equipment will be disposed of in accordance with local laws and regulations, recycling materials when feasible

**Objective(s):**
Provide room to install new equipment and work safely

Comply with applicable disposal laws
5.3003.1 - Data Plate Verification

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

5.3003.1a - Data plate verification

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

**Specification(s):**
Equipment will be visually inspected

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

**Objective(s):**
Ensure technician has equipment data necessary for commissioning and future service work
5.3003.3 - Evaluating Air Flow

Desired Outcome:
Air flow is properly tested

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

5.3003.3a - Total air flow

Desired Outcome:
Air flow is properly tested

Specification(s):
Total system air flow will be measured by one of the following methods:

- Temperature rise
- Flow plate
- Fan depressurization device (e.g., Duct Blaster®, DucTester®)

Objective(s):
Ensure equipment:

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

5.3003.3b - External static pressure

Desired Outcome:
Air flow is properly tested

Specification(s):
External static pressure will be in accordance with manufacturer specifications

Objective(s):
Ensure equipment:
5.3003.3c - Pressure

**Desired Outcome:**
Air flow is properly tested

**Specification(s):**
Pressure drop across cooling coils will be in accordance with manufacturer specifications

**Objective(s):**
Ensure equipment:

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

5.3003.3d - Filter Inspection

**Desired Outcome:**
Air flow is properly tested

**Specification(s):**
Visual inspection to verify filter type is per manufacturer specifications, and is clean

**Objective(s):**
Ensure equipment:

- Operates as designed
- Operates efficiently
- Provides comfort
- Operates safely
- Is durable
5.3003.3e - Balancing room flow: new ductwork

**Desired Outcome:**
Air flow is properly tested

**Specification(s):**
Proper air flow delivery to each room will be ensured by one of the following:

- Measuring air flow at each register

OR

- Measuring heat rise, room pressures, and interviewing residents to ensure their comfort.

**Objective(s):**
Ensure equipment:

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

5.3003.3f - Supply and return temperature measurements

**Desired Outcome:**
Air flow is properly tested

**Specification(s):**
Supply and return wet bulb (wet bulb temperature is measured for cooling systems only) and dry bulb air temperatures will be recorded

**Objective(s):**
Ensure equipment:

- Operates as designed
- Operates efficiently
- Provides comfort
- Operates safely
- Is durable
5.3003.3h - Temperature rise: gas and oil furnaces only

Desired Outcome:
Air flow is properly tested

Specification(s):
Temperature rise between the supply and return will be in accordance with manufacturer specifications

Objective(s):
Ensure equipment:

- Operates as designed
- Operates efficiently
- Provides comfort
- Operates safely
- Is durable
5.3003.4 - Evaluating Electrical Service

Desired Outcome:
Electrical components properly tested

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

5.3003.4a - Polarity

Desired Outcome:
Electrical components properly tested

Specification(s):
Polarity of equipment will be correct

Objective(s):
Ensure equipment operates as designed
Ensure equipment operates safely

5.3003.4b - Voltage/amperage: incoming power

Desired Outcome:
Electrical components properly tested

Specification(s):
Voltage/amperage will be in accordance with manufacturer specifications

Objective(s):
Ensure equipment operates as designed

5.3003.4c - Voltage: contactor

Desired Outcome:
Electrical components properly tested

Specification(s):
In accordance with manufacturer specifications, voltage drop will be within acceptable range

**Objective(s):**
- Ensure contactor does not overheat
- Ensure equipment operates as designed

### 5.3003.4d - Grounding

**Desired Outcome:**
Electrical components properly tested

**Specification(s):**
Grounding must conform to meet NFPA 70 National Electric Code

**Objective(s):**
- Ensure equipment operates as designed
- Ensure equipment operates safely

### 5.3003.4e - Blower amperage

**Desired Outcome:**
Electrical components properly tested

**Specification(s):**
Amperage will not exceed manufacturer full load amperage

**Objective(s):**
- Ensure equipment operates as designed
- Ensure equipment operates efficiently
- Ensure equipment operates safely

### 5.3003.4f - Compressor amperage

**Desired Outcome:**
Electrical components properly tested
Specification(s):
Amperage will not exceed manufacturer full load amperage

Objective(s):
Ensure equipment operates as designed
Ensure equipment operates efficiently
Ensure equipment operates safely

5.3003.4g - Door switch operation

Desired Outcome:
Electrical components properly tested

Specification(s):
Blower compartment safety switch operation will be verified

Objective(s):
Ensure blower does not operate during service

5.3003.4h - Heat pump: emergency heat

Desired Outcome:
Electrical components properly tested

Specification(s):
Emergency heat circuit functions will be verified

Objective(s):
Ensure system delivers heat in case of compressor failure
5.3003.5 - Refrigerant Line Inspection

Desired Outcome:
Refrigerant lines properly installed

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

5.3003.5a - Insulation

Desired Outcome:
Refrigerant lines properly installed

Specification(s):
All suction or vapor refrigerant lines, will be insulated to a minimum of R-4

High-side or liquid refrigerant lines will not be insulated unless specified by the equipment's manufacturer

Objective(s):
Ensure refrigerant lines do not gain excessive heat, or cause condensation to occur inside the building envelope

5.3003.5b - Ultraviolet (UV) protection of insulation

Desired Outcome:
Refrigerant lines properly installed

Specification(s):
If exposed to sunlight, refrigerant line insulation will be protected from UV degradation in accordance with manufacturer specifications, IRC or local code

Objective(s):
Install insulation so it does not degrade

5.3003.5c - Sizing

Desired Outcome:
Refrigerant lines properly installed

**Specification(s):**
Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment

**Objective(s):**
Ensure system moves appropriate volume of refrigerant

---

**5.3003.5d - Installation quality**

**Desired Outcome:**
Refrigerant lines properly installed

**Specification(s):**
Refrigerant lines will be installed without kinks, crimps, or excessive bends

**Objective(s):**
Ensure system moves appropriate volume of refrigerant

---

**5.3003.5e - Support**

**Desired Outcome:**
Refrigerant lines properly installed

**Specification(s):**
Refrigerant lines will be routed, supported, and secured to house in a manner that protects the line from damage by workers or occupants

**Objective(s):**
Ensure refrigerant lines do not move, vibrate, or sag

Protect lines from damage
5.3003.9 - Heating and Cooling Controls

Desired Outcome:
Heating and cooling controls installed and set properly

5.3003.9a - Removal of mercury-based thermostats

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
Mercury based thermostat will be removed safely and disposed of in accordance with EPA regulations

Objective(s):
Protect workers and occupants from injury

Protect environment from damage

5.3003.9b - Removal of existing controls

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
Existing controls will be removed in accordance with EPA lead-safe work rules

Objective(s):
Protect workers and occupants from injury

Protect environment from damage

5.3003.9c - Penetrations

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
Penetrations for control wiring will be sealed with a durable sealant (e.g., caulk, silicone, foam)

**Objective(s):**
Ensure controls operate as designed
Minimize infiltration and exfiltration from house

### 5.3003.9d - Thermostat location

**Desired Outcome:**
Heating and cooling controls installed and set properly

**Specification(s):**
Thermostats will be installed to reflect the temperature of the zone in which they are installed
Thermostats will not be exposed to extreme temperatures, radiant heat sources, and drafts

**Objective(s):**
Ensure controls operate as designed

### 5.3003.9e - Blower speed

**Desired Outcome:**
Heating and cooling controls installed and set properly

**Specification(s):**
Blower speed will be set for equipment in accordance with manufacturer specifications

**Objective(s):**
Ensure equipment has correct air flow

### 5.3003.9f - Thermostat selection: heat pump

**Desired Outcome:**
Heating and cooling controls installed and set properly

**Specification(s):**
A thermostat with equipment supplementary heat lockout that can interface with an outside temperature sensor will be selected
Objective(s):
Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load

5.3003.9g - Heat pump: supplementary heat

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
Supplementary heat will be used on air-to-air heat pumps with conditions that allow for a balance point of less than 30°F

Supplementary heat lockout will be installed and set to manufacturer specifications

Objective(s):
Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load

5.3003.9h - Heat pump: low ambient compressor lockout

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
For air-to-air heat pumps, low ambient compressor lockout will be set to 0°F outdoor temperature or to manufacturer specifications

Objective(s):
Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load

5.3003.9i - Heat pump: outside temperature sensor

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
An outdoor temperature sensor will be installed in accordance with manufacturer specifications

Objective(s):
Ensure equipment operates as designed

5.3003.9j - Heat pump: supplementary heat wiring

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
Supplementary heat will be wired onto second-stage heating terminal in accordance with manufacturer specifications

Objective(s):
Do not operate supplementary heat in stage one heating

5.3003.9k - Thermostat: installer programming

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
The installer options will be set to match the thermostat to the equipment and control board settings

Objective(s):
Ensure equipment operates as designed

5.3003.9l - Time delay settings

Desired Outcome:
Heating and cooling controls installed and set properly

Specification(s):
Time delay for equipment will be set in accordance with manufacturer specifications and as appropriate for the climate zone (e.g., no time delay for hot humid climates)

Objective(s):
Maximize transfer of heat without adversely affecting indoor humidity levels
5.3003.9m - Humidistat: location

**Desired Outcome:**
Heating and cooling controls installed and set properly

**Specification(s):**
Humidistat will be installed to reflect humidity of the zone in which it is installed

Humidistat will be installed in a dry location

**Objective(s):**
Ensure controls operate as designed

5.3003.9n - Occupant education

**Desired Outcome:**
Heating and cooling controls installed and set properly

**Specification(s):**
Occupants will be educated on proper use of thermostat including:

- Proper use of setbacks for air conditioners and heat pumps
- Allowing occupant comfort to determine setback for combustion heating appliances
- Using emergency heat appropriately

**Objective(s):**
Ensure equipment and controls operate as designed

Provide comfort throughout house
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. PVC primer and cement

PVC cement is not actually glue, but rather a solvent that softens the surfaces and welds them together. Clean and dry the surfaces, then apply purple primer to prepare them for solvent welding.
Coat both surfaces with PVC cement. Insert the pipe or male fitting into the female socket until it bottoms out, and then twist them a quarter turn to evenly spread the cement. Wipe away the excess cement, and wait the period of time specified by the cement manufacturer before allowing water through the connection.

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

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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

This AC unit is located below the drain location, requiring a pump to eject the condensate upward

After

Route AC condensate line into a pump and run the discharge outdoors if AC is located too low to drain by gravity

Use condensate pumps equipped with safety switches. Wire the switch to the HVAC unit so that it will shut off the unit in the event the condensate pump backs up or overflows.

Ductless mini-split AC unit is mounted to a wall which cannot be penetrated

Pipe the condensate to a pump. Provide a power supply for the pump

Route the pump discharge outside or into the sewage system

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

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

5.3003.14a - Gas Pressure

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

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

**Objective(s):**
Ensure equipment:

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

5.3003.14b - Place appliance in operation

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

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

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

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

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

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

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

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
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
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

See also ASHRAE 62.2-2013.
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

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**Bad Practice**
Uninsulated ducts in unconditioned spaces can result in condensation issues, mold, water damage, and energy losses

**Best Practice**
Insulated exhaust and fresh air ducts save energy and reduce problems from condensation, mold, and water damage

**Tools:**
1. Utility knife
2. Metal snips
3. Wire cutters
4. Outward clinching (stitch) stapler

**Materials:**
1. R-8 insulation with vapor barrier
2. Nylon twine or webbing
3. Light gauge galvanized wire
4. UL-181 duct tape
5. Staples

See also ASHRAE 62.2-2013. Check local codes to verify that R-8 is a sufficient level of insulation.

Sheet metal (for example, a curved piece of flashing or opened, flattened section of metal duct) may be used to support insulated duct without causing the insulation to be compressed.
6.6002.1c - Duct support

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

**Specification(s):**
Flexible and duct board ducts and plenums will be supported every 4’ using a minimum of 1 ½” wide material

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

Metal ducts will be supported by 1/2” or wider 18-gauge strapping or 12 gauge or thicker galvanized wire no less than 10’ apart

**Objective(s):**
Effectively move the required volume of air

Preserve the integrity of the duct system

Eliminate falling and sagging
Before
Ducts should not be allowed to droop or sag to maximize efficiency

After
Supports should be evenly spaced to allow for minimal distance of run

Tools:
1. Drill
2. Metal snips
3. Utility knife

Materials:
1. Durable straps at least 1 1/2" wide
2. 18 gauge metal strap at least 1/2" wide
3. 12 gauge galvanized wire
4. Staples
5. Fasteners

See also ASHRAE 62.2-2013.

BAD: Make sure supports DO NOT compress insulation or duct

Flex ducts should have support straps at least every 4 feet

Support straps should be at least 1 1/2 inches wide
6.6002.1d - Duct connections

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

**Specification(s):**
Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws

Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic- plus-embedded-fabric systems, or tapes

Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool

PVC-to-PVC materials will be fastened with approved PVC cement

Other specialized duct fittings will be fastened in accordance with manufacturer specifications

In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

**Objective(s):**
Effectively move the required volume of air

Preserve the integrity of the duct system
**6.6002.1e - Duct materials**

**Desired Outcome:**

- Fan duct is disconnected and venting into the attic space.
- Fan has been vented with sealed, insulated duct material.

1. Apply mastic to the connection fitting.
2. Snug duct liner onto connection fitting.
3. Use zip tie and tensioner to secure liner to connection fitting.
4. Apply mastic to fan connection.
5. Using mechanical fasteners, secure connection fitting to fan connection.
6. Snug insulation to fan housing and strap into place.
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

**Tools:**
1. utility knife
2. wire cutters
3. zip tie tensioning tool
4. disposable brushes
5. hacksaw

**Materials:**
1. rigid metal duct
2. UL 181 listed flexible duct
3. PVC pipe
4. mastic duct sealant
5. zip ties
6. UL 181 listed tape
7. PVC cement (only if using PVC pipe as duct material)
8. sheet metal screws
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

Exhaust fans need exterior ventilation, often through roofs and walls

Hole should be no more than 1/4" larger than termination fitting diameter
Locate the center of your vent hole by drilling from inside through roof

Measure the termination fitting to determine proper hole saw diameter

Based on termination fitting size (in this case, 4”), mark to cut hole

Hole should be no more than 1/4” 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

Before Termination is not mechanically fastened, or sealed appropriately.

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

**Tools:**
1. wire cutters
2. disposable chip brush
3. zip tie tensioning tool
4. utility knife
5. hacksaw

**Materials:**
1. insulated flex duct with liner
2. mastic duct sealant
3. zip tie straps
4. UL 181 listed tape
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.

**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

Before
Holes for termination fitting need to be sealed to weatherproof

After
Termination installation should follow shingling to deter water penetration

Tools:
1. Hole saw
2. Caulk gun
3. Drill

Materials:
1. Fasteners
2. Caulk

Termination fitting is installed to repel water and sealed

6.6002.2e - Pest exclusion

Desired Outcome:
Securely installed termination fittings with unrestricted air flow

Specification(s):
Screen material with no less than ¼” and no greater than ½” hole size in any direction will be used

Installation will not inhibit damper operation or restrict air flow
Objective(s):
Prevent pest entry
Ensure proper air flow

Exhaust terminations without screens are an invitation to pest intrusion
Screen mesh should be between 1/4" and 1/2" in either direction

6.6002.2f - Termination location

Desired Outcome:
Securely installed termination fittings with unrestricted air flow

Specification(s):
Terminations will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors.

Terminations will be installed:

- A minimum of 3' away from any property line
- A minimum of 3' away from operable opening to houses
- A minimum of 10' away from mechanical intake
- As required by authority having jurisdiction

Objective(s):
Prevent exhaust from reentering house
Unsafe

Unsafe
Exhaust vent has been improperly mounted too close to mechanical vent

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.
6.6002.3 - Exhaust-Only Ventilation—Fan Intake Grille Location

Desired Outcome:
Exhaust grille location optimizes either primary or local ventilation

Note:

6.6002.3a - Primary whole house ventilation

Desired Outcome:
Exhaust grille location optimizes either primary or local ventilation

Specification(s):
Fan intake grille will be installed in a central location within the main body of the house

Ensure it is accessible for filter change and cleaning

Objective(s):
Provide whole house air exchange

6.6002.3b - Local ventilation

Desired Outcome:
Exhaust grille location optimizes either primary or local ventilation

Specification(s):
Fan intake grille will be installed in the space where odor, moisture vapor, or other contaminants are generated

Objective(s):
Remove contaminated air at the source
6.6003.1 - Surface-Mounted Ducted

Desired Outcome:
Surface-mounted ducted fans installed to specification

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

6.6003.1a - Hole through interior surface

Desired Outcome:
Surface-mounted ducted fans installed to specification

Specification(s):
A hole no greater than a 1/4" greater than the assembly will be cut to accommodate fan assembly

Objective(s):
Minimize repair work
Ensure a secure installation

6.6003.1b - Wiring

Desired Outcome:
Surface-mounted ducted fans installed to specification

Specification(s):
Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

Objective(s):
Prevent an electrical hazard

6.6003.1c - Fan mounting

Desired Outcome:
Surface-mounted ducted fans installed to specification
**Specification(s):**
Fan outlet will be oriented toward the final termination location

Fan will be oriented so the equivalent length of the duct run is as short as possible

Fan will be mounted securely in accordance with manufacturer specifications

**Objective(s):**
Ensure short duct run to achieve optimum air flow

Ensure a secure installation

Ensure fan housing does not shake, rattle, or hum when operating

---

**6.6003.1d - Backdraft damper**

**Desired Outcome:**
Surface-mounted ducted fans installed to specification

**Specification(s):**
A backdraft damper will be installed between the outlet side of the fan and the exterior

**Objective(s):**
Prevent reverse air flow when the fan is off

---

**6.6003.1e - Duct to fan connection**

**Desired Outcome:**
Surface-mounted ducted fans installed to specification

**Specification(s):**
Duct-to-fan outlet will be connected and sealed as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- PVC-to-PVC materials will be fastened with approved PVC cement
• Other specialized duct fittings will be fastened according to manufacturer specifications
• In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

**Objective(s):**
Exhaust to outside

### 6.6003.1f - Fan housing seal

**Desired Outcome:**
Surface-mounted ducted fans installed to specification

**Specification(s):**
Gaps and holes in fan housing will be sealed with caulk or other sealants in accordance with manufacturer recommendations

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

**Objective(s):**
Prevent air leakage through fan housing

Ensure a permanent seal

Prevent a fire hazard

### 6.6003.1g - Fan to interior surface seal

**Desired Outcome:**
Surface-mounted ducted fans installed to specification

**Specification(s):**
Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

**Objective(s):**
Prevent air leakage between house and fan
6.6003.1h - Air flow

Desired Outcome:
Surface-mounted ducted fans installed to specification

Specification(s):
Air flows in cubic feet per minute (CFM) will be measured and adjusted to meet the whole house upgrade design requirements

Objective(s):
Exhaust sufficient air from desired locations to outside

6.6003.1i - Preventing air leakage caused by exhaust fans

Desired Outcome:
Surface-mounted ducted fans installed to specification

Specification(s):
Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)

Objective(s):
Ensure occupant health and safety

6.6003.1j - Combustion safety

Desired Outcome:
Surface-mounted ducted fans installed to specification

Specification(s):
Pressure effects will be assessed and corrected on all combustion appliances

Objective(s):
Ensure safe operation of combustion appliances
6.6003.2 - Inline

**Desired Outcome:**
Inline fans installed to specification

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

6.6003.2a - Wiring

**Desired Outcome:**
Inline fans installed to specification

**Specification(s):**
Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes

**Objective(s):**
Prevent an electrical hazard

6.6003.2b - Access

**Desired Outcome:**
Inline fans installed to specification

**Specification(s):**
Fan and service switch will be accessible for maintenance according to NFPA 70 National Electric Code or local authority having jurisdiction

**Objective(s):**
Fan and service switch will be accessible for maintenance

6.6003.2c - Fan mounting

**Desired Outcome:**
Inline fans installed to specification

**Specification(s):**
Fan outlet will be oriented toward the final termination location

Fan will be oriented so the equivalent length of the duct run is as short as possible

Fan will be mounted securely in accordance with manufacturer specifications

Fan will be isolated from the building framing unless specifically designed to be directly attached

Fan will be installed remotely by installing ducting from intake grille

**Objective(s):**
Ensure short duct run to achieve optimum air flow

Ensure fan is installed securely

Ensure fan housing or building framing does not shake, rattle, or hum when operating

Minimize noise

### 6.6003.2d - Backdraft damper

**Desired Outcome:**
Inline 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

### 6.6003.2e - Duct connections

**Desired Outcome:**
Inline fans installed to specification

**Specification(s):**
Ducts will be connected and sealed to the intake fan and 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

Objective(s):
Exhaust from desired location to outside
Preserve integrity of the duct system and building envelope

6.6003.2f - Boot to interior surface seal

Desired Outcome:
Inline 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

6.6003.2g - Air flow

Desired Outcome:
Inline 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
6.6003.2h - Preventing air leakage caused by exhaust fans

Desired Outcome:
Inline fans installed to specification

Specification(s):
Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)

Objective(s):
Ensure occupant health and safety

6.6003.2i - Combustion safety

Desired Outcome:
Inline fans installed to specification

Specification(s):
Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards

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

Objective(s):
Ensure safe operation of combustion appliances
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. saw
2. prybar
3. goggles
4. gloves
5. measuring tape

*Before*
Measure the vent size to compare to opening. 1/4" gap or less is desired.

*After*
Hole size allows sufficient room for vent installation and proper sealing.
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

Fan wiring showing proper grounding, wiring connections, and clamp
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.

Make all connections to existing wiring in junction boxes. Use wire nuts on line and neutral and crimp sleeves on ground

### 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
Best Practice

Using provided holes or template, drill holes and fasten fan securely.

Tools:
1. drill
2. drill bits

Materials:
1. fasteners

6.6003.3d - Weatherproof installation

Desired Outcome:
Through the wall fans installed to specification

Specification(s):
Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Termination fitting installation will not inhibit damper operation

Manufacturer specifications will be followed

Objective(s):
Preserve integrity of the building envelope

Ensure a weather tight and durable installation

Ensure unrestricted air flow
Best Practice

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

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

With the termination cap pushed against the wall, wipe away excess sealant and install mechanical fasteners.

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
Best Practice

Damper should be installed to maintain exterior air barrier

6.6003.3f - Fan housing seal

Desired Outcome:
Through the wall fans installed to specification

Specification(s):
Sealants will be compatible with their intended surfaces
Sealants will be continuous and meet fire barrier specifications

Objective(s):
Prevent air leakage through fan housing
Ensure a permanent seal to the building air barrier

Before
Apply sealant behind termination cap.

After
Compress sealant ensuring an airtight, weatherproof seal.
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

In Progress

Apply approved sealant around interior opening. Fan housing should compress sealant.

Tools:  
1. caulk gun

Materials:  
1. code approved caulk

6.6003.3i - Air flow

Desired Outcome:  
Through the wall fans installed to specification

Specification(s):
Air flows in CFM will be measured and adjusted to meet the design requirements

Objective(s):
Exhaust sufficient air from desired locations to outside

Best Practice
Using a digital manometer, exhaust flow meter and fabricated cover, measure the fan flow.

Best Practice
Air flow should be within acceptable limits for the location of the fan.

Tools:
1. exhaust fan flow meter
2. manometer

Materials:
1. a fabricated cover for fans larger than the flow meter

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
Installing new ventilation can cause imbalances within the house.

**Tools:**

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits.

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

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

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

After mitigation, verify that...
depressurization limits are not being exceeded
6.6005.1 - Clothes Dryer

Desired Outcome:
Dryer air exhausted efficiently and safely

6.6005.1a - Clothes dryer ducting

Desired Outcome:
Dryer air exhausted efficiently and safely

Specification(s):
Clothes dryers will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors

As short a run as practical of rigid sheet metal or semi-rigid sheet metal venting material will be used in accordance with manufacturer specifications

Dryer ducts exceeding 35’ in duct equivalent length will have a dryer booster fan installed

Plastic venting material will not be used

Uninsulated clothes dryer duct will not pass through unconditioned spaces such as attics and crawl spaces, except where allowed by the authority having jurisdiction

Ducts will be connected and sealed as follows:

- UL listed foil type or semi-rigid sheet metal to rigid metal will be fastened with clamp
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

In addition:

- Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used
- Condensing dryers will be plumbed to a drain

Objective(s):
Preserve integrity of building envelope
Effectively move air from clothes dryer to outside

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

**After**
Dryer is vented outdoors with semi-rigid metal duct. Run is as short and straight as possible ensuring maximum flow.

**Tools:**
1. tin snips
2. drill
3. wire cutters

**Materials:**
1. metal flex duct
2. dryer vent kit
3. hose clamps
4. UL 181 listed tape

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.

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

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**Unsafe**
Neglect of clothes dryer maintenance can cause fire hazards

**Best Practice**
Occupants should be taught to clean lint filters and termination fittings
In homes with booster fans, occupant should know location and how to clean

Occupants should be taught never to put flammable articles in dryer (in this case, oily rags)
6.6005.2 - Kitchen Range

Desired Outcome:
Kitchen range fan installed to specification

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

6.6005.2b - Fan venting

Desired Outcome:
Kitchen range fan installed to specification

Specification(s):
Kitchen range fans will be vented to the outdoors
Recirculating fans will not be used as a ventilating device

Objective(s):
Remove cooking contaminants from the house
Preserve integrity of building envelope

Refer to ASHRAE 62.2-2013
6.6005.2c - Fan ducting

Desired Outcome:
Kitchen range fan installed to specification

Specification(s):
Kitchen range fans will be ducted to the outdoors

As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications

Ducting will be connected and sealed as follows:

- Metal-to-metal will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- For down-draft exhaust systems, PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Objective(s):
Preserve integrity of building envelope

Effectively move air from range to outside

Exhaust duct should be smooth-walled and in as short a run as possible

Daylight visible through dampered kitchen exhaust proves outside access
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.

![Image 1](image1.png)  Duct run should be as smooth and short as possible

![Image 2](image2.png)  Duct should be fastened securely with three evenly-spaced screws

![Image 3](image3.png)  Then joints should be secured with fiberglass tape

![Image 4](image4.png)  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
**Objective(s):**
Ensure safe operation of combustion appliances

Ensure occupant health and safety

**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

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 that combustion appliances are operating within depressurization limit

Tools:

1. Manometer

See SWS 2.0299.1a-i for CAZ depressurization limits

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

If appliances exceed depressuization limit, mitigate to reduce risk

Install a source of make-up air, such as a passive inlet vent
After mitigation, verify that depressurization limits are not being exceeded.
6.6102.1 - Outside Air Ventilation Supply Ducts

**Desired Outcome:**
Ventilation supply ducts effectively move the required amount of air and prevent condensation

**Note:**

**6.6102.1a - Duct design and configuration**

**Desired Outcome:**
Ventilation supply ducts effectively move the required amount 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

**6.6102.1b - Duct insulation**

**Desired Outcome:**
Ventilation supply ducts effectively move the required amount of air and prevent condensation

**Specification(s):**
Ventilation supply ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes

**Objective(s):**
Prevent moisture condensation

**6.6102.1c - Duct support**

**Desired Outcome:**
Ventilation supply ducts effectively move the required amount 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
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 integrity of the ventilation supply duct system
Eliminate falling and sagging

6.6102.1d - Duct connections

Desired Outcome:
Ventilation supply ducts effectively move the required amount of air and prevent condensation

Specification(s):
All connections will have a contact overlap of at least 1”

Ducts will be connected and sealed as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded- fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- Flexible duct between the cable tie and end of metal or PVC duct will be screwed
- PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications

Outdoor air ventilation supply ducts attached to the return side of forced air systems will be:

- Attached as close to the heating, ventilation, and air conditioning (HVAC) systems fan as possible while remaining in compliance with manufacturer specifications
• Set up to provide filtration of outdoor ventilation air before reaching the HVAC system (for minimum MERV 6 filter)
• Attached via a mechanically fastened takeoff collar

All joints and connections in ductwork will be fastened and sealed with UL181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus-embedded-fabric systems

Objective(s):
Effectively move the required volume of air
Preserve integrity of the ventilation supply duct system and building envelope

6.6102.1e - Duct materials

Desired Outcome:
Ventilation supply ducts effectively move the required amount of air and prevent condensation

Specification(s):
Flexible air duct material will meet UL 181, NFPA 90A/90B, International Mechanical Code, or the Uniform Mechanical Code

Objective(s):
Effectively move the required volume of air
Preserve integrity of the duct system and building envelope

6.6102.1f - Outdoor air intake location

Desired Outcome:
Ventilation supply ducts effectively move the required amount of air and prevent condensation

Specification(s):
Outdoor air intake will be installed in accordance with the following:

• A minimum of 6" from grade
• A minimum of 10' from contaminant sources or exhaust outlets
• Above local snow or flood line
• A minimum of 18" above an asphalt based roof
• Never on a flat roof
• As required by authority having jurisdiction
Objective(s):
Prevent contaminants from entering house

Ensure unrestricted air flow
6.6102.2 - Intakes

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

6.6102.2a - Hole in building shell

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**Specification(s):**
A hole no greater than a 1/4" greater than the fitting will be cut to accommodate intake fitting

**Objective(s):**
Ensure a weather tight installation

6.6102.2b - Intake fitting

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**Specification(s):**
Collar will be at least the same diameter as the duct; if collar is larger than duct, 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 draw the required volume of air from the outdoors

Preserve integrity of the building envelope

Ensure durable installation

6.6102.2c - Occupant education

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**Specification(s):**
Intake fitting will be labeled "ventilation air intake"

Occupant will be instructed to keep yard debris and other contaminants clear of the intake

**Objective(s):**
Ensure unrestricted air flow

### 6.6102.2d - Damper (if applicable)

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**Specification(s):**
The damper will be installed to open in the direction of the desired flow

Damper will close when system is off

**Objective(s):**
Ensure unrestricted air flow

### 6.6102.2e - Connection to intake fitting

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**Specification(s):**
Duct to intake fitting will be connected and sealed as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- Flexible duct between tie band and end of metal or PVC duct will be screwed into place
- PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer
In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Ensure fasteners do not inhibit intake damper operation

**Objective(s):**
Preserve integrity of the building envelope
Ensure a weather tight and durable intake installation
Ensure unrestricted air flow

### 6.6102.2f - Weatherproofing

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**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 intake installation
Ensure unrestricted air flow

### 6.6102.2g - Pest exclusion

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**Specification(s):**
Corrosion resistant screen, louver, or grille material no less than ¼" and no greater than ½" hole size in any direction will be used, or as specified by authority having jurisdiction
Screen will be installed so it does not inhibit intake damper operation

**Objective(s):**
Prevent pest entry
Ensure unrestricted air flow

### 6.6102.2h - Intake location

**Desired Outcome:**
Intake optimizes air flow while limiting the entry of insects, debris, and contaminants

**Specification(s):**
Intake will be installed according to the following:

- A minimum of 6" from grade
- A minimum of 10' from contaminant sources or exhaust outlets
- Above local snow or flood line
- A minimum of 18" above an asphalt based roof
- Never on a flat roof
- As required by authority having jurisdiction

**Objective(s):**
Prevent contaminants from entering house
Ensure unrestricted air flow
6.6102.3 - Intake for Ventilation Air to Forced Air System Used for Heating or Cooling

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

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

6.6102.3a - Forced air system requirements

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

**Specification(s):**
Existing forced air system leakage to outside will be less than 10% of the air handler flow when measured at 25 pascals with reference to outside

Any portion of the return located inside the combustion appliance zone will be air sealed

**Objective(s):**
Reduce migration of pollutants

6.6102.3b - Wiring

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

**Specification(s):**
Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes

**Objective(s):**
Prevent an electrical hazard
6.6102.3c - Access

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

**Specification(s):**
Motorized damper and service switch will be accessible for maintenance in accordance with required code or authority having jurisdiction

**Objective(s):**
Ensure accessibility for maintenance

6.6102.3d - Mounting intake duct

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

**Specification(s):**
Ventilation duct will be attached as close to the HVAC system’s fan as possible while remaining in compliance with HVAC manufacturer specifications

Filtration of ventilation air will be provided before passing through the thermal conditioning components

Duct will be connected to intake fitting

Connection and seal will be performed according to supply duct detail

**Objective(s):**
Ensure short duct run to achieve optimum air flow

Preserve integrity of the duct system and building envelope

6.6102.3e - Motorized damper

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

**Specification(s):**
A motorized damper or equivalent technology will be installed between the intake fitting and the
return side of the air handler

Air flow will be provided by sequenced operation of the damper or equivalent technology

**Objective(s):**
Prevent air flow when none is desired

### 6.6102.3f - Intake filter

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

**Specification(s):**
An accessible filter will be installed

Filter will be able to remove contaminants consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 52.2

Filter or air cleaning systems that intentionally produce ozone will not be allowed

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

Preserve integrity of the building envelope

### 6.6102.3g - Occupant education

**Desired Outcome:**
Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability

**Specification(s):**
Occupant will be educated on how and when to change filter

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

Preserve integrity of the building envelope
6.6103.1 - Inline or Multi-Port

Desired Outcome:
Inline or multi-port fan installed in accordance with specifications

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

6.6103.1a - Wiring

Desired Outcome:
Inline or multi-port fan installed in accordance with specifications

Specification(s):
Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

Objective(s):
Prevent an electrical hazard

6.6103.1b - Access

Desired Outcome:
Inline or multi-port fan installed in accordance with specifications

Specification(s):
Fan and service switch will be accessible for maintenance, service, and replacement in accordance with applicable code or authority having jurisdiction

Objective(s):
Ensure accessibility for maintenance

6.6103.1c - Fan mounting

Desired Outcome:
Inline or multi-port fan installed in accordance with specifications

Specification(s):
Fan will be oriented with inlet toward the fan intake fitting

Fan will be oriented so the equivalent length of the duct run is as short as possible

Fan will be securely mounted in accordance with manufacturer specifications

Fan will be isolated from the building framing unless specifically designed to be directly attached

Fan will be installed remotely by ducting from supply register or grilles

**Objective(s):**
Ensure short duct run to achieve optimum air flow

Ensure fan is mounted securely

Ensure fan housing or building framing does not shake, rattle, or hum when operating

Minimize noise

### 6.6103.1d - Damper (required for intermittent operation)

**Desired Outcome:**
Inline or multi-port fan installed in accordance with specifications

**Specification(s):**
Damper will be installed to open in the direction of the desired flow

Damper will close when system is off

**Objective(s):**
Ensure unrestricted air flow

### 6.6103.1e - Duct connections

**Desired Outcome:**
Inline or multi-port fan installed in accordance with specifications

**Specification(s):**
Ducts will be connected and sealed to the intake fitting, fan, and register or grilles as follows:

* Metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced
screws

- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- Flexible duct between the cable tie and end of metal or PVC duct will be screwed
- PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications

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):
Provide desired air flow
Preserve integrity of the duct system and building envelope

6.6103.1f - Filter

Desired Outcome:
Inline or multi-port fan installed in accordance with specifications

Specification(s):
An accessible filter will be installed between the intake fitting and the fan

Contaminant removal will be consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 52.2

Filter or air cleaning systems that intentionally produce ozone will not be allowed

Objective(s):
Ensure occupant health and safety
Preserve integrity of the building envelope

6.6103.1g - Occupant education

Desired Outcome:
Inline or multi-port fan installed in accordance with specifications

Specification(s):
Occupant will be educated on how and when to change filter

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

### 6.6103.1h - Boot to interior surface seal

**Desired Outcome:**
Inline or multi-port fan installed in accordance with specifications

**Specification(s):**
All gaps between boot and interior surface 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 around intake housing
Ensure a permanent seal to the building air barrier
Prevent a fire hazard
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
With interior doors open, put reference hose to exterior

Take baseline reading

Turn on exhaust fans and close interior doors

With hose under door, check pressure again. Readings >+/-3pa are no good and require interior ventilation
6.6202.1 - Controls

Desired Outcome:
Fan controls support ventilation strategy

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

6.6202.1a - Primary ventilation fan (whole-house volume)

Desired Outcome:
Fan controls support ventilation strategy

Specification(s):
Controls will be used that can meet the following conditions:

- Run fan continuously or intermittently depending upon the intended schedule of operation
- Operate fan to produce the intended flow for each intended flow setting

Objective(s):
Deliver intended air exchange
Ensure fan controls meet intended ventilation strategy

6.6202.1b - Local exhaust—local fan

Desired Outcome:
Fan controls support ventilation strategy

Specification(s):
Controls will be used that meet the following conditions:

- Run fan continuously or intermittently depending on the intended schedule of operation
- Run fan for intended time for timed operation
- Operate fan to produce the intended flow for each intended flow setting

Objective(s):
Deliver intended air exchange
Ensure fan controls meet intended ventilation strategy

6.6202.1c - Wiring

Desired Outcome:
Fan controls support ventilation strategy

Specification(s):
Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

Objective(s):
Prevent an electrical hazard

Ensure fan controls meet intended ventilation strategy

6.6202.1d - Manual override

Desired Outcome:
Fan controls support ventilation strategy

Specification(s):
A labeled switch for manual override will be included for the ventilation system

Objective(s):
Ensure fan controls meet intended ventilation strategy

6.6202.1e - Occupant education

Desired Outcome:
Fan controls support ventilation strategy

Specification(s):
A system operation guide designed for occupants (non-professionals) will be provided to explain how and why to operate system

A label indicating the presence and purpose of the ventilation system will be included or a copy of the system operation guide will be posted at the electrical panel
Objective(s):
Educate occupants about system operation and importance

Deliver intended air exchange
6.6202.2 - Heat Recovery Ventilator (HRV) and Energy Recovery Ventilator (ERV) Installation

Desired Outcome:
HRV and ERV systems installed to specifications

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

6.6202.2a - Wiring

Desired Outcome:
HRV and ERV systems installed to specifications

Specification(s):
Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

Objective(s):
Prevent an electrical hazard

6.6202.2b - Access

Desired Outcome:
HRV and ERV systems installed to specifications

Specification(s):
Fans, service switch, filters, drain, and drain pan will be accessible for maintenance in accordance with authority having jurisdiction

Objective(s):
Maintain designed air flows and system performance

Ensure occupant health and safety
6.6202.2c - Fan mounting

**Desired Outcome:**
HRV and ERV systems installed to specifications

**Specification(s):**
Fan will be securely mounted in accordance with manufacturer specifications

Fan will be oriented so the equivalent length of the duct run is as short as possible; calculate "equivalent length" in accordance with ANSI/ACCA Manual D (Residential Duct Systems)

Fan will be isolated from the building framing unless specifically designed to be directly attached

**Objective(s):**
Ensure short duct runs achieve optimum air flows

Ensure fan is mounted securely

Ensure fan housing or building framing does not shake, rattle, or hum when operating

Minimize noise

6.6202.2d - Backdraft dampers (required for intermittent operation)

**Desired Outcome:**
HRV and ERV systems installed to specifications

**Specification(s):**
A backdraft damper will be installed between the heat recovery ventilator (HRV) or energy recovery ventilator (ERV) and the exterior, unless the system operates continuously

Outdoor air intakes and exhausts will be equipped with automatic or gravity dampers that close when the ventilation system is not operating

**Objective(s):**
Prevent reverse air flow when the system is off
6.6202.2e - Installation of fittings

**Desired Outcome:**
HRV and ERV systems installed to specifications

**Specification(s):**
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):**
Achieve the desired air flows to and from the designated locations

Ensure unrestricted air flow

Preserve integrity of the building envelope

6.6202.2f - Duct connections

**Desired Outcome:**
HRV and ERV systems installed to specifications

**Specification(s):**
Ducts will be connected to applicable registers or grilles, collector box, HRV or ERV, intake fitting, and termination fitting

Ducts will be connected and sealed as follows:

- Metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- Flexible duct between tie band and end of metal or PVC duct will be screwed into place
- 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):
Achieve the desired air flows to and from the desired locations
Preserve integrity of the duct system and building envelope

6.6202.2g - Duct layout

Desired Outcome:
HRV and ERV systems installed to specifications

Specification(s):
Air to be exhausted to the outdoors will not be taken directly from the forced air system
Supply ducts attached to the return side of forced air systems will be:

• Attached as close to the HVAC system's fan as possible while remaining in compliance with manufacturer specifications
• Set up to provide filtration of outdoor ventilation air before reaching the HVAC system with minimum MERV 6 filter
• Connected to the intake fitting
• Connected and sealed in accordance with the supply duct detail

Objective(s):
Achieve the desired air flows to and from the desired locations
Preserve integrity of duct system and house
Ensure occupant health and safety

6.6202.2h - Insulation

Desired Outcome:
HRV and ERV systems installed to specifications

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):
Preserve integrity of the duct system by eliminating condensation
6.6202.2i - Sealant selection

Desired Outcome:
HRV and ERV systems installed to specifications

Specification(s):
Gap between registers or grilles and interior surface will be sealed

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

Objective(s):
Prevent air leakage around registers or grilles

Ensure a permanent seal

Prevent a fire hazard

6.6202.2j - Balance and flow

Desired Outcome:
HRV and ERV systems installed to specifications

Specification(s):
Air flows will be measured and adjusted to match to the system's intent

Objective(s):
Achieve the desired air flows to and from the desired locations

6.6202.2k - Occupant education

Desired Outcome:
HRV and ERV systems installed to specifications

Specification(s):
Occupant will be educated on how and when to change filter and clean drain pan, if applicable, according to manufacturer specifications
Objective(s):
Ensure occupant health and safety

Preserve integrity of system
6.9901.1 - Supplemental Ventilation Information—ASHRAE 62.2

Desired Outcome:
To provide supplemental ventilation information—ASHRAE 62.2

6.9901.1a - Ventilation fan flow rate

Desired Outcome:
To provide supplemental ventilation information—ASHRAE 62.2

Specification(s):
ASHRAE Standard 62.2 and the calculation of the infiltration credit allow adjustments to primary ventilation fan flow rates for existing houses using a single fan.

Objective(s):
To provide supplemental ventilation information--ASHRAE 62.2
7.8001.1 - Refrigerator and Freezer Replacement

Desired Outcome:
A more energy efficient appliance installed

7.8001.1a - Selection

Desired Outcome:
A more energy efficient appliance installed

Specification(s):
Appliance shall be ENERGY STAR® qualified or at least as energy efficient

Appliance will fit in the available space without blocking access to light switches, cabinets, etc.

Appliance will carry a minimum one-year warranty that will provide a replacement appliance if repeated issues relating to health, safety, or performance occur

Objective(s):
Energy efficient appliance installed

7.8001.1b - Installation

Desired Outcome:
A more energy efficient appliance installed

Specification(s):
Appliance will be installed in accordance with manufacturer specifications and local codes

Any penetrations to the exterior of the home created by the installation of the appliance will be sealed

Energy-related appliance controls will be demonstrated to the occupant

Specific information on the proper maintenance of the equipment will be provided to the occupant

Warranty information, operation manuals, and installer contact information will be provided to the occupant

Objective(s):
Achieve intended appliance function
Preserve food at low energy use
Educate occupant on how to operate and maintain the appliance

7.8001.1c - Decommissioning

**Desired Outcome:**
A more energy efficient appliance installed

**Specification(s):**
Appliances replaced by new units will be recycled or disposed of in accordance with federal, state, or local regulations
Appliances infested with pests will be enclosed before moving

**Objective(s):**
Prevent reuse of inefficient equipment and components
Protect the environment
Protect worker safety
7.8001.2 - Cleaning and Tuning Existing Refrigerators and Freezers

Desired Outcome:
Energy used for food preservation reduced

7.8001.2a - Clean and tune

Desired Outcome:
Energy used for food preservation reduced

Specification(s):
Dirty or clogged coils will be cleaned

Air flow to the coils will be provided in accordance with manufacturer specifications

Appliance will be located away from heat sources (e.g., supply registers, direct sunlight) if possible

Interior temperatures will be measured, and the appliance must maintain:

- Freezer temperature at 0°
- Fresh food at 35-40°

Specific information about the proper maintenance of the equipment will be provided to the occupant

Condensation control switch will be left in the appropriate position, given occupant preference and moisture load in the house

Objective(s):
Reduce energy use

Improve performance

Educate occupant on how to operate and maintain the appliance
7.8101.1 - Shower Head and Faucet Aerator

**Desired Outcome:**
Energy and water use reduced while occupant needs for water flow maintained

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

7.8101.1a - Work assessment

**Desired Outcome:**
Energy and water use reduced while occupant needs for water flow maintained

**Specification(s):**
Installer pre-work assessment will be conducted to determine if plumbing needs correction before installing high-efficiency shower head or faucet

**Objective(s):**
Verify scope of work

7.8101.1b - Selection

**Desired Outcome:**
Energy and water use reduced while occupant needs for water flow maintained

**Specification(s):**
The rated flow of new shower heads will be 2.5 gallons per minute (GPM) or less

If multiple heads are provided, the total flow rate will not exceed 2.5 GPM

Aerator flow rate will be 2.2 GPM or less

Features will be selected that meet any special needs of the occupant (e.g., shut off, swivel, handheld showers)

**Objective(s):**
Reduce water and energy consumption

Ensure occupant satisfaction
7.8101.1c - Installation

**Desired Outcome:**
Energy and water use reduced while occupant needs for water flow maintained

**Specification(s):**
Equipment will be installed in accordance with manufacturer specifications and meet all applicable building codes

Water quality will be evaluated for debris that may clog the equipment

Once installed, high-efficiency shower heads or faucet aerators will be tested to determine if equipment is tightened adequately to prevent leakage at the point of connection

If needed, shower diverter will be repaired or replaced

Any penetrations to the exterior of the home created by the installation of the equipment will be sealed

Any damage done to the house during installation will be repaired

Specific information about proper maintenance of the equipment will be provided to the occupant

Warranty information, operation manuals, and installer contact information will be provided to the occupant

Water flow that satisfies the occupant will be provided by all shower heads and faucet aerators

Occupant's acceptance of the shower head and/or aerator will be documented

**Objective(s):**
Reduce water and energy consumption

Ensure occupant satisfaction with water flow

Eliminate water leakage

Prevent water damage

7.8101.1d - Decommissioning

**Desired Outcome:**
Energy and water use reduced while occupant needs for water flow maintained

**Specification(s):**
Replaced shower heads and faucet aerators will be recycled or disposed of properly

**Objective(s):**
Prevent the reuse of inefficient equipment and components
7.8102.1 - Water Heater Selection

Desired Outcome:
Safe, reliable, and efficient hot water source selected that meets occupant needs at lowest possible cost of ownership and operation

7.8102.1a - Selection parameters

Desired Outcome:
Safe, reliable, and efficient hot water source selected that meets occupant needs at lowest possible cost of ownership and operation

Specification(s):
Equipment will provide sufficient, affordable, safe, and healthy hot water for the occupant in accordance with IRC

Potential for solar hot water heating or other renewable energy systems will be assessed in selecting the hot water equipment

Potential for health and safety hazards (e.g., backdrafting, flame rollout, obstructions) will be assessed in selecting equipment and the cost of remediying such problems will be included in any cost and benefit calculations

If a combustion based system is selected, it will be either direct vented or power vented, and ENERGY STAR® qualified or an Energy Factor (EF) of 0.58 or higher

If combustion equipment is selected, a low nitrogen oxide burner will be included

Equipment will be functional at high efficiency under all load conditions

Standby losses will be reduced to maximum potential

Fuel type will be selected based on affordability to occupant

Equipment will be freeze resistant or installed in a conditioned space

Efficiency of equipment will be maintained throughout life of system

Occupant control of hot water temperature will be provided on the equipment

The following will be determined from the occupant:
• Lifestyle
• Current and future needs
• Space considerations
• Fuel options
• Health and safety considerations
• Appliance options
• Maintenance and operation costs
• Return on investment concerns

Objective(s):
Save energy and water

Protect the environment

Identify appliance options based on the needs and wants of the occupant

7.8102.1b - Product selection

Desired Outcome:
Safe, reliable, and efficient hot water source selected that meets occupant needs at lowest possible cost of ownership and operation

Specification(s):
Water heater will be selected based on performance requirements of the occupant, available fuel sources, energy efficiency, and total life cycle cost

In very cold climates, on-demand water heaters will be sized to meet the demand of water flow at very low water intake temperatures

When evaluating an existing thermal solar water heating system, a solar expert should be consulted

The proper installation and maintenance of solar hot water systems is provided in the Uniform Solar Energy Code (USEC) and IRC

Objective(s):
Ensure equipment meets the occupant's expectations while providing efficient energy and water use
7.8102.2 - Storage-Type Appliance

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

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

7.8102.2e - Expansion tank

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

Specification(s):
Expansion tanks will be installed where required and in accordance with the AHJ

Objective(s):
Protect the storage tank from expansion

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

Safe
Expansion tank is installed on the cold water supply side

Appropriate licensing for installer required. This specification applies only in the case of new and/or replacement systems.
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
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.
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

**Tools:**
1. Thermometer

**Unsafe**
Water heaters producing water over 120 degrees raise heating costs

**Safe**
Water heaters should produce water under 120 degrees to prevent scalding
Test temperature of hot water at faucets in house

Hot water temperatures should not exceed 120 degrees Fahrenheit

Adjust water heater settings and insulate as needed

After adjustment and insulation, retest to verify temp is under 120 degrees
7.8102.3 - On-Demand 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.

7.8102.3a - 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.

Occupants 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.

7.8102.3b - 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.
- Seal any unused chimney openings and penetrations in accordance with IRC.
Remove unused oil tank, lines, valves, and associated equipment in accordance with IRC

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

7.8102.3c - New equipment installation

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

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

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

7.8102.3d - 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
7.8102.3e - 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

7.8102.3f - 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 to accepted industry standards, in accordance with the IRC and according to manufacturer specifications

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

7.8102.3g - Backflow prevention and pressure regulator

**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

House water pressure and volume will be verified as sufficient to be in accordance with
manufacturer specifications

All applicable codes will be followed

**Objective(s):**

Protect the water supply from contamination

Provide for sufficient volume and pressure

### 7.8102.3h - Thermal efficiency

**Desired Outcome:**

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

**Specification(s):**

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

**Objective(s):**

Reduce line losses

### 7.8102.3i - Required combustion air

**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 IRC, NFGC and NFPA 31 and 54 for gas and oil, or NEC for electric

Energy input required by the appliance will be in accordance with manufacturer specifications

All on-demand appliances will be installed per manufacturer recommendations/specifications

**Objective(s):**

Ensure adequate combustion air for operation of the appliance
7.8102.3j - Venting of flue gases

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

**Specification(s):**
Combustion byproducts will be removed in accordance with IRC, authority having jurisdiction, and manufacturer specifications

**Objective(s):**
Ensure the safety and durability of the venting system

7.8102.3k - Flue gas testing

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

**Specification(s):**
Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T

If combustion is not in compliance with BPI-1100-T, diagnostics and adjustments will be done to manufacturer specifications or local codes

**Objective(s):**
Confirm that combustion is occurring safely with maximum efficiency

7.8102.3l - Electric and fossil 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 IRC, NFGC and NFPA 31 and 54 for gas and oil, or NEC for electric
Energy input required by the appliance will be in accordance with manufacturer specifications

**Objective(s):**
Provide sufficient fuel to the water heater burner or element

### 7.8102.3m - Cold water supply

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

**Specification(s):**
The volume and pressure of the water supplied to the appliance will be in accordance with manufacturer specifications

**Objective(s):**
Provide sufficient volume and pressure of water to the appliance

### 7.8102.3n - 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 in accordance with manufacturer instructions and in compliance with local codes

Use extreme caution when temperature setting is above 120°F

**Objective(s):**
Ensure safe hot water supply temperature to fixtures

### 7.8102.3o - 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 connected and filled:

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

Manufacturer specifications and all relevant industry standards will be met in commissioning

Objective(s):
Ensure system functions safely with lowest possible cost of ownership

7.8102.3p - Ambient carbon monoxide (CO)

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

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

Objective(s):
Ensure occupant health and safety

7.8102.3q - 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
• Operation of backflow preventer and pressure regulator (no occupant maintenance required)
• Importance of keeping operating manuals accessible

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

- **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

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**Best Practice**

- Standard water heaters have built-in insulation ranging from R-7 to R-20.
- Storage-type water heaters should be wrapped to bring total value to R-24
Tools:
1. Utility knife

Materials:
1. Pipe wrap
2. Water heater blanket
3. Foil tape
4. Long zip ties

Check occupant’s water heater model to see what R-value is built-in

Blanket does not obstruct draft diverter or plumbing pipes and elements

Wrap does not obstruct ventilation, thermostat access plate, hi-limit switch, or fuel line

Data plate should still be accessible after wrapping

Both hot and cold water pipes should be insulated to R-3 for first 6ft

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**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