Retrofitting Washington

Department of Commerce

Standard Work Specifications
Field Guide for

Single-Family and
Manufactured Homes

created by

Washington Department of Commerce

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Appendix

Tip: Clicking on the blue SWS numbers below will bring you to that SWS on the NREL website

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 sharp objects

Unsafe

Recognize potential risks

Safe

Wear appropriate hand protection

2.0100.1b - Hand Protection

GOOD: Wear nitrile gloves when handling mastic


Inspect gloves for holes and damage to minimize risk

2.0100.1c - Respitory 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 MSDSs for respiratory protection requirements

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

Unsafe

Workers face health risks without the proper respirators.

Best Practice

Retrofits can have multiple different respiratory protection requirements, depending on materials being installed

2.0100.1c - Respiratory Protection

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

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

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

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

When unsure what level of protection is necessary, check the 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

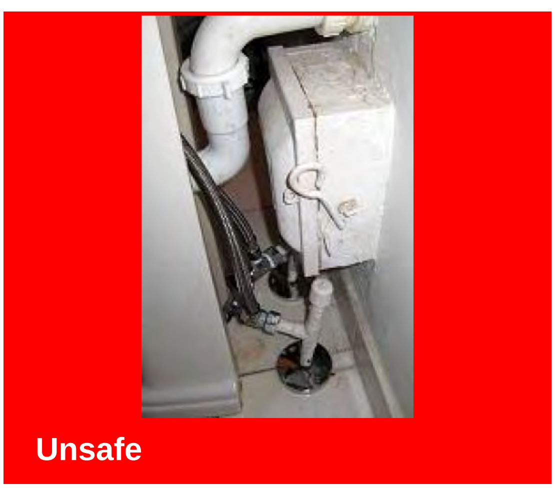
Metal ladders will be avoided

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



Inspect house for unsafe electrical situations


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

2.0100.1d - Electrical Safety

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

Electrical wiring should not be located near a water source

Use fiberglass ladders in place of metal

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

Follow NFPA 70E 2012 guidelines for arc flash hazards

2.0100.1e - Carbon Monoxide (CO)

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

All homes will have a carbon monoxide alarm

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

Objective(s):

Protect worker and occupant health

Unsafe

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

Best Practice

Install carbon monoxide alarms

Tools:

1. Personal Carbon Monoxide (CO) monitor during combustion safety testing

Materials:

1. Carbon Monoxide (CO) alarm

Carbon Monoxide (CO) Detectors: Local agencies shall install a minimum of one carbon monoxide (CO) detector in every dwelling unit where detectors are not present or are inoperable. Replacement of operable CO detectors is not an allowable cost. CO detectors shall be installed in accordance with manufacturer's requirements. a. Detector standards: Detectors shall have:

(1) A 5-year warranty for residential models or 1-year warranty for commercial low-level models.

(2) An electrochemical sensor.

(3) A digital display that indicates CO levels in Parts Per Million (ppm).

(4) The capability to accurately detect and display low levels of carbon monoxide to 15 ppm.

(5) A label to verify testing and listing to the UL 2034 Standard.

Exception: CO Detectors need not be UL listed if a low level detector is desired. To comply with this exception, these commercial low-level detectors must meet or exceed all of the following:

(a) (1) through (4) above.

(b) ACGIH and NIOSH Standards.

2.0100.1f - Protective Clothing

Desired Outcome:

Work completed safely without injury or hazardous exposure

Specification(s):

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

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

Objective(s):

Protect worker from skin contact with contaminants

Minimize spread of contaminants

Before

Workers should be aware of work required and dress appropriately

After

Ensure workers have proper protective equipment for work environment

2.0100.1g - Confined Space Safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Access and egress points will be located before beginning work

Inspection will be conducted for frayed electrical wires

Adequate ventilation will be provided

Use of toxic material will be reduced

Objective(s):
Prevent build-up of toxic or flammable contaminants

Provide adequate access and egress points

Prevent electrical shock

After

Locate all access and egress points of confined spaces before entering

2.0100.1g - Confined Space Safety


Perform visual inspection of confined spaces before beginning work


Check for frayed or worn electrical wires


In confined spaces, use a ventilator

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

2.0100.1h - Power Tool Safety

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

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

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

Objective(s):
Prevent power tool injuries

2.0100.1j - 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 - Heat and Thermal Stress

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

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

Excessive heat easily builds up in attic spaces. When the heat in these spaces is enough to overcome a worker and preventy them from exiting without assistance, it is known as a thermal hazard. Prevent worker exposure to thermal hazards with the following measures:

- reduce the temperature in the space with mechanical ventilation.
- ensure workers are drinking plenty of water
- workers will wear *cool vests*
- reschedule work for times when those spaces do not present thermal hazards

2.0100.1p - Lead Paint Assessment

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

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

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

Exterior lead containment elements

EPA-recognized Lead Test Kit

Tools:

1. PPE
2. Containment tools
3. HEPA Vacuum
4. Lead safe engineering controls

Materials:

1. EPA approved Lead test kit
2. Containment materials: caution tape, signs, poly

2.0104.1b - Vermiculite

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

Specification(s):
OSHA asbestos abatement protocol 29 CFR 1926.1101 will be followed if vermiculite insulation is present

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

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

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

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

Objective(s):
Protect workers from toxic exposure

Before

Material identified as vermiculite may contain asbestos

After

If asbestos is suspected, call an EPA-accredited professional

Note: It is assumed Vermiculite is an Asbestos Containing Material (ACM) since sample testing protocols of a non homogeneous material are unable to "prove" absence of Asbestos in all the material present.

Removal of vermiculite in attics shall be done by certified Asbestos professionals licensed by the state of Washington Labor and Industry in accordance WAC 296-65-010 workers, 296-65-012 supervisors, 296-65-017 certified firms

The Zonolite Vermiculite Insulation Trust has been established to assist homeowners with cost of removal of Zonolite insulation in attics, the Trust will also assit with cost of reinsulating attic. See link for additional information http://www.zonoliteatticinsulation.com/claim-form/

2.0104.1b - Vermiculite

Do not disturb vermiculite by vacuuming, dusting, or sweeping

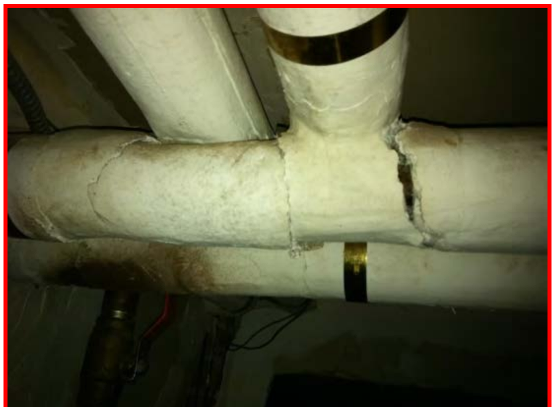
Do not disturb vermiculite by drilling, sanding, scraping, sawing, etc.

2.0105.2c - Asbestos

Desired Outcome:
Work completed safely without injury or hazardous exposure

Specification(s):
Identify asbestos hazards in boiler and pipe insulation and remediate in accordance with EPA guidelines

Objective(s):
Protect workers and occupants from asbestos exposure



Unsafe

Suspicious pipe insulation may contain asbestos

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

2.0105.1c - 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

Before

Fuel leaks need to be repaired by appropriate professional

After

Notify occupant of any leaks

Tools:

1. Gas sniffer
2. Bubble solution

2.0105.1c - Raw Fuel

Check all raw fuel lines for leaks

Use multiple methods to test for leakage--bubble solution

If bubbles develop, leak is present. Notify occupant

Any leaks found should be reported to occupant and work stopped

Any leaks found should be reported to occupant and work stopped

2.0105.2b - Mercury

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

Objective(s):
Protect workers and occupants from mercury exposure

Unsafe

Mercury thermostats should be replaced and disposed of properly

Unsafe

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

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

4.1005.2d, 4.1301.1d, 4.1103.1b - 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 specifications

Objective(s):

Document job completion to contract specifications

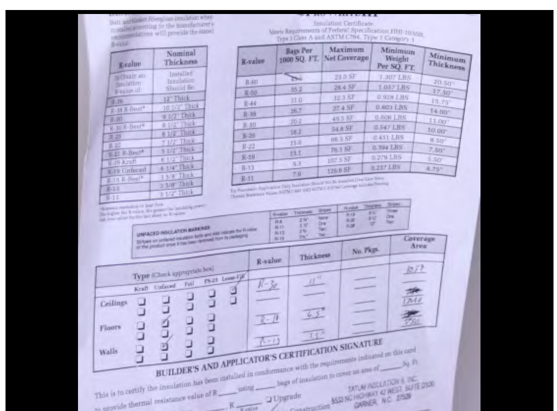
Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17

Best Practice

Information on insulation installed should be posted nearby



Best Practice

Posted info includes insulation type, r-value, depth, coverage area, etc.

This requirement applys whenever insulation is installed.

Reference 16 CFR 460.17: The installer, must provide the customer or client documentation regarding the insulation installed. Documentation will indicate the coverage area, thickness, and

R-value of the insulation.The insulation certification must be dated and signed by the installer. Insulation certificate to be posted at entrance to attic or crawlspace and a copy shall be provided for project file.

To figure out the R-value of the insulation, use the data that the manufacturer gives you.

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7a Basic operation	Basic operation of the equipment will be explained to the occupant (e.g., design conditions, efficiency measures, differences from previous system or situation)	Ensure occupant has a reasonable expectation of the equipment's capability	
	5.3003.7b System controls (e.g., thermostat, humidistat)	Proper operation and programming of system controls to achieve temperature and humidity control will be explained to the occupant	Ensure occupant can operate system controls	
	5.3003.7c System disconnects	Indoor and outdoor electrical disconnects and fuel shut-offs will be demonstrated to occupant	Ensure occupant can shut off equipment in emergencies	
	5.3003.7d Combustion air inlets	Location of combustion air inlets will be identified for occupant in accordance with NFPA 31, 54, and 58 Importance of not blocking inlets will be explained to occupant	Ensure occupant does not block combustion air inlets	

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7e Blocking air flow	Importance of cleaning dust and debris from return grilles will be explained to occupant Proper placement of interior furnishings with respect to registers will be explained to occupant Negative consequences of closing registers will be explained to occupant Importance of leaving interior doors open as much as possible will be explained to occupant	Ensure occupant does not prevent equipment from operating as designed	

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7f Routine maintenance	Proper filter selection and how to change the filter will be explained to occupant Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant Importance and timing of routine professional maintenance will be explained to occupant There will be no air bypass around the filters and new central forced air HVAC systems will have minimum MERV 6 filtration	Ensure equipment operates as designed	

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7g Calling heating, ventilation, and air conditioning (HVAC) contractor	Situations when the occupant should contact the HVAC contractor will be explained, including: • Fuel odors • Water draining from secondary drainline • Emergency heat indicator always on for a heat pump system • System blowing cold air during heating season and vice versa • Icing of the evaporator coil during cooling mode • Outside unit never defrosts • Unusual noises • Unusual odors	Notify occupant to contact installer when system is not operating as designed	
	5.3003.7h Carbon monoxide (CO)	A carbon monoxide (CO) alarm will be installed	Occupant will be made aware of operation of CO alarm	
	5.3003.7i Warranty and service	Occupant will be provided with relevant manuals and warranties The labor warranty will be explained and the occupant will be given a phone number to call for warranty service	Provide manuals and warranties for future servicing	

6.6202.1e - Occupant Education>Ventilation

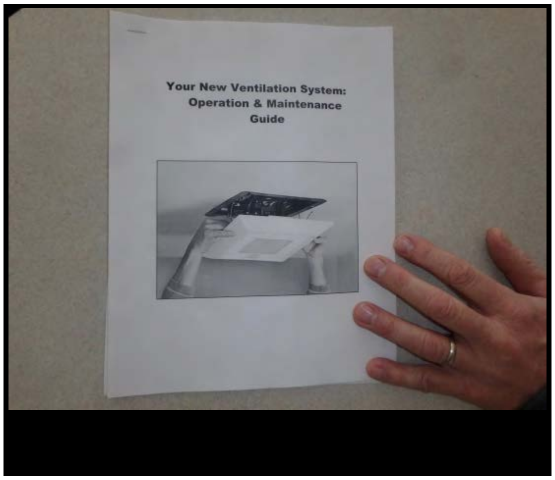
Desired Outcome:
Fan controls support ventilation strategy

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



Ventilation system operation guide for occupants

A labeled switch for manual override

SWS 6.6202.1d - A labeled switch for manual override to be included for the ventilation system. Locations suitable for the manual override label include:

- Switch plate
- Breaker panel
- Fan housing

6.6005.1e - Occupant Education>Dryer Vent Maintenance

Desired Outcome:
Dryer air exhausted efficiently and safely

Specification(s):
Occupant will be instructed to keep lint filter and termination fitting clean

Occupant will be instructed to keep dryer booster fan clean, if present

Occupant will be instructed on clothes dryer operation safety including information on items that must not be placed in the clothes dryer (items with any oil or other flammable liquid on it, foam, rubber, plastic or other heat-sensitive fabric, glass fiber materials)

Objective(s):
Effectively move air from clothes dryer to outside

Unsafe

Neglect of clothes dryer maintenance can cause fire hazards

Best Practice

Occupants should be taught to clean lint filters and termination fittings

6.6005.1e - Occupant Education>Dryer Vent Maintenance

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)

2.0201.1a - Assessment

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

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

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

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

Objective(s):

Ensure system does not have fatal problems

Ensure combustion appliance has adequate combustion and dilution air

Before

Unsafe combustion appliances indicate need for repair or replacement

After

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

Follow State of Washington combustion safety testing protocols found in Appendix A

2.0201.1a - Assessment

Assess existing combustion appliances for damage and replace when necessary

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

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

Stop the misuse of combustion appliances -- here an unvented propane heater is found inside

Keep occupant apprised of any health or safety concerns

2.0201.1b - Fuel Leak Detection

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

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

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

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

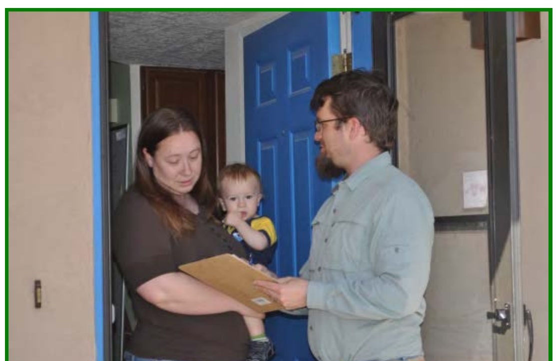
Objective(s):

Detect fuel gas leaks

Determine and report need for repair

Before

Fuel lines should be inspected for leakage



After

If leaks are found, notify occupant immediately to facilitate repair

Tools:

1. Gas sniffer
2. Spray bottle

Materials:

1. Bubble solution

2.0201.1b - Fuel Leak Detection

Inspect exterior gas and oil lines for leaks and damage

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

2.0201.1c - Venting

Desired Outcome:
Accurate information about appliance safe operation is gathered

Specification(s):
Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards

Objective(s):
Determine if a draft regulator is present and working and if vent system is in good condition and installed properly

Unsafe

If combustion venting puts occupants at risk, it needs immediate attention

Safe

Properly vented appliances make a house healthier and more efficient

Follow Washington State Combustion safety protocols See Appendix C and D

Determine if a draft regulator is installed and working

Inspect ventilation systems for damage

Inspect ventilation systems for disconnected pipes

Inspect ventilation systems for inadequate slope

Inspect for missing draft diverter

Clearance to Combustibles for Combustion Appliance Vents

Fuel	Vent type	Minimum Clearance to combustables
Gas, LP	Type B gas vent	1"
	Single wall metal	6"
Fuel Oil	Type L vent	9"
	Single wall metal	18"
Solid Fuel	Type L vent	9"
	Single wall metal	18"
Pellet fuel	Type L vent	per manufacturer's Specification

All combustion appliances vents and flues must maintain clearance to combustibles.

2.0201.1i - Combustion Safety Testing at Completion of Retrofitting Home

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

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

Objective(s):

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

Unsafe

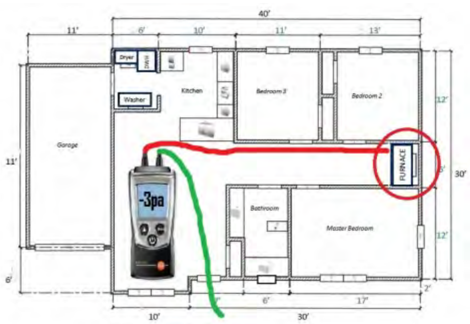
Conduct spillage and depressurization testing at the end of the work day

Tools:

1. Manometer
2. Smoke pencil
3. Timer

Each combustion appliance in homes that are weatherized or repaired must be reported pre- and post- on a combustion safety test report. Additionally, local agency or Subcontractor shall perform Daily In-Progress Combustion Safety Tests (comprised of a worst-case depressurization test and spillage test) at the end of each work day when work has been done that alters the building shell, HVAC system, or interior configuration (including comfort air sealing, altering of interior doors) of the dwelling unit. See Appendix B "In progress" combustion safety form.

2.0201.1i - Combustion Safety Testing at Completion of Retrofitting Home



Run depressurization test at the end of the work day


Complete spillage test using chemical smoke pencil


Test for spillage on all sides of draft diverter


Complete spillage testing on all combustion appliances

2.0201.2a - WA Variance - 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 2012 IRC for the type of appliance installed

Objective(s):

Prevent combustion byproducts from entering the house

Washington variance approved, adding combustion air is required only if performance testing indicates combustion air is needed for proper operation of a combustion appliance.

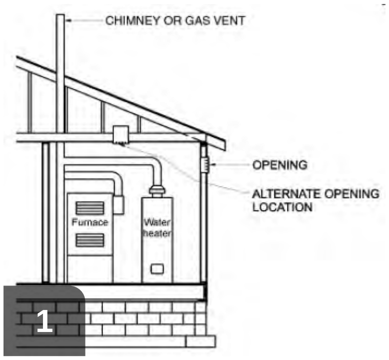
When adding combustion air there are 3 options:

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

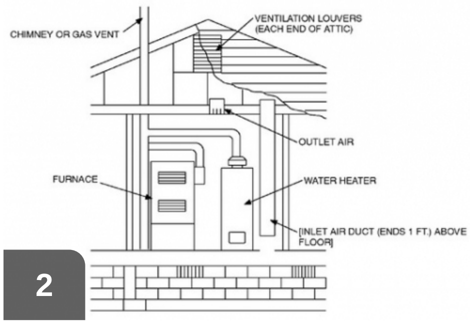
Image 2: For homes with two permanent vertical duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in2 per 4,000 Btu/h (550 mm2/kW) of total input rating of all appliances

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

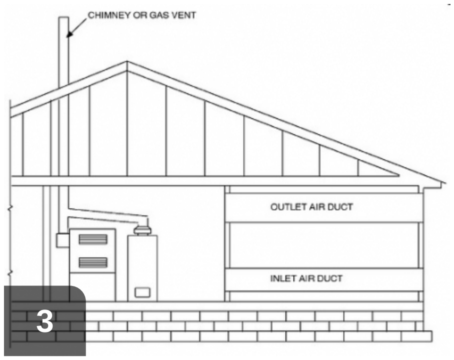
2.0201.2a - WA Variance - Outside Combustion Make-Up Air



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



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



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

2.0201.2b - New Appliances

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

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

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

Objective(s):

Prevent combustion byproducts from entering the house

Before

Damaged combustion appliances beyond repair should be replaced

After

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

2.0201.2b - New Appliances

Two-pipe 90% efficiency furnaces, and other sealed combustion, direct vent aplliances are viable replacement appliances

2.0201.2d - WA Variance - Gas Ovens

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

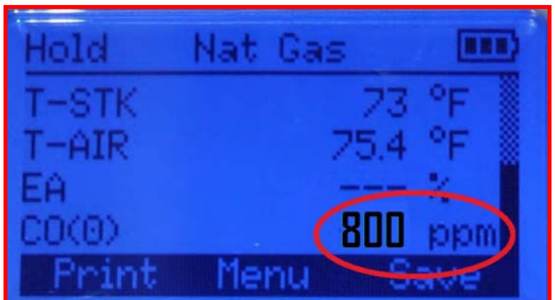
Specification(s):

Gas ovens will be tested for CO

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

Objective(s):

Ensure clean burn of gas ovens



Unsafe

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

Best Practice

Test gas oven for carbon monoxide using a combustion gas analyzer

Tools:

1. Combustion analyzer with probe

Note: Washington variance to DOE SWS in place. Complete Washington State combustion safety form and follow action steps as outlined in technical support document Appendix C

2.0201.2d - WA Variance - Gas Ovens

1

Table 3.1: CO Test Action Levels for Ovens at Steady State Operation (Line 18)	
CO Test Result for undiluted flue gas	**Retrofit Action**
0 - 99 ppm	Proceed with work.
100 - 300 ppm	Recommend service.
>300 ppm	Unit must be serviced prior to Wx work.

2.0201.2e - WA Variance - Gas Range Burners

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

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

Objective(s):

Ensure clean burn and operation of gas range burners

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

2.0201.2e - WA Variance - Gas Range Burners

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

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

Blue, even flames indicate burners are working properly

2.0201.2f - 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

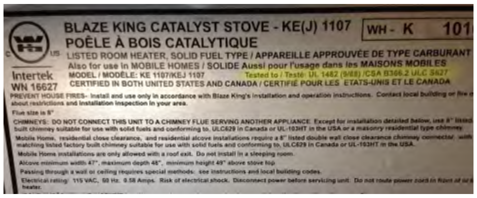
Unsafe solid fuel burning appliances should be replaced

New appliances should be UL-listed and EPA-certified

1. New wood stoves installed on or after May 15, 2015, must meet EPA emission requirementsand be certified to not discharge into the atmosphere any gases that contain particulate matter in excess of a weighted average of 4.5 g/hr.
2. Washington State Dept. of Commerce requires completion of the Solid Fuel Burning Appliance Systems Supplemental Audit Form when repairing or replacing wood stoves.
3. Wood stoves installed in mobile homes shall be rated for use in mobile homes. Follow all manufacturer's installation specifications, especially regarding venting, mounting surfaces, and distance to surrounding surfaces.

2.0201.2f - Solid Fuel Burning Appliances

Locate data plate to find out appliance ratings



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

2.0301.1b - Smoke Alarm (Battery Operated)

Desired Outcome:
Properly installed smoke alarms

Specification(s):
Battery operated alarms will be installed in accordance with the 2012 IRC and manufacturer specifications

Objective(s):
Ensure proper installation

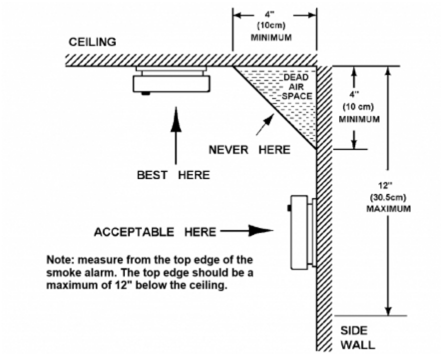
Best Practice

All homes should have UL-217 rated smoke alarms

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

2.0301.1b - Smoke Alarm (Battery Operated)

Smoke alarms can be battery-operated



Smoke alarms shall not be within 4" of a corner. If mounted on the wall, the alarm must be within 12" of the ceiling.

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 ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction

Objective(s):

Ensure proper installation

Before

Houses should have carbon monoxide monitors installed near sleeping areas

After

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

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

Labeling: Installer shall write the date installed or manufacturers recommended replacement date on the device label so it is visible without having to remove the device.

Carbon Monoxide (CO) Detectors: Local agencies shall install a minimum of one carbon monoxide (CO) detector in every dwelling unit where detectors are not present or are inoperable. Replacement of operable CO detectors is not an allowable cost. CO detectors shall be installed in accordance with manufacturer's requirements. a. Detector standards: Detectors shall have:

(1) A 5-year warranty for residential models or 1-year warranty for commercial low-level models.

(2) An electrochemical sensor.

(3) A digital display that indicates CO levels in Parts Per Million (ppm).

(4) The capability to accurately detect and display low levels of carbon monoxide to 15 ppm.

(5) A label to verify testing and listing to the UL 2034 Standard.

Exception: CO Detectors need not be UL listed if a low level detector is desired. To comply with this exception, these commercial low-level detectors must meet or exceed all of the following:

(a) (1) through (4) above.

(b) ACGIH and NIOSH Standards.

2.0601.1a - WA Variance - Knob and Tube Identification & Required Inspection

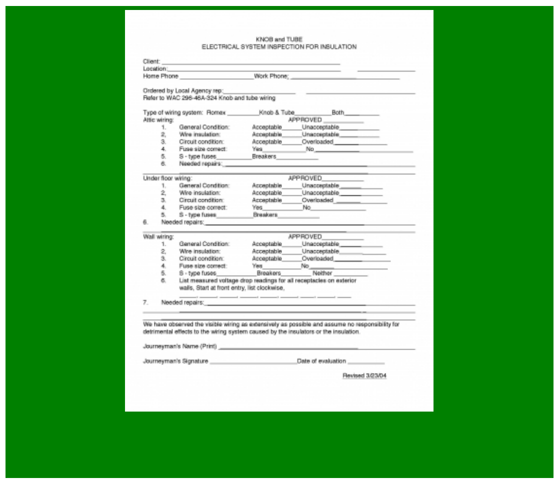
Desired Outcome:
Live unsafe wiring identified and brought to local codes

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 & Tube wiring in an attic.



KNOB and TUBE
ELECTRICAL SYSTEM INSPECTION FOR INSULATION

Client: ____________________
Location: ____________________ ____________
Home Phone ____________ Work Phone; ____________

Ordered by Local Agency rep: ____________ ____________
Refer to WAC 296-46A-324 Knob and tube wiring

Type of wiring system: Romex ______ Knob & Tube ______ Both ______

Attic wiring: APPROVED ______
1. General Condition: Acceptable ______ Unacceptable ______
2, Wire insulation: Acceptable ______ Unacceptable ______
3. Circuit condition: Acceptable ______ Overloaded ______
4. Fuse size correct: Yes ______ No ______
5. S - type fuses ______ Breakers ______
6. Needed repairs: ____________________

Under floor wiring: APPROVED ______
1. General Condition: Acceptable ______ Unacceptable ______
2, Wire insulation: Acceptable ______ Unacceptable ______
3. Circuit condition: Acceptable ______ Overloaded ______
4. Fuse size correct: Yes ______ No ______
5. S - type fuses ______ Breakers ______
6. Needed repairs: ____________________

Wall wiring: APPROVED ______
1. General Condition: Acceptable ______ Unacceptable ______
2, Wire insulation: Acceptable ______ Unacceptable ______
3. Circuit condition: Acceptable ______ Overloaded ______
4. Fuse size correct: Yes ______ No ______
5. S - type fuses ______ Breakers ______ Neither ______
6. List measured voltage drop readings for all receptacles on exterior walls, Start at front entry, list clockwise.
____, ____, ____, ____, ____, ____, ____, ____, ____
7. Needed repairs: ____________________

We have observed the visible wiring as extensively as possible and assume no responsibility for detrimental effects to the wiring system caused by the insulators or the insulation.

Journeyman's Name (Print) ____________________

Journeyman's Signature ____________ Date of evaluation ______

Revised 3/23/04

Knob & Tube wiring inspection form, to be completed by licensed electrician prior to insulating

Tools:
1. AC Voltage Detector

Washington Variance allows knob and tube (K&T) wiring to be covered with insulation, but first requires a licensed electrician to inspect and certify in writing the knob and tube wiring system is safe for insulation contact.

2.0601.1a - WA Variance - Knob and Tube Identification & Required Inspection

1

First determine whether K&T wiring is active using an AC voltage detector. The tip glows red for active wiring.

2

Remember, K&T wiring can be beneath the floor and in wall cavities too.

KNOB and TUBE
ELECTRICAL SYSTEM INSPECTION FOR INSULATION

Client: ____
Location: ____
Home Phone ____ Work Phone: ____

Ordered by Local Agency rep: ____
Refer to WAC 296-46A-324 Knob and tube wiring

Type of wiring system: Romex ____ Knob & Tube ____ Both ____

Attic wiring: APPROVED ____

1. General Condition: Acceptable ____ Unacceptable ____
2. Wire insulation: Acceptable ____ Unacceptable ____
3. Circuit condition: Acceptable ____ Overloaded ____
4. Fuse size correct: Yes ____ No ____
5. S - type fuses ____ Breakers ____
6. Needed repairs: ____

Under floor wiring: APPROVED ____

1. General Condition: Acceptable ____ Unacceptable ____
2. Wire insulation: Acceptable ____ Unacceptable ____
3. Circuit condition: Acceptable ____ Overloaded ____
4. Fuse size correct: Yes ____ No ____
5. S - type fuses ____ Breakers ____
6. Needed repairs: ____

Wall wiring: APPROVED ____

1. General Condition: Acceptable ____ Unacceptable ____
2. Wire insulation: Acceptable ____ Unacceptable ____
3. Circuit condition: Acceptable ____ Overloaded ____
4. Fuse size correct: Yes ____ No ____
5. S - type fuses ____ Breakers ____ Neither ____
6. List measured voltage drop readings for all receptacles on exterior walls, Start at front entry, list clockwise.
7. Needed repairs: ____

We have observed the visible wiring as extensively as possible and assume no responsibility for detrimental effects to the wiring system caused by the insulators or the insulation.

Journeyman's Name (Print) ____

Journeyman's Signature ____ Date of evaluation ____

Revised 3/23/04

3

If the K&T wiring is active, a licensed electrician must inspect the wiring and document the findings.

3.1001.1c - Sealant Selection

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

Specification(s):
Sealants will be compatible with their intended surfaces

Sealants will allow for differential expansion and contraction between dissimilar materials

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

Objective(s):
Select permanent sealant

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

Before

Wiring penetration in wall top allows air leakage and moisture movement between unconditioned and conditioned space.

After

Air sealing prevents air leakage and moisture movement between unconditioned and conditioned space

Tools:

1. Caulk gun
2. Foam gun

Materials:

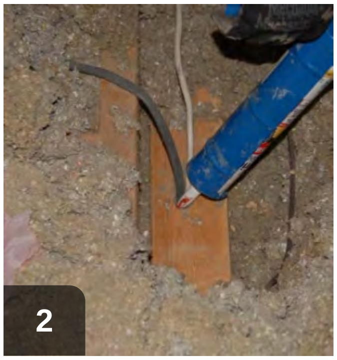
1. Caulk
2. One-part foam
3. Backing or infill

Seal around penetrations in the ceiling made by plumbing pipes and vent stacks, chimneys, ducting, ventilation equipment, electrical wiring, lighting fixtures and top plates to adjacent materials.

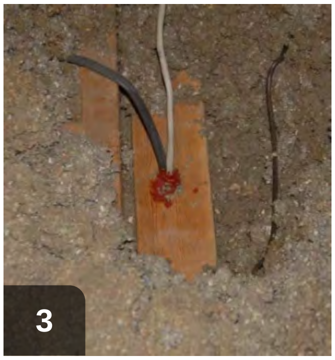
Cost effectiveness of sealing top plates along outside walls may prohibit this measure, due to difficult access. Document when such measures are not cost effective.

3.1001.1c - Sealant Selection

Locate wall tops in attic and look for plumbing and electrical penetrations.



Fill wall top penetrations with caulk or one-part foam.



Sealed wall top penetration.

Top plate sealed to ceiling material.

3.1001.1d - High Temperature Application: Attic Air Sealing

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

Gaps around combustion exhaust flues need to be sealed

Sealed penetrations and chases should utilize high-temperature materials

Tools:

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

Materials:

1. High-temperature caulking, tested with accordance to ASTM E 136
2. Non-combustible damming material
3. Fasteners

Use appropriate gloves when working with sheet metal.

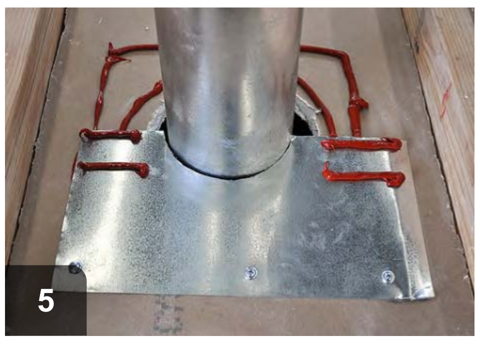
3.1001.1d - High Temperature Application: Attic Air Sealing

Prepare work area by removing any insulation and debris

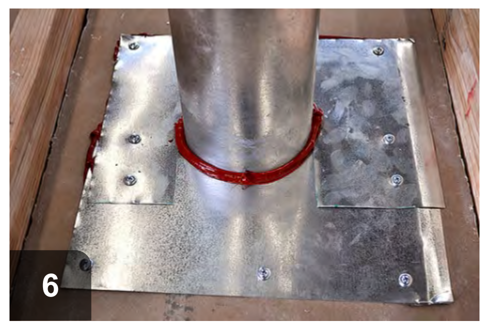
Use high-temperature caulking (600F min), tested in accordance with ASTM E 136

Apply first ring of caulking to match shape of opening

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



Fasten rigid, non-combustible material and apply additional caulking



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

Clearance to Combustibles for Combustion Appliance Vents		
Fuel	Vent type	Minimum Clearance to combustables
Gas, LP	Type B gas vent	1"
	Single wall metal	6"
Fuel Oil	Type L vent	9"
	Single wall metal	18"
Solid Fuel	Type L vent	9"
	Single wall metal	18"
Pellet fuel	Type L vent	per manufacturer's Specification

7

3.1001.2b - Standard Chase (Interior Walls Covered With Dryall 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

Unsealed standard chases covered with drywall can be leakage points

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

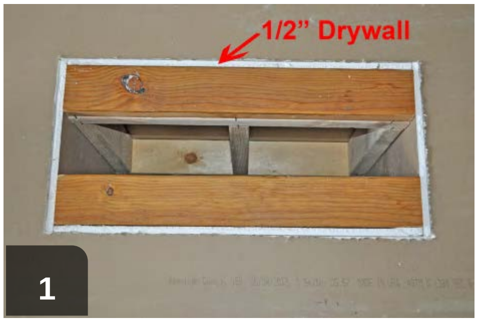
Tools:

1. Drill/screwdriver
2. Caulk gun

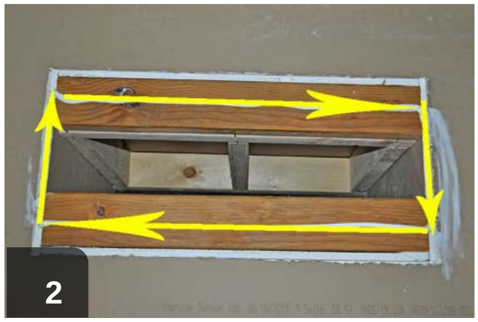
Materials:

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

3.1001.2b - Standard Chase (Interior Walls Covered With Drywall or Plaster)

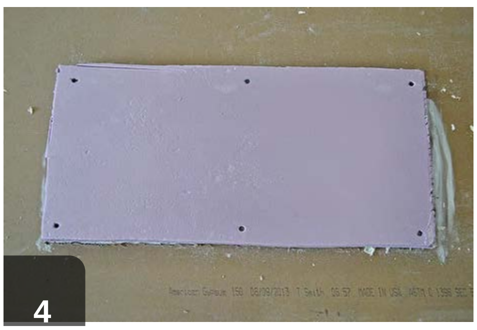


Clear area of debris and insulation in preparation for work



Apply sealant all the way around opening

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



Fasten rigid material appropriately, such as with screws

3.1001.2c - 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 2012 IRC R302.9

Objective(s):

Prevent a fire hazard

Before

Paneled drop soffits typically are more combustible than plain drywall

After

When sealing on attic side use 5/8 inch drywall, fasteners and sealant

Tools:

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

Materials:

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

EPS or bead-board are not acceptable materials.

3.1001.2c - Non-Standard Chase (Interior Walls Covered With Wood or Paneling)

3.1003.6d

3.1001.2d - Support - Capping Chases Greater Than 24"

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

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

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

Before

Spans greater than 24 inches require additional bracing before capping

After

Support should prevent cap from sagging or moving

Tools:

1. Drill
2. Saw
3. Tape measure

Materials:

1. Lumber
2. Drywall
3. Fasteners

3.1001.2d - Support - Capping Chases Greater Than 24"

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


When supporting from above, apply adhesive between drywall and bracing


Bracing can be screwed to drywall before capping chase


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


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

3.1001.2e - Joint Seal - Capping Open Attic Chase

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

Before

Chases need to be capped and sealed to prevent leakage

After

Chase is sealed along all cracks, gaps, and penetrations

Tools:

1. Spray foam gun
2. Caulk gun
3. Screw gun

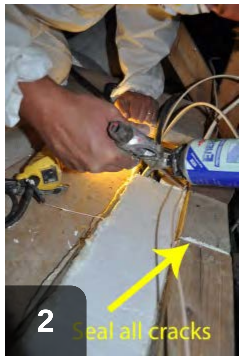
Materials:

1. Spray foam
2. Caulk
3. Drywall

Always wear protective gloves, eye protection and respirator when working with insulation and sealants.

3.1001.2e - Joint Seal - Capping Open Attic Chase

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

3.1001.3b - Sealing Methods - Open Wall Top

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

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

Material will be cut to fit and fastened as required

OR

Wall below openings will be dense packed

OR

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

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

Objective(s):
Prevent air leakage from wall cavity to attic

Before

Wall cavities are open to attic

After

Whatever option chosen, test for visible air movement with chemical smoke at 50 pascals of pressure difference

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

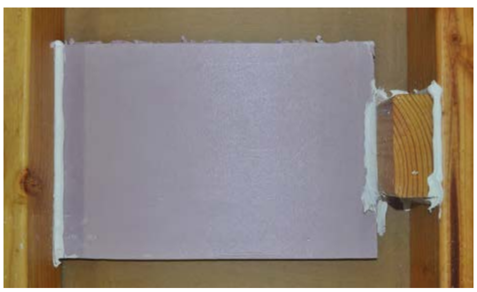
REMEMBER: gaps larger than 24" require support for some air sealing materials. See Field Guide spec 3.1001.2d.

3.1001.3b - Sealing Methods - Open Wall Top

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

Option 2: Bridge cavities with spray foam

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



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

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

REMEMBER: gaps larger than 24" require support for some air sealing materials. See Field Guide spec 3.1001.2d.

3.1001.3e - Adjacent Framing - Open Wall Top

Desired Outcome:

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

Specification(s):

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

OR

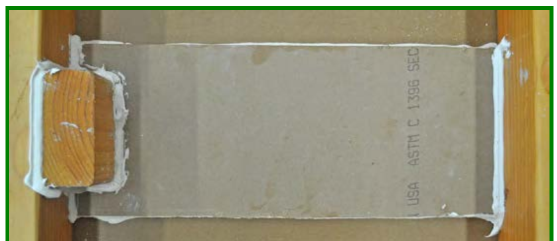
All remaining gaps at the top of the chase will be sealed

Objective(s):

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

Before

Balloon framing needs to be capped and sealed to prevent leakage



After

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

Tools:

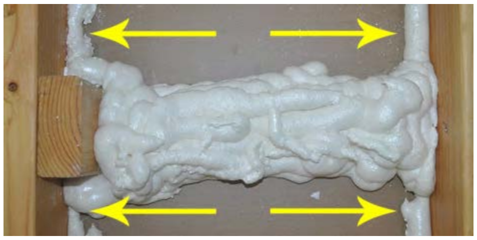
1. Spray foam gun
2. Caulk gun

Materials:

1. Spray foam (SPF)
2. Caulk

3.1001.3e - Adjacent Framing - Open Wall Top

For rigid material applications, sealant should be applied to framing



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

3.1003.1b - Sealing Methods - Drop Ceiling

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

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

Material will be cut to fit and fastened as required

OR

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

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

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

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

Damage to an older ceiling reveals the new ceiling below

Rigid material sealed in place creates an air barrier

Tools:

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

Materials:

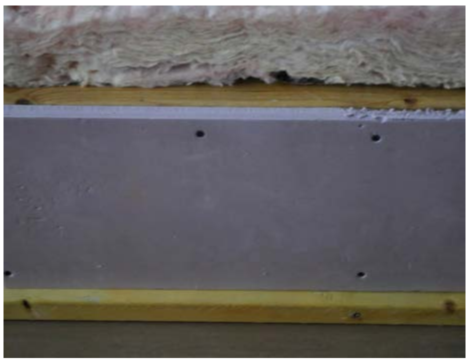
1. Caulk sealant
2. Rigid material -- XPS or Drywall
3. Spray foam
4. Fasteners
5. Dense packable insulation
6. Wrapped fiberglass batts

3.1003.1b - Sealing Methods - Drop Ceiling

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 at 50 pascals of pressure difference to verify no leakage

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:

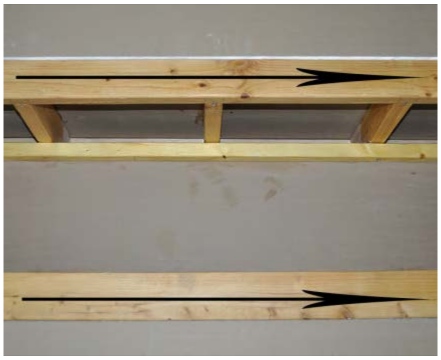
1. Utility knife
2. Saw
3. Tape measure
4. Insulation machine
5. Drill
6. Caulk gun
7. Spray foam gun
8. Smoke pencil

Materials:

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

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)

3.1003.3b - Above Closets and Tubs



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

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

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

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

Option 3: Dense pack cavity through fastened wood cap

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

All Options: Test with chemical smoke at 50 pascals of pressure difference to verify no air movement

3.1003.3e - Adjacent Framing - Above Closets and Tubs

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

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

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

Before

Dropped soffits need to be capped and sealed to prevent leakage

After

No gaps should remain after sealant is applied along adjacent framing

Tools:

1. Caulk gun
2. Spray foam gun

Materials:

1. Caulk sealant
2. Spray foam

3.1003.3e - Adjacent Framing - Above Closets and Tubs

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

3.1003.6b - Soffit General

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

Specification(s):
Air flow will be blocked at soffit in locations where access allows

Objective(s):
Provide continuous air barrier across soffit openings

Before

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

After

Completely sealed drop soffits and chases minimize heat transfer

Tools:

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

Materials:

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

There 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

Before

Standard soffits are often open to the attic and uninsulated

After

Rigid material encloses the soffit into the conditioned living space

Tools:

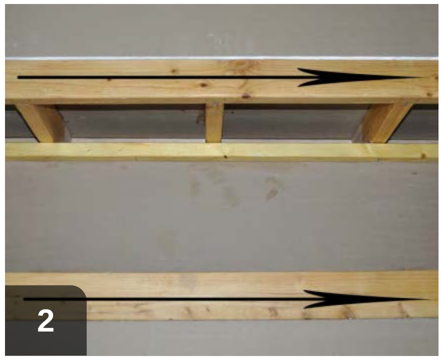
1. Drill/screwdriver
2. Caulk gun

Materials:

1. Drywall
2. Sealant

3.1003.6c - Option 1: Bring Soffit Inside (Seal at Top)

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



Apply sealant along top plates

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

Fasten cap with screws to set sealant and create air barrier

Insulate over now-capped soffit

3.1003.6d - Option 2: Leave Soffit Outside (Seal at Bottom or Side)

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

Specification(s):
Each stud bay will be spanned with rigid material will be cut to fit and fastened as required

OR

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

OR

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

OR

A sealed rigid barrier will be installed at all transitions

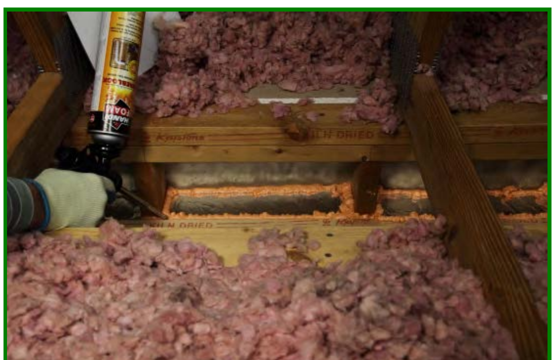
Objective(s):
Prevent air leakage from wall to soffit

Reduce opening to what can be sealed with sealant

Ensure soffit is outside of the thermal boundary

Before

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



After

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

Tools:

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

Materials:

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

3.1003.6d - Option 2: Leave Soffit Outside (Seal at Bottom or Side)

Clear work area of insulation and debris

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

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

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

4.1001.1a - Air Barrier System - Non-IC Rated Recessed Light

Desired Outcome:

Ensure safety from fire and prevent air leakage

Specification(s):

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

OR

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

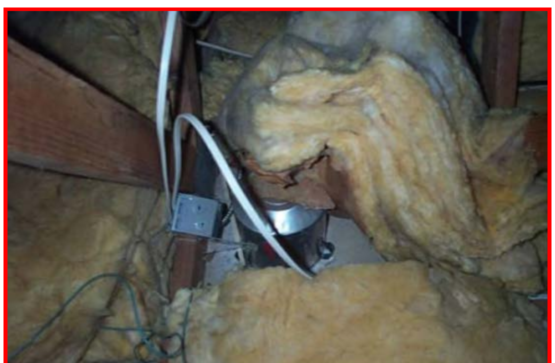
OR

Air sealing measures as approved by the authority having jurisdiction

Objective(s):

Prevent a fire hazard

Prevent air leakage through fixture



Before

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

After

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

Tools:

1. Utility knife
2. Tape measure
3. Screw gun
4. Sheet rock saw

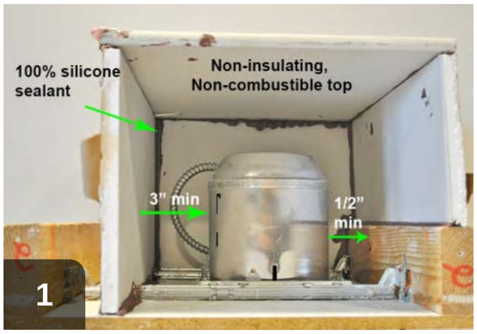
Materials:

1. 5/8" sheet rock or equivalent
2. Mastic, foam or caulk sealant
3. Screws

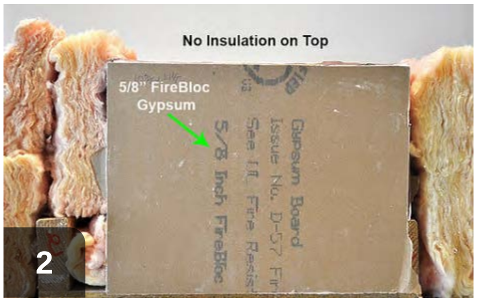
Note: 3" clearance between enclosure and fixture. Enclosure height shall be above surrounding insulation. Top of enclosure shall not be insulated. Enclosure lid may not exceed R value of .5. if this spec cannot be met, replace Non IC rated fixture with Airtight IC-rated fixture or surface-mounted fixture.

Recessed fixtures must meet air barrier test at 50 pascal pressure difference with no smoke movement, or measure less than one pascal using a pressure pan.

4.1001.1a - Air Barrier System - Non-IC Rated Recessed Light



Box should be constructed with clearances in mind



Sealed box should be constructed of fire-rated drywall

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

Air Barrier System - IC Rated Recessed Light

Specification(s):

Use air sealing measures as approved by the authority having jurisdiction with the purpose of reducing air flow from conditioned space into unconditioned space. Recessed fixtures must meet air barrier test at 50 pascal pressure difference with no smoke movement, or measure less than one pascal using a pressure pan.

Notes:

A fire-rated air barrier system (i.e., equivalent to 5/8 fire code gypsum wallboard) will be used when constructing covers over the tops of IC Rated recessed fixtures. Covers over the tops of IC Rated recessed fixtures must be a Class 1 material, according to ASTM E84 (flame spread not to exceed 25, smoke index not to exceed 450). When applying sealant directly to IC rated recessed fixture, and sealant will be covered with insulation, ASTM 136 Fire Rated sealant must be used.

IC rated recessed fixtures might have air leakage at two locations: between the can and the ceiling material, and between the inner and outer "cans" of the fixture.

Use latex caulk to air seal gaps from the interior of the home.

Air Barrier System - IC Rated Recessed Light

IC rated recessed fixture air sealed from the interior of the home.

IC rated recessed fixtures can also be sealed from the attic when accessible.

IC rated recessed fixtures can be sealed with fire-rated box assemblies.

When applying sealant directly to IC rated recessed fixtures, the sealant must meet ASTM136 fire rating.

4.1001.3 - Air Seal and Dam Around Hot Pipe

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

Insulation is combustible and does not meet clearance requirements from flue.

After

Damming around flue maintains 3" clearance from hot surface and shall extend above final insulation level.

Tools:

1. PPE: gloves, protective eyewear
2. Metal snips
3. Caulk gun
4. Fasteners

Materials:

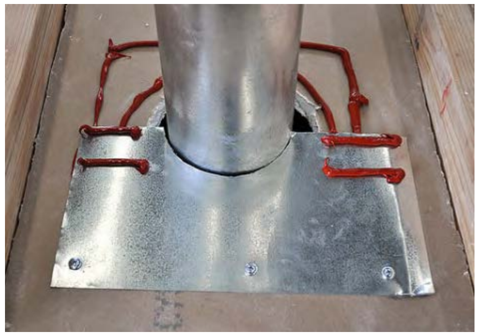
1. Aluminum coil stock
2. High temperature caulk with ASTM E136 listing
3. Caulk
4. Backer rod
5. Spray foam
6. Rigid non-combustable material for damming

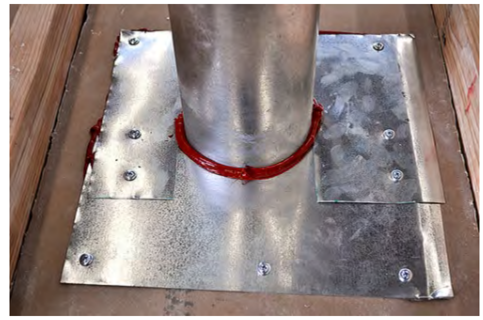
1. Air seal chimney penetration prior to damming.
2. Construct and install a rigid dam to ensure a 3" clearance between the dam material and the combustion flue or chimney.
3. Fasten damming to substrate or framing to prevent it from moving.
4. Damming shall extend higher than the top of the insulation to be installed.

5. Ensure the dam material does not bend, move, or sag.
6. Fiberglass batt may be used for damming in areas where installation of rigid daming is not feasible.

4.1001.3a - Air Seal and Dam Around Hot Pipe


Gaps around flues and penetrations need to be sealed before insulating


Rigid, non-combustible material should be used to construct seals and dams on flues


Only construct dam after sealing has been completed properly


Damming is held in place with mechanical fasteners and maintains 3" clearance from flue.


Air leak around masonry chimney, needs to be air sealed.


Rigid, non-combustible material should be used to construct seals and dams on chimneys


Only construct dam after sealing has been completed properly.


Damming is held in place with mechanical fasteners and maintains 3" clearance from chimney.

Clearance to Combustibles for Combustion Appliance Vents

Fuel	Vent type	Minimum Clearance to combustables
Gas, LP	Type B gas vent	1"
	Single wall metal	6"
Fuel Oil	Type L vent	9"
	Single wall metal	18"
Solid Fuel	Type L vent	9"
	Single wall metal	18"
Pellet fuel	Type L vent	per manufacturer's Specification

All combustion appliance venting and flues must maintain clearance to combustibles.

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

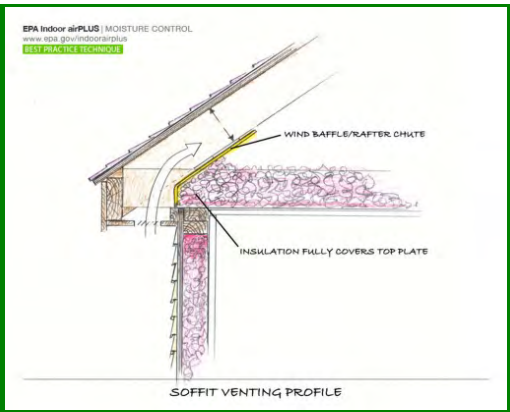
Objective(s):

Ensure insulation R-value is not reduced

Maintain attic ventilation

Before

Insulation should not block vented eaves



After

Tools:

1. Stapler

Materials:

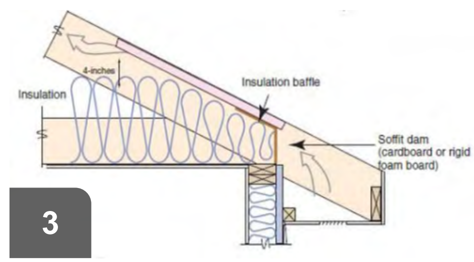
1. Baffles
2. Staples

Low attic-vent baffles shall extend vertically a minimum of 4" above the final level of the insulation. Mechanical fasteners shall permanently affix baffle in place.

4.1001.4a - Installation

Low attic-vent baffles should be securely fastened to prevent movement over time

Allow a standard one-inch gap for air flow between baffle and underside of roof



Low attic-vent baffles shall be placed to allow insulation over top plate and prevent insulation from falling into eave

4.1004.2a - Knee Wall Prep for Batts

Desired Outcome:
Airtight cavity and properly insulated knee wall

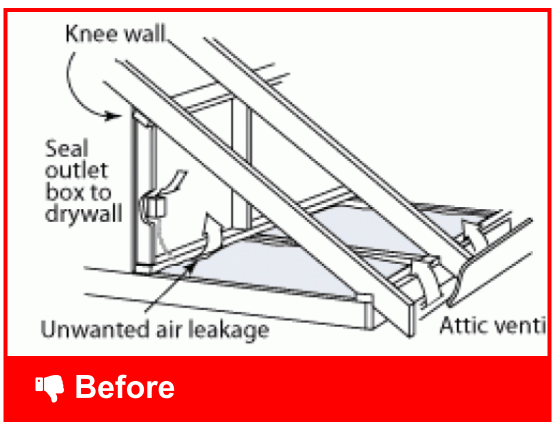
Specification(s):
All knee walls will have a top and bottom plate or blockers installed using a rigid material

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

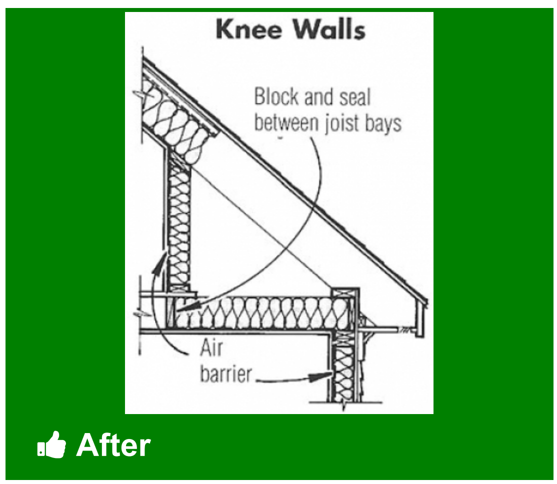
Objective(s):
Eliminate bending, sagging, or movement that may result in air leakage

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

Create an air barrier



Unsealed joist cavity below knee wall



Sealed joist cavity below knee wall

Tools:

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

Materials:

1. XPS
2. OSB, plywood, drywall,
3. Caulk
4. Spray foam
5. Fasteners

4.1004.2a - Knee Wall Prep for Batts

Measure floor joist opening so material can be cut and installed to prevent air leakage.

Install blocking to prevent air leakage.

Blocking material is sealed to surrounding joist and framing

4.1004.2b - Knee Wall - 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

NOTE: Required twine or lath support for knee wall insulation is same as that for floor insulation. See insulation support matrix below. Also, if knee wall area is used for storage fiberglass shall be covered with weather resistant barrier (WRB) or FSK to prevent human contact with fiberglass

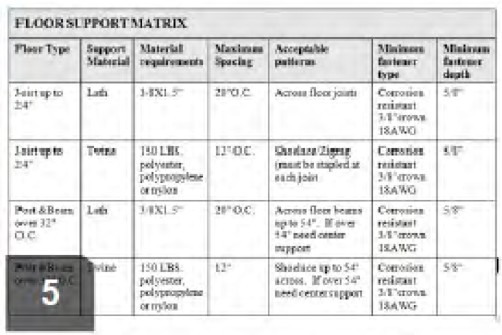
4.1004.2b - Knee Wall - Installation


1
Where existing insulation is improperly installed, fix it


2
Kraft-face should go to "warm in winter" side and batt should fill bay


3
Batts should fill entire volume of knee wall stud bays


4
Knee wall insulation is supported by nylon, stapled in a zig zag pattern, 12" on center.



FLOOR SUPPORT MATRIX

Floor Type	Support Material	Material requirements	Maximum Spacing	Acceptable patterns	Minimum fastener type	Minimum fastener depth
Joist up to 24"	Lath	3/8X1.5"	20"O.C.	Across floor joists	Corrosion resistant 3/8" crown 18AWG	5/8"
Joist up to 24"	Twine	150 LBS. polyester, polypropylene or nylon	12"O.C.	Shoelace/Zigzag (must be stapled at each joist	Corrosion resistant 3/8" crown 18AWG	5/8"
Post & Beam over 32" O.C.	Lath	3/8X1.5"	20"O.C.	Across floor beams up to 54". If over 54" need center support	Corrosion resistant 3/8" crown 18AWG	5/8"
Post & Beam over [illegible] O.C	Twine	150 LBS. polyester, polypropylene or nylon	12"	Shoelace up to 54" across. If over 54" need center support	Corrosion resistant 3/8" crown 18AWG	5/8"

5
Required twine or lath support for knee wall insulation is same as that for floor insulation.

4.1005.2a - Accessible Floors - Loose-Fill Installation - Preperation

Desired Outcome:

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

Specification(s):

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

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

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

Open electrical junctions will have covers installed

Insulation dams and enclosures will be installed as required

Objective(s):

Access the workspace

Verify uniformity of insulation material

Provide location of electrical boxes for future servicing

Prevent an electrical hazard

Before

Accessible attic floors should be air sealed and insulated

After

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

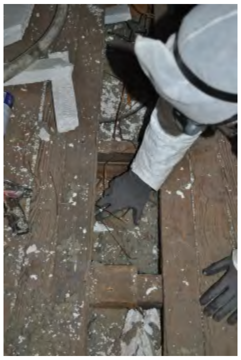
Tools:

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

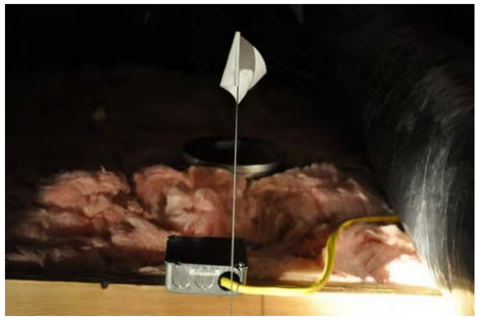
Materials:

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

4.1005.2a - Accessible Floors - Loose Fill Installation - Preparation



Check cavity for electrical junctions and penetrations



Flag and install covers on electrical junctions

Seal any penetrations

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

Install depth markers and insulation dams above height of insulation

4.1005.2c - Accessible Floor - Loose Fill Installation - Installation

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

Specification(s):
All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value

Objective(s):
Reduce heating and air conditioning costs

Improve comfort

Minimize noise

Insufficient level of insulation allows heat loss and wasted energy.

Attic floor blown with loose fill, achieving R-value of program requirements.

Tools:

1. Insulation machine
2. Rake or stick to level insulation as needed

Materials:

1. Loose fill insulation
2. paper rulers to mark insulation depth
3. Insulation manufacturer's coverage chart

NOTE: 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.

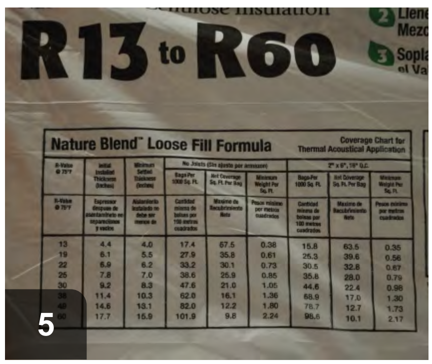
4.1005.2c - Accessible Floors - Loose Fill Installation - Installation

Adjust machine settings for loose fill: open gate for high material flow, allow enough air pressure to avoid clogging.

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

PPE for attic includes N-95 respirator or greater, gloves, and coveralls.

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



Use the manufacturer's coverage chart to ensure R-value and post the chart with the insulation certificate

4.1006.1a - Pull-Down Attic Stair - Installation

Desired Outcome:

Pull-down attic stair properly sealed and insulated

Specification(s):

Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly

Pull-down stair rough opening will be surrounded with a durable dam that is higher than the level of the attic floor insulation

Counter-weights should be considered to ease accessibility for excessively heavy hatches

Objective(s):

Achieve uniform R-value

Prevent loose insulation from entering the living area

Before

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

After

Insulated pull-down stairs cover installed to prevent air leakage

Tools:

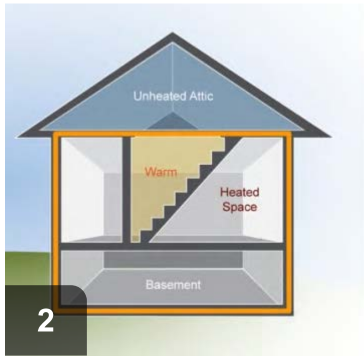
1. Tape measure, saw, drill
2. Caulk/ foam gun
3. Insulation machine and loose fill gear

Materials:

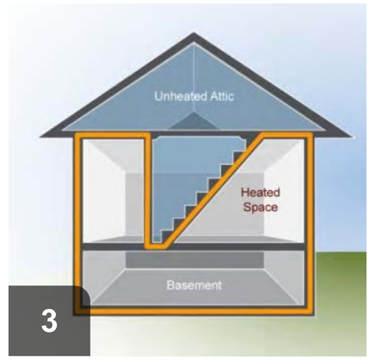
1. Caulk/ foam sealant
2. Lumber
3. Insulation: rigid XPS, or loosefill
4. Pre-fabricated stairwell cover, if applicable

4.1006.1a - Pull-Down Attic Stair - Installation

Stairs and hatch should both be insulated to match r-value of attic



Attic stairwell, Option One: Establish pressure and thermal boundary consistent with attic floor.



Attic stairwell, Option Two: insulate stairwell walls and beneath stair treads, insulate and air seal stairwell door.

4.1006.2a - Attic Access Door - 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 protective baffle that is higher than the level of the surrounding attic floor insulation

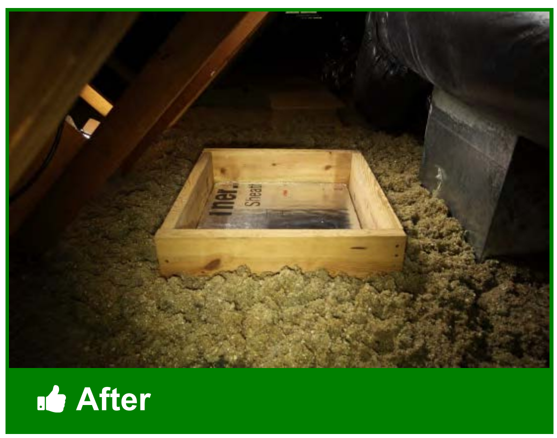
Objective(s):

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 hatch



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

Materials:

1. Baffle or damming around horizontal access: 1/2" plywood or OSB.
2. Fiberglass batt or rigid foam to achieve R-value on hatch.
3. Strapping to attach fiberglass batt to access hatch.
4. Adhesive or fasteners to attach rigid foam to access hatch.

When a rigid dam is not practical or possible due to hatch location (less than 24inches clearance from top of damming to bottom of roof truss or rafter), fiberglass batts may be used to prevent loose insulation from falling into conditioned space when hatch is opened.

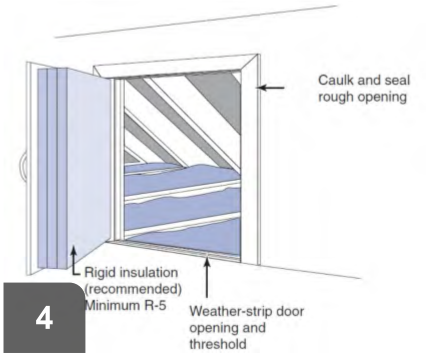
Ensure ceiling hatch is tight fitting and if necessary weatherstripped to prevent air leakage between conditioned space and attic.

4.1006.2a - Attic Access Door - Installation

Create hatch cover that matches r-value of surrounding insulation

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

Hatch shall be tight fitting. Install weather strip if needed.



Alternate installation for vertical access panel to attic

4.1005.2d, 4.1301.1d, 4.1103.1b - 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 specifications

Objective(s):

Document job completion to contract specifications

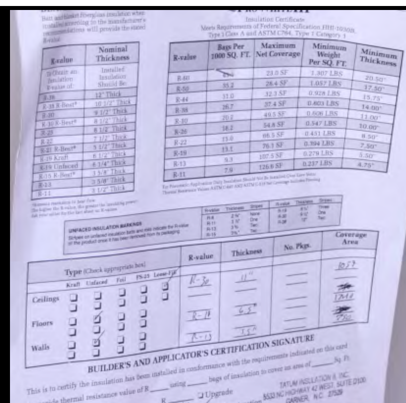
Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17

Best Practice

Information on insulation installed should be posted nearby



Best Practice

Posted info includes insulation type, r-value, depth, coverage area, etc.

This requirement applys whenever insulation is installed.

Reference 16 CFR 460.17: The installer, must provide the customer or client documentation regarding the insulation installed. Documentation will indicate the coverage area, thickness, and

R-value of the insulation.The insulation certification must be dated and signed by the installer. Insulation certificate to be posted at entrance to attic or crawlspace and a copy shall be provided for project file.

To figure out the R-value of the insulation, use the data that the manufacturer gives you.

2.0111.3a - Debris Removal

Desired Outcome:

Clean, safe, and easily accessible crawl space created

Specification(s):

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

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

Objective(s):

Minimize punctures in ground liner

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

Before

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

After

Clear away trash, wood debris and overgrowth. Remove anything that could puncture the ground cover.

Tools:

1. PPE

Note: axles, tires can be left in place

2.0403.1b - Coverage - Ground Moisture Barrier

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

Specification(s):
A ground moisture barrier that covers 100% of the exposed crawl space floor will be installed

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

Before

Uncovered crawl space floors can cause moisture damage

After

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

Materials:

1. Polyethylene plastic, white or black minimum 6 mil
2. Materials to secure poly: landscape staples, landscape blocks

Note: Reference SWS 2.0403.1a-e and SWS 2.0111.3a debris removal

Crawlspace shall be cleared of all wood debris or vegitation and anything likely to puncture the poly once it is in place.

- Poly shall cover 100% of bare ground,
- All seams shall overlap a minimum of 12 inches.
- Poly shall not be in direct contact with wood posts or framing.
- Where necessary, poly shall be fastened in place using landscape staples, spikes with washers or ballast to prevent shifting caused by routine access or other factors such as sloping grade or wind.

2.0701.2b - Sign Content - Crawlspace Maintenance

Desired Outcome:

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

Specification(s):

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

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

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

Objective(s):

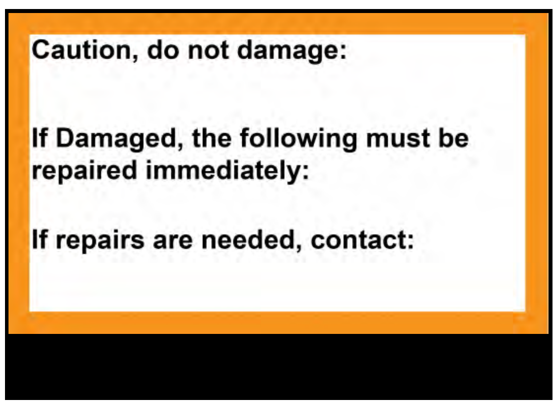
Prevent damage to the crawl space after upgrade

Educate anyone entering the crawl space

Provide occupants with a way to contact the installer

Best Practice

Mount sign where clearly visible to anyone entering crawl space



Be sure sign includes relevant information to aid occupant in repairs

Tools:

1. Printer
2. Staple gun

Materials:

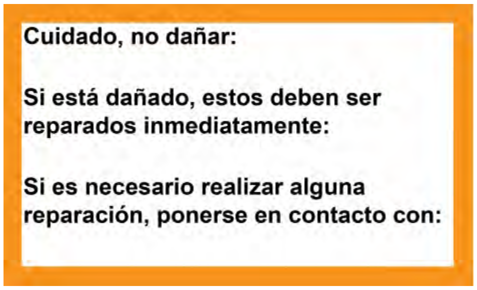
1. Paper
2. Laminant
3. Staples

Note: SWS 2.0701.2a-c requires a sign (min.8.5"x11") at entrance of crawlspace that states:

1) Ground cover, air barrier and insulation if disturbed shall be repaired and maintained.

2) Hazardous or flammable materials or liquids shall not be stored in crawlspace.

2.0701.2b - Sign Content - Crawlspace Maintenance



Hacer la señal en español también

3.1402.1c - Floor Plane Air Sealing: High Temperature Application

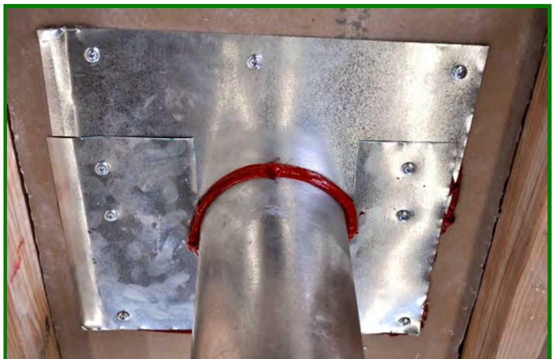
Desired Outcome:
Air leakage prevented and indoor air quality protected

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

Objective(s):
Prevent a fire hazard

Before

Gaps around floor penetrations allow air and moisture movement



After

Use non-combustible materials, such as sheet metal and high-temp caulk

Tools:

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

Materials:

1. High-temperature caulk, in accordance with ASTM E 136
2. Non-combustible sheet material

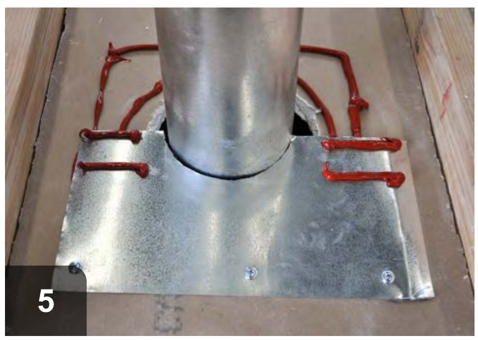
3.1402.1c - Floor Plane Air Sealing: High Temperature Application

Prepare work area by removing any insulation and debris

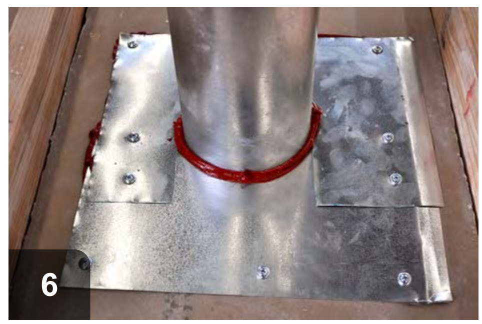
Use high-temperature caulking (600F min), in accordance with ASTM E 136

Apply first ring of caulking to match shape of opening

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



Fasten rigid, non-combustible material and apply additional caulking



Fasten rigid, non-combustible material to cover penetration and seal against flue with caulk

Clearance to Combustibles for Combustion Appliance Vents

Fuel	Vent type	Minimum Clearance to combustibles
Gas, LP	Type B gas vent	1"
	Single wall metal	6"
Fuel Oil	Type L vent	9"
	Single wall metal	18"
Solid Fuel	Type L vent	9"
	Single wall metal	18"
Pellet fuel	Type L vent	per manufacturer's Specification

7

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

Before

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

After

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

Tools:

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

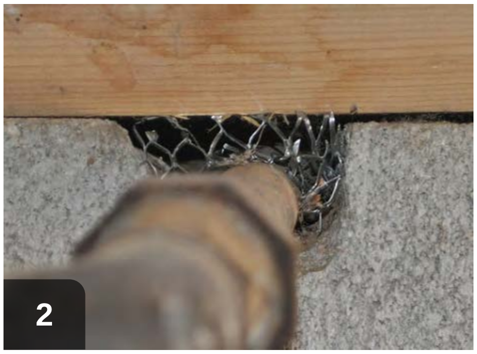
Materials:

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

Note: If there is evidence of pests entering vented crawlspace these same techniques can be used to exlude pests

3.1402.3b - Pest Exclusion

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



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

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

4.1301.1a - Sealing - Floor Plane Air 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

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
4. Rigid sheet material
5. Fasteners

- 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.
- Ensure resulting closure is permanent and supports any load (e.g., insulation).
- Ensure sealant does not fall out.
- Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.

4.1301.1a - Sealing - Floor Plane Air Sealing


1
Locate gaps around penetrations for plumbing, electrical, etc.

2
Fill gaps greater than 1/4 inch with backer rod or spray foam


3
Caulk smaller gaps and to hold backer rod in place


4
open tub chase


5
Seal large tub chase using rigid, sheet material (foam board, sheet metal, plywood, etc) then caulk or foam edges

4.1301.1c - Securing Batts - Floor Insulation

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

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

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

Fiberglass batts must not hang away from subfloor. Fasteners must not compress batts.

Floor insulation twine and lath support

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

Materials:
1. Batt insulation
2. Twine
3. Lath
4. Staples

Note: Insulation batt shall be sized to fill the cavity and installed without voids, gaps or compression. In complete contact with the underside of floor over crawlspace

Please see Appendix D for Floor Support Matrix for support requirements using Twine or Lath.

4.1301.1c - Securing Batts - Floor Insulation

Batt must be in contact with subfloor without being overly compressed.

Twine fastened across bays in a zig-zag pattern

FLOOR SUPPORT MATRIX						
Floor Type	**Support Material**	**Material requirements**	**Maximum Spacing**	**Acceptable patterns**	**Minimum fastener type**	**Minimum fastener depth**
Joist up to 24"	Lath	3/8X1.5"	20"O.C.	Across floor joists	Corrosion resistant 3/8"crown 18AWG	5/8"
Joist up to 24"	Twine	150 LBS. polyester, polypropylene or nylon	12" O.C.	Shoelace/Zigzag (must be stapled at each joist	Corrosion resistant 3/8"crown 18AWG	5/8"
Post &Beam over 32" O.C.	Lath	3/8X1.5"	20" O.C.	Across floor beams up to 54". If over 54" need center support	Corrosion resistant 3/8"crown 18AWG	5/8"
Post &Beam over 32" O.C	Twine	150 LBS. polyester, polypropylene or nylon	12"	Shoelace up to 54" across. If over 54" need center support	Corrosion resistant 3/8"crown 18AWG	5/8"

Required twine or lath support for floor insulation

Wire batt support rods (known as tiger teeth) are prohibited because they compress insulation, rust, and fall out.

4.1301.2b - Netting, Fabric - Dense Pack Floor Insulation

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

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

Netting or fabric will meet local fire codes

Objective(s):
Secure insulation

Before

Uninsulated floors above unconditioned spaces are an energy drain

In Progress

Netting is secured to joists and sills to create cavities for insulation

Tools:

1. Utility knife
2. Scissors
3. Stapler

Materials:

1. Fabric netting
2. Staples

4.1301.2b - Netting, Fabric - Dense Pack Floor Insulation

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

4.1401.2a - Preparation

Desired Outcome:
Closed crawl spaces insulated to achieve best thermal performance possible

Specification(s):
The rim joist, sill plate and adjacent surfaces will be sufficiently clean and free of debris to allow for the proper adhesion of any caulks, adhesives or spray foam used during installation.

Objective(s):
Prepare all surfaces for the installation of insulation

Use cleaning tools to remove debris and dirt that ight prevent sealants from sticking to framing members

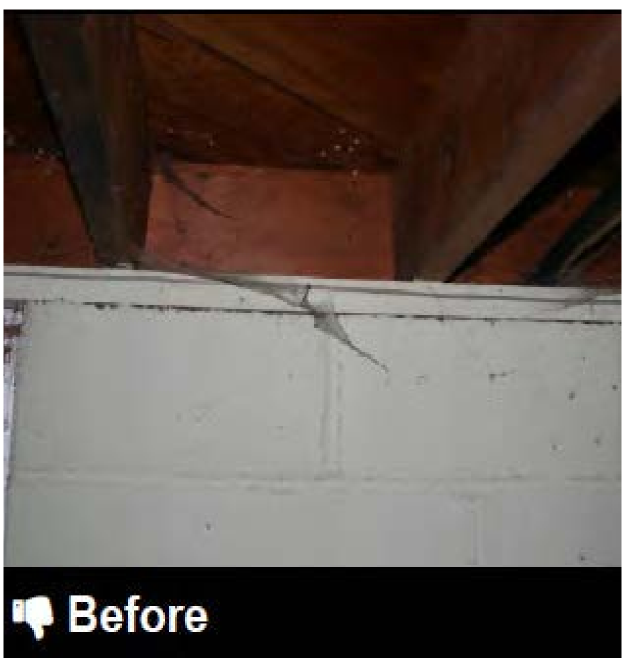
Tools:
1. Vacuum, compressed air, hand broom

4.1401.2b - Insulation Installation

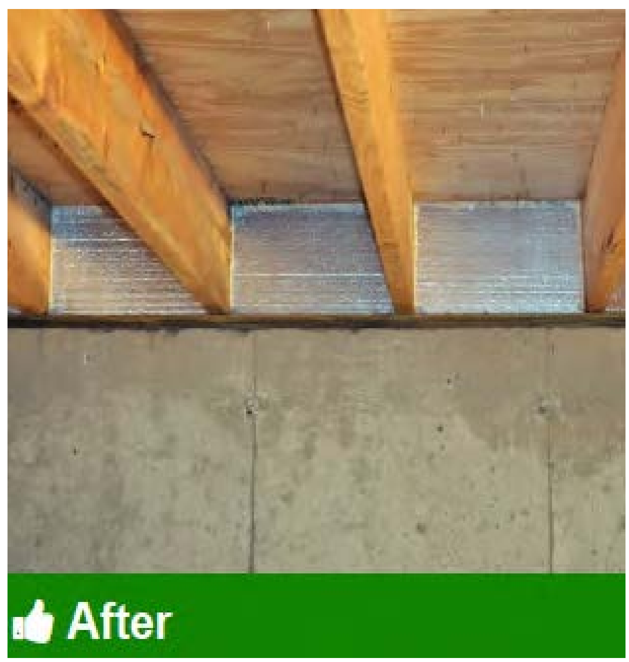
Desired Outcome:
Closed crawl spaces insulated to achieve best thermal performance possible

Specification(s):
Insulation and sealant will be installed so as to create a continuous thermal and pressure boundary.

Objective(s):
Improve thermal performance Prevent moisture condensation on the inside of the band joist



Uninsulated basement rim joist



Basement rim joist insulated and air sealed

Tools:

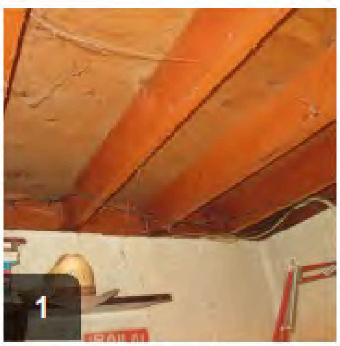
1. Insulation knife
2. Measuring tape
3. Foam gun

Materials

1. Insulation: rigid foam (DOE thermax; or R-max tSX 8500) or fiberglass batt with FSK (or MBI)
2. Sealant

This Specification is for basment or closed crawl application. Insulation must be a Class 1 material, according to ASTM E84 (flame spread not to exceed 25, smoke index not to exceed 450). Two rigid foam products meet this requirement: DOW thermax, and R-max tSX 8500.

Fiberglass batts shall be FSK or MBI to serve as vapor retarder.



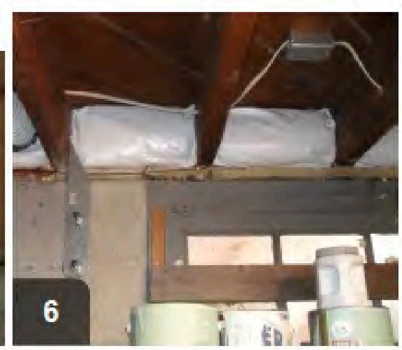
Rim joists in a conditioned basement lack pressure and thermal boundaries.

Save time by pre-cutting pieces of rigid foam to fit between floor joists. Gaps will be air sealed.

Pressure fit rigid insulation into

Air seal all seams where insulation meets framing.

Cut insulation to fit around utility penetrations in rim joists. Air seal all seams.



Fiberglass needs vapor retarder facing. FSK batting or metal building insulation (MBI) are acceptable.

4.1005.2d, 4.1301.1d, 4.1103.1b - 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 specifications

Objective(s):

Document job completion to contract specifications

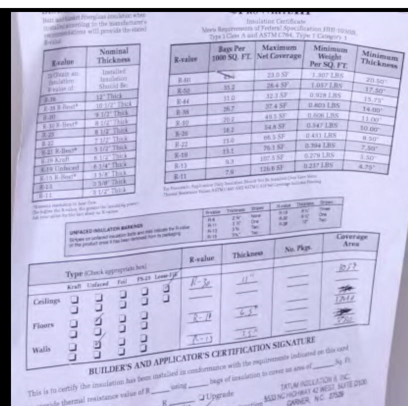
Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17

Best Practice

Information on insulation installed should be posted nearby



Best Practice

Posted info includes insulation type, r-value, depth, coverage area, etc.

This requirement applys whenever insulation is installed.

Reference 16 CFR 460.17: The installer, must provide the customer or client documentation regarding the insulation installed. Documentation will indicate the coverage area, thickness, and

R-value of the insulation.The insulation certification must be dated and signed by the installer. Insulation certificate to be posted at entrance to attic or crawlspace and a copy shall be provided for project file.

To figure out the R-value of the insulation, use the data that the manufacturer gives you.

4.1103.1a

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

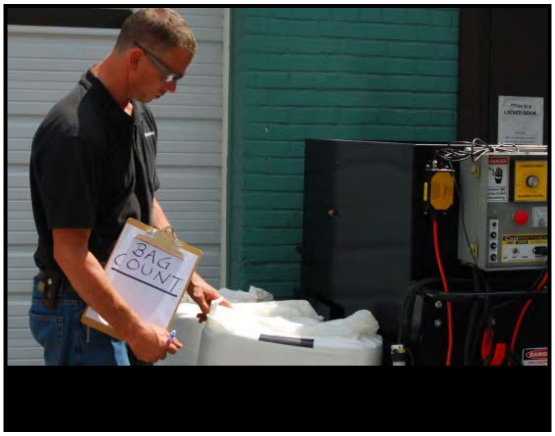
Specification(s):
Using fill tube, 100% of each cavity will be filled to a consistent density:

- Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density
- Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit air flow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using BPI-102 "Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications – Material Specification" or ASTM C 522, E 283, or E 2178; the number of bags installed will be confirmed and will match the number required on the coverage chart

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

Objective(s):
Eliminate voids and settling

Minimize framing cavity air flows



Make accurate count of insulation bags to be installed

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

Tools:

1. insulation blowing machine
2. pressure gauge
3. blower door
4. tools for removing siding: hammer, pry bar, knife
5. chemical smoke dispenser
6. drill
7. tape measure
8. ladder

Materials:

1. cellulose or fiberglass insulation (any fiberglass material used must be specifically approved for air flow resistance by the manufacturer)
2. wooden, plastic, or foam plugs to fill installation holes
3. piece of fiberglass batt or towel to stop insulation from blowing out around the hose
4. Siding repair materials: caulk, exterior-grade spackle, primer/ paint

When possible, exterior siding shall be removed or lifted to gain access to the exterior wall for drilling. Score and snap method of siding removal is permitted when proper paint preparation follows. Siding shall be replaced after insulation is installed. Any siding that is damaged shall be repaired or replaced with matching siding that is primed and painted to match existing siding.

Exterior siding not containing asbestos that cannot be removed or lifted before drilling walls may be drilled through with the owner's permission. Holes shall be drilled in a level line, and all holes will be filled with a tight-fitting, wooden plug that is installed using an exterior grade, non-silicone-based adhesive, and then filled and smoothed with exterior-grade spackle, textured to match existing surface(s), allowed to cure per manufacturer's specifications, primed, and painted to match existing siding.

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

Remove siding and drill holes in sheathing for installing insulation. Follow lead safe work practices when needed.

Only drill through the siding if it can't be removed. Follow lead safe work practices when needed.

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

Adjust the pressure (controls shown here) and the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes.

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

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

Check that cavities are filled and are the proper density.

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

4.1005.2d, 4.1301.1d, 4.1103.1b - 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 specifications

Objective(s):

Document job completion to contract specifications

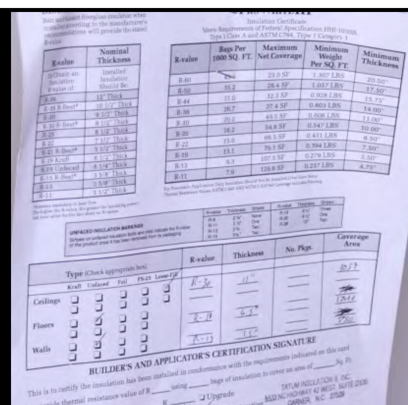
Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17

Best Practice

Information on insulation installed should be posted nearby



Best Practice

Posted info includes insulation type, r-value, depth, coverage area, etc.

This requirement applys whenever insulation is installed.

Reference 16 CFR 460.17: The installer, must provide the customer or client documentation regarding the insulation installed. Documentation will indicate the coverage area, thickness, and

R-value of the insulation.The insulation certification must be dated and signed by the installer. Insulation certificate to be posted at entrance to attic or crawlspace and a copy shall be provided for project file.

To figure out the R-value of the insulation, use the data that the manufacturer gives you.

3.1501.1a - Penetrations

Desired Outcome:
Openings from garage sealed to prevent leakage

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

Objective(s):
Prevent air leakage and pollutant entry

Before

Penetrations between the garage and house can leak hazardous fumes

After

Seal penetrations to minimize risks and air leakage

Materials:

1. Backer Rod
2. Caulk
3. Spray foam

3.1501.1b - 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

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

After

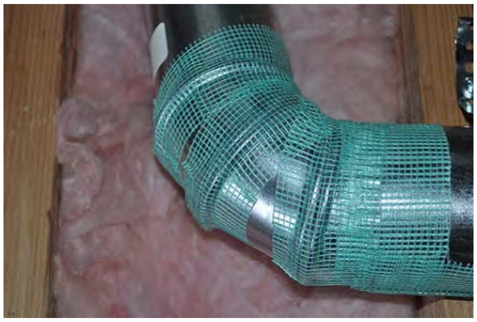
Sealed ductwork connections help prevent leakage.

Materials:

1. Mesh tape
2. Mastic

3.1501.1b - Ductwork


Prepare work area by assessing any safety concerns.


Wrap joint with fiberglass mesh tape.


Apply UL 181 mastic to seal joint.

3.1501.1d - Garage to House Door

Desired Outcome:

Openings from garage sealed to prevent leakage

Specification(s):

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

Objective(s):

Prevent air leakage and pollutant entry

Before

Daylight visible under door to garage indicates leakage

After

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

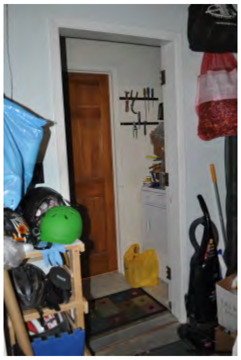
Tools:

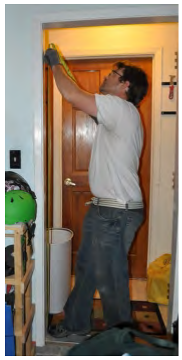
1. Caulk gun
2. Screwdriver
3. Utility knife
4. Hacksaw
5. Saw
6. Tape measure
7. Drill
8. Planer

Materials:

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

3.1501.1d - Garage to House Door


Remove door for access to work space and to install sweep


Measure for weatherstripping around door


Install weatherstripping into rabbit around door


Corners of weatherstripping should be snug and secure


Adjust threshold to minimize contaminant and water infiltration


Caulk along threshold to minimize water and contaminant infiltration


Cut door sweep to width of the door


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


Rehang door to verify snug fit and smooth operation

Duct Sealing

3.1602.1

Sealing Small, Medium & Large Holes

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

After gaining access to the leakage site, choose the appropriate sealing technique from below. Each of these step-by-step groupings illustrate a specific sealing technique based on the hole size. There are 3 sets to choose from:

(Small Holes) - Mastic + Mesh Tape:
Seams, cracks, joints, holes and penetrations that are 1/4-inch or less.

(Medium Holes) – Temporary Tape + Mastic + Mesh Tape:
Seams, cracks, joints, holes and penetrations that are 1/4-inch to 3/4-inch.

(Large Holes) – Rigid Support + Mastic + Mesh Tape:
Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

Materials:

Mastic
Fiberglass mesh tape
Duct tape
Sheet metal
Support material
Screws

Tools:

Utility knife or scissors
Mastic brush
Tin snips
Flashlight/headlamp
Drill

Safety & Notes:
Gloves, appropriate respirator, safety glasses

3.1602.1 - Duct Sealing

Sealing Small Holes

Seams, cracks, joints, holes and penetrations that are 1/4-inch or less.

Seal with mastic.

Notes:

3.1602.1 - Duct Sealing

Sealing Medium Holes

STEP 1: Seams, cracks, joints, holes and penetrations that are 1/4-inch to 3/4-inch.

STEP 2: Install temporary tape over seams, cracks, joints, holes and penetrations.

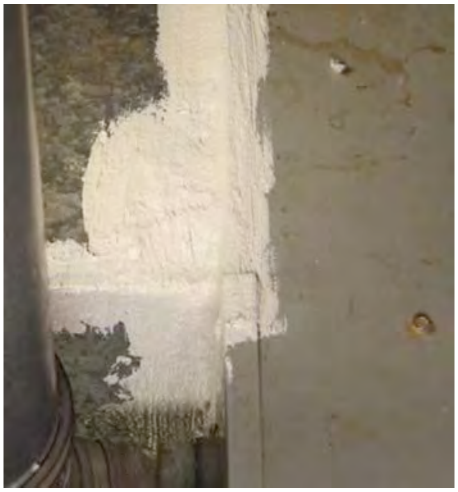
STEP 3: Apply a base coat of mastic to completely cover and extend beyond tape.

STEP 4: Apply fiberglass mesh tape to completely cover and extend beyond mastic.

3.1602.1 - Duct Sealing

Sealing Medium Holes (cont.)

STEP 5: Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.



Notes:

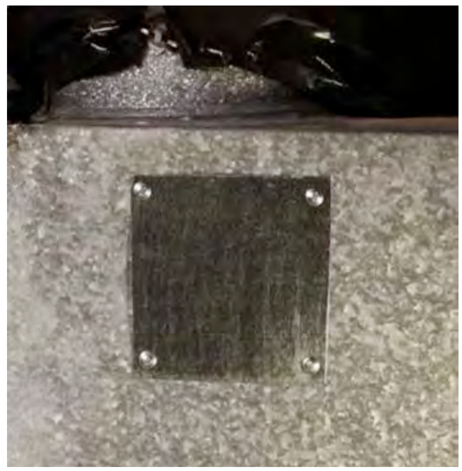
Temporary tape can be a variety of different types of tape. It is used to prevent mastic from falling into the hole and should only be used if also using mesh tape for reinforcement.

3.1602.1 - Duct Sealing

Sealing Large Holes

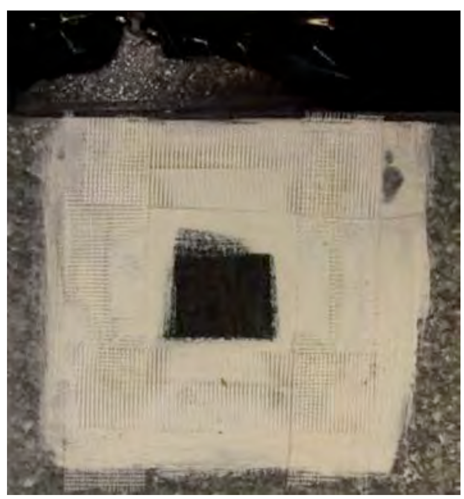
STEP 1: Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

STEP 2: Install rigid duct support material that is at least 1 inch larger than the hole.



STEP 3: Apply a base coat of mastic to completely cover and extend beyond support material.

STEP 4: Apply fiberglass mesh tape to completely cover and extend beyond mastic.



3.1602.1 - Duct Sealing

Sealing Large Holes (cont.)

STEP 5: Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.

Notes:

3.1602.1 - Duct Sealing

Sealing Large Holes

STEP 1: Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

STEP 2: Install rigid duct support material that is at least 1 inch larger than the hole.

STEP 3: Apply a base coat of mastic to completely cover and extend beyond support material.

STEP 4: Apply fiberglass mesh tape to completely cover and extend beyond mastic.

3.1602.1 - Duct Sealing

Sealing Large Holes (cont.)

STEP 5: Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape..

Notes:

3.1602.1 - Duct Sealing

Sealing Large Holes

STEP 1: Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

STEP 2: Install rigid duct support material that is at least 1 inch larger than the hole.

STEP 3: Apply a base coat of mastic to completely cover and extend beyond support material.

STEP 4: Apply fiberglass mesh tape to completely cover and extend beyond mastic.

3.1602.1 - Duct Sealing

Sealing Large Holes (cont.)

STEP 5: Apply a second coat of mastic atop

Notes:

3.1602.1 - Duct Sealing

Sealing Large Holes

STEP 1: Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

STEP 2: Install rigid duct support material that is at least 1 inch larger than the hole.

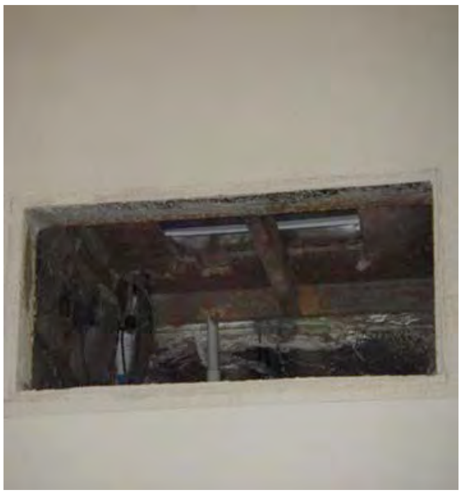
STEP 3: Apply a base coat of mastic to completely cover and extend beyond support material.

STEP 4: Apply fiberglass mesh tape to completely cover and extend beyond mastic.

3.1602.1 - Duct Sealing

Sealing Large Holes (cont.)

STEP 5: Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.



Notes:

3.1601.1c - Flex to Metal

Desired Outcome:

Ducts and plenums properly fastened to prevent leakage

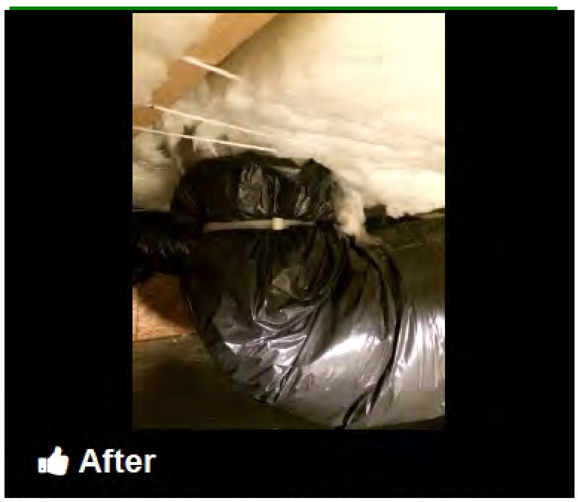
Specification(s):

Joints will be fastened with tie bands using a tie band tensioning tool

Objective(s):

Ensure durable joints

Inner liner of flex duct secured with panduit straps



Outer covering secured with panduit strap.

Tools:

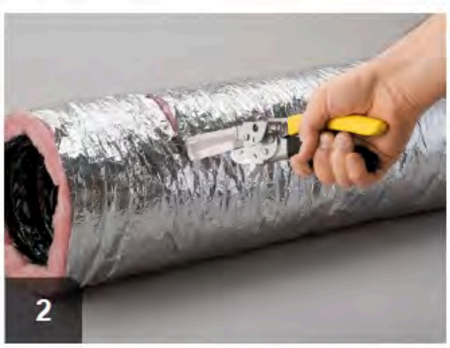
1. metal snips
2. scissors or knife
3. panduit tensioning tool

Materials:

1. heavy duty panduit straps

Use panduit-tensioning tool to secure all panduits. Use panduits to secure both the inner liner, and the outer insulation covering of the flex duct.

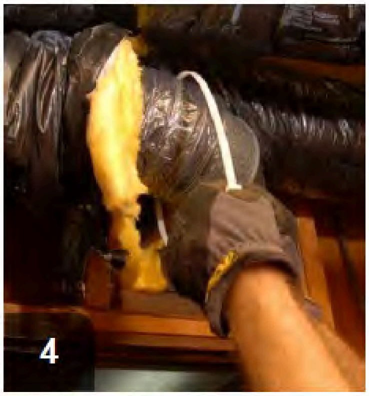
Secure both inner liner and outer covering of flex duct with panduit straps. Tighten the straps with a tensioning tool.



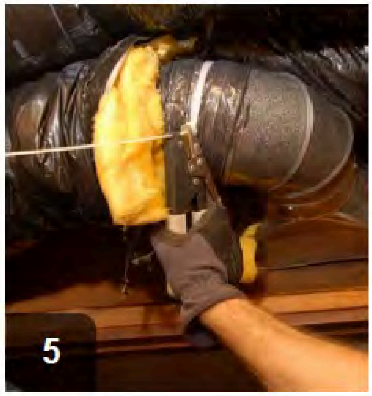
If needed, eliminate duct sagging by shortening length of flex duct.

Cutting the reinforcing wire will require metal snips or similar.

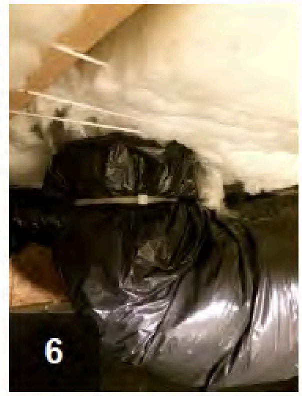
3.1601.1c - Flex to Metal



Place panduit strap around the connection.



Tighten panduit strap using a tensioning tool.



Pull flex duct insulation to cover rigid ducting, then secure outer covering over rigid duct with panduit strap.

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 galvinized wire
3. Synthetic fabric support straps (at least 1 1/2" wide)
4. Staples
5. Fasteners

3.1601.3a - Support (Applies to All Duct Types)

BAD: Make sure supports DO NOT compress insulation or duct

Flex ducts should have supports no less than every 4 feet

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

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

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

Metal wire should be at least 12 gauge and galvanized

3.1602.1c - Existing Component to Existing Component

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

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

Fiberglass mesh and mastic will become the primary seal

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

Fiberglass mesh and mastic will overlap repair joint by at least 1" on all sides

Fiberglass mesh and mastic will be the primary seal

Objective(s):

Eliminate air leakage into or out of ducts and plenums

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

Reinforce seal

Support fiberglass mesh and mastic during curing

Before

Duct to plenum not sealed

After

Duct to plenum sealed

Tools:

1. Nylon strap tensioning tool

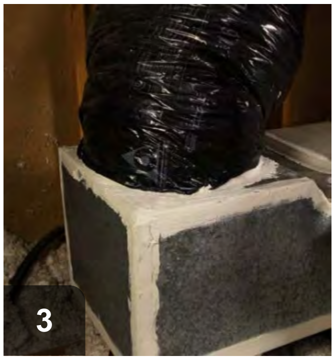
Materials:

1. Mastic
2. Fiberglass mesh tape
3. Nylon tensioning ties

3.1602.1c - Existing Component to Existing Component

Peel back outer layer of insulation, seal plenum with mastic using appropriate sealing technique based on hole size

Install nylon tie band around inner liner using a tie band tensioning tool.



Replace outer liner and insulation.

Install nylon tie band around inner liner using a tie band tensioning tool.

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 2012 IRC R302.9

Objective(s):
Prevent air leakage

Prevent a fire hazard

Before

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

After

Use a mesh tape and mastic or UL 181 Aluminum butyl tape to seal duct boot to interior surface

Tools:

1. Utility knife
2. Spray bottle
3. Putty knife
4. Drill motor or hammer

Materials:

1. Mastic
2. Mesh tape
3. Fasteners (screws or nails)
4. UL 181 Aluminum Butyl Tape

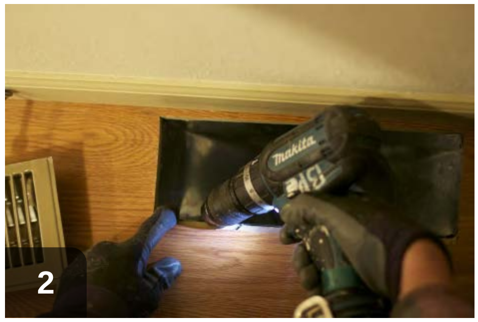
Use fasteners to close any large gaps between interior surface and the duct boot

Use mesh tape and mastic or UL 181 Aluminum Butyl tape for gaps larger than 1/4 inch

When using mastic allow mastic to set before replacing register cover

3.1602.4a - Duct Boot to Interior Surface

Remove grill to expose duct boot and gaps

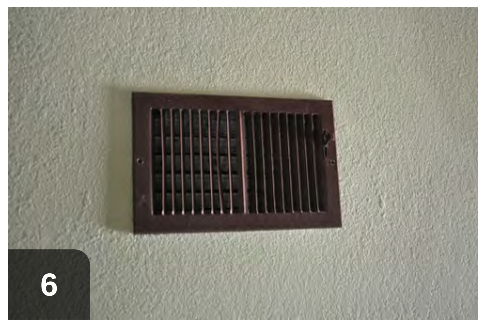


Use fasteners to close gaps before applying mastic

Wet the edges of the drywall to ensure a good bond

Cut mesh or UL 181 Aluminum Butyl tape to fit around duct boot and cover gaps

Apply mastic over tape to create heat resistant, durable bond



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

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

Before

Unnecessary holes in the air handler cabinet need to be sealed

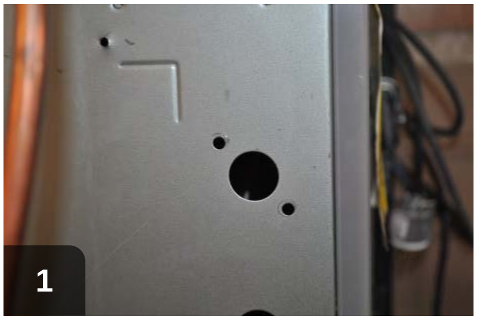
After

Use removable foil tape to seal holes

Materials:

1. Foil tape

3.1602.4c - Air Handler Cabinet



Unnecessary holes in the air handler cabinet should be sealed

Removable foil tape should be used to seal

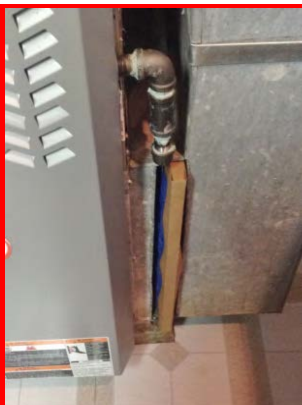
Fully cover holes with tape to seal completely

3.1602.4d - Filter Slot

Desired Outcome:
Ducts and plenums sealed to prevent leakage

Specification(s):
A pre-manufactured or site manufactured durable filter slot cover will be installed

Objective(s):
Reduce air leakage while maintaining accessibility



Before

Uncovered filter slots are a point of leakage

After

Filter slots should be covered

Return Ducts Inside Combustion Appliance Zone

Specification(s):

Return ducts/plenums will be sealed according to 3.1601 and 3.1602 when located in a zone with an atmospheric combustion appliance.

Objective(s):

Return duct leakage will not create depressurization in a zone where an atmospheric combustion appliance is located.

Notes:

Return duct leakage allows the furnace fan to draw air from the surrounding area, depressurizing the zone. Sealing return leakage in combustion appliance zones may not be an energy measure, but will reduce depressurization which can cause spillage of exhaust gas from combustion appliances.

A forced air furnace and return ducts located in zone where atmospheric appliance (water heater) is present.

As the amount of return ducts in a zone increases, so does the chance of return duct leakage, which results in zon depressurization.

Return Ducts Inside Combustion Appliance Zone

Pan joist return ducting is often leaky, creating depressurization in the zone.

Furnace filter slots located in the return plenum are often leaky, creating depressurization in the zone.

Furnace filter slots located in the return plenum are often leaky, creating depressurization in the zone.

Magnetic covers work well to seal leakage at the filter slot.

Return Ducts Inside Combustion Appliance Zone

Magnetic covers work well to seal leakage in the filter slot.

3.1602.10b - Reduce Excess Flex Duct Length

Desired Outcome:
Deliver air from trunk to termination (register/diffuser) without leakage

Specification(s):
Excess flex duct will be removed between the takeoff at trunk and floor register boot

Objective(s):
Improve air flow

Before

This duct is far too long, resulting in poor airflow.

After

The duct has been shortened, and is now properly supported.

3.1602.11d - Performance Testing

Desired Outcome:

Ducts and plenums sealed to prevent leakage

Specification(s):

Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and results will be documented and reported to the homeowner and/or program

Objective(s):

Document post-retrofit duct leakage performed

Best Practice

Test duct performance using pressure pan or duct blaster, before and after work

Best Practice

Duct pressurization tests, before and after, can also be used to determine improvement in performance

Tools:

1. Blower door
2. Manometer
3. Pressure Pan

Washington State weatherization workers will performance test duct sealing measures with pressure pan measurments. Duct pressurization tests, which quantify duct leakage (CFM@25), are also allowed.

3.1602.11d - Performance Testing

Set-up blower door to perform pressure pan testing

Perform pressure pan test on ductwork before beginning work. Record result

Perform pressure pan test after work is completed and compare to 'before' reading

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

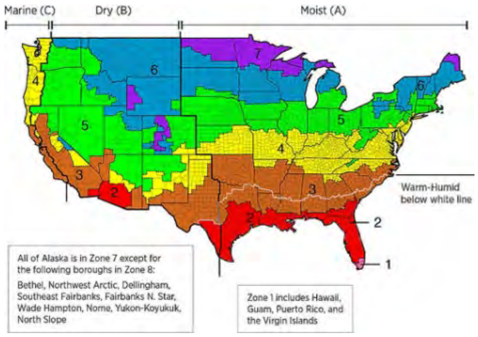
After

Properly insulated ducts operate at much higher rates of efficiency

4.1601.2a - Selection of Duct Insulation Material

R-8 is the minimum insulation level in unconditioned spaces. Insulation requires a vapor retarder

Ducts can be buried in loose fill insulation in attic spaces.



Burying ducts is discouraged in warm coastal and hot, humid regions

4.1601.2c - Attachment of Duct Insulation

Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

Specification(s):

Duct insulation will be secured to the duct system using metal wire or rot-proof nylon twine

Pattern of the wire or twine will be sufficient to securely hold the duct insulation tight to the duct

Objective(s):

Ensure a secure connection between the duct system and the duct insulation

Before

Materials holding insulation in place should not compress or kink duct

After

Durable materials can be attached without compressing insulation

Tools:

1. Scissors
2. Metal snips

Materials:

1. Nylon twine
2. Wire
3. Tie bands

4.1601.2d - Taping of the Duct Insulation

Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

Specification(s):

Using a tape approved by the manufacturer, all seams and connection of the duct insulation will be taped

No gaps will exist between pieces of duct insulation

Objective(s):

Prevent gaps in the vapor barrier of the insulation

Before

Unsecured and sealed insulation around ducts is useless

After

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

Tools:

1. Utility knife

Materials:

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

Bath Fan Installation

Specification(s):

Exhaust fan will be installed to exhaust humidity and other pollutants out of the home.

Notes:

All mechanical ventilation fan exhaust ducting (whole building and local) shall comply with the following:
a. Extend directly to the outside of the structure (preferably through a vertical surface, rather than through the roof).
b. All exhaust fans shall be equipped with a back draft damper located at either the fan outlet or the vent termination.
c. Duct shall connect to a collar of the termination cap. Collar shall pass through the building envelope.
d. Entire duct system, including termination cap shall have at least the equivalent net free area of the fan outlet.
e. Ducting shall be constructed of rigid vent pipe material.
Exception: Where rigid vent pipe is impracticable, flex duct may be used for runs no longer than 6 feet from fan to vent cap. For runs longer than 6 feet, flex duct may be used if the duct diameter is increased an additional 50% from the fan outlet diameter. In no installation shall the flex duct be allowed to loop. If one is running flex duct across varying heights (such as ceiling joists), the flex duct shall be stretched and secured to a splint to avoid sagging and the collection of condensation.
f. Insulated to minimum R-8 with unfaced fiberglass insulation if it passes through unconditioned space.
g. Air-tight and mechanically fastened at each joint using a minimum of 2 screws, including connection to the fan outlet and to the collar of termination cap. For metal ducting, the insert end of the duct shall extend into the adjoining duct or fittingin the direction of airflow.

Bath Fan Installation

Measure, mark, and cut hole for new fan. Plan for fastening to joists, blocking, or manufacturer's mounting brackets.

Install fan adapter first. Plan to ensure positive connection between adapter and fan housing.

Place new fan. Fasten to joist with screws and attend to mounting brackets in attic if applicable.

Complete fan mounting and air seal ceiling penetration.

Bath Fan Installation

Assemble fan ducting.

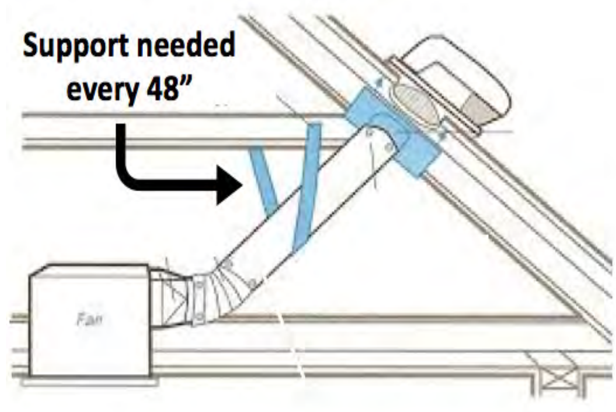
Fasten fan ducting with minimum of three screws at each connection.

Exhaust fan ducted through vertical surface, still needs to be sealed, insulated, and supported if applicable.

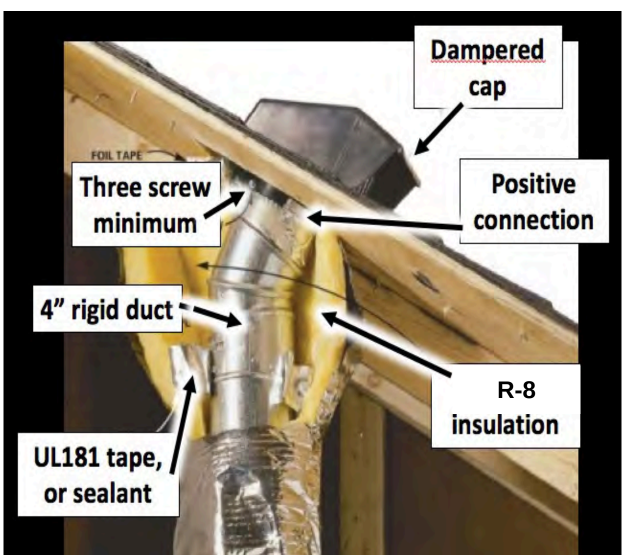
Seal exhaust fan duct seams with mastic of UL181 tape.

Bath Fan Installation

Insulate exhaust fan ducting to R-8 when in unconditioned space.



Exhaust fan ducts require support every 48”.



Exhaust fan duct assembly showing dampered cap with collar.

6.6002.1a - Duct Design and Configuration

Desired Outcome:

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

Specification(s):

Ventilation ducts will be as short, straight, and smooth as possible

Ventilation ducts will not be smaller than the connections to which they are attached

Objective(s):

Effectively move the required volume of air

Before

Duct work for exhaust fans should be short, smooth, and shall not transition to smaller diameter.

After

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

Tools:

1. Metal snips
2. Drill
3. Nylon tie tensioning tool

Materials:

1. Metal duct, or flexible duct materials with UL 181 listing or Air Diffusion Council approved.
2. Fasteners
3. Nylon tensioning ties
4. Sealant: mesh tape and mastic
5. Sealant: aluminum butyl tape with UL 181 listing

Listed flex-duct with the same inside diameter as the fan outlet shall not exceed 6' feet in length.

Exception: allowable flex duct length can exceed 6' provided diameter is increased by 50% (ie, 4" to 6").

6.6002.1b - Duct Insulation

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

Specification(s):
Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes

Objective(s):
Prevent condensation from forming or collecting inside of the ductwork

Uninsulated fan venting

Insulated fan venting prior to addition of loose fill cellulose.

Tools:

1. Utility knife
2. Metal snips

Materials:

1. R-8 insulation
2. Nylon twine
3. Wire

Exhaust fan venting insulation does not require a vapor barrier.

Ventilation - Duct Support

Specification(s):

Metal venting support requirements
a. Sections shall be securely connected to each other using a minimum of 3 screws for round ducts and 4 for rectangular.
b. Horizontal and vertical duct runs shall be supported using nylon, plastic, or metal strapping having a minimum width of ½ inch. Support strapping or hangers shall not unduly compress the insulation.
c. Support strapping or hangers shall be installed within 1 foot of a joint or connection with a maximum of 4 feet between supports.

Flexible venting support requirements

a. Flex duct, existing or installed, shall be insulated to a minimum, effective R-8.
b. Flex duct shall be of the proper length for connection between two points without excessive bends or sag.
c. Horizontal and vertical runs of flex duct shall be supported using nylon, plastic, or metal strapping having a minimum width of ½ inch. Support strapping or hangers shall not compress the insulation.
d. Support strapping or hangers shall be installed within 1 foot of a joint or connection with a maximum of 4 feet between supports.
e. Flex duct shall be connected to metal collars or boots. The inner layer of the flex shall be secured using a compression strap. The outer layer of insulation shall also be secured using a compression strap.

Objective(s):

Effectively move the required volume of air, Preserve the integrity of the duct system, Eliminate falling and sagging;

Rigid vent material supported with nylon strapping

Tools:
Tape Measure, Scissors or knife, Drill/driver

Materials:
Nylon, plastic or metal strapping, fasteners

Note(s):
WA Variance Allows

6.6002.2a - Hole in Building Shell - Roof Termination

Desired Outcome:
Securely installed termination fittings with unrestricted air flow

Specification(s):
A hole no greater than a 1/4" greater than the fitting will be cut to accommodate termination fitting

Objective(s):
Allow for ease of weatherproofing

Before

Exhaust fans need exterior ventilation, often through roofs and walls

After

Hole should be no more than 1/4" larger than termination fitting diameter

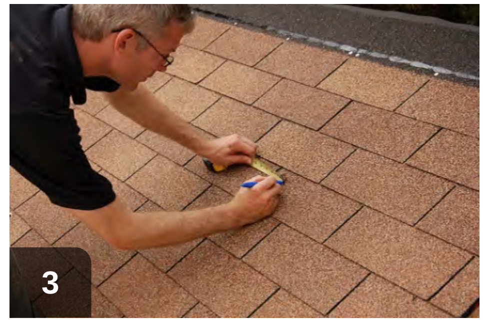
Tools:

1. Hole saw
2. Drill
3. Tape measure

6.6002.2a - Hole in Building Shell - Roof Termination

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 - Requirements

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

A termination fitting with an integrated collar will be used

Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used

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

Objective(s):

Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation

Before

Termination fittings with no collar are to be avoided

After

Properly sized ducts with snug connections to collared fittings last longer

Tools:

1. Drill

Materials:

1. Fasteners

6.6002.2b - Termination Fitting - Requirements


BAD: Termination fittings without collars should be avoided


Termination fittings with collars should be used for exhaust ventilation


Collared fittings extend through the roof to fasten securely with duct

6.6002.2d - Weatherproof Installation - Vent Cap

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Installation will not inhibit damper operation

Manufacturer specifications will be followed

Objective(s):

Preserve integrity of the building envelope

Ensure a weather tight and durable termination installation

Ensure unrestricted air flow

Before

Holes for termination fitting need to be sealed to weatherproof

After

Termination installation should follow shingling to deter water penetration

Tools:

1. Hole saw
2. Caulk gun
3. Drill

Materials:

1. Fasteners
2. Caulk

6.6002.2d - Weatherproof Installation - Vent Cap

Termination fitting is installed to repel water and sealed

6.6002.2e - Pest Exclusion - Ventilation

Desired Outcome:
Securely installed termination fittings with unrestricted air flow

Specification(s):
Screen material with no less than ¼" and no greater than ½" hole size in any direction will be used

Installation will not inhibit damper operation or restrict air flow

Objective(s):
Prevent pest entry

Ensure proper air flow

Before

Exhaust terminations without screens are an invitation to pest intrusion

After

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

6.6002.2f - Termination Location

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

Terminations will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors.

Terminations will be installed:

- A minimum of 3' away from any property line
- A minimum of 3' away from operable opening to houses
- A minimum of 10' away from mechanical intake
- As required by authority having jurisdiction

Objective(s):

Prevent exhaust from reentering house

Exhaust vent has been improperly mounted too close to mechanical vent

Exhaust vent was properly mounted over 3ft from door, window, and deed line

Tools:

1. Measuring tape
2. Hole saw
3. Drill

6.6002.2g - Kitchen Exhaust

Desired Outcome:

Securely installed termination fittings with unrestricted air flow

Specification(s):

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

Objective(s):

Prevent a fire hazard

Before

Kitchen exhaust vents should not be made from highly combustible materials

After

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

6.6003.3a - Hole in Building Shell - Sidewall Termination

Desired Outcome:

Through the wall fans installed to specification

Specification(s):

A hole no greater than a 1/4 inch greater than the assembly will be cut to accommodate fan assembly

Objective(s):

Allow for ease of weatherproofing

Before

Determine size to cut hole by measuring fan assembly and ducting

After

A snug fit should be ensured to minimize weatherproofing required

Tools:

1. Tape measure
2. Saw

6.6003.3a - Hole in Building Shell - Sidewall Termination

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

Hole should be no more than 1/4" larger than assembly diameter

Clear wall surface and mark hole size 1/4" larger than termination fitting

Since opening is larger than most hole saws, precision cutting is important

6.6003.3e - Backdraft Damper

Desired Outcome:

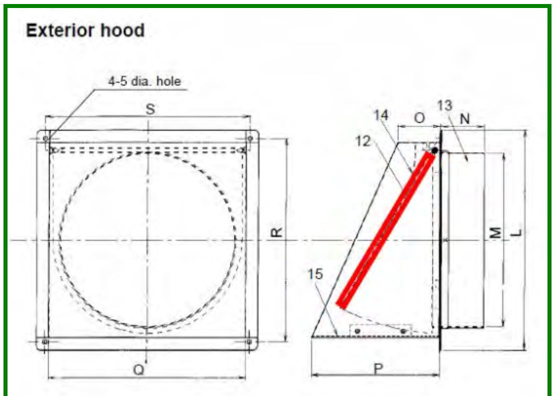
Through the wall fans installed to specification

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

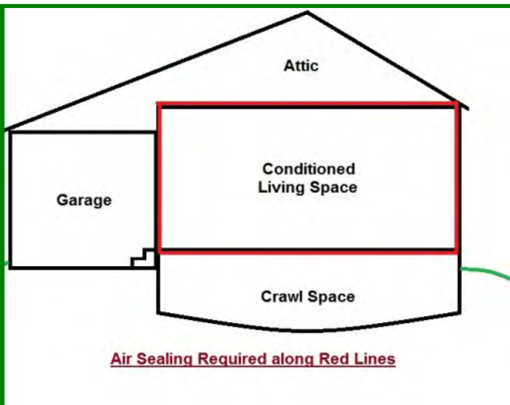
Damper should be installed to maintain exterior air barrier

6.6003.3j - 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.

6.6005.1a - 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

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

unacceptable dryer venting

After

Proper vent material and connection to collar at wall

Tools:

1. crimper
2. panduit strap tensioning tool
3. knife
4. metal shears
5. tape measure

Materials:

1. Aluminum UL 181 tape
2. Mastic
3. Mesh tape
4. Panduit straps
5. R-8 Insulation
6. 4 inch diameter, rigid venting material
7. 4 inch metal flex

In addition Clothes dryer venting installed shall comply with the following:

a.Vent shall terminate in a non-screened vent cap with a damper. The exhaust vent shall terminate not less than 3 feet in any direction from openings into the building.

b. Have a smooth interior finish and shall be constructed of metal a minimum 0.016 inch (0.4 mm) thick. The exhaust vent size shall be 4 inches (102 mm) nominal in diameter.

c.The insert end of the venting shall extend into the adjoining venting or fitting in the direction of airflow.

d. Not exceed 35 feet in length from dryer location to outlet terminal. The maximum length shall be reduced two and one-half (2.5) feet for every 45 degree elbow and five (5) feet for each 90 degree elbow.

f. Both vertical and horizontal runs shall be supported using nylon, plastic, or metal strapping with a minimum width of ½ inch. Support strapping or hangers shall be installed within one (1) foot of a joint or connection and a maximum of every four (4) feet thereafter.

g. Dryer vents located in unconditioned space shall be insulated to a minimum R- 8.

Dryer transition piece:

The dryer transition piece is the venting component between the dryer and the point at which it goes through the wall, floor, or ceiling and leaves the vicinity of the dryer. This venting shall be listed and labeled in accordance with UL 2158A. Semi-rigid duct materials shall not be used as the transition piece. The transition piece shall not exceed eight feet in length and be long enough to allow for moving the dryer away from the wall, but not allow excess bending and kinking that can trap lint and water in the venting. The flexible transition piece shall not pass through a wall, floor, or ceiling. The transition piece shall connect to a smooth metal vent or a metal collar where it penetrates the ceiling, wall, or floor.

6.6005.1a - Clothes Dryer Ducting

Dryer vent transition piece: panduit straps, metal collar at wall, foam air sealing

Uninsulated dryer venting in unconditioned space

Supported and Insulated dryer vent through unconditioned space. Venting slopes downward toward termination.

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

6.6005.1b - Termination Fitting

Most modern dryer vents have a built-in backdraft damper

To minimize pest intrusion, mesh >1/4" square can be used (see 6.6002.2e)

6.6005.1d - 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

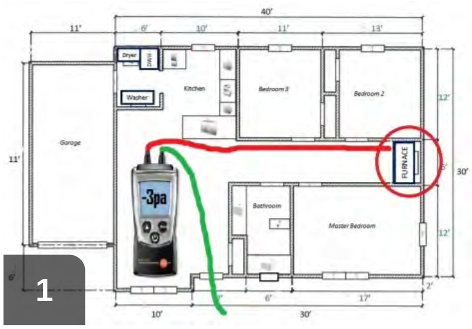
Test to verify combustion appliances are within depressurization limits

Tools:

1. Manometer

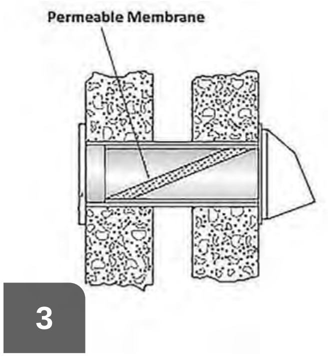
See SWS 2.0299.1a-i for CAZ depressurization limits

6.6005.1d - Combustion Safety



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

If depressurization limit is exceeded, mitigate to eliminate safety risk



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

After mitigation, verify that depressurization limit is not being exceeded

6.6005.2b - Fan Venting - Kitchen Fan

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

Before

Recirculating fans over ranges do not actually remove contaminants.

After

Kitchen exhaust vented to the outside and insulated when passing through unconditioned space.

Tools:

1. Drill
2. Metal snips
3. Tape measure
4. Saw

Materials:

1. Metal ducting
2. Sealant: mesh tape and mastic
3. Sealant: UL 181 listed tape
4. Fasteners

Kitchen range fans will be vented to the outdoors. As short a run as practical of smooth wall metal venting will be used.

Venting will be connected and sealed as follows:

- Metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes

- Other specialized vent fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, vent connections will be sealed with UL 181B or 181B-M listed material
- Exhaust venting passing through unconditioned space will be insulated to a minimum R-8 and secured with twine or wire.

6.6005.2d - Termination Fitting - Kitchen Fan

Desired Outcome:
Kitchen range fan installed to specification

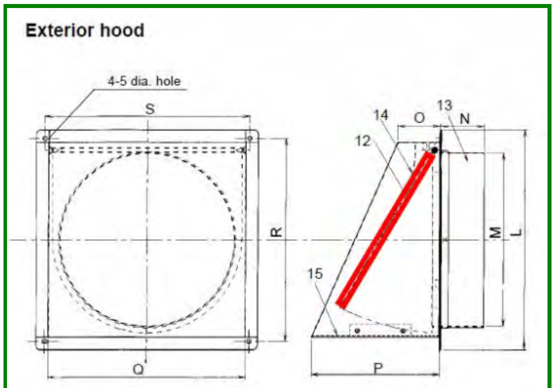
Specification(s):
Termination fitting will be installed including a backdraft damper, as described in termination fitting detail

Objective(s):
Ensure safe operation of combustion appliances

Ensure occupant health and safety

Before

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



After

Exhaust fans should have backdraft dampers

6.6005.2d - Termination Fitting - Kitchen Fan


Backdraft damper on roof mounted exhaust fan


An interior backdraft damper can also be installed for good measure

6.6005.2e - Make-Up Air - Kitchen Fan

Desired Outcome:

Kitchen range fan installed to specification

Specification(s):

Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction

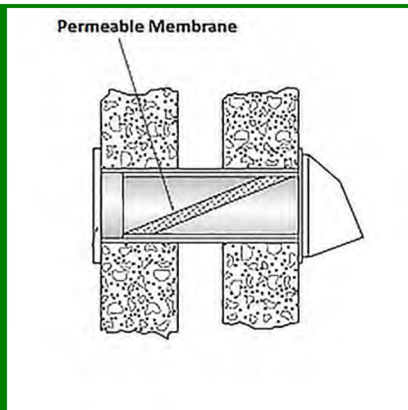
Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety

Before

If kitchen exhaust is venting at more than 200 cfm, provide make-up air



After

A passive inlet vent can provide make-up air for kitchen exhaust

Tools:

1. Drill
2. Hole saw
3. Caulk gun

Materials:

1. Caulk sealant
2. Fasteners

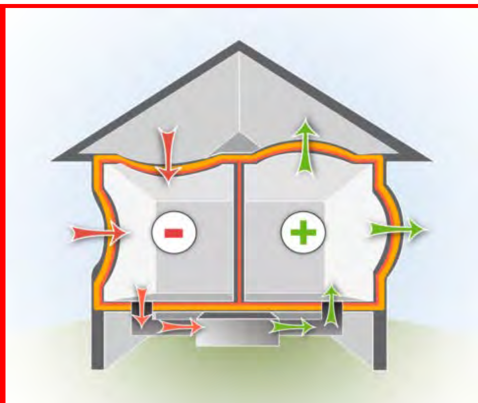
WA Variance - Air Handler>Pressure Balancing

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)
The air handler shall not cause room pressures to exceed 5 pascals with reference to the main body of the house

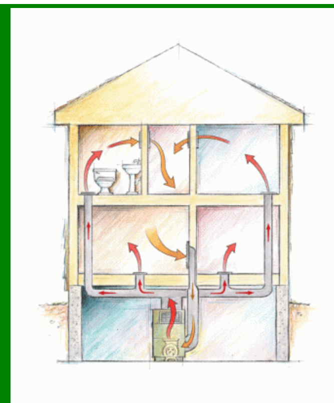
Objective(s):
Ensure free flow of air between rooms

Preserve integrity of the building envelope



Before

A forced air furnace can create excessive pressures and pressure imbalance between rooms and the main body of the house.



After

Pressure balancing allows conditioned air to flow freely in the home and reduces pressures behind closed doors.

Tools:

1. Undercut doors: circular saw, saw horses
2. Install transfer Grille: tape measure, saw, drill motor
3. Reduce supply airflow to area with high pressure: sheet metal tools, drill motor
4. Install jumper duct: saw, sheet metal tools, drill motor
5. Measure room pressures: manometer and probe/ hose

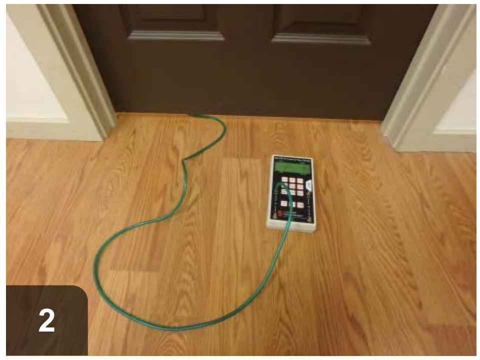
Materials:

1. Undercut doors: masking tape to prevent splintering
2. Install passive transfer grille: grille
3. Reduce supply airflow to area with high pressure: sheet metal, pre-fab damper, fasteners, mastic
4. Install jumper duct: ducting, fasteners, mastic

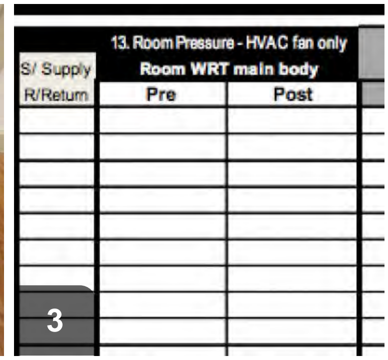
Washington variance approved.

Air Handler>Pressure Balancing

If the house has forced air (electric, natural gas, or propane), turn on the furnace.



Close all interior doors and measure pressure behind door with reference to (WRT) main body of the house.



	13. Room Pressure - HVAC fan only	
S/ Supply	Room WRT main body	
R/Return	Pre	Post

Measure and record pressures for all rooms with closing doors. Room pressures shall not exceed 5 pa WRT main body.

Tools:

1. Undercut doors: circular saw, saw horses
2. Install transfer Grille: tape measure, saw, drill motor
3. Reduce supply airflow to area with high pressure: sheet metal tools, drill motor
4. Install jumper duct: saw, sheet metal tools, drill motor
5. Measure room pressures: manometer and probe/ hose

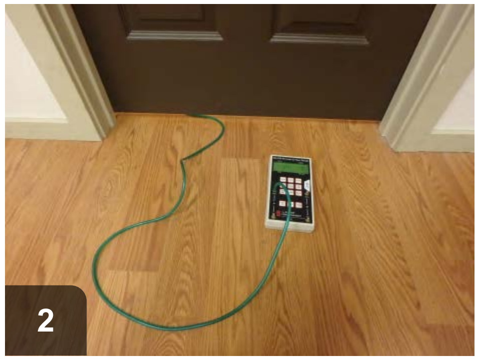
Materials:

1. Undercut doors: masking tape to prevent splintering
2. Install passive transfer grille: grille
3. Reduce supply airflow to area with high pressure: sheet metal, pre-fab damper, fasteners, mastic
4. Install jumper duct: ducting, fasteners, mastic

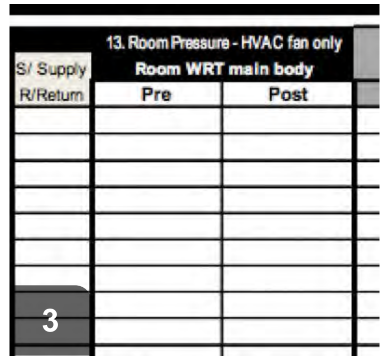
Washington variance approved.

Air Handler>Pressure Balancing

If the house has forced air (electric, natural gas, or propane), turn on the furnace.



Close all interior doors and measure pressure behind door with reference to (WRT) main body of the house.



	13. Room Pressure - HVAC fan only	
S/ Supply	Room WRT main body	
R/Return	Pre	Post

Measure and record pressures for all rooms with closing doors. Room pressures shall not exceed 5 pa WRT main body.

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

7.8102.2d - Emergency Drain Pan

Desired Outcome:

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

Specification(s):

When installing a replacement water heater, an emergency drain pan will be installed with side that extend a minimum of 2.5" above floor if leakage would cause damage to the home and in accordance with P2801.5 of the 2012 IRC

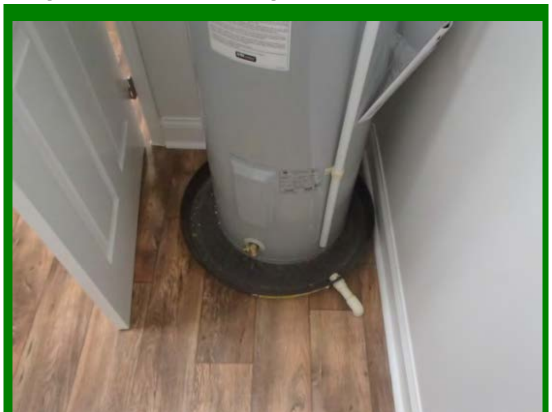
A ¾" drainline or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 IRC

Objective(s):

Collect and safely dispose of water escaping from the storage tank

Before

Water leak from a failing water heater will damage a home.



After

New installation requires proper emergency drain pan with drain line plumbed to daylight.

7.8102.2k - Discharge Temperature - Insulating Tank and Supply Lines

Desired Outcome:

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

Specification(s):

Discharge temperature will be set not to exceed 120° or as prescribed by local code

Objective(s):

Ensure safe hot water supply temperature to fixtures

Unsafe

Water heaters producing water over 120 degrees raise heating costs

Safe

Water heaters should produce water under 120 degrees to prevent scalding

Tools:

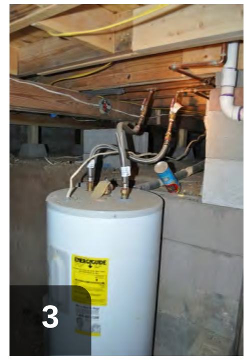
1. Thermometer

Plumbing code defines hot water as water at a temperature at or greater than 110 degrees F (43 degrees C).

7.8102.2k - Discharge Temperature - Insulating Tank and Supply Lines

Test temperature of hot water at faucets in house

Hot water temperatures should not exceed 120 degrees Fahrenheit



Adjust water heater settings and insulate as needed

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

7.8103.1c - Thermal Efficiency

Desired Outcome:
Safe, reliable, and efficient operation of the appliance maintained

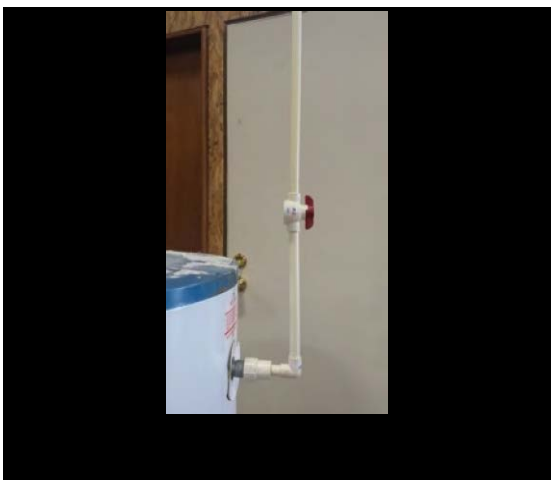
Specification(s):
Water heater storage tanks shall have a minimum R-value of R-11, unless the SIR to add insulation is less than 1.0

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

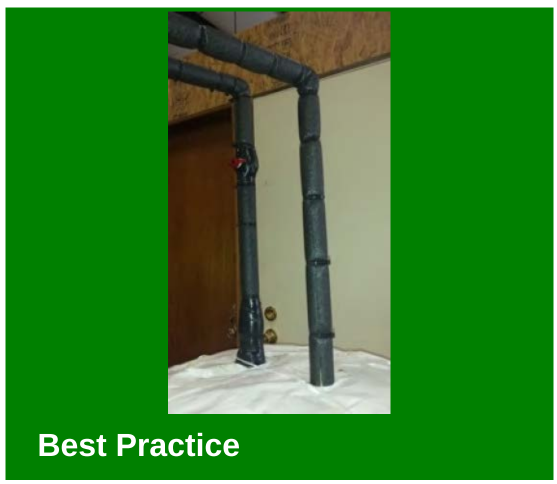
The first 6' of inlet and outlet piping will be insulated in accordance with 2012 IRC N1103.4.2 or local requirements, whichever is greater

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

Ensure insulation does not make contact with flue gas venting



Water heater and 1st 6 feet of pipe uninsulated



1st 6 feet of hot and cold water pipes attached to electric water heater insulated with R-3 foam pipe wrap

Tools:

1. Utility knife

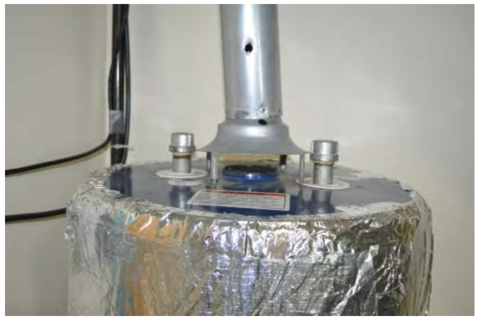
Materials:

1. Pipe wrap
2. Water heater blanket
3. Elastic tape
4. zip ties

Caution: When adding insulation to pipes or water heaters, maintain clearance to combustibles from flues and draft hoods. Do not cover burner access or draft diverter on gas fired water heaters.

7.8103.1c - Thermal Efficiency

Check occupant's water heater model to see what r-value is built-in


Blanket does not obstruct draft diverter or plumbing pipes and elements


Wrap does not obstruct ventiation, thermostat access plate, hi-limit switch, or fuel line


Data plate should still be accessible after wrapping

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 P2803 of the 2012 IRC and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC

Objective(s):
Discharge excessive energy (pressure or temperature) from storage tank to safe location

Before

Water heaters should be not capped off at t&p valve

After

T&P discharge should be piped to a safe and observable location

Tools:

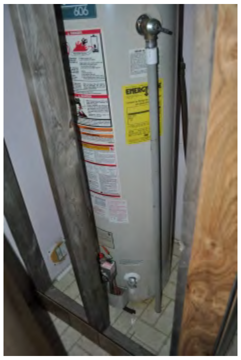
1. Pipe wrench
2. Hacksaw

Materials:

1. PVC approved for high temperature
2. Plumber's epoxy
3. Copper pipe

Check local jurisdictional codes. reference 2012 IRC P2803.6.1: Temperature and pressure relief valve discharge pipes should not be connected to drainage system. T&P discharge pipes should be a clean line without valve or tee, flowing with gravity to an observable and safe location that cannot cause personal injury or structural damage -- the floor, an existing drain pan, a waste receptor, or to the outdoors. Pipe should not terminate more than 6" from floor, pan or waste receptor.

7.8103.1e - Temperature and Pressure Relief Valve



GOOD: T&P discharge should be piped within 6" of the floor or to outdoors

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

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

Water Pipe Insulation

Specification(s):

1. The Local Agency shall install insulation on accessible hot and cold water lines. Exceptions: Water pipes shall not be insulated if any of these conditions are present:
   a. Water pipes or valves are leaking or are improperly supported.
   b. When electric heat tape is being used to prevent freezing of pipes and heat tape manufacturer does not approve product for insulation coverage.

2. Pipe insulation R-value: Water pipe insulation installed by the Local Agency shall have a minimum effective insulation value of R-3.
   a. Insulate the first 6 feet of both cold-water inlet and hot-water outlet pipes begin ning at the water heater tank.
   b. Insulate hot and cold water distribution pipe in unconditioned space.

3. Installation standard for foam pipe insulation: Insulation shall be installed to these standards:
   Insulation with a lengthwise slit shall be positioned on horizontal pipe so that the slit is on the bottom side of the pipe.
   Insulation shall be sized to fit and firmly secured to the pipe. Products that are glued shall use the manufacturer's recommended adhesive and all slits in the ma terial shall be sealed.
   c. Products that are not glued shall be held in place with elasticized tape, wire, or plastic ties.
   d. Elasticized tape shall be applied every nine (9) inches on center, and around each joint between separate pieces of material.
   e. If ties are used, they must be made of either galvanized wire or non-slipping plastic.
   f. The ties shall be spaced at one inch from each end of the material and thereafter every nine (9) inches on center.
   g. Other techniques for attaching pipe insulation may be acceptable if approved in writing by Commerce.
   h. Insulation material shall be cut and folded, or otherwise molded, to completely cover all elbows or curved pipe without compressing the insulation or allowing gaps to occur in the insulation.

4. Installation standard for fiberglass: If fiberglass batts are used, then the batts shall be at least R-7 when flat. After installation a minimum of R-3 shall be present on any water pipes, including piping for refrigerator ice makers that are not enclosed within the floor insulation. The insulation shall be permanently attached to the pipe with wire, cable ties, twine, strapping tape, or by other approved methods. Materials used to attach the fiberglass shall be spaced at one inch from each end of the fiberglas insulation and thereafter every nine (9) inches on center. Waste or drain pipes are excluded from this insulation requirement. Water pipes that are protected by (enclosed within) installed floor insulation are not required to be separately wrapped.

5. Insulation of pipes exposed to weather: If insulation is installed on pipes exposed to the weather, then such insulation shall be resistant to degradation from moisture, ultraviolet light, and extremes in temperature, or a jacket or facing shall be installed that protects the insulation from these conditions.

Objective(s): Prevent heat loss and pipe freezing in unconditioned spaces.

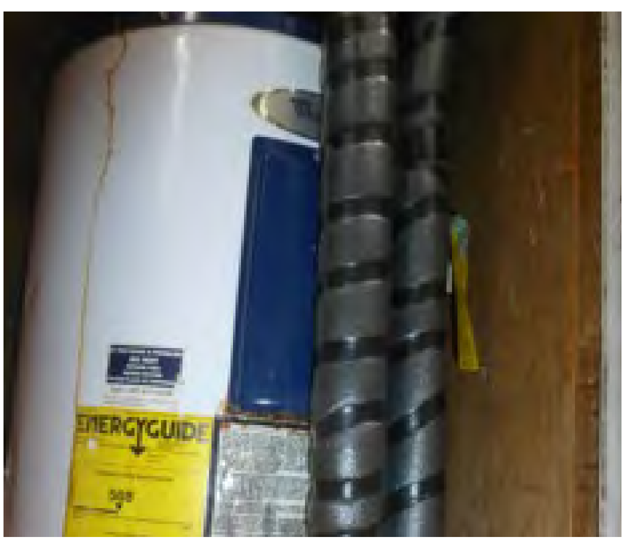
Water Pipe Insulation

Tools:
1. Utility knife
2. Tape measure

Materials:
Foam pipe wrap
Fiberglass batt insulation
Elasticized tape
Wire
Plastic ties

Water supply lines insulated with R-3 foam pipe wrap

Water supply lines insulated with R-3 foam pipe wrap



Insulate the first 6 feet of both cold-water and hot-water outlet pipes beginning at the water heater tank

2.0100.2k - Heat and Thermal Stress

Desired Outcome:
Work completed safely without injury or hazardous exposure

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

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

Excessive heat easily builds up in attic spaces. When the heat in these spaces is enough to overcome a worker and preventy them from exiting without assistance, it is known as a thermal hazard. Prevent worker exposure to thermal hazards with the following measures:

- reduce the temperature in the space with mechanical ventilation.
- ensure workers are drinking plenty of water
- workers will wear *cool vests*
- reschedule work for times when those spaces do not present thermal hazards

2.0602.1a - Rigid Fill Tube

Desired Outcome:
Prevention of static electric shock to the insulation installer when using rigid tubing

Specification(s):
Rigid fill tubes will be made of a material that will not hold an electric charge, such as Schedule 40 PVC Electrical Conduit, or be grounded

Objective(s):
Prevent injury to the installer

Rigid fill tubes should be low-conductivity and be grounded

Tools:

1. Wrench

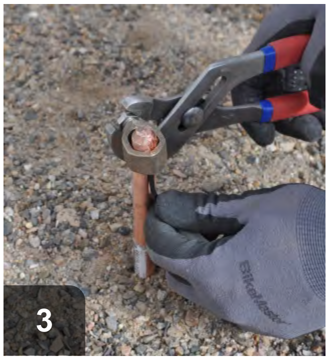
Materials:

1. Couplers
2. Schedule 40 PVC fill tube
3. Grounding wire
4. Grounding rod

2.0602.1a - Rigid Fill Tube

Select rigid fill tubes that are low conductivity -- Schedule 40 PVC fill tube

Attach grounding wire to fill tubes to minimize shock risk



Attach grounding wire to rod with coupler

Blow insulation

2.0602.1b - Metal Coupler Grounding

Desired Outcome:
Prevention of static electric shock to the insulation installer when using rigid tubing

Specification(s):
For an additional level of protection, the metal coupler on the hose will be connected to the grounding wire

Grounding wire will be connected to the grounding rod

Grounding rod will be driven into the ground a minimum of 8' when possible; grounding wire will be connected in compliance with local code and authority having jurisdiction

Objective(s):
Divert static discharge of electricity to ground instead of installer

Unsafe

Ungrounded fill tubes can build up static electricity during insulation blowing

Best Practice

Fill tubes should be grounded to prevent electric shock to workers

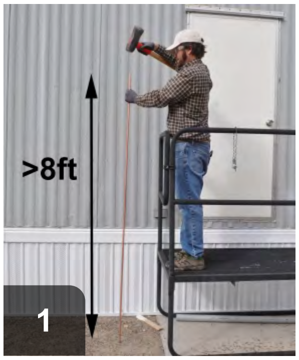
Tools:

1. Sledgehammer
2. Wrench

Materials:

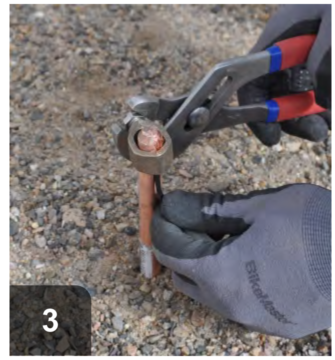
1. Grounding rod, at least 8'
2. Grounding wire
3. Metal coupler
4. Grounding coupler

2.0602.1b - Metal Coupler Grounding



Copper grounding rod should be at least 8' long

Grounding rod should be driven into the ground so that nearly all of rod is underground



Attach grounding wire to rod with coupler

Attach grounding wire to fill tube

Blow in insulation with peace of mind that workers will not be electrocuted

2.0204.1b - Air Seal Closet

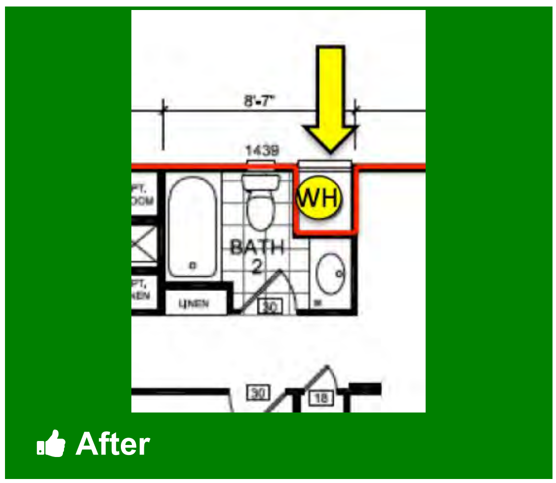
Desired Outcome:
Isolate combustion water heater closet from conditioned space

Specification(s):
When the water heater closet contains a heater that is not sealed combustion or power vented, the closet will be isolated/separated from the rest of the home through air sealing with fire-rated materials, if feasible

Avoiding frozen pipes must be considered without creating an additional utility burden (e.g., heat tape)

Objective(s):
Prevent combustion gases from entering living area and minimize extension of interior pressures caused by exhaust fan, dryers, and interior door closure into the water heater closet

Water heaters that are open combustion must be isolated from the conditioned space by air sealing the closet.



Air sealing the water heater closet has established the pressure boundary around the water heater, isolating it.

Tools:

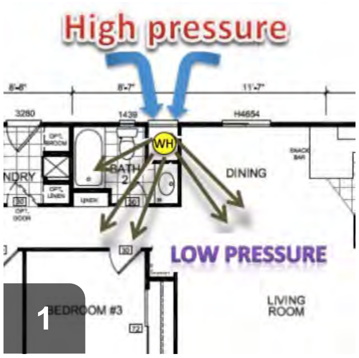
1. Caulk gun
2. Single-component foam gun
3. Manometer, hoses, pressure probes

Materials:

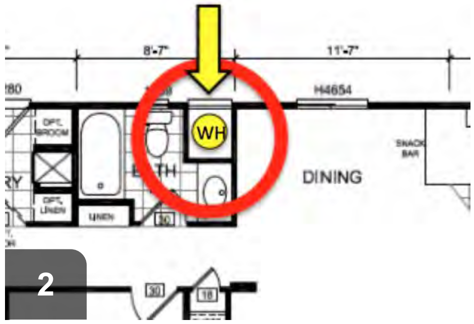
1. Caulk/ foam sealant
2. Water line insulation

If combustion make-up air is needed for proper combustion apliance operation upon completion of isloting the water heater, refer to Specification 2.0201.2a - Outside combustion make-up air.

2.0204.1b - Air Seal Closet



Before the water heater closet is isolated, combustion gases can be pulled into the living space.

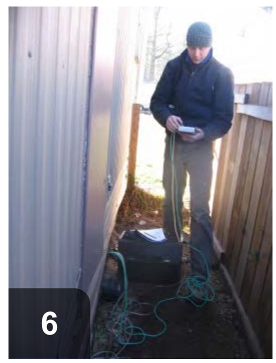


Locate the combustion water heater, determine the materials needed to air seal the closet.

Air seal the water heater closet to eliminate all air pathways from the closet into the living space.

After air sealing the closet, the water heater is isolated from the rest of the house.

Use pressure diagnostics and Washington State combustion safety testing to confirm the appliance operates safely.



Due to limited space in water heater closets, perform pressure diagnostics and combustion safety tests from outside.

4.1003.8a - Attic, Ceiling, and Roof Verification

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
All combustion appliance flues will be terminated to the outdoors and terminations will maintain proper clearance above snow loads

Maintain clearance to combustibles between any combustion appliance flue and combustible materials, unless zero clearance flue is in place

All ventilation systems will maintain a continuous connection and terminate to the outdoors

All broken mushroom vents will be replaced or removed and sealed

All plumbing stacks will be terminated to the outdoors

Non-IC rated light fixtures will be replaced with air-tight IC-rated fixtures or air-tight damming will be installed around existing Non IC-rated fixture when access allows

All recessed lights will be labeled as having an air leakage rate no more than 2.0 CFM when tested in accordance with ASTM E 283 at a 75 pascals pressure differential

All obvious ceiling penetrations will be sealed

The space between combustion appliance flues and the ceiling will be sealed with fire-rated materials

All roof, attic, and ceiling assemblies will be structurally sound; loose ceiling panels will be secured

Temporary ceiling bracing will be recommended during the insulation installation process

All known roof water leaks will be repaired before insulation installation

Objective(s):
Ensure occupant and worker safety

Verify attic space is ready to insulate

Ensure structural integrity of the roof and ceiling assembly

Prevent intrusion of bulk moisture

Prevent damage during the insulation installation process

Before

Roof leak, missing cap on vent

After

Properly connected and sealed roof vent

Tools:

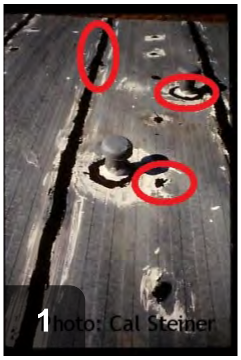
1. Scaffolding and ladders
2. Screw gun
3. Long, flat prybar
4. 5-in-one paint scraper tool
5. Flashlights and headlamps
6. Digital camera

Materials:

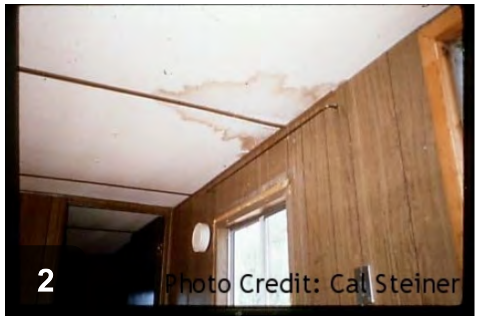
1. Wooden blocks

Inspect and correct each of the specified items: flues terminated to outside, 2" clearance to combustibles from flues, ventilation ducts terminated outdoors, non-airtight, non-IC rated recessed lighting replaced with airtight, IC-rated recessed units or air sealed from above, broken mushroom vents replaced or removed, plumbing vents terminated outdoors, ceiling penetrations sealed, structural defects in roof, attic, and ceiling assemblies corrected, and all roof leaks repaired.

4.1003.8a - Attic, Ceiling, and Roof Verification



Inspect roof for evidence of water pooling, leaks, or damage. Verify proper vent terminations



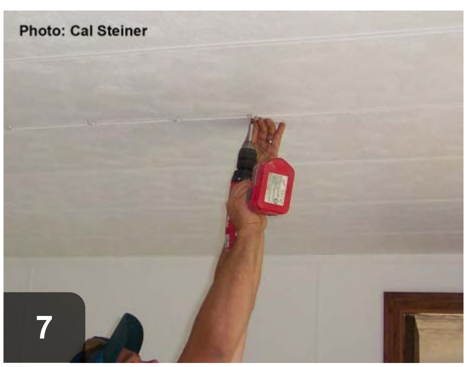
Inspect ceiling for weakness, leaks, clearance to combustibles, loose panels, and penetrations

Verify presence of rain caps on all vents

Inspect all patches and repairs, and correct deficiencies if necessary

Verify at least 2" clearance to combustibles, unless flue is designed for zero clearance. Repair if needed

Use temporary supports to avoid ceiling collapse during insulation install



Add fasteners wherever needed to firmly attach ceiling to the trusses

Investigate all water stains and sources of moisture. Repair before insulating the attic

After opening the roof edge, verify proper clearance to combustibles and inspect vent connections

Manufactured Home - Attic Insulation Precheck

Project:

▯	N/A		PREPARATION
☐	☐	1	All combustion appliance venting and flues maintain clearance to combustibles, unless zero clearance flue is in place
☐	☐	2	All ventilation systems maintain a continuous connection and terminate to the outdoors
☐	☐	3	All plumbing stacks are terminated to the outdoors
☐	☐	4	Non-IC rated light fixtures are replaced with air-tight IC rated fixtures
☐	☐	5	All ceiling-plane air sealing is complete, including marriage line, passive jumper ducts, and skylights
☐	☐	6	All roof, attic, and ceiling assemblies are structurally sound
☐	☐	7	Dishing and pooling issues of the roof that allow standing water are addressed
☐	☐	8	All known roof leaks are repaired

4.1003.8b - Attic Access

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Fasteners will be removed from the J channel and the roof edge on the most easily accessible side of the house

Roof will be separated from the heel plate and siding roof will be lifted and propped to accommodate fill tube

Length of opening will be enough to allow ease of access and reattachment while minimizing potential damage from high winds

If subsheathing is present, access will be gained through subsheathing

Attic will be visually inspected for the location of existing insulation, obstructions, hazards, and construction type

Objective(s):
Create access to the full attic cavity

Protect roof from wind damage during installation

Ensure ease of roof reattachment

Determine insulation installation technique

Best Practice

Pitched, bowed, and vaulted roofs are good candidates for insulation via roof side lift

Best Practice

Insulation can be installed without disturbing the interior environment

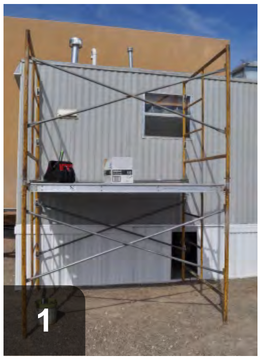
Tools:

1. Pry bar
2. Drill
3. Utility knife
4. Pliers

Materials:

1. Wood blocks

4.1003.8b - Attic Access



Ensure a safe work environment by setting up scaffolding. Work in manageable sections

Remove fasteners from the J-channel

Cut through putty tape and pry J-channel away from roof seam

Work in manageable sections to minimize roof damage. One section of J-channel is a long enough area

Remove staples as necessary to lift roof and inspect underneath

Place blocks to lift roof and enable inspection of roof cavity for obstructions and other concerns

Work in small sections to minimize flexing of roof and risk of wind damage

Once visual inspection has shown roof cavity to be viable, begin blowing insulation

4.1003.8d - Fiberglass Blown Insulation Installation

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot

Using fill tube, 100% of each cavity will be filled to a consistent density

Fill tube will be inserted within 6" of the end of each attic cavity

Insulation will be installed into the void of the attic cavity:

- If existing insulation is roof-mounted, insulation will be blown below
- If existing insulation is ceiling-mounted, insulation will be blown above
- If existing insulation is mounted at both locations, insulation will be blown in between

Avoid overfilling of roof edges and above attic trusses

Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84

Objective(s):
Fill entire attic cavity to the prescribed R-value to reduce air infiltration

Avoid clogging of the cavity and the fill tube

Prevent damage to the ceiling

Allow roof to be returned to original position

Fire safety will be maintained

4.1003.8d - Fiberglass blown insulation installation

In Progress

In Progress

4.1003.8d - Fiberglass Blown Insulation Installation

If insulation is roof mounted, blow below it.

If insulation is ceiling mounted, blow above it.

If insulation is mounted at both the ceiling and the roof, blow between it.

Insulation meets ASTM E 84.

4.1003.8e - Roof Reattachment

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

If existing J channel is damaged, it will be replaced

Existing sealant will be removed from the roof edge and J channel

At a minimum, new sealant will be reinstalled at the original location

Roof and J channel will be fastened to the original location with new screws

All seams, edges, and penetrations will be sealed as necessary

Objective(s):

Prepare roof edge and J channel for reattachment

Reattach roof edge and J channel without leaks

Before

If salvageable, clean J-channel before reinstallment

After

Attach J-channel using old holes and new fasteners

Tools:

1. Drill
2. Utility knife
3. Snips

Materials:

1. Fasteners
2. J-channel
3. Putty tape

4.1003.8e - Roof Reattachment

If J-channel is salvageable, clean thoroughly before applying putty tape

Apply putty tape to new or reused J-channel to seal roof seam

Using new fasters, attach J-channel along roof seam and seal as necessary

4.1003.8f - Verification of Details

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process

Objective(s):
Verify the integrity of the house has been maintained

Best Practice

Exterior should be inspected to verify that roof has not been damaged

Best Practice

Interior ceiling should also be inspected to make sure that no damage was incurred

4.1003.9a - Attic, Ceiling, and Roof Verification

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
All combustion appliance flues will be terminated to the outdoors and terminations will maintain proper clearance above snow loads

A distance no less than 2" will be maintained between any combustion appliance flue and combustible materials, unless zero clearance flue is in place

All ventilation systems will maintain a continuous connection and terminate to the outdoors

All broken mushroom vents will be replaced or removed and sealed

All plumbing stacks will be terminated to the outdoors

Non-IC rated light fixtures will be replaced with airtight IC-rated fixtures or air-tight damming will be installed around existing Non IC-rated fixture when access allows

All recessed lights will be labeled as having an air leakage rate not more than 2.0 CFM when tested in accordance with ASTM E 283 at a 75 pascals pressure differential

All obvious ceiling penetrations will be sealed

The space between combustion appliance flues and the ceiling will be sealed with fire-rated materials

All roof, attic, and ceiling assemblies will be structurally sound:

- Loose ceiling panels will be secured
- Temporary ceiling bracing will be recommended during the insulation installation process

Dishing and pooling issues that allow standing water will be addressed

All known roof water leaks will be repaired before installing installation

Objective(s):
Ensure occupant and worker safety

Verify attic space is ready to insulate

Ensure structural integrity of the roof and ceiling assembly

Prevent intrusion of bulk moisture

Prevent damage while installing insulation

Before

Roof leak, missing cap on vent

After

Properly connected and sealed roof vent

Tools:

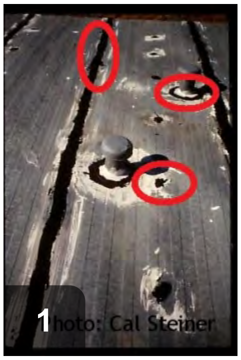
1. 2-1/2" hole saw
2. Power drill
3. Borescope
4. Inspection mirror
5. Flashlight

Materials:

1. Material requirements will vary based on conditions
2. Drywall or paneling
3. IC/Airtight recessed lights
4. Fire caulk
5. Vent terminations
6. Silicone caulk
7. Galvanized sheet metal and screws
8. Roof cement
9. Temporary ceiling bracing

Inspect and correct each of the specified items: flues terminated to outside, 2" clearance to combustibles from flues, ventilation ducts terminated outdoors, non-airtight, non-IC rated recessed lighting replaced with airtight, IC-rated recessed units or air sealed from above, broken mushroom vents replaced or removed, plumbing vents terminated outdoors, ceiling penetrations sealed, structural defects in roof, attic, and ceiling assemblies corrected, ponds on roof remedied, and all roof leaks repaired.

4.1003.9a - Attic, Ceiling, and Roof Verification



Inspect roof for evidence of water pooling, leaks, or damage. Verify proper vent terminations

Inspect all patches and repairs, and correct deficiencies if necessary

Verify presence of rain caps on all vents

Inspect ceiling for weakness, leaks, clearance to combustibles, loose panels, and penetrations

Verify at least 2" clearance to combustibles, unless flue is designed for zero clearance. Repair if needed

Repair and refasten sagging or unsecured ceiling panels. Caulk and seal seams to prevent insulation spilling into house

Use temporary supports to avoid ceiling collapse during insulation install

4.1003.9b - Attic Access

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Access to the attic cavity will be created using one of these methods:

- Drilling
- Cutting
- Continuous slicing along the center line (at the highest point of the roof)

Access location will be placed to allow for consistent and uniform coverage of installed insulation throughout the attic assembly

There will be, at a minimum, one opening between each roof truss

Openings will be large enough to accommodate the chosen fill tube

If subsheathing is present, access will be gained through subsheathing

Attic will be visually inspected for the location of existing insulation, wiring, flues, obstructions, hazards, and construction type

Objective(s):
Create access to the full attic cavity

Maintain the integrity of the roof truss

Protect roof from wind damage during installation

Determine technique for installing insulation

Manufactured home attic cavity accessed by cutting through roof.

Manufactured home attic cavity accessed by cutting through roof.

Tools:

1. 7-1/4" circular saw
2. Electric driil
3. Carbide-tipped hole saw bits
4. Insulation blowing machine
5. 10 feet long 2" PVC pipe, or 8 foot 2" flexible blow hose
6. 4-1/2" or 7" angle grinder with flexible sanding wheels
7. Tape measure and chalk lines

Materials:

1. Abrasive or carbide-toothed cutting wheels, or other cutting tools
2. Galvanized steel roofing pieces
3. Self-tapping sheet metal screws
4. Fiberglass mesh
5. Elastomeric roof coating
6. For gable access: appropriately sized soffit vent cover screens for hiding siding patches
7. Siliconized exterior caulk

Gable end attic access: when the manufactured home has partial vaulted ceilings or a compromised roof, access may be gained through the gable ends for the flat ceilings. Gable end access requires patching the siding with sheet metal, siliconized caulk, and optional vent cover to conceal patch.

Always use hand protection when working with metal edges and/or sharp tools.

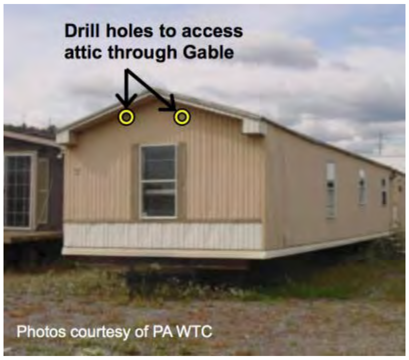
4.1003.9b - Attic Access


Determine and mark truss locations on roof, and choose method of access. Avoid drilling or sawing into trusses


Cut a hole into each truss cavity, big enough to inspect the opening and admit the fill tube


Regardless of access method, visually inspect attic for existing insulation, wiring, flues, obstructions, and hazards


Another option: cut the roof open along the highest point from end to end. Make crosswise cuts at each end if needed



Locate the ceiling level and truss framing prior to drilling through gable siding.

4.1003.9d - Fiberglass Blown Insulation Installation

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot

Using fill tube, 100% of each cavity will be filled to a consistent density

Fill tube will be inserted within 6" of the end of each attic cavity

Insulation will be installed into the void of the attic cavity:

- If existing insulation is roof-mounted, insulation will be blown below
- If existing insulation is ceiling-mounted, insulation will be blown above
- If existing insulation is mounted at both locations, insulation will be blown in between

Insulation will be filled no higher than the top of the truss

Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84

Objective(s):
Fill entire attic cavity to the prescribed R-value to reduce air infiltration

Avoid clogging of the cavity and the fill tube

Prevent damage to the ceiling

Allow roof to be returned to original position

Fire safety will be maintained

In Progress

Always wear PPE appropriate to the work environment and job at hand.

4.1003.9d - Fiberglass Blown insulation installation

If insulation is roof mounted, blow below it.

If insulation is ceiling mounted, blow above it.

If insulation is mounted at both the ceiling and the roof, blow between it.

Insulation meets ASTM E 84.

4.1003.9e - Patching and Sealing Openings

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
If the roof is sliced:

- A solid metal ridge cap will be centered over the slice
- A flexible and durable sealant will be sandwiched between the roof and the ridge cap
- Screws will be installed to prevent wrinkles and create a permanent seal
- Screws will not go into any wood framing
- A durable and flexible final coating will be applied over the screws and edge of the ridge cap to create a continuous seal between the roof and the perimeter of the ridge cap

For holes that are drilled or cut, the initial patch will be applied using the following procedure:

- At least 6" of surface surrounding the opening will be cleaned before patch is installed
- Sealant will be continuous and applied in between the patch and the roof
- Sealant will be an all-weather adhesive that is flexible and durable

If a metal patch is used:

- Patch will overlap the opening by 2" on all sides
- Gauge will be equal to or greater than the roof material
- Fasteners will be installed to prevent wrinkles and create a permanent seal
- If a plug is used, it will be flanged and have a tight fit
- Screws will not go into any wood framing

A durable and flexible 45 mil adhesive patch will be applied in accordance to manufacturer specifications over the initial patch and will have at a minimum:

- Tear strength of 640g
- Elongation of 380%
- Application temperature no lower than 55°F and no greater than 110°F
- Services temperature no less than -25°F and no greater than 150°F
- Adhesive patch will overlap the initial patch by 2" on all sides
- A durable and flexible final coating will be applied over the adhesive patch to create a continuous seal between the roof and the perimeter of the patch
- All remaining seams, edges, and penetrations will be sealed as necessary

Objective(s):
Effectively patch and seal all openings

Create a durable patch that will prevent roof leaks

In Progress

Rough cut hole that will need to be sealed.

In Progress

Placing sealant around the exposed edges of the roof patch ensures a watertight seal.

Tools:

1. Roller
2. Self adhering patch
3. sheet metal
4. 6" duct cap(to match 6" hole)
5. heat gun
6. drill

4.1003.9e - Patching and Sealing Openings

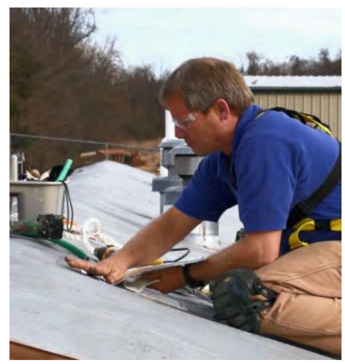
Insert 6" plug and seal around the perimeter of the opening.

Firmly push the plug into place, until it is flush with the roof surface.

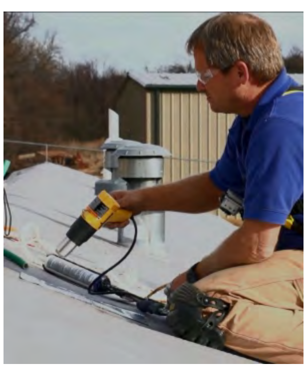
Use a 10"x10" sheet metal patch to mark the center of the hole.

Apply sealant to the underside of the sheet metal patch.

Secure the metal patch to the roof being sure to place mechanical fasteners through the sealant.



Apply a 14"x14" self adhering roof patch on top of the sheet metal patch.



Use a heat gun to make the adhesive pliable to get the best possible seal.

Forcefully roll the patch into place, starting from the center and working toward the edge.

4.1003.9f - Verification of Details

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process

Objective(s):

Verify the integrity of the house has been maintained

In Progress

Verify that no damage has been done by the workers. When in doubt, verify with photo documentation.

After

Document and repair any damage the workers caused.

Tools:

1. IR camera

4.1003.10a - Attic, Ceiling, and Roof Verification

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

All combustion appliance flues will be terminated to the exterior of the house and terminations will maintain proper clearance above snow loads

A distance no less than 2" will be maintained between any combustion appliance flue and combustible materials, unless zero clearance flue is in place

All ventilation systems will maintain a continuous connection and terminate to the outdoors

All broken mushroom vents will be replaced or removed and sealed

All plumbing stacks will be terminated to the outdoors

Non-IC rated light fixtures will be replaced with airtight IC-rated fixtures, if feasible and only when installed measures will compromise the fire rating of the fixture

All recessed lights will be labeled as having an air leakage rate no more than 2.0 CFM when tested in accordance with ASTM E 283 at a 75 pascals pressure differential

All obvious ceiling penetrations will be sealed

The space between combustion appliance flues and the ceiling will be sealed with fire-rated materials

All roof, attic, and ceiling assemblies will be structurally sound:

- Loose ceiling panels will be secured
- Temporary ceiling bracing will be recommended while installing installation

Dishing and pooling issues that allow standing water will be addressed

All known roof water leaks will be repaired before installing installation

Objective(s):

Ensure occupant and worker safety

Verify attic space is ready to insulate

Ensure structural integrity of the roof and ceiling assembly

Prevent intrusion of bulk moisture

Prevent damage while installing insulation

Best Practice

90+ flue terminates above the snow line and penetrations have been sealed.

Best Practice

Flue penetrations have been sealed correctly from the interior.

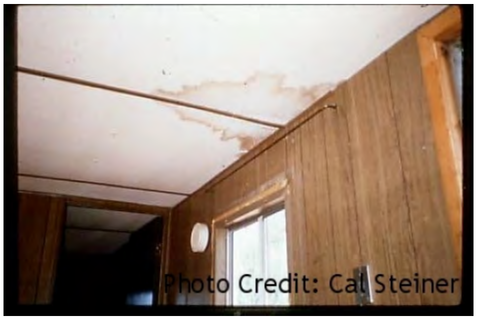
4.1003.10a - Attic, Ceiling, and Roof Verification

Plumbing stacks must be terminated to the outdoors.

Dishing and pooling issues must be addressed.

Mushroom vents must be replaced, or removed and sealed.

Proper clearance to combustibles will be maintained through the roof assembly.



Inspect ceiling for weakness, leaks, clearance to combustibles, loose panels, and penetrations.

4.1003.10b - Construction Prep

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Special precautions will be taken to limit fiberglass and construction dust exposure to the occupant and occupant belongings

Objective(s):
Protect occupant health and safety

Protect occupant belongings

Bad Practice

Improperly prepared workspace with cellulose all over client belongings and bedroom

Best Practice

Worker has removed or covered occupant belongings. Be sure to ask permission before removing any client belongings

Tools:

1. Utility knife

Materials:

1. Plastic sheeting
2. Removable, low-residue tape

4.1003.10e - Fiberglass Blown Insulation Installation

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot

Using fill tube, 100% of each cavity will be filled to a consistent density

Fill tube will be inserted within 6" of the end of each attic cavity

Insulation will be installed into the void of the attic cavity:

- If existing insulation is roof-mounted, insulation will be blown below
- If existing insulation is ceiling-mounted, insulation will be blown above
- If existing insulation is mounted at both locations, insulation will be blown in between

Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84

Objective(s):
Fill entire attic cavity to the prescribed R-value to reduce air infiltration

Avoid clogging of the cavity and the fill tube

Prevent damage to the ceiling

Fire safety will be maintained

In Progress

Attic insulation should be consistently installed in each cavity to the edge.

4.1003.10e - Fiberglass Blown Insulation Installation

If insulation is roof mounted, blow below it.

If insulation is ceiling mounted, blow above it.

If insulation is mounted at both the ceiling and the roof, blow between it.

Insulation meets ASTM E 84.

4.1003.10f - Patching and Sealing Holes

Desired Outcome:
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Holes will be plugged or covered and sealed to be aesthetically pleasing

If existing trim was removed, it will be reinstalled

Objective(s):
Create an airtight seal

Create a visually acceptable ceiling finish


In Progress
Holes should be effectively sealed, as well as aesthetically pleasing.

Tools:
1. color matched plug

Materials:
1. color matched plug

4.1003.10g - Verification of Details

Desired Outcome:

Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process

Objective(s):

Verify the integrity of the house has been maintained

In Progress

Verify that no damage has been done by the workers. When in doubt, verify with photo documentation.

Best Practice

Document and repair any damage the workers caused.

3.1101.3c - Marriage Line Air Sealing

Desired Outcome:

Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs to maintain structural integrity

Specification(s):

All accessible holes and penetrations at marriage lines will be sealed continuously at end walls, floors, and ceiling

Backing or infill will be provided at the marriage line as needed

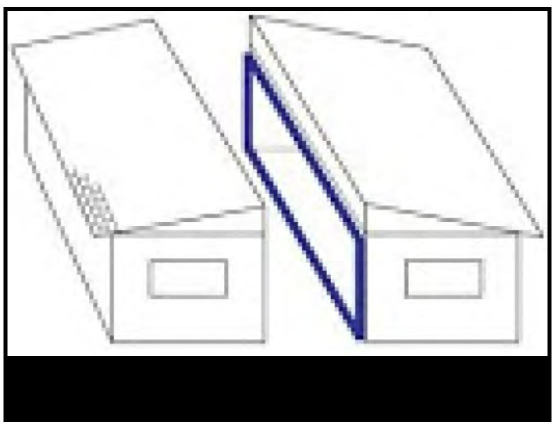
All remaining gaps will be sealed with an approved material

Objective(s):

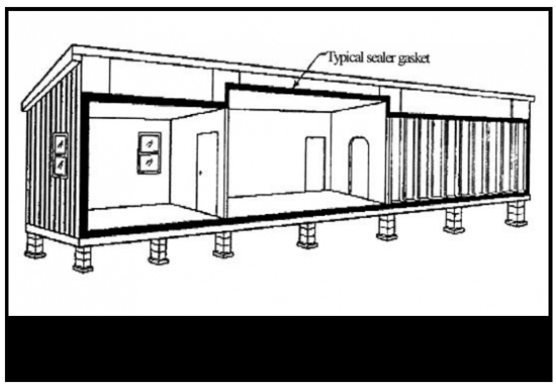
Minimize air leakage

Maintain durability

Ensure sealant is effective and durable



The marriage line is a common location of air leakage in a mobile home building shell.



Identify leaks in marriage line using a blower door

Tools:

1. Reusable foam sealant gun
2. Caulking gun
3. Utility knife
4. Tape measure
5. Screw gun
6. Hammer
7. Prybar
8. Blower door
9. Chemical smoke dispenser

Materials:

1. Caulk
2. Foam sealant
3. Foam board
4. Screws

The marriage line is air sealed from inside the home and from underneath. Use a blower door and chemical smoke to pinpoint air leakage locations.You may need to remove interior trim to determine what type of sealing is needed at the marriage line. Some double wide manufactured homes are constructed with a compressed open-cell polyurethane foam sealing strip with excellent air sealing properties and will need little or no additional work. Other construction methods may feature fiberglass or other ineffective air sealing measures and require extensive caulking and foaming to reduce air infiltration.

3.1101.3c - Marriage Line Air Sealing

Identify leaks in marriage line using a blower door and smoke

Foam, caulk, and seal leaks between halves of double wide manufactured homes

Foam sealant has been installed to air seal the floor plane marriage line, accessed from below.

Marriage line air sealing of the ceiling plane is accessed from inside the home.

3.1301.2d - Floor Repair

Desired Outcome:
Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs will maintain structural integrity

Specification(s):
Floor repair material will meet or exceed strength of existing floor material

Repair will span from joist to joist and blocking added as needed to support floor

Patches smaller than 144 square inches will not require repairs from joist to joist

Floor repair material will be glued, fastened, and air sealed

Objective(s):
Ensure floor is structurally sound

Minimize air leakage

Before

Remove floor coverings from damaged area

After

Completed floor repair

Tools:

1. Circular saw
2. Reciprocating saw
3. Caulking gun
4. Cordless driver/drill
5. Framing square
6. Speed square
7. Utility knife
8. Sawhorses
9. Clamps
10. Jig saw or keyhole saw
11. Paddle bits to drill starter holes in floor

Materials:

1. 5/8" or 3/4" oriented strand board or plywood subflooring
2. Polyurethane caulk
3. Construction adhesive
4. 2" deck screws
5. 3" deck screws
6. 8-penny galvanized ring shank or spiral shank nails
7. 16-penny galvanized ring shank or spiral shank nails
8. 2X4, or 2X6 blocking material for nailers
9. Air sealing foam (one- or two-part SPF)
10. Belly repair tape

Paddle bits may be used to drill starter holes at the corners of the area to be patched. Cut the new patch 1/4" shorter than the hole in both length and width to allow room for expansion and contraction. Make sure to cut the patch so that the strength axis is perpendicular to the joists (the strong direction in plywood and OSB is parallel to the 8' length).

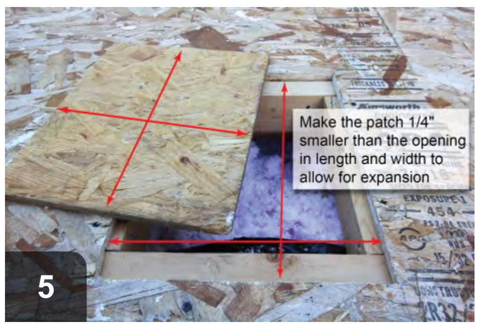
3.1301.2d - Floor Repair

Mark the joist locations on either side of the damaged area

Cut out damaged area even with the inside edges of the floor joists

Cut four 2X4 blocks to support the patch

Install nailers flat against the joists. Finish by toenailing or screwing 2X4s between the joists



Make the patch 1/4" smaller than the opening in length and width to allow for expansion.

Apply subfloor adhesive to nailers

Fasten with 2" deck screws

3.1602.8d - Repair Work Access

Desired Outcome:
Deliver all air from air handler to the trunk duct without leakage or restriction

Specification(s):
Point of access options include:

Option 1: Through the trunk duct

- Repair and seal access hole in the trunk duct
- Install insulation
- Repair belly/bottom liner

Option 2: Remove crossover duct

- Reattach crossover duct
- Seal and insulate crossover duct
- Repair belly/bottom liner

Option 3: Remove air handler

- Install new gasket, if necessary
- Mechanically attach furnace to the structure
- Reconnect utilities
- Replace and seal panels

Option 4: Through the furnace panel

- Replace and seal panels

Objective(s):
Repair work access

Prevent condensation

Minimize heat loss and heat gain from plenum

Various methods can be employed, but the key is to seal the furnace to trunk duct connection

Tools:

1. Utility knife
2. Saw
3. Prybar
4. Screw gun
5. Hammer
6. Drill
7. Saw
8. Disposable brushes

Materials:

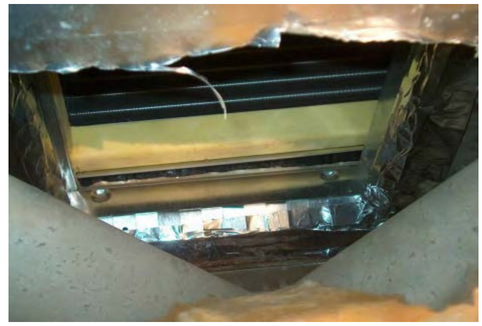
1. Belly repair tape
2. Mastic duct sealant
3. Fiberglass mesh tape
4. Insulation
5. Air handler gasket
6. Sheet metal patch, if trunk is cut into

    1. Choose the least invasive and labor-intensive method that will allow full access for sealing.
    2. Patch trunk using sheet metal patch, fastened mechanically and sealed with mastic.
    3. Always wear hand protection when working with sharp objects.

3.1602.8d - Repair Work Access

For electric furnaces, follow lockout/ tag-out procedures to break circuits that supply furnace with electricity.

Cut belly to expose duct trunk. Use a utility knife to cut access under furnace plenum



Create an opening large enough to completely seal the plenum to the trunk line. Patch opening with sheet metal and seal.

Using mastic and mesh tape, fully seal the furnace to the trunk line. Repair and seal the access holes in duct and belly

Removing the crossover duct may provide access to the plenum. Replace and seal the crossover duct after sealing plenum

Remove the furnace panel. If the plenum to trunk connection is accessible here, complete sealing from this point

Plenum to duct trunk connection coated with mastic sealant

As with all duct sealing and repair, confirm success with pressure diagnostics.

3.1602.9b - Crossover Ducts

Desired Outcome:
Deliver all air from trunk to trunk without leakage or restriction

Specification(s):
Crossover ducts will be added, rebuilt, or repaired when found to be disconnected, damaged, or otherwise inadequately delivering supply air.

Assemble crossover ducts as follows:

- Contructed of rigid, 26 gauge metal ducting
- Mechanically fastened at all junctions
- Sealed using UL-listed sealant that is durable and structurally sound
- Insulated to a minimum R-8 and equipped with a vapor retarder

Whenever possible, rigid elbow or equivalent will be installed in crawl space crossover ducts

Floor insulation will be in contact with the outer liner of the crossover duct

Crossover duct vapor retarder will be sealed to the bottom liner (e.g., belly fabric)

New flex duct installation will be insulated to a minimum of R-8

When feasible, 26-gauge hard duct should be installed

If a new crossover is required, it must be insulated to at least R-8 and be air sealed

Objective(s):
Ensure lasting durable connections

Minimize air leakage and heat transfer

Maintain duct diameter around the turns

Maximize air flow and distribution

Before

Poorly performing crossover duct: poor materials, excess length and contacting ground.

After

Crossover duct of rigid material, sealed, insulated and supported to specification.

Tools:

1. Drill
2. Metal snips
3. Metal crimper

Materials:

1. Rigid ducting: elbows, straight sections
2. Sheet metal screws
3. Mastic or other appropriate sealant
4. Vinyl-faced fiberglass insulation, R-8 or greater.
5. Nylon twine or wire
6. Rigid foam
7. Duct support materials

1. Crossover duct support shall comply with *3.1601.3a - Support*
2. New crossover installation using flexduct is allowable only when rigid ducting is not feasible. A minimum of R-8 is still required for the crossover duct.

3.1602.9b - Flexible Crossover Duct Connections

Attach elbow duct and orient in correct direction to minimize duct run

Fasten elbow in place with at least three evenly-spaced fasteners

Apply mastic at all metal-to-metal connections

Apply mastic to all elbow joints and flange

Insulate and support crossover duct

When clearance requires crossover to contact ground, crossover shall rest on vapor barrier and closed cell rigid foam.

All duct sealing and repair will be confirmed with pressure diagnostics.

4.1302.1b - Preparation

Desired Outcome:
Belly floor cavity ready for insulation

Specification(s):
Where bottom board/rodent barrier is missing or damaged and accessible, the following will be ensured:
- Duct sealing completed
- Gas, water, and electrical lines secured at least every 4' to a floor joist or framing mem ber
- Water line will be located on the warm side of the insulation; if not, the water lines will be insulated appropriately
- No water or gas leaks are present
- Waste lines are sloped to ¼" per foot
- Bottom board/rodent barrier is sound/strong enough to support insulation

When bottom board is intact, the following will be ensured:
- Holes and penetrations in the bottom board and decking sealed
- Duct sealing completed
- No water or gas leaks present
- Bottom board is sound/strong enough to support insulation
- Water lines are secured to the floor joists/warm side of the insulation; if not, the water lines will be insulated appropriately

Problems will be corrected before floor cavity insulation work begins

Objective(s):
Ensure problems are corrected before floor cavity insulation work begins
Keep pipes from freezing

Damaged rodent barrier ("belly") must be patched prior to insulating, or to reduce air flow if not insulating.

Belly with patching complete.

Tools:

1. Stitch stapler
2. Pneumatic stapler
3. drill motor

Materials:

1. Belly patch material (house wrap or similar)
2. Staples
3. Screws
4. Adhesive or suitable tape
5. Lath or dimensional lumber

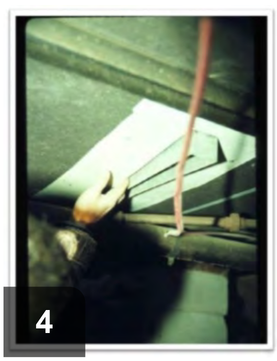
1. The belly board (flexible rodent-barrier) must be complete and intact in areas where insulation is blown-in. The rodent barrier shall be supported as required to avoid sagging.
2. Holes in the rodent barrier shall be patched with like or similar materials that are stitch stapled or mechanically fastened and glued to the existing rodent barrier with adhesive, mastic, or caulk.
3. Stitch staples shall be at a minimum size 9/16, type galvanized or stainless, and gauge 4M. Patches must be sealed with caulk, glue, mastic, or adhesive (peel & seal) and have a minimum number of 4 staples per patch.
4. Holes in the rim joist used to install insulation in the cavity between the belly board and sub-floor shall be plugged with wooden plugs glued in place with an exterior-rated sealant.

4.1302.1b - Preparation

Belly damage: rodent barrier and insulation are damaged, revealing a main supply duct known as a trunk.

Mobile home duct systems (plenum, trunk terminations) should be sealed from below prior to patching the belly.

Workers install new material where rodent barrier is missing.



Maintain all combustion air intake openings when patching belly material.

Pin up sagging belly material to prevent installing excessive amounts of insulation material.

Manufactured Home - Underfloor Insulation Precheck

Project:

▯	N/A		PREPARATION
☐	☐	1	All plumbing supply leaks are repaired
☐	☐	2	All plumbing drain leaks are repaired
☐	☐	3	All forced air supply ducts are sealed, including trunk-lines and any jumper ducts
☐	☐	4	Furnace plenum connection to trunk-line duct is sealed
☐	☐	5	Cross over duct is installed or repaired to specification (see Fied Guide 3.1602.9b - Crossover ducts)
☐	☐	6	All floor-plain air sealing is complete, including marriage line, hole under the tub, plumbing penetrations, and electrical penetrations
☐	☐	7	All combustion air inlets that are ducted into crawlspace are maintained (they could be for wood stove, pellet stove, water heater, furnace)
☐	☐	8	All belly repairs and patching are complete
☐	☐	9	Belly material is pinned up against floor joists where possible in odrer to reduce sag and amount of insulation needed

4.1303.1c - Insulate Floors

Desired Outcome:
Consistent thermal boundary between conditioned and unconditioned space that reduces heat flow

Specification(s):
Each cavity will be insulated to specified R-value and density

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

Objective(s):
Eliminate voids and settling

Tools:

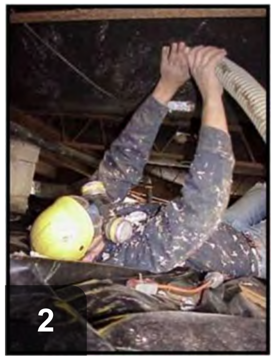
1. Utility knife
2. Stitch stapler
3. Insulation machine and loose fill gear, flexible belly hose

Materials:

1. Staples
2. Tape compatible with rodent barrier material
3. Fiberglass insulation

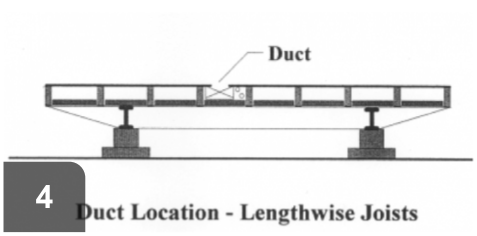
4.1303.1c - Insulate Floors

Holes are cut through rodent barrier (belly material) to insert insulation blow hose.

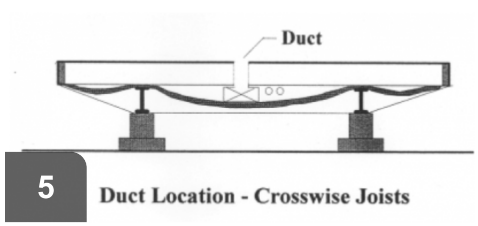


Loose fill insulation is blown into mobile home belly cavity.

Blow holes in belly material patched.



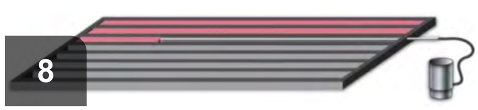
Cross section of belly cavity viewed from end of mobile home with lengthwise joists. Note duct location.



Cross section of belly cavity viewed from end of mobile home with crosswise joists. Note duct location.

Belly cavity blown by drilling through rim joists.

Cut away view of belly cavity with joists running crosswise. Insulation blown through rim joist.



Cut away of belly cavity with joists running lengthwise. Insulation blown through rim joist.

4.1104.1a - Access Wall Cavities

Desired Outcome:
Consistent thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
If skirting overlaps siding, skirting will be detached to allow access to the wall cavity

Fasteners will be removed from the bottom of the siding, working upward until the siding can be pulled away from the framing approximately 6" without damaging the siding

Temporary fasteners will be installed near the bottom of the siding panels at the seams to prevent separation

If a subsheathing is present under the siding, access through the subsheathing will be required

Objective(s):
Gain access to the wall cavity without damaging or separating the siding

Remove fasteners from along bottom and side seams to access wall cavity

Remove enough fasteners to create at least a 6in gap without damaging siding

Tools:

1. Drill

4.1104.1a - Access Wall Cavities

If skirting overlaps siding, remove skirting

Temporarily fasten siding panels at joint to hold seam together

Seam should remain together with temporary fastener

4.1104.1b - Exterior Wall Cavity Inspection

Desired Outcome:
Consistent thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Wall cavities will be inspected for moisture damage, pest locations, and integrity of the wiring, and holes to the interior

Siding will be repaired as necessary

Location of belt rails, obstructions, and existing insulation will be identified

All interior surfaces of exterior walls will be inspected for loose paneling joints, occupant wall hangings, location of switches and outlets, and other wall obstructions

Objects will be removed from the interior surfaces of the walls being insulated

Interior paneling will be repaired as necessary

Objective(s):
Prepare wall cavity for insulation

Prevent water leaks from occurring

Before

Take note of obstacles in the wall cavity, such as belt rails and electrical wiring

In Progress

Assess that holes in both exterior siding and interior walls have been patched before beginning installation

Tools:

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

Materials:

1. Spackle
2. Metal siding patch
3. Caulk
4. Fasteners

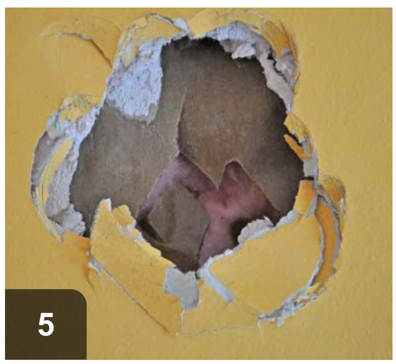
4.1104.1b - Exterior Wall Cavity Inspection

Obstacles should be noted and planned for--insulation should be tucked behind belt rails

Holes in exterior siding should be patched

Apply sealant to back of patch to maintain air barrier

Ensure that patch is securely fastened and water-tight



Holes and penetrations in the interior wall should be patched as well

Verify that patches to both interior and exterior have been completed before beginning installation

4.1104.1c - Fiberglass Batt Installation Tool (Stuffer)

Desired Outcome:

Consistent thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

A sheet of polycarbonate, such as Lexan, will be cut to the following specifications to create a stuffer tool:

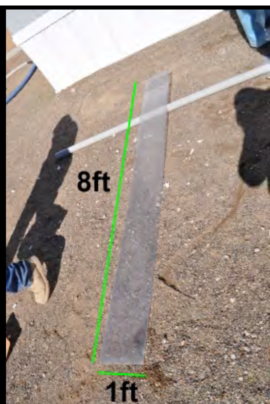
- Approximately 1' x 8' x ¼" with a 5 degree bend 7' ½" from the bottom
- All corners of the Lexan (polycarbonate) will be rounded and all edges will be sanded

Other clear sheet plastics will not be used due to a tendency to shatter under stress

Objective(s):

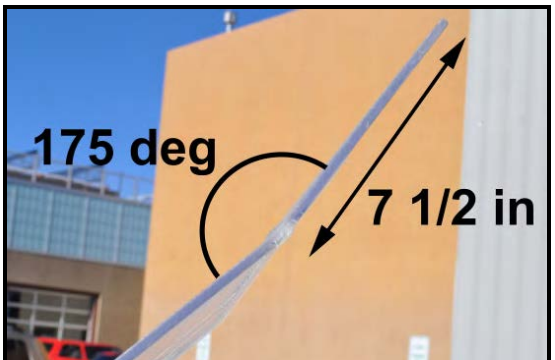
Create a tool to install a fiberglass batt into the cavity

Ensure worker safety



Best Practice

Insulation stuffing tool should be made of 1/4" polycarbonate, cut to 1' wide and 8' long



Best Practice

At one end, a bend of 5 degrees (175 degree supplement) should be made 7 1/2" from narrow edge

Tools:

1. Tape measure
2. Table saw with fine-toothed blade
3. Sander
4. Heat gun
5. Clamp
6. Protractor
7. Heat-resistant gloves

Materials:

1. Polycarbonate, like Lexan
2. Sandpaper

Most crews should have this tool in their supply. If one needs to be fabricated, find someone who has worked with polycarbonate before and ensure correct tool usage as well as proper PPE during fabrication.

4.1104.1d - Fiberglass Batt Installation

Desired Outcome:
Consistent thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):
Thickness of the batt will fill the void without deforming siding or damaging structure

Fiberglass batts will fill the cavity (e.g., batt may be cut approximately 1" longer to ensure proper fill and allow for lap at the top)

Flexible membrane will have an appropriate perm rating for the region

Flexible membrane will be cut 2" wider than the cavity and approximately 1' longer than the batt

Stuffer tool, membrane, and fiberglass batt will be aligned for installation

Stuffer tool will be used to install the fiberglass batt and membrane at the same time

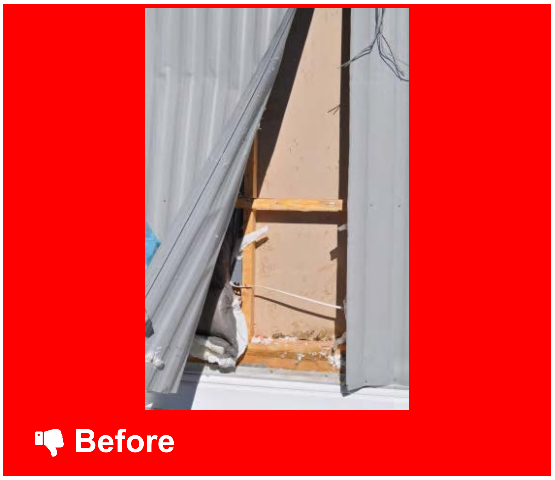
Excess fiberglass batt and membrane vapor retarder extending below the cavity will be rolled and tucked into the cavity

A poly-encased fiberglass batt may be used in place of the fiberglass batt and membrane assembly

The membrane will be installed in contact with the side of the wall that is compatible with the local climate zone

Objective(s):
Maintain integrity of the batt

Aid in the installation process



Uninsulated and underinsulated wall cavities can be filled from the exterior with fiberglass batts

Fiberglass batt should fill entire cavity without creating bulging in exterior paneling

Tools:

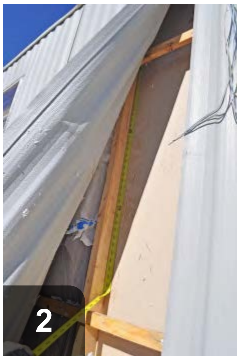
1. Tape measure
2. Utility knife

Materials:

1. Fiberglass batts, may be wrapped
2. Vapor barrier appropriate for region

4.1104.1d - Fiberglass Batt Installation

Uninsulated wall cavity can be accessed from exterior of mobile home through paneling



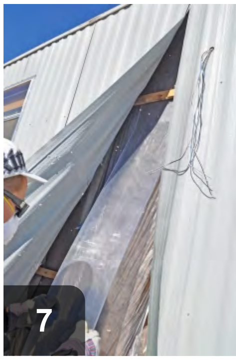
Measure length of cavity

Measure depth of cavity

Select appropriate batt thickness and R-value. Wrapped batts provide a built in vapor barrier

Measure batt to length of cavity with extra for overlap from stuffing tool

Lap cut batt over bent end of stuffing tool



Beginning with lapped end, tuck batt under top belt rail and stuff batt up to top of cavity. Remove stuffing tool

Tuck bottom of batt behind bottom belt rail. If longer than cavity, cut to within 1" longer, roll and tuck into cavity

4.1104.1f - Reattachment

Desired Outcome:

Consistent thermal boundary and air barrier between the conditioned space and unconditioned space

Specification(s):

If skirting was removed, skirting will be reinstalled to shed water to the outside of the skirting

Siding will be reattached with new fasteners

Siding will be reattached without bulges or wrinkles

Objective(s):

Ensure the integrity of the drainage plane

Return siding to existing conditions without damage

After wall cavities have been stuffed, paneling needs to be put back into place and refastened

Once work is finished, reattach siding and skirting, ensuring neither have been damaged

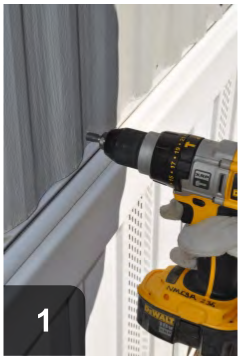
Tools:

1. Drill

Materials:

1. Fasteners

4.1104.1f - Reattachment



Using new fasteners, reattach paneling

Reinstall skirting, if necessary

Reattach trim, if necessary

Verify that siding and skirting have not been damaged and show no signs of bulging

Department of Commerce
Innovation is in our nature.

Combustion Safety Test Report

Client		**Date**				
Address		**Auditor & Inspector name** *initials do not suffice*				

Pre-test: *START CO measurement (Monoxer) outside*

Combustion Appliance Zone (CAZ)		**PRE**	**POST**	**PRE**	**POST**
1	**CAZ Pressure** with reference to (WRT) outside "BASELINE"				
2	Outside wind speed				
3	Outside temperature				
4	Designate appliance(s): Appliance name	1:		2:	
	Appliance location	1:		2:	
	Type of combustion **open/closed**	1:		2:	
	Type of draft **natural/induced/forced**	1:		2:	
	Shared venting **yes/no**	1:		2:	
	Vent Category **Type I, II, III, IV**	1:		2:	
5	Hazardous or unsafe conditions observed?	Y/N	Y/N	Y/N	Y/N
6	Visible signs of vent pipe leaks or damage observed?	Y/N	Y/N	Y/N	Y/N
7	Smell of gas or indication of fuel leak(s) observed?	Y/N	Y/N	Y/N	Y/N

*Furnace **on** or **off**? Could be worst case either way, depending on duct leakage.*	on/off	on/off	on/off	on/off

Set up CAZ in Worst Case Depressurization (see Exhibit 5.3.1B Tech Support Doc)			**PRE**	**POST**	**PRE**	**POST**
8	**CAZ pressure** WRT outside. Door **open/closed** (circle one)	Line 8 - Line 1 ______ = (8a)				
8a	Result of Line #8 minus Line #1"baseline" = Worst Case Dep.					
8b	Record CAZ Depressurization Limit: See Reference Tables					

Start up combustion appliance		**PRE**	**POST**	**PRE**	**POST**
9	Flame roll-out observed	Y/N	Y/N	Y/N	Y/N
10	Did the equipment spill gasses for more then 1 minute? If yes, **STOP** test. Let cool. Continue test in **natural** conditions. (circle)	Y/N	Y/N	Y/N	Y/N
11	Did the flame change when the air handler turned on?	Y/N/NA	Y/N/NA	Y/N/NA	Y/N/NA

After 5 minutes of combustion (steady state)		**PRE**	**POST**	**PRE**	**POST**
12	**Measure ambient CO** in the living space.				
13	**Measure draft pressure** in combustion appliance vent WRT CAZ				
13a	Record Minimum Acceptable Draft Pressures: See Reference Tables				
14	**Measure CO** in the exhaust gases of the vented appliance				
15	**Measure draft pressure** in the combustion appliance vent WRT CAZ (From line #8, if door is closed-open it. If door is open-close it) Door is **open / close** (circle one)				
16	**Measure heat rise temperature** across heat exchanger				
16a	Record manufacturer's acceptable heat rise range from label				

Fireplace/Wood Stove Zone (FPWSZ)		**PRE**	**POST**	**PRE**	**POST**
17	**Measure FPWSZ pressure** WRT outside				
	Vent pipe, chimney, or clearance problems observed (note below)	Y/N	Y/N	Y/N	Y/N

Oven		**PRE**	**POST**	**PRE**	**POST**
18	**Measure CO in the exhaust gases of the oven**				
	Ambient 1				
	Ambient 2				

Return house to pretest conditions		**PRE**	**POST**	**PRE**	**POST**
19	Check box when done. Add any comments or notes below.	☐	☐	☐	☐

Notes:

COMBUSTION SAFETY TEST REPORT REFERENCE TABLES

Vent Categorization Per NFPA 54 (Line 4)	
Category I NFGC	***Category III Airtight***
Non-Condensing Negative Pressure (-) High Temperature Flue Gases Natural or Fan Assisted Drafts AFUE usually 65-83% Typical Materials: Single wall metal, B-Vent, Lined Masonry	Non-Condensing Positive Pressure (+) High Temperature Flue Gases Fan Assisted Draft AFUE usually 78-87% Typical Materials: Sealed metal or plastics per manufacturer
Category II Corrosion Resistent	***Category IV Airtight & Corrosion Resistent***
Condensing Negative Pressure (-) Low Temperature Flue Gases *<<very little equipment in this category>>* Typical Materials: Special as designated by manufacturer	Condensing Positive Pressure (+) Low Temperature Flue Gases Sealed Combustion AFUE usually 90% + Typical Materials: Sealed plastics per manufacturer specification

Table 4: CAZ Depressurization Limits (Line 8b)

Venting Condition	Limit (Pa)
Stand alone natural draft water heater (including outside chimneys)	-5
Orphaned natural draft water heater	-2
Natural draft boiler or furnace vented in combination w/ water heater	-3
Natural draft boiler or furnace w/ vent damper commonly vented w/ water heater	-5
Induced draft boiler or furnace commonly vented w/ water heater	-5
Individual natural draft boiler or furnace	-5
Fireplace	-4
Wood stoves & fire place inserts, including air tight models w/ outside combustion air	-5
Power vented or induced draft boiler or furnace alone, also Pellet Stoves	-15
Chimney-top draft inducer; High static pressure flame retention head burner; Direct vented appliances; Sealed combustion appliances	-50

Min Acceptable Draft Pressures (Line 13a)

Temp (F)	Draft (Pa)
≤15	-2.4
20	-2.3
25	-2.1
30	-2.0
35	-1.9
40	-1.8
45	-1.6
50	-1.5
55	-1.4
60	-1.3
65	-1.1
70	-1.0
75	-0.9
80	-0.8
85	-0.6
≥ 90	-0.5

Table 3: Combustion Safety Test Action Level Table (Line 14)

CO Test Result for undiluted flue gas at steady state	And/Or	Spillage and Draft Test Results	Retrofit Action
0 - 25 ppm	***And***	**Passes**	Proceed with work
26 - 100 ppm	***And***	**Passes**	Recommend that CO problem be fixed
26 - 100 ppm	***And***	**Fails under Worst case only**	Recommend a service call for the appliance. Correct problems causing combustion appliance to fail under worst case test
>100 - 400 ppm	***Or***	**Fails under natural conditions**	**Stop Work**: Work may not proceed until the system is serviced and the problem is corrected.
> 400 ppm	***And***	**Passes**	**Stop Work**: Work may not proceed until the system is serviced and the problem is corrected.
>400 ppm	***And***	**Fails under any condition**	**Emergency**: Shut off fuel to the appliance. Owner/Agency call for service immediately.

Depressurization Result - ACTION

The Local Agency shall perform a worst-case depressurization test in each combustion appliance zone.

When combustion appliance zone (CAZ) depressurization limits are exceeded under worst-case conditions, the depressurization shall be brought within acceptable limits as detailed in Table 4: CAZ Depressurization Limits (above).

Exception: If Local Agency is unable to meet CAZ Depressurization Limits or standards, the reasonable efforts attempted, the actions taken, and the education provided to the client shall be documented in the client file.

Table 3.1: CO Test Action Levels for Ovens at Steady State Operation (Line 18)

CO Test Result for undiluted flue gas	**Retrofit Action**
0 - 99 ppm	Proceed with work.
100 - 300 ppm	Recommend service.
>300 ppm	Unit must be serviced prior to Wx work.

State of Washington, Weatherization Assistance Program

Technical Support Document

Combustion Safety

This document is intended to support in detail the Combustion Safety Test Report. The Combustion Safety Test Report is a tool to document the condition of two (2) appliances and their performance. Each combustion appliance in homes that are weatherized or repaired must be reported pre- and post- on a combustion safety test report. The added columns allow two (2) combustion appliances per form. Each row of the pre- and post- columns must be addressed.

The Combustion Safety Test Report must be filled out in detail for each completed project. You must document in the comments section of the Combustion Safety Test Report any special circumstances or health and safety related concerns that might help someone understand the condition of the home (pre- and post-), as well as the concerns expressed by the occupants, or the agency concerns for the occupants safety at the time testing was performed.

The testing procedure outlined in this document is intended to be the minimum tests needed to understand the condition and performance of an appliance. It is recommended that more in-depth testing be performed where multiple appliances share a chimney, or where other indications of potential problems exist.

Pre-test:

Start CO measurement (Monoxer) outside.

Line #1 Measure existing Combustion Appliance Zone (CAZ) pressure (baseline), CAZ With Respect To (WRT)) outside.

Measure the existing CAZ pressure (baseline), house with reference to outside. You will need this measurement when measuring combustion appliance zone worse case and other procedures that are normally low-pressure measurements (-15pa to 15pa).

Line #2 Outdoor wind speed

Using a Dwyer wind gauge, measure and record the outside wind speed if there is noticeable wind at the time of testing. If the wind speed is consistently in excess of 15 mph or gusting to the point of not being able to get an accurate test, document this condition and return at a later date to get accurate test results. If winds in excess of 15 mph do exist, this condition does not preclude performing Section I and Section II of the diagnostic test report. Under these conditions you will have to come back (when there is wind less than 15 mph) to confirm lines #8, 13, 15 and 17. You may find hazardous conditions before you get to line #8, or other problems not related to pressure and draft.

Line #3 Outdoor temperature

Record the outside ambient temperature. You will need this number to determine if there is adequate minimum draft (line #13 &15).

Line #4 Combustion Appliance Zone(CAZ)*, designate appliance

Record what kind of appliance (furnace, hot water heater, parlor stove, fireplace, woodstove, etc.) is in the CAZ. Write it in on the line provided. Also determine what type of appliance it is in terms of direct vent, sealed combustion, induced draft, etc. This will help determine how and where an appliance should be tested later in this procedure.

***Definition:** Combustion appliance zone (CAZ) is the physical area in which the combustion appliance is located or contained by door or access closure. Examples: A closet with a closing door, an attic with a closing access panel between the living space and attic, a living room that contains a fireplace or wood stove and has doors that isolate this area from bedrooms and other rooms. A combustion appliance zone is any area (zone) which can be physically closed off to another part of the home, and that contains a combustion appliance. If the only combustion source is a fireplace or wood stove go to line #17.

Line #5 Is there a hazardous or unsafe condition?

Is there anything in the CAZ that could be considered a health and safety problem? Indoor Air Quality (IAQ), electrical discrepancies, fire hazards, combustibles, or potential testing problems that should be documented. If yes, you must comment with name and date.

Line #6 Are there visible signs of vent pipe leaks or damage?

Are there any problems with the combustion appliance vent pipe, connecting chimney, chimney liner, or vent termination that need repairs or further inspection?

Line #7 Is there the smell of gas or indication of fuel leak

Do you or the client smell any gas? Did you check with a combustible gas detector or with detection fluid? If there is a leak, indicate by marking yes, and contact the local natural gas company or a contractor and document the location of the leak below in the comments section .

Worst-case* set-up test for Combustion Appliance Zone.

*Definition: Worst-case is any condition that puts the appliance being tested in the most hazardous condition through means of house configuration. These configurations such as opening and shutting bedroom, laundry, garage, closet, basement, doors, etc., may occur during normal use of the home. This may be different for different lifestyles and occupants, but the CAZ should be tested in a manner that would address many clients and lifestyles. All reasonable house configurations should be considered.

Worst-Case Set-Up procedure

Prepare house:

1. Close all interior and exterior doors and windows. Is furnace air handler on or off? Could be worst case either way, depending on duct leakage. Turn on all exhaust fans - bathroom, kitchen, clothes dryers (clean out lint filter).*

2. Start at the room furthest from the combustion appliance and perform a smoke test at each interior door to determine whether to leave it open or closed.

    a. Position yourself in or towards the main body of the house.

    b. Open the door slightly (3/4"). If the smoke goes in, leave the door all the way open. If the smoke comes back toward the main body or towards you, close the door.

3. Smoke test the door to the CAZ. If the smoke comes toward the main body or towards you, open the door. If the smoke goes into the CAZ, close the door.

*** EXCEPTION TO STEP (1.)** If the furnace does not have a manual fan switch you may have to turn on all your fans first (smoke the doors) then turn on the furnace. In this case you must do line #13 a second time, going back and smoking the interior doors again to ensure you had the correct setup. If this is the case, and you go back and find that you had a door in the incorrect position (opened or closed), adjust, retest, document the results, and go back through lines #8 through #13.

Always check rooms that contain mechanical exhaust equipment with chemical smoke as a confirming test. Many times the combination of leaky buildings and supply ducts in a room negate a fans negative effect on the CAZ or main body.

Line #8 Measure the CAZ WRT outdoors. Is the CAZ door Open or closed?

Follow worst-case set -up procedure (above) to determine whether to leave open or shut the CAZ room door(s). Please circle whether you left the CAZ door OPEN or CLOSED. Then record what the pressure is in the CAZ WRT outside using line #1, CAZ baseline pressure to have a better understanding of the contribution the mechanical systems are having on the home versus natural pressures (i.e. stack wind etc.).

****Action Level**

Table 4: *CAZ Depressurization Limits*

Line #9 Was there flame roll-out of combustion equipment?

When the (furnace or hot water heater) combustion appliance starts up, does the flame come out of the appliance? When possible, this test should be done with a cold startup. Many times if the chimney or vent pipe is already heated, the appliance will draft, but it may not be able to start a draft in a cold chimney. Also, check cover panels and the area around the burner for burned or charred spots. If you see flame roll out or signs that it may be happening intermittently then circle **YES** and comment in file.

Line #10 Did the equipment spill gases for more than one minute?

Does the atmospheric draft or induced draft (hot water heater, parlor stove, furnace etc.) appliance spill combustion gases for more than a minute? If **YES**, STOP test. Let cool. Continue test in natural conditions. Check all around the draft hood with chemical smoke, as some appliances will spill combustion gases and draft at the same time.

Table 2: Maximum Acceptable Appliance Spillage Periods

Appliance Type	Spillage Test Period (minutes)
Water Heater, Gravity Furnace, Boiler	1.0
Space Heater	1.0
Forced Air Furnace	1.0

**** Note:** Generally you will find that if an appliance spills combustion gases for more than one (1) minute, this is an indicator that there will be a draft, chimney configuration, or pressure problems detected at some point between lines 13 and 16.

Line #11 Did the flame change in the furnace when the air handler turned on?

Did the flame change when the fan in the furnace turned on? This can indicate a crack in the heat exchanger. If yes, comment in the file and have it checked by HVAC technician.

**** Note:** If you are working on a furnace without a manual fan switch, you may have to shut down the furnace and start it again to observe this condition because you will have a lot going on when the air handler comes on the first time. Checking for flame change may not detect an existing cracked heat exchanger. Other possible indications of a cracked heat exchanger may be soot in the home, the smell of un-burnt gas or oil, elevated CO levels in the appliance exhaust, and elevated CO levels in the living space when the furnace is running. If you encounter any of these conditions, there are other tests for cracked heat exchangers that you may want to identify and have performed by a qualified professional (check with your HVAC contractor or technician). Caution and a full understanding of the operating performance of all the combustion appliances in the home must be considered when attributing soot, un-burnt gas smells, and elevated CO levels to a cracked heat exchanger.

Line #12 After 5 minutes measure the CO in the ambient air in the living space

Zero the monoxer outside before proceeding. After the combustion appliance has been running for 5 minutes, test the ambient air of the living room or upstairs hallway (if it is a two story) for CO with your monoxer. Record any CO in the living space above zero (0) in parts per million (PPM).

****Action level:** If the ambient CO in the home is above 9 PPM (maximum allowable 9 PPM) and attributable to any combustion appliance in the home, then action must be taken to mitigate the source of the CO before weatherization or repair work starts, or the ambient CO level must be monitored and the problem(s) resolved as part of the work specified. **No home shall be left with ambient CO greater than 9 PPM (attributable to existing combustion appliances) after 5 minutes of run time for an appliance.**

Line #13 Measure the draft pressure in the vent of the combustion appliance Test the combustion appliance vent WRT CAZ

With your digital manometer, measure the draft pressure in the combustion appliance vent (preferably 18" up the vent pipe from the appliance) with reference to the room and record the number in pascals. Be sure to indicate whether negative or positive. Always check your draft pressure measurements with chemical smoke as a confirming test.

If the appliance does not have adequate draft under worst-case conditions, you can start evaluating the problem by turning off all fans and see if the appliance drafts under any or best case condition.

Refer back to line# 2 and check the wind speed, if the wind speed is consistently in excess of 15 mph or gusting to the point of not being able to get an accurate test, document this condition and return at a later date to get accurate test results. If there is marginal draft or a condition that may cause back drafting or spillage, inform the occupants of this situation and make the appropriate recommendations for use of the appliance until additional testing or repairs can be made. Document the condition in the comments section.

Line #13a Minimum Acceptable Draft Pressure: Calculate the minimum acceptable draft pressure using the ranges in Table 1 and record limit in the box.

Table 1: Minimum Acceptable Draft Test Action Levels

Outside Temperature (degree F)	Draft Pressure Standard (Pa)
<10	-2.5
10-90	(Outside temp / 40) – 2.75*
>90	-0.5

*Calculation is as follows: Divide the outside temp by 40, then subtract 2.75 from this value. The result is the minimum acceptable draft.

Line #14 Measure the CO in the exhaust gases of the vented appliance

With your monoxer, take a measurement in the undiluted flue gases of the combustion appliance. Where practical, this test should be measured in the flue ports of the appliance. If you cannot measure at the appliance, measure at its termination point realizing this is a diluted sample but better than not testing at all.

Table 3: *Combustion Safety Test Action Level Table*

Line #15 If the door of CAZ is closed - open it. If the door is open – close it. Open/closed. Combustion Appliance vent WRT CAZ.

If in the beginning of your worst-case set-up test, you left the CAZ door closed, then open it. If left open in the beginning, then close it. Then record the draft pressure combustion appliance vent WRT CAZ as in line #13. This is a verifying test. This test double checks your measurements and helps confirm the results. Always check your draft pressure measurements with chemical smoke as a confirming test.

****Action Level:** *See action level* **Table 4 - *CAZ Depressurization Limits***

Line #16 Heat Rises: Measure temperature across heat exchanger: Heat rise = supply plenum temp - return plenum temp

To get the "heat rise", measure the temperature in the supply air plenum and return air plenum. Subtracting the return plenum temperature from the supply air temperature equals the "heat rise". Take these temperature measurements in the plenums as close to the furnace as possible. Record in degrees Fahrenheit. The manufacturer's acceptable range for heat rise for the unit is often on the nameplate of the furnace.

****Action level:** If the heat rise (the difference between return air temp at the plenum and supply air temp at the plenum) is outside the manufacturer's acceptable range the system fails and there must be a referral made for further analysis by a furnace technician. If the heating unit has not been serviced within the last twelve months, a furnace clean and tune is recommended.

Exception: If manufacturer's acceptable heat rise range is unavailable, the default acceptable heat rise range is greater than 40° and less than 70° Fahrenheit.

Line #17 Fireplace/wood stove zone worst case test: FPWSZ zone WRT outdoors

Record the pressure of the zone that the fireplace or wood stove occupies. See *Worst-Case Set-Up Procedure* between lines #7 and #8, this procedure is the same for fireplace/wood-stove zones. Also document any vent pipe, chimney, or clearance problems with the wood-burning appliance in the comments section.

****Action Level:** *See action level* **Table 4 - *CAZ Depressurization Limits*** *on reverse side of Combustion Safety Test Report (Exhibit 5.3.1A)*

Line #18 Measure the CO in exhaust gases of Ovens:

Interim Gas/Propane Oven Testing Procedure

Ovens produce moisture and oxides of nitrogen. Excess moisture is not good for the durability of the home (possibly contributing to mold problems) and NOX is not healthy. These combustion appliances are capable of producing CO, which is a health hazard. In all cases a carbon monoxide detector is recommended and homeowners should use exhaust ventilation when using these appliances. New appliances may require an extended warm up period to reach steady state.

a. Remove any items/foil in or on oven.
b. Make sure self cleaning features are not activated, set oven to highest setting.
c. Test oven for CO in the flue, before dilution air.
d. After 5 minutes of operation, check for steady state:

If the appliance is located in a confined space and mechanical ventilation is not readily available, mechanical ventilation shall be recommended.

Ventilation provided for unvented gas ovens must provide a minimum capacity of 25 cfm continuous airflow or 100 cfm intermittent.

Oven

Then take a reading in the undiluted flue gases of the oven (after 5 minutes of burn time) and record in PPM. Look in the oven for anything that may melt or catch fire before performing the test. Make sure the oven burner is actually on during the test.

Ambient CO Levels

Carbon monoxide levels in the ambient air around the technician must be monitored throughout all combustion safety tests. Diagnostic evaluations and inspections must be aborted if ambient CO concentrations **greater than 35 ppm** are recorded. CO producing appliances must be disabled and repaired before proceeding with additional diagnostics or inspections.

Ambient CO levels shall be monitored upon entering the combustion appliance zone and during the test period for all appliances. If ambient levels **exceed 35 ppm** at any time, turn off the appliance immediately and make appropriate repair recommendations according to the charts provided.

****Action Level:** *See action level*

Line #19 Return house to pre-test condition, circle DONE when complete

Comments: Provide comments in detail when you encounter unsafe conditions. Also document procedures or repairs that were undertaken to resolve or prevent any unsafe conditions. Use both sides of the form or additional paper as needed.

Abbreviations:

CO: Carbon monoxide

CA: Combustion appliance

CAZ: Combustion appliance zone

FPWSZ: Fireplace wood stove zone

HDL: House Depressurization Limit (a standard adopted by Commerce)

HVAC: Heating, ventilation, air conditioning

IAQ: Indoor Air Quality

PPM: Parts per million

Pa: Pascals

WRT: With reference to

Terms:

Air handler – A steel cabinet containing a blower with cooling and/or heating coils connected to ducts, which transport indoor air to and from the air handler.

Backdrafting – Continuous spillage of combustion gases from a combustion appliance.

Bimetal element – A metal spring, lever, or disc made of two dissimilar metals that expand and contract at different rates as the temperature around them changes. This movement operates a switch in the control circuit of a heating or cooling device.

Burner – A device that facilitates the burning of a fossil fuel like gas or oil.

Carbon monoxide – An odorless and poisonous gas produced by incomplete combustion.

Combustion air – Air that chemically combines with a fuel during combustion to produce heat and flue gases, mainly carbon dioxide and water vapor.

Combustion analyzer – A device used to measure steady-state efficiency of combustion heating units.

Depressurize – Cause to have a lower pressure or vacuum with respect to a reference of a higher pressure.

Dilution air – Air that enters through the dilution device --- an opening where the chimney joins to an atmospheric-draft combustion appliance.

Dilution device – A draft diverter or barometric draft control on an atmospheric-draft combustion appliance.

Draft diverter – A device located in gas appliance chimneys that moderates draft and diverts down drafts that could extinguish the pilot or interfere with combustion.

Fan control – A bimetal thermostat that turns the furnace blower on and off as it senses the presence of heat.

Flue – a channel for combustion gases.

Heat anticipator – A very small electric heater in a thermostat that causes the thermostat to turn off before room temperature reaches the thermostat setting, so that the house does not overheat from heat remaining in the furnace and ducts after the burner shuts off.

Heat rise – The number of degrees of temperature increase that air is heated as it is blown over the heat exchanger. Heat rise equals supply temperature minus return temperature.

High limit – A bimetal thermostat that turns the heating element of a furnace off if it senses a dangerously high temperature.

House pressure – The difference in pressure between the indoors and outdoors measured by a manometer.

Inch of water – Small air pressure differences caused by wind, blower doors, furnace fans, and chimneys are measured in inches of water (in.-H_20) in the American measurement system.

Input rating – The rate at which an energy-using device consumes electricity or fossil fuel.

Intermittent ignition device – A device that lights the pilot light on a gas appliance when the control system calls for heat thus saving the energy wasted by a standing pilot.

Make-up air – Air supplied to a space to replace exhausted air.

Manometer –Measuring device for small gas pressures

Mortar – A mixture of sand, water, and cement used to bond bricks, stones, or blocks together.

Net free area – The area of a vent after that area has been adjusted for insect screen, louvers, and weather coverings. The free area is always less than the actual area.

Open-combustion heater – A heating device that takes its combustion air from the surrounding room air.

Orphaned Natural Draft Water Heater - A natural draft water heater vented into an oversized chimney.

Oxygen depletion sensor (ODS) – A safety device for unvented combustion heaters that shuts gas off when oxygen is depleted.

Pascal – A unit of measurement of air pressure. (See Inch of water.)

Plenum – The piece of ductwork that connects the air handler to the main supply duct.

Pressure – A force encouraging movement by virtue of a difference in some condition between two areas.

Return air – Air circulating back to the furnace from the house, to be heated by the furnace and supplied to the rooms.

Room heater – A heater located within a room and used to heat that room.

Sealed-combustion heater – A heater that draws combustion air from outdoors and has a sealed exhaust system.

Space heating – Heating the living spaces of the home with a room heater or central heating system.

Spillage – Temporary flow of combustion gases from a dilution device.

Stack effect – The draft established in a building from air infiltrating low and exfiltrating high.

Stand-Alone Natural Draft Water Heater - A natural draft water heater vented into a properly-sized chimney in accordance with NFPA 31 for oil-fired units, NFPA 54 for gas-fired units, NFPA 58 for propane-fired units and NFPA 211 for solid-fueled units or the venting tables of a chimney liner manufacturer.

Steady-state efficiency – The efficiency of a heating appliance, after an initial start-up period, that measures how much heat crosses the heat exchanger. A combustion analyzer measures the steady-state efficiency.

Supply air – Air that has been heated or cooled and is then moved through the ducts and out the supply registers of a home.

Vent connector **–** The vent pipe carrying combustion gases from the appliance to the chimney.

Vent damper – An automatic damper powered by heat or electricity that closes the chimney while a heating device is off.

Venting – The removal of combustion gases by a chimney.

Worst-case depressurization test –A safety test, performed by specific procedures, designed to assess the probability of chimney back drafting.

WRT – "With respect to" used to show that the air pressures between two areas are being compared.

Zone – A room or portion of a building separated from other rooms by an air barrier----not usually an effective air barrier.

Department of Commerce
Innovation is in our nature.

Daily In-Progress Combustion Safety Test Report

Client		Date	
Address		Auditor Name *initials do not suffice*	

Local Agency Auditor: Complete Line 4 and 8b

4	*FA=Forced Air, HWT=Hot Water Tank, WS=Wood Stove, FP=Fireplace, PS=Pellet Stove, R=Range*	***Place abbreviation for appliance in lines below***			
	Fuel Type: (LP, NG, Oil, Wood, Pellet)				
	Designate appliance(s): Appliance (App) Name	App 1:		App 2:	
	Appliance Location	App 1:		App 2:	
	Type of combustion (**open/closed**)	App 1:		App 2:	
	Type of draft (**natural/induced/forced**)	App 1:		App 2:	
	Shared venting (**yes/no**)	App 1:		App 2:	
	Vent Category (**Type I, II, III,IV**)	App 1:		App 2:	
8b	Record CAZ Depressurization Limit (See Reference Tables)				

	Date - Day One	Date - Day Two	Date - Day Three
Contractor/Technician: Complete remainder of form			
	Day One	Day Two	Day Three
Working CO Detector present or installed Day One?	yes / no		
Technician Name/Date *(initials do not suffice)*			

		Day One		Day Two		Day Three	
Set up CAZ in Worst Case Depressurization (see Exhibit 5.3.1B Technical Support Document)		App 1	App 2	App 1	App 2	App 1	App 2
1	**"Baseline" CAZ Pressure** with reference to (WRT) outside						
	Furnace on or off? Either could be Worst Case, depending on duct leakage.	on / off	on / off	on / off	on / off	on / off	on / off
	Indicate whether CAZ door is open or closed (circle one)	open/closed	open/closed	open/closed	open/closed	open/closed	open/closed
8	Record CAZ pressure WRT outside						
8a	Record result of Line #8 minus Line #1 ("baseline")						
	Record CAZ Depressurization Limit from 8b (above)						

If worst case depressurization exceeds depressurization limit, ACTION is required. See back of form.

		Day One		Day Two		Day Three	
Start up Appliance		App 1	App 2	App 1	App 2	App 1	App 2
10	Did the equipment spill gasses for more than 1 minute?	yes / no	yes / no	yes / no	yes / no	yes / no	yes / no

If answer is "yes," ACTION is required. See back of form.

		Day One	Day Two	Day Three
Return house to pretest conditions				
19	Check box when done. Add any comments or notes below	☐	☐	☐

Notes:

Revised July 2014

COMBUSTION SAFETY TEST REPORT REFERENCE TABLES

Table 4: CAZ Depressurization Limits (Line 8b Combustion Safety Test Report)

Venting Condition	Limit (Pa)
Stand alone natural draft water heater (including outside chimneys)	-5
Orphaned natural draft water heater	-2
Natural draft boiler or furnace vented in combination w/ water heater	-3
Natural draft boiler or furnace w/ vent damper commonly vented w/ water heater	-5
Induced draft boiler or furnace commonly vented w/ water heater	-5
Individual natural draft boiler or furnace	-5
Fireplace	-4
Wood stoves & fire place inserts, including air tight models w/ outside combustion air	-5
Power vented or induced draft boiler or furnace alone, also Pellet Stoves	-15
Chimney-top draft inducer; High static pressure flame retention head burner; Direct vented appliances; Sealed combustion appliances;	-50

Depressurization Result - ACTION

The Local Agency shall perform a worst-case depressurization test in each combustion appliance zone.

When combustion appliance zone (CAZ) depressurization limits are exceeded under worst-case conditions, the depressurization shall be brought within acceptable limits as detailed in Table 4: CAZ Depressurization Limits (above).

Exception: If Local Agency is unable to meet CAZ Depressurization Limits or standards, the reasonable efforts attempted, the actions taken, and the education provided to the client shall be documented in the client file.

In-Progress Daily Test Out - ACTION Items

If worst case depressurization exceeds depressurization limit ACTION is required.

	Document ACTIONS Taken	√ Done	Levels	Initials	Date
1.	Document Daily Test Out levels that exceed limit:				
2.	Call Auditor for direction and document:				
3.	Do one or more of the following				
a.	Confirm CO Detector is in place and operational:				
b.	Take steps to mitigate issue for overnight:				
(1)	Reduce depressurization				
	Disable/Disengage fan that is creating problem:				
	Tape of switch:				
	Other: ____				
(2)	Ventilate				
	Provide makeup air for interim:				
	Open window:				
	Other: ____				
4.	Inform Client of ACTION(s) taken (temporary):		Client signature - received info		
	Educate Client steps must take (or not) to remain safe:				
5.	Re-test and Document after taking mitigation actions:				

Department of Commerce

Diagnostic Test Report

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Client Name:

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Address:

Pre Blower Door:

i.	Client Eligibility Date:		
ii.	Audit Date:		
iii.	Client Interview Performed?	Yes	No
iv.	Pollution Source Survey Completed?	Yes	No
v.	Contaminants present that would either prohibit blower door test completely or require pressurization test:		
vi.	Technician:		
vii.	Date:		

	CALCULATIONS	Pre	In-Progress	Post
1	Calculated total square footage of heated area			
2	Calculated volume of conditioned space			
	BASELINE CONDITIONS & HOUSE TIGHTNESS - Blower door	Pre	In-Progress	Post
3	Primary heat source fuel type (example: nat. gas, electric, propane, wood)			
4	Windspeed MPH			
5	Outside temperature °F			
6	Blower door location			
7	Baseline without blower door on in pa (stack effect)			
8	Blower door configuration: O=open fan A=ring A B=ring B LF= low flow ring			
9	Total CFM50			
10	**ZONAL PRESSURES** - Blower door	Pre	In-Progress	Post
	ATTIC WRT house			
	CRAWLSPACE WRT house			
	GARAGE WRT house			
	OTHER: WRT house			
	OTHER: WRT house			
	OTHER: WRT house			
11	Location of existing ducts: A=inside B=outside C=inside/outside			
12	12. Duct Pressure Test - Blower Door			

13			13. Room Pressure - HVAC fan only				
	Location	S/ Supply R/Return	**Room WRT main body**		**Pressure Pan:** House WRT Duct		
			Pre	**Post**	**Pre**	**In Progress**	**Post**
a.							
b.							
c.							
d.							
e.							
f.							
g.							
h.							
i.							
j.							
k.							
l.							

	TESTING AIRHANDLER (HVAC) EFFECTS: HVAC fan only	Pre	In-Progress	Post
14	**Dominant Duct Leak Test:** Main Body WRT outside (all interior doors open)			
15	**All Doors Closed Effect:** Main Body WRT outside (all interior doors closed)			
16	Duct location after Wx and Repairs: A=inside B=outside C=inside/outside			
17	Electric furnace heat rise test (*supply°F–return°F*) acceptable range:>40°to<70°			
18	Return house to pre test conditions (Check box when done)	☐	☐	☐

NOTES/DOCUMENTATION:

Revised July 2013

Pressure Pan Tests

In typical mobile home duct configurations, pre pressure pan tests help locate areas of significant leakage or disconnected duct work. After belly is filled with insulation, post pressure pan tests results may not be useful.

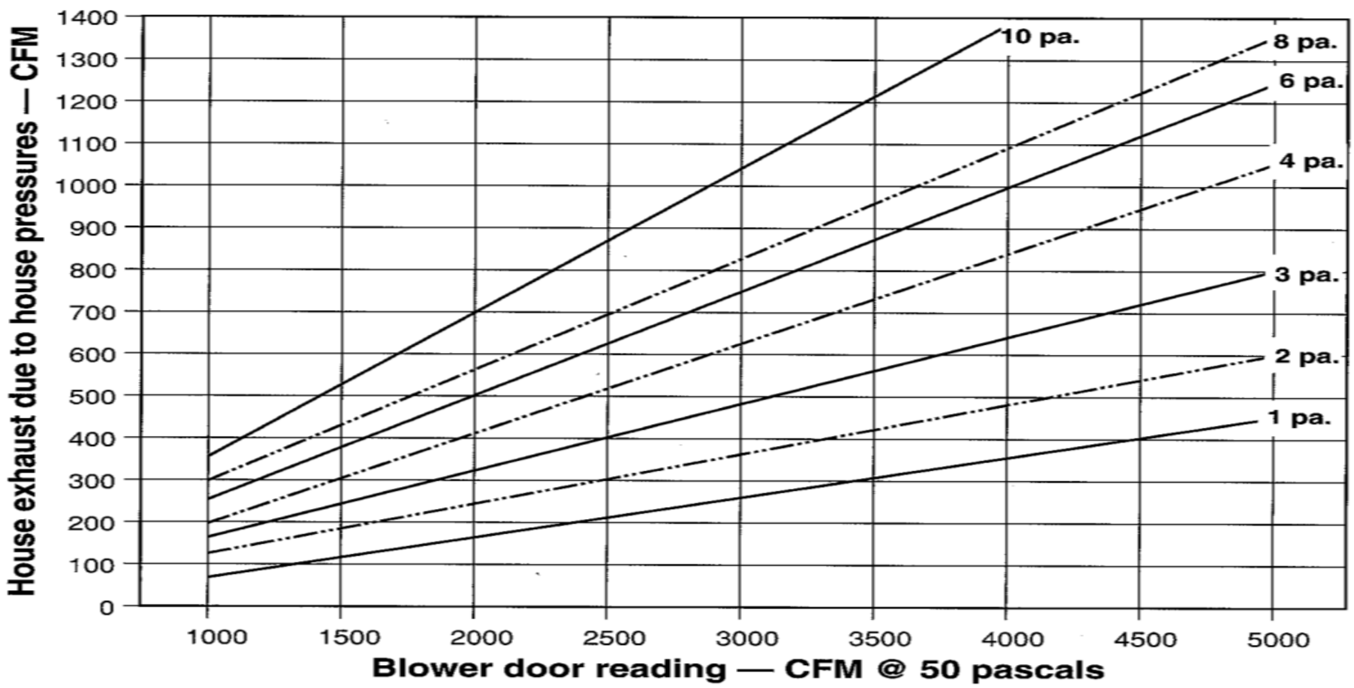
In site built homes with supply and return duct systems enclosed entirely within the thermal and pressure boundaries, pressure pan tests are not required.

Dominant Duct Leak Test

In typical mobile home duct configurations, dominant duct leak tests are especially useful. You can quantify the amount of duct leakage by using the Air Leakage Chart (aka Tooley Chart) if the return is isolated in the conditioned space and the supplies are isolated in the belly. No more than 100CFM of total supply duct leakage is recommended.

In site built homes with supply and return duct systems enclosed entirely within the thermal and pressure boundaries, dominant duct leak tests are not required.

Air Leakage Chart



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State of Washington, Weatherization Assistance Program

Technical Support Document (TSD)

Diagnostic Test Report

This document is intended to support in detail the Diagnostic Test Report. The Diagnostic Test Report must be filled out in detail for each completed project. You must document in the comments section of the Diagnostic Test Report any special circumstances or health and safety related concerns that might help someone understand the condition of the home (pre- and post-), as well as the concerns expressed by the occupants, or the agency concerns for the occupants safety at the time testing was performed.

The testing procedure outlined in this document is intended to be the minimum tests needed to understand the condition of the home.

Pre Blower Door

i. Client Eligibility date:

Enter date Client was determined eligible. Ensure both Client Eligibility and Energy Audit dates are within the Period of Eligibility. See **Section 1.3, *Period of Eligibility***

ii. Audit Date:

Enter date Energy Audit was performed.

iii. Client Interview Performed?

Answer yes/no

iv. Pollution Source Survey Completed?

Answer yes/no

v. Contaminants Present that would either prohibit blower door test completely, or require pressurization test:

(including but not limited to: Lead, Friable Asbestos, Mold, Smokers, Pets, Sewage, etc)
Document any contaminants or conditions that would prevent blower door testing or require pressurization testing.

vi. Technician:

Enter name of Technician performing: Pre, In-Progress, and Post diagnostic testing.

vii. Date:

Enter date Technician is performing: Pre, In-Progress, and Post diagnostic testing.

Baseline Conditions & House Tightness – Blower Door

Line #7 Primary heat source fuel type (example: nat gas, elec, propane, oil, wood)

Determine by interviewing (not their HIF or Wx application) the occupants, observing their habits and analyzing their heating bills what their primary heat source is and circle the type of fuel that is used in the appliance. Document the type (boiler, woodstove, forced air etc.) in the comments section.

Line #8 Windspeed MPH

Record or estimate wind speed before setting up the blower door. Measure the wind speed with a wind gauge (record if there is apparent steady or gusting wind).

Line #9 Outside temperature °F

Record outside temperature in degrees Fahrenheit

Line #10 Blower door location

Record which doorway the blower door was mounted in for testing procedures. Mount the blower door in the doorway which has the least obstructions in the pathway of airflow (of the blower door) both inside and outside.

Note: Blower door set up procedure: follow manufacturer's instructions.

Line #11 Baseline without blower door on in pa (stack effect)

Measure the house with reference to outside without the blower door running. Make sure the blower door fan is covered and the house is prepared for blower door testing.

Line #12 Blower door configuration
O=open fan A=ring A B=ring B LF=low flow ring

Record which ring or configuration (number of holes unplugged) the blower door was set up in for testing lines 13 through 16.

Note: Always use the smallest ring possible to get the highest fan pressure when performing blower door testing. The higher the fan pressure the more accurate the test.

Line #13 Total CFM50

Prepare the house for blower door testing. Normally test should be taken in the negative pressure mode, if positive pressure is used for testing note in the comments section and set up the house per manufacturer's specifications in the blower door manual.

Zonal Pressures – Blower Door

Line# 14 Zonal Pressures

Hook up your manometer as indicated on the field form for each test and record the pressure. Be sure to take verifying tests (house WRT zone, zone WRT outside, etc.). Start in a clockwise direction and describe room on the adjacent line and record pressures, zone WRT outside (confirming test: zone WRT outside).

Line #15 Location of existing ducts:
A=Inside B=outside C=inside/outside

Determine and record where the duct system was designed to be located originally, inside the thermal boundary, outside the thermal boundary, or a combination of inside and outside.

Duct Pressure Test – Blower Door
Line #16 Duct Pressure Test – Pressure Pan
House WRT Duct (clockwise from front door)

Face the front door looking out. Record (down to tenths) whether the duct tested is a supply or return duct and what zone it is located in from line #15. Record whether it is located inside or outside the intended thermal envelope (by design).

Testing Air Handler Effect – HVAC fan only

The tests performed in lines 17 through 19 are performed with only the furnace air handler fan on. The blower door or any exhaust fans should be turned off during these tests. These tests indicate the effect of the air supply and return on pressures in rooms and the house.

Line #17 Room Pressure:
Room WRT Main Body (interior doors closed)

This testing is to see if there are large pressure differentials between rooms of the home that could possibly cause a problem to the operation of the combustion appliance or cause moisture damage the structure of the house.

Line #18 Dominant Duct Leak Test:
Main Body WRT Outside (all interior doors open)

Record the pressure of the main body of the house WRT outside with all interior doors open.

Line #19 All Doors Closed Effect:
Main Body WRT outside (all interior doors closed)

Now close all the interior doors and record main body WRT outside.

Line #20 Duct location after Wx and repair: A=inside B=outside C=inside/outside

Did you change the location of the ducts or are they in the same place as before? If as a result of the retrofit the location (inside to outside, outside to inside, etc.) of the duct system has been changed document in the comments section.

Line #21 Electric furnace heat rise test: Heat Rise = supply°F – return°F

With the electric furnace running, measure the temperature in the supply air plenum and return air plenum. Subtracting the return plenum temperature from the supply air temperature equals the "heat rise". Take these temperature measurements in the plenums as close to the furnace as possible. Record in degrees Fahrenheit. The manufacturer's acceptable range for heat rise for the unit is often on the nameplate of the furnace.

****Action level:** If the heat rise (the difference between return air temp at the plenum and supply air temp at the plenum) is outside the manufacturer's acceptable range the system fails and there must be a referral made for further analysis by a furnace technician. If the heating unit has not been serviced within the last twelve months, a furnace clean and tune is recommended.

Exception: If manufacturer's acceptable heat rise range is unavailable, the default acceptable heat rise range is greater than 40° and less than 70° Fahrenheit.

Line #22 RETURN HOUSE Pre Test Conditions

Check box when done.

Exhaust Fan Testing

Line #23 Exhaust Fan Testing (Actual CFM)

Test and record flow for all exhaust fans (local (source specific) and whole building (whole house)) using exhaust fan flow meter and digital pressure gauge.

Specifications:

Flow Accuracy: ±10% of reading when used with a 1% accurate pressure gauge with a display resolution of 0.1 Pa. (such as a DG-700,)

Flow Range:
Door position E1 44 - 124 cfm
Door position E2 21 - 59 cfm
Door position E3 10 - 28 cfm

FLOOR SUPPORT MATRIX						
Floor Type	**Support Material**	**Material requirements**	**Maximum Spacing**	**Acceptable patterns**	**Minimum fastener type**	**Minimum fastener depth**
Joist up to 24"	Lath	3/8X1.5"	20"O.C.	Across floor joists	Corrosion resistant 3/8"crown 18AWG	5/8"
Joist up to 24"	Twine	150 LBS. polyester, polypropylene or nylon	12" O.C.	Shoelace/Zigzag (must be stapled at each joist	Corrosion resistant 3/8"crown 18AWG	5/8"
Post &Beam over 32" O.C.	Lath	3/8X1.5"	20" O.C.	Across floor beams up to 54". If over 54" need center support	Corrosion resistant 3/8"crown 18AWG	5/8"
Post &Beam over 32" O.C	Twine	150 LBS. polyester, polypropylene or nylon	12"	Shoelace up to 54" across. If over 54" need center support	Corrosion resistant 3/8"crown 18AWG	5/8"

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7a Basic operation	Basic operation of the equipment will be explained to the occupant (e.g., design conditions, efficiency measures, differences from previous system or situation)	Ensure occupant has a reasonable expectation of the equipment's capability	2264
	5.3003.7b System controls (e.g., thermostat, humidistat)	Proper operation and programming of system controls to achieve temperature and humidity control will be explained to the occupant	Ensure occupant can operate system controls	2265
	5.3003.7c System disconnects	Indoor and outdoor electrical disconnects and fuel shut-offs will be demonstrated to occupant	Ensure occupant can shut off equipment in emergencies	2266
	5.3003.7d Combustion air inlets	Location of combustion air inlets will be identified for occupant in accordance with NFPA 31, 54, and 58 Importance of not blocking inlets will be explained to occupant	Ensure occupant does not block combustion air inlets	2267

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7e Blocking air flow	Importance of cleaning dust and debris from return grilles will be explained to occupant Proper placement of interior furnishings with respect to registers will be explained to occupant Negative consequences of closing registers will be explained to occupant Importance of leaving interior doors open as much as possible will be explained to occupant	Ensure occupant does not prevent equipment from operating as designed	2268

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7f Routine maintenance	Proper filter selection and how to change the filter will be explained to occupant Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant Importance and timing of routine professional maintenance will be explained to occupant There will be no air bypass around the filters and new central forced air HVAC systems will have minimum MERV 6 filtration	Ensure equipment operates as designed	2269

Occupant Education>Forced Air systems
Single-Family Homes

	Title	Specification(s)	Objective(s)	
	5.3003.7g Calling heating, ventilation, and air conditioning (HVAC) contractor	Situations when the occupant should contact the HVAC contractor will be explained, including: • Fuel odors • Water draining from secondary drainline • Emergency heat indicator always on for a heat pump system • System blowing cold air during heating season and vice versa • Icing of the evaporator coil during cooling mode • Outside unit never defrosts • Unusual noises • Unusual odors	Notify occupant to contact installer when system is not operating as designed	2270
	5.3003.7h Carbon monoxide (CO)	A carbon monoxide (CO) alarm will be installed	Occupant will be made aware of operation of CO alarm	2271
	5.3003.7i Warranty and service	Occupant will be provided with relevant manuals and warranties The labor warranty will be explained and the occupant will be given a phone number to call for warranty service	Provide manuals and warranties for future servicing	2272

Checklist: ENCLOSED WALL CAVITY INSULATION (Dense Pack)

Project:

✓	N/A		PREP
☐	☐	1	Complete a combustion safety test and record the results.
☐	☐	2	Review ventilation strategy and plan any exhaust fan, electrical, or ducting install work before insulating.
☐	☐	3	Put on all personal protection equipment (PPE).
☐	☐	4	Identify all worker and occupant safety hazards.
☐	☐	5	Identify any exterior lead-based paint hazards and set up RRP-compliant containment accordingly.
☐	☐	6	Assess walls from the interior of home to identify weak plaster, drywall, or panelling.
☐	☐	7	Identify any durability issues such as signs of moisture or pests.
☐	☐	8	Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.
✓	**N/A**		**WORK**
☐	☐	9	Remove siding and drill through sheathing to gain access to all wall cavities and probe for obstructions and/or hazards.
☐	☐	10	Install insulation according to the manufacturer's specifications.
☐	☐	11	View completed sections using an IR camera with a blower door operating. Drill and repack any voids or low density areas.
☐	☐	12	Seal access points of all wall cavities and reinstall siding. Any new siding installed will match existing style and be primed and painted to match.
✓	**N/A**		**CLOSE OUT**
☐	☐	13	Clean the work areas.
☐	☐	14	Educate the occupants on the work completed.
☐	☐	15	Post Insulation Certificate and insulation manufacturer's coverage chart.

Checklist: FLOOR INSULATION

Project:

✓	N/A		PREP
☐	☐	1	Review ventilation strategy and plan any exhaust fan, electrical, or ducting install work before insulating.
☐	☐	2	Put on all personal protection equipment (PPE).
☐	☐	3	Identify all worker and occupant safety hazards.
☐	☐	4	Identify any durability issues such as signs of moisture or pests.
☐	☐	5	Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.
✓	**N/A**		**WORK**
☐	☐	6	Identify areas where insulation will not be installed.
☐	☐	7	Remove existing damaged insulation from the crawlspace and/or basement.
☐	☐	8	Complete air sealing according to location of pressure boundary (floor plane, perimeter, or combination): seal all holes between the crawlspace and/or basement and the interior and/or exterior of the house.
☐	☐	9	Install insulation according to the manufacturer's specifications and Insulation Support Matrix. Verify that all insulation has no gaps, voids, compression or misalignment.
☐	☐	10	Install baffles at foundation venting if needed.
✓	**N/A**		**CLOSE OUT**
☐	☐	11	Clean the work areas.
☐	☐	12	Educate the occupants on the work completed.
☐	☐	13	Post Insulation Certificate and insulation manufacturer's coverage chart.

Checklist: ATTIC INSULATION

Project:

✓	N/A		PREP
☐	☐	1	Review ventilation strategy and plan any exhaust fan, electrical, or ducting install work before insulating.
☐	☐	2	Put on all personal protection equipment (PPE).
☐	☐	3	Identify all worker and occupant safety hazards.
☐	☐	4	Identify any durability issues such as signs of moisture or pests.
☐	☐	5	Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.
☐	☐	6	If K&T present, confirm K&T inspection form complete.
☐	☐	7	Confirm all working connections are in junction boxes.
✓	N/A		WORK
☐	☐	8	Flag junction boxes.
☐	☐	9	Install insulation depth measuring sticks.
☐	☐	10	Identify areas where insulation will not be installed.
☐	☐	11	Complete ceiling-plane air sealing: seal all holes between the interior of the house and the attic.
☐	☐	12	Install baffles at low venting.
☐	☐	13	Install insulation dams at attic accesses and around heat producing devices.
☐	☐	14	Install insulation according to the manufacturer's specifications. Verify that all insulation has no gaps, voids, compression or misalignment.
✓	N/A		CLOSE OUT
☐	☐	15	Clean the work areas.
☐	☐	16	Educate the occupants on the work completed.
☐	☐	17	Post Insulation Certificate and insulation manufacturer's coverage chart.

WALLS - common air leakage details include but are not limited to: **Project:**

✓	N/A		PREPARATION
☐	☐	1	Openings behind and under tubs, showers, and tub/shower enclosures
☐	☐	2	Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
☐	☐	3	Pocket door framing open into floor or attic above and exterior walls
☐	☐	4	Seams and openings in walls and ceilings between attached garages and house
☐	☐	5	All joints seams and penetrations in surfaces without an air retarding membrane
☐	☐	6	Gaps in tongue in groove paneling where angles change at hips, valleys, and where walls meet slants and ceilings
☐	☐	7	Built-in cabinets, dressers or book shelves in knee walls.
☐	☐	8	Common wall openings between dwelling units
☐	☐	9	Rim joist junctions and gaps between sill and foundation, including open block cores
☐	☐	10	Utility penetrations and direct openings through foundation walls
☐	☐	11	Openings in gypsum board including un-taped joints above suspended ceiling and behind cabinets
☐	☐	12	Openings between window and door assemblies and their respective jambs and framing when no interior or exterior trim is present

FLOOR PLANE - common air leakage details include but are not limited to: **Project:**

✓	N/A		PREPARATION
☐	☐	1	Plumbing wet walls, duct chases, duct seams, joints and boot leaks
☐	☐	2	Openings behind and under tubs, showers, and tub/shower enclosures
☐	☐	3	Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
☐	☐	4	Floors open under knee walls, walls open at level changes and gable ends
☐	☐	5	Pocket door framing open into floor or attic above and exterior walls
☐	☐	6	All joints seams and penetrations in surfaces without an air retarding membrane
☐	☐	7	Gaps below baseboard and behind carpet nailing strip at subfloor joint to exterior wall
☐	☐	8	Rim joist junctions and gaps between sill and foundation, including open block cores

ATTIC - common air leakage details include but are not limited to: **Project:**

✓	N/A		PREPARATION
☐	☐	1	Dropped soffits, dropped ceilings and ceiling height changes
☐	☐	2	Plumbing wet walls, duct chases, duct seams, joints and boot leaks
☐	☐	3	Chimney and combustion vent chases
☐	☐	4	Wall tops open into attic, gaps between gypsum ceiling and wall plates
☐	☐	5	Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
☐	☐	6	2^{nd} story floors open to attached roofs over porches and additions or garages
☐	☐	7	Inside framing open into attic stairs and landings
☐	☐	8	Pocket door framing open into floor or attic above and exterior walls
☐	☐	9	Non-IC recessed light fixtures. IC rated fixtures with no airtight insert
☐	☐	10	Bath and kitchen fans venting into the attic
☐	☐	11	All joints seams and penetrations in surfaces without an air retarding membrane
☐	☐	12	Gaps in tongue in groove paneling where angles change at hips, valleys, and where walls meet slants and ceilings
☐	☐	13	Acoustical tile and suspended ceilings with no solid ceiling above.
☐	☐	14	Missing gypsum behind decorative ceiling light trays or above decorative ceiling beams
☐	☐	15	Built-in cabinets, dressers or book shelves in knee walls.
☐	☐	16	Attic access openings, operable doors and hatches without tight weather-strip
☐	☐	17	Pull down attic access stair or cover
☐	☐	18	Attic floor where interior surface will not support dense pack, has weak plaster, active Knob and Tube (K&T), non IC lights, vermiculite, etc.

AIR SEALING - common air leakage details include but are not limited to: **Project:**

✓	N/A		PREPARATION
☐	☐	1	Dropped soffits, dropped ceilings and ceiling height changes
☐	☐	2	Plumbing wet walls, duct chases, duct seams, joints and boot leaks
☐	☐	3	Chimney and combustion vent chases
☐	☐	4	Openings behind and under tubs, showers, and tub/shower enclosures
☐	☐	5	Wall tops open into attic, gaps between gypsum ceiling and wall plates
☐	☐	6	Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
☐	☐	7	Floors open under knee walls, walls open at level changes and gable ends
☐	☐	8	2nd story floors open to attached roofs over porches and additions or garages
☐	☐	9	Inside framing open into attic stairs and landings
☐	☐	10	Pocket door framing open into floor or attic above and exterior walls
☐	☐	11	Seams and openings in walls and ceilings between attached garages and house
☐	☐	12	Non-IC recessed light fixtures. IC rated fixtures with no airtight insert
☐	☐	13	Bath and kitchen fans venting into the attic
☐	☐	14	All joints seams and penetrations in surfaces without an air retarding membrane
☐	☐	15	Gaps in tongue in groove paneling where angles change at hips, valleys, and where walls meet slants and ceilings
☐	☐	16	Acoustical tile and suspended ceilings with no solid ceiling above.
☐	☐	17	Missing gypsum behind decorative ceiling light trays or above decorative ceiling beams
☐	☐	18	Built-in cabinets, dressers or book shelves in knee walls.
☐	☐	19	Gaps below baseboard and behind carpet nailing strip at subfloor joint to exterior wall
☐	☐	20	Common wall openings between dwelling units
☐	☐	21	Attic access openings, operable doors and hatches without tight weather-strip
☐	☐	22	Pull down attic access stair or cover
☐	☐	23	Rim joist junctions and gaps between sill and foundation, including open block cores
☐	☐	24	Utility penetrations and direct openings through foundation walls
☐	☐	25	Openings in gypsum board including un-taped joints above suspended ceiling and behind cabinets
☐	☐	26	Openings between window and door assemblies and their respective jambs and framing when no interior or exterior trim is present
☐	☐	27	Attic floor where interior surface will not support dense pack, has weak plaster, active Knob and Tube (K&T), non IC lights, vermiculite, etc.

Department of Commerce

ASHRAE 62.2 Intermittent fan flow calculator

Project Identifier	
Inspection Date	
Auditor Inspector	

Enter amount of continuous ventilation required #VALUE! *** your input goes in the green box*

IF you choose to use a cycle time of one hour you may use this calculator, for other cycle times please refer to the table below.

Intermittent Fan #1
Measured Fan Flow cfm *Minutes Per Hour required for this fan only* 0 ***Set fan to this many minutes per hour for single intermittent fan strategy. Note: If the value in this box is greater than 59 the additional amount must be dealt with by another fan***

If you choose a strategy with two intermittent fans enter the minutes intermittent fan #1 is set for here: min. ***Otherwise leave this blank***

Intermittent Fan #2
Measured Fan Flow cfm *Minutes Per Hour required for this fan* 0 ***Set second fan to this many minutes for double intermittent fan strategy***

Cycle Time

Time between the start of fan "ON" cycles must not exceed the times below (in hours).

Example: If your cycle time is fan on once every hour; use the 0-4 column. If it is once every three hours use the 0-4 column. You must move to the 8 hour column if you exceed 4 hours..and up to 12 if you exceed 8 etc.

	Run Time (min)	0-4	8	12	24
Run Time	6	######	######	not allowed	not allowed
Fan must be set to run for at least this many minutes of each hour in desired cycle	12	######	######	#VALUE!	not allowed
	18	######	######	#VALUE!	not allowed
	24	######	######	#VALUE!	#VALUE!
	30	######	######	#VALUE!	#VALUE!
	36	######	######	#VALUE!	#VALUE!
	42	######	######	#VALUE!	#VALUE!
	48	######	######	#VALUE!	#VALUE!
	54	######	######	#VALUE!	#VALUE!
	60	######	######	#VALUE!	#VALUE!

Example: If your cycle time is fan on once per hour the run time is as shown. If your cycle time is two hours multiply the times shown by two and that is the number of minutes required.

Fan Flow must measure at least the amount shown at the intersection of the appropriate run time per hour and cycle time shown above (in CFM)

Example: If your cycle time is fan on once every 12 hours AND your run time is only 6 minutes per hour, you see this is not allowed. If your cycle time is between 0 and 4 hours AND your run time is 30 minutes per hour, your fan flow must equal exactly twice the amount of continuous ventilation you entered in the green box above

Notes

This is the note box

Revised 6/26/17

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ASHRAE 62.2 Ventilation, Pre-Weatherization Conditions *** Your input goes in the green squares ***

Technical Document Line Reference

IMPORTANT INFORMATION

Before entering any information in this sheet "save as" a new file. For best results always use a fresh template

This worksheet is only for calculating those projects for which all necessary inputs are reflected on the sheet. For all other projects refer directly to the ASHRAE 62.2-2013 standard.

This upper section of the worksheet is for recording data and existing fan conditions at the project start.

Complete all inputs in GREEN cells according to instructions.

Project Identifier	
Audit Date	
Auditor Inspector	

Item	Input	Value	Line
Pre-Weatherization blower door reading CFM50			1
People (not less than one)	1		2
Bedrooms (not less than one)	1	15.0	3
Conditioned Square Footage		0.0	4
Initial Fan Flow Required (Q_{fan}) per ASHRAE calculation 4.1a		15.0	5

Room	Room Exists? (y/n)	Window cfm	Operable Window? (y/n)	Intermittent Required		Intermittent Measured Fan (cfm)	Continuous Required		Continuous Measured Kitchen = ach		Deficits (cfm)	Line
Kitchen	y	0		100	cfm		5	ach		ach	100.0	6
Bath 1		0		50	cfm		20	cfm		cfm	None	7
Bath 2		0		50	cfm		20	cfm		cfm	None	8
Bath 3		0		50	cfm		20	cfm		cfm	None	9
										Total Deficit	100.0	10
										Deficit /4	25.0	11

Needed Ventilation Estimate (prior to credits)	cfm	40.0	12

N-Values for Infiltration Credit (ASHRAE 62.2 - 2013)

Washington	WSF	1	1.5	2	2.5	3
Olympia	0.54	35.6	30.3	27.0	24.7	22.9
Seattle	0.56	34.3	29.2	26.0	23.8	22.1
Spokane	0.64	30.0	25.5	22.8	20.8	19.4
Yakima	0.57	33.7	28.7	25.6	23.4	21.7
Portland	0.51	37.7	32.1	28.6	26.1	24.3

For most accurate estimate: Enter a blower door reading following air sealing and any other measures significantly affecting building tightness. If no other reading is entered, CFM50 from line 1 (above) will transfer here.	Blower Door CFM50	N-Value from table (at left)	Actual Infiltration Estimate	Line
	0	#VALUE!	#VALUE!	13

14

15

16

Input location and number of stories belows:

Location

Stories

Sum of existing continuous bathroom ventilation from above (cfm)	0.0	17
Enter the total cfm of all additional continuous ventilation that is not shown on lines 7-9. Include any continuous kitchen ventilation in CFM		18
Required mechanical ventilation rate	#VALUE!	19

Pre Weatherization Notes:

ASHRAE 62.2 Ventilation Requirements - Post Weatherization(FINAL)

Line Reference

IMPORTANT INFORMATION

This worksheet is only for calculating those projects for which all necessary inputs are reflected on the sheet. For all other projects refer directly to the ASHRAE 62.2-2013 standard.

This lower section of the worksheet is for recording data and existing fan conditions at the project completion. Complete all inputs in GREEN cells according to instructions.

Note: Some input values may transfer from estimate sheet. You MUST verify all numbers in green cells are the final values for your project.

Inspection Date	
Auditor Inspector	

Item	Input	Value	Line
People (not less than one)	1		20
Bedrooms (not less than one)	1	15.0	21
Conditioned Square Footage	0	0.0	22
Q_{fan} total per ASHRAE calculation 4.1a		15.0	23

Room	Room Exists? (y/n)	Window cfm	Operable Window? (y/n)	Intermittent Required		Intermittent Measured Fan (cfm)	Continuous Required		Continuous Measured Kitchen = ach		Deficits (cfm)	Line
Kitchen	y	0	0	100	cfm		5	ach		ach	100.0	24
Bath 1	0	0	0	50	cfm		20	cfm		cfm	None	25
Bath 2	0	0	0	50	cfm		20	cfm		cfm	None	26
Bath 3	0	0	0	50	cfm		20	cfm		cfm	None	27
										Total Deficit	100.0	28
										Deficit /4	25.0	29

Needed Ventilation (prior to credits)	cfm	40.0	30

This is the final blower door number for this project. A final measured CFM50 must be entered to calculate infiltration credit	Blower Door CFM50	N-Value	Actual Infiltration	Line
		#VALUE!	#VALUE!	31

32

33

34

Sum of existing continuous bathroom ventilation from above (cfm)	0.0	35
Enter the total cfm of all additional continuous ventilation that is not shown on lines 25-27. Include any continuous kitchen ventilation in CFM		36
Continuous Ventilation Required To Add Per ASHRAE 62.2-2013 (needed-credit-existing continuous) Number must be less than or equal to fifteen (15) at final OR documentation of intermittent strategy for remaining amount must be added to project file. Numbers less than fifteen (15) reflect amount of ventilation over 62.2 minimum requirements.	#####	37

Post Weatherization (Final) Project Notes:

1	Location	WSF	1.0	1.5	2.0	2.5	3.0
2	Bellingham Intl AP	0.58	33.2	28.2	25.1	23.0	21.4
3	Bremerton National	0.55	35.0	29.7	26.5	24.2	22.5
4	Dalles Municipal Arpt	0.61	31.5	26.8	23.9	21.9	20.3
5	Ephrata AP FCWOS	0.6	32.1	27.3	24.3	22.2	20.7
6	Fairchild AFB	0.63	30.5	26.0	23.1	21.2	19.7
7	Felts Fld	0.56	34.3	29.2	26.0	23.8	22.1
8	Gray AAF	0.52	37.0	31.4	28.0	25.6	23.8
9	Hanford	0.61	31.5	26.8	23.9	21.9	20.3
10	Hoquiam AP	0.61	31.5	26.8	23.9	21.9	20.3
11	Kelso Wb AP	0.52	37.0	31.4	28.0	25.6	23.8
12	Moses Lake Grant County AP	0.55	35.0	29.7	26.5	24.2	22.5
13	Olympia Airport	0.54	35.6	30.3	27.0	24.7	22.9
14	Pasco	0.54	35.6	30.3	27.0	24.7	22.9
15	Pullman/Mosco Rgnl	0.59	32.6	27.7	24.7	22.6	21.0
16	Quillayute State Airport	0.56	34.3	29.2	26.0	23.8	22.1
17	Renton Muni	0.51	37.7	32.1	28.6	26.1	24.3
18	Seattle - Tacoma Intl A	0.56	34.3	29.2	26.0	23.8	22.1
19	Seattle Boeing Field [ISIS]	0.49	39.2	33.4	29.7	27.2	25.3
20	Snohomish Co	0.54	35.6	30.3	27.0	24.7	22.9
21	Spokane International AP [Cheney - UO]	0.64	30.0	25.5	22.8	20.8	19.4
22	Stampede Pass	0.66	29.1	24.8	22.1	20.2	18.8
23	Tacoma McChord AFB	0.54	35.6	30.3	27.0	24.7	22.9
24	Tacoma Narrows	0.53	36.3	30.9	27.5	25.2	23.4
25	Toledo - Winlock Mem	0.52	37.0	31.4	28.0	25.6	23.8
26	Walla Walla City County AP	0.56	34.3	29.2	26.0	23.8	22.1
27	Wenatchee/Pangborn	0.57	33.7	28.7	25.6	23.4	21.7
28	Whidbey Island NAS	0.61	31.5	26.8	23.9	21.9	20.3
29	William R Fairchild	0.57	33.7	28.7	25.6	23.4	21.7
30	Yakima Air Terminal	0.57	33.7	28.7	25.6	23.4	21.7
31	Portland	0.51	37.7	32.1	28.6	26.1	24.3

1	Stories		
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State of Washington, Weatherization Assistance Program

Technical Support Document

Mechanical Ventilation Worksheet

ASHRAE 62.2-2013

This document is intended to support in detail the Mechanical Ventilation Worksheet (Exhibit 9.3). The worksheet is designed to be both a calculation and documentation tool. **The Mechanical Ventilation Worksheet is only for calculating projects using a continuous whole building ventilation strategy and for which all necessary inputs are reflected on the sheet.** For all other projects within the scope of ASHRAE 62.2-2013 refer directly to the standard for calculation guidance.

The upper portion of the Mechanical Ventilation Worksheet is for recording pre-weatherization conditions of the project and to help estimate continuous ventilation to be added. **If you plan to use an intermittent strategy for whole building ventilation you must refer directly to the standard.**

The lower portion of the Mechanical Ventilation Worksheet is for recording post-weatherization conditions and documenting compliance with ASHRAE 62.2-2013.

User entries to the worksheet are made in the GREEN BOXES.

NOTE: For best results ALWAYS use a fresh worksheet template. For user convenience some of the data transfers to other areas of the sheet. Starting with a fresh template will help ensure old data is not causing an erroneous result.

For convenient simplified instructions while working on the worksheet simply hover the cursor over cells with a red triangle in the upper right hand corner. Comment boxes should appear with abbreviated help notes.

Line #1 Pre-Weatherization Blower Door Reading cfm50

Enter the cfm50 from the initial audit prior to any weatherization work per Commerce s4.1.

Line #2 People

Enter the total number of occupants. May not be less than one. *Per ASHRAE 62.2-2013 section 4.1.1*

Line #3 Bedrooms

Enter the number of bedrooms. Not to be less than one. *Per ASHRAE 62.2-2013 section 4.1*

Calculation: The yellow box on this line calculates (number of bedrooms +1)*7.5 OR (number of occupants)*7.5, Whichever is greater. *Per ASHRAE 62.2-2013 section 4.1.1*

Line #4 Conditioned Square Footage

Enter total conditioned square footage for the building.

Calculation: The yellow box on this line calculates (conditioned square footage)*.01

Line #5 Fan Flow Required (*Qfan*)

This is a calculated value as defined as *Qfan* in ASHRAE 62.2-2013 section 4.1. This value will be at, or below the value shown in ASHRAE 62.2-2013 table 4.1a.

Note regarding lines #6-9

This section is to determine any local exhaust deficits. Each line has four possible boxes for user entry. The first two boxes on the left of each line require a "y" entry if the room exists in the building or an operable window exists in a room. You may enter "n" in these boxes if the response is no, or leave the box blank. The entire line may be left blank if the "room exists" response is no.

The default deficit on each line is "None". When the room indicator is set to "y" the required intermittent ventilation will show in the deficit column. ASHRAE 62.2-2013 does not require these deficits to be overcome but the whole building ventilation system must make up for any deficiency. Consult Commerce specifications, especially section 10, for other fan location requirements dependent upon building conditions such as excess moisture and gas ranges.

STRATEGY NOTE: Experimenting with different fan strategies on lines 6-10 can help the auditor achieve a whole building ventilation strategy using lower cfm continuous fans in required ventilation rooms. For file documentation purposes return the entries in the boxes to the actual measured values prior to printing, or saving the document.

This section assumes all fans entered are properly vented, or will be vented to the exterior during the weatherization process.

Line #6 Kitchen

In the "Intermittent Measured Fan" column enter the measured fan flow in cubic feet per minute (cfm) for any existing intermittent fan which is vented to the exterior of the building. See Commerce specification 10.0.3 for additional information flow measurement and exceptions. This column may be left blank if there is no fan, the fan has no flow, or is not vented to the exterior.

IF a continuous fan exists calculate the air changes per hour (ach) and enter this value in the "Continuous Measured" column. To calculate air changes per hour determine measured fan flow rate per hour (fan cfm*60) and divide it by the volume of the kitchen (Volume = length*width*height).

- Example: Kitchen dimensions are: 10' width by 12' length by 8' height and the continuous measured fan flow is 22 cfm. Volume = 10*12*8 = 960 cubic feet, Hourly fan flow = 22*60 = 1320 cubic feet per hour, 1320/960 = 1.375 ach.

Line #7 through #9 Bath 1, 2 or 3

Enter only rooms meeting the definition of a bathroom on these lines. Per ASHRAE 62.2-2013 definitions a bathroom is: any room containing a bathtub, a shower, a spa, or a similar source of moisture. Do not enter ½ baths, water closets etc*.

Enter existing intermittent fan flows in the third column of this section. If continuous fans exist enter the fan flow in cfm in the fourth column.

**Note: Intermittent fans in ½ baths, water closets, laundry rooms etc. shall not be entered on this worksheet. Properly vented continuous fans in these types of areas should be listed on line 18.*

Line #10 Total Deficit

This line represents the existing deficit in local ventilation per ASHRAE 62.2-2013 Normative Appendix A *especially section A.3.1.*

Line #11 Required Additional Airflow

The additional airflow required is the total deficit divided by four (per ASHRAE 62.2-2013 Normative Appendix A *especially section A.3.3*). This ventilation requirement can be overcome by addressing local ventilation issues in rooms requiring specific ventilation, through the whole building ventilation fan, or a combination of both.

Line #12 Needed Ventilation Estimate (prior to credits)

This entry is a sum of lines 5 and 11.

Line #13 Actual Infiltration Estimate

For most accurate estimate enter a blower door reading taken after air sealing and any other measures significantly affecting building tightness in the first box. If no other reading is entered, CFM50 from line 1 will automatically transfer here.

A value from the "N-Values for Infiltration Credit" table must be entered in the second box on this line. This value should be determined using the city which most accurately reflects the location and climatic conditions and the number of stories for the building. The default value is a one story building in Olympia, WA. *Note: Portland Oregon is included to more accurately address conditions in southwest Washington.*

The third box on this line is a function of the blower door number divided by the N-Value.

Line #14 Assumed Infiltration

ASHRAE 62.2-2013 assumes an infiltration rate of 2cfm per square foot of the building (per ASHRAE 62.2-2013 section 4.1.3). The first box on this line reflects the square footage entered on line 4. The second box is a function of the square footage multiplied by .02.

Line #15 Infiltration actual minus assumed

This line is merely a function of the actual measured infiltration from line 13 less the ASHRAE assumed value on line 14. If the value is zero or less there will be no infiltration credit and the assumed value is automatically included in the required ventilation calculation.

Line #16 Infiltration Credit

Per ASHRAE 62.2-2013 section 4.1.3 the infiltration credit allowed is ½ of the difference between the actual and assumed ventilation. No increase is required if the measured infiltration is lower than the assumed rate.

Line #17 Sum of existing bathroom ventilation

ASHRAE 62.2 currently does not include a provision for partial credit of continuous local ventilation in the deficit calculation (lines 6-10). Continuous ventilation is included in lines 6-10 for the purpose of overcoming the deficit if the fan flow is in excess of the required amounts (5 ach Kitchens and 20 cfm Bathrooms). These continuous amounts should be counted as part of a whole building continuous strategy. Any continuous bath fan ventilation is summed and transferred to this line. (See also Strategy Note regarding lines #6-9 above)

Line #18 Other Continuous Ventilation (including kitchen cfm)

If there is any other existing continuous ventilation that is expected to remain such as laundry, water closet, whole building, etc. sum all cfm and enter it here. Since kitchen ventilation was entered in ach on line 6 the actual cfm must be manually entered as part of this line total.

Line #19 Estimated Continuous Ventilation to Add

This line is the estimated continuous ventilation needed to meet ASHRAE 62.2-2013. The value is a function of line 12 subtracting lines 16, 17 and 18. If the total is less than zero the box will indicate "None".

Repeated from above:

STRATEGY NOTE: Experimenting with different fan strategies on lines 6-10 can help the auditor achieve a whole building ventilation strategy using lower cfm continuous fans in required ventilation rooms. For file documentation purposes return the entries in the boxes to the actual measured values prior to printing, or saving the document.

Estimate Notes

Be sure to record any relevant pre-weatherization or estimate notes in the box for file documentation.

Lines #20-23

All instructions for these lines are synonymous to the corresponding cells in lines #1-5 above. For user convenience values will transfer from original entries. If people, bedrooms or square footage have change simply enter the new values in the green boxes.

Lines #24-27

All instructions for these lines are synonymous to the corresponding cells in lines #6-9 above. For user convenience values will transfer from original entries in the "room exists" and "operable window" columns. Post weatherization (final flow) measurements are required for all required fans. These numbers must be manually entered in this section when utilized the Mechanical Ventilation Worksheet to demonstrate compliance with the standard.

Lines #28-30

No entry required. All instructions and explanations for these lines are synonymous to the corresponding cells in lines #10-12 above.

Line #31Final Blower Door cfm50

Enter the post weatherization blower door number in cfm50. The N-Value will transfer from the previous section. If you did not enter a proper N-Value in the upper section of the worksheet (from the "N-Values for Infiltration Credit" table) you must do so now. The actual building infiltration will calculate automatically by dividing the post weatherization blower door cfm50 by the N-Value.

Lines #32-34

No entry required. All instructions and explanations for these lines are the same as lines #14-16 above.

Line #35 Sum of Continuous Bath Fan Ventilation

No entry required. All instructions and explanations for this line are the same as line #17 above.

Line #36 Other Continuous Ventilation (including kitchen cfm)

Enter the total cfm of all continuous ventilation that **is not** shown on lines 25-27. **IMPORTANT NOTE Any continuous kitchen ventilation entered in ach on line 24 must be manually entered in cfm as part of this line total** (Measure post weatherization cfm of continuous kitchen fan or use other approved Commerce/ASHRAE 62.2-2013 method to determine flow value).

Line #37 Continuous Ventilation Required

This line is the continuous ventilation still needed to meet ASHRAE 62.2-2013. The value is a function of line 61 subtracting lines 34, 35 and 36. This value must be at, or less than “0” to demonstrate compliance to the standard. A negative number represents the amount of over-ventilation installed. Adjust fans/ventilation strategy to get the closest result to “0” if the equipment and building conditions allow it.

Final Project Notes

Be sure to record any relevant post-weatherization or other final notes in the box for file documentation.

Abbreviations:

ach: air changes per hour

cfm: cubic feet per minute

cfm50: leakage rate measured at a pressure of 50 pascals

Terms:

Air handler – A steel cabinet containing a blower with cooling and/or heating coils connected to ducts, which transport indoor air to and from the air handler.

Backdrafting – Continuous spillage of combustion gases from a combustion appliance.

Bimetal element – A metal spring, lever, or disc made of two dissimilar metals that expand and contract at different rates as the temperature around them changes. This movement operates a switch in the control circuit of a heating or cooling device.

Burner – A device that facilitates the burning of a fossil fuel like gas or oil.

Carbon monoxide – An odorless and poisonous gas produced by incomplete combustion.

Combustion air – Air that chemically combines with a fuel during combustion to produce heat and flue gases, mainly carbon dioxide and water vapor.

Combustion analyzer – A device used to measure steady-state efficiency of combustion heating units.

Depressurize – Cause to have a lower pressure or vacuum with respect to a reference of a higher pressure.

Dilution air – Air that enters through the dilution device --- an opening where the chimney joins to an atmospheric-draft combustion appliance.

Dilution device – A draft diverter or barometric draft control on an atmospheric-draft combustion appliance.

Draft diverter – A device located in gas appliance chimneys that moderates draft and diverts down drafts that could extinguish the pilot or interfere with combustion.

Fan control – A bimetal thermostat that turns the furnace blower on and off as it senses the presence of heat.

Flue – a channel for combustion gases.

Heat anticipator – A very small electric heater in a thermostat that causes the thermostat to turn off before room temperature reaches the thermostat setting, so that the house does not overheat from heat remaining in the furnace and ducts after the burner shuts off.

Heat rise – The number of degrees of temperature increase that air is heated as it is blown over the heat exchanger. Heat rise equals supply temperature minus return temperature.

High limit – A bimetal thermostat that turns the heating element of a furnace off if it senses a dangerously high temperature.

House pressure – The difference in pressure between the indoors and outdoors measured by a manometer.

Inch of water – Small air pressure differences caused by wind, blower doors, furnace fans, and chimneys are measured in inches of water (in.-H_20) in the American measurement system.

Input rating – The rate at which an energy-using device consumes electricity or fossil fuel.

Intermittent ignition device – A device that lights the pilot light on a gas appliance when the control system calls for heat thus saving the energy wasted by a standing pilot.

Make-up air – Air supplied to a space to replace exhausted air.

Manometer –Measuring device for small gas pressures

Mortar – A mixture of sand, water, and cement used to bond bricks, stones, or blocks together.

Net free area – The area of a vent after that area has been adjusted for insect screen, louvers, and weather coverings. The free area is always less than the actual area.

Open-combustion heater – A heating device that takes its combustion air from the surrounding room air.

Orphaned Natural Draft Water Heater - A natural draft water heater vented into an oversized chimney.

Oxygen depletion sensor (ODS) – A safety device for unvented combustion heaters that shuts gas off when oxygen is depleted.

Pascal – A unit of measurement of air pressure. (See Inch of water.)

Plenum – The piece of ductwork that connects the air handler to the main supply duct.

Pressure – A force encouraging movement by virtue of a difference in some condition between two areas.

Return air – Air circulating back to the furnace from the house, to be heated by the furnace and supplied to the rooms.

Room heater – A heater located within a room and used to heat that room.

Sealed-combustion heater – A heater that draws combustion air from outdoors and has a sealed exhaust system.

Space heating – Heating the living spaces of the home with a room heater or central heating system.

Spillage – Temporary flow of combustion gases from a dilution device.

Stack effect – The draft established in a building from air infiltrating low and exfiltrating high.

Stand-Alone Natural Draft Water Heater - A natural draft water heater vented into a properly-sized chimney in accordance with NFPA 31 for oil-fired units, NFPA 54 for gas-fired units, NFPA 58 for propane-fired units and NFPA 211 for solid-fueled units or the venting tables of a chimney liner manufacturer.

Steady-state efficiency – The efficiency of a heating appliance, after an initial start-up period, that measures how much heat crosses the heat exchanger. A combustion analyzer measures the steady-state efficiency.

Supply air – Air that has been heated or cooled and is then moved through the ducts and out the supply registers of a home.

Vent connector **–** The vent pipe carrying combustion gases from the appliance to the chimney.

Vent damper – An automatic damper powered by heat or electricity that closes the chimney while a heating device is off.

Venting – The removal of combustion gases by a chimney.

Worst-case depressurization test –A safety test, performed by specific procedures, designed to assess the probability of chimney back drafting.

WRT – “With respect to” used to show that the air pressures between two areas are being compared.

Zone – A room or portion of a building separated from other rooms by an air barrier----not usually an effective air barrier.

Manufactured Home - Underfloor Insulation Precheck

Project:

▯	N/A		PREPARATION
☐	☐	1	All plumbing supply leaks are repaired
☐	☐	2	All plumbing drain leaks are repaired
☐	☐	3	All forced air supply ducts are sealed, including trunk-lines and any jumper ducts
☐	☐	4	Furnace plenum connection to trunk-line duct is sealed
☐	☐	5	Cross over duct is installed or repaired to specification (see Fied Guide 3.1602.9b - Crossover ducts)
☐	☐	6	All floor-plain air sealing is complete, including marriage line, hole under the tub, plumbing penetrations, and electrical penetrations
☐	☐	7	All combustion air inlets that are ducted into crawlspace are maintained (they could be for wood stove, pellet stove, water heater, furnace)
☐	☐	8	All belly repairs and patching are complete
☐	☐	9	Belly material is pinned up against floor joists where possible in odrer to reduce sag and amount of insulation needed

Manufactured Home - Attic Insulation Precheck

Project:

☐	N/A		PREPARATION
☐	☐	1	All combustion appliance venting and flues maintain clearance to combustibles, unless zero clearance flue is in place
☐	☐	2	All ventilation systems maintain a continuous connection and terminate to the outdoors
☐	☐	3	All plumbing stacks are terminated to the outdoors
☐	☐	4	Non-IC rated light fixtures are replaced with air-tight IC rated fixtures
☐	☐	5	All ceiling-plane air sealing is complete, including marriage line, passive jumper ducts, and skylights
☐	☐	6	All roof, attic, and ceiling assemblies are structurally sound
☐	☐	7	Dishing and pooling issues of the roof that allow standing water are addressed
☐	☐	8	All known roof leaks are repaired