

Retrofitting Washington



Department of Commerce
Innovation is in our nature.

Standard Work Specifications Field Guide for **Single-Family and Manufactured Homes**

created by

Washington Department of Commerce

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Tip: Clicking on the [blue](#) SWS numbers below will bring you to that SWS on the NREL website

2.0100.1b - Hand Protection

DYgJfYX'Ci Ht'a Y.

Work completed safely without injury or hazardous exposure

Specifications:

Durable and wrist-protecting gloves will be worn that can withstand work activity

.....

Minimize skin contact with contaminants

Protect hands from sharp objects



Recognize potential risks



Wear appropriate hand protection

&'\$\$%'!<UbX'PfchWjcb



GOOD: Wear nitrile gloves when handling mastic



Inspect gloves for holes and damage to minimize risk

&'\$\$%'W- Respiratory Protection

DYgJfYX'Ci Ht-a Y.

Work completed safely without injury or hazardous exposure

GdYVZVUjcbfgL

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 SDSs for respiratory protection requirements

CVYVj YfgL

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



I bgUZ

Workers face health risks without the proper respirators.



6 YghDf UWjVW

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

&'\$\$%'W!`F YgdJfUrcfmiPfchWjcb



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

&'\$\$%'X - 9lectrical Safety

DYgJfYX`Ci Hwta Y.

Work completed safely without injury or hazardous exposure

GdYVqZWHjcbfgL

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

CV`Wfj YfgL

Avoid electrical shock and arc flash hazards



I bgUZ

Inspect house for unsafe electrical situations



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

&'\$\$%'X!'E`YwfjWU`SUZYm



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

&'\$\$%' - Carbon Monoxide (CO)

DYgJfYX'Ci HŁa Y.

Work completed safely without injury or hazardous exposure

GdYVZVUjcbfŁ

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 70 parts per million (ppm)

CVYVj YfŁ

Protect worker and occupant health



I bŁZ

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



6 YghDfUWjVW

Install carbon monoxide alarms

Hcc`g.

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

A UHfjUg.

1. Carbon Monoxide (CO) alarm

Carbon Monoxide (CO) Detectors: Local agencies shall install a minimum of one carbon monoxide (CO) detector per floor 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) ACGIH and NIOSH Standards.

&'\$\$%'Z- Protective Clothing

DYgJfYX'Ci Hwta Y.

Work completed safely without injury or hazardous exposure

GdYVZVUfcbfbl

SDSs 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)

CV'Wfj Yfbl

Protect worker from skin contact with contaminants

Minimize spread of contaminants



6 YZcfY

Workers should be aware of work required and dress appropriately



5 ZYf

Ensure workers have proper protective equipment for work environment

&'\$\$%' - Confined Space Safety

DYgJfYX'Ci Hta Y.

Work completed safely without injury or hazardous exposure

GdYVZVUHjcbfgL

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

CV^Wij YfgL

Prevent build-up of toxic or flammable contaminants

Provide adequate access and egress points

Prevent electrical shock



Locate all access and egress points of confined spaces before entering

&'\$\$%' !'7 cbZbYX'SdUW'SUZYm



Perform visual inspection of confined spaces before beginning work



Check for frayed or worn electrical wires



In confined spaces, use a ventilator

CHEMICAL NAME	
HEALTH HAZARDS	
PHYSICAL HAZARDS	
PHYSICAL HAZARDS	
TARGET ORGAN EFFECTS	
PERSONAL PROTECTIVE EQUIPMENT	
SEE SAFETY DATA SHEET	

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

&'\$\$%' - Power Tool Safety

DYgfYX'Ci Hta Y.

Work completed safely without injury or hazardous exposure

GdYVZVUHcbfgL

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

CV^Wij YfgL

Prevent power tool injuries

&'\$\$%'!`- 9rgonomic Safety

DYgJfYX`Ci Htca Y.

Work completed safely without injury or hazardous exposure

GdYVjZWUjcbfbl

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

CV`Wj Yfbl

Prevent injuries from awkward postures, repetitive motions, and improper lifting



I bgUZ

Workers will take precautions to protect themselves on the job site



6 YghDfUWjW

Hard hats, knee pads, bump caps, and team lifts help to prevent injury

2"1\$\$\$'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 prevent 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

&'\$\$%'d'!' - Lead Paint Assessment

DYgJfYX'Ci Hwta Y.

Work completed safely without injury or hazardous exposure

GdYVZVUJcbfgL

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

CV^WVj YfgL

Protect workers and occupants from potential lead hazards



Exterior lead containment elements



EPA-recognized Lead Test Kit

Hcc`g.

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

AUHfJUg.

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

&'\$\$(' '% - Vermiculite

DYgJfYX`Ci Hwta Y.

Work is completed safely without injury or hazardous exposure

GdYVqZWHjcbfgL

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

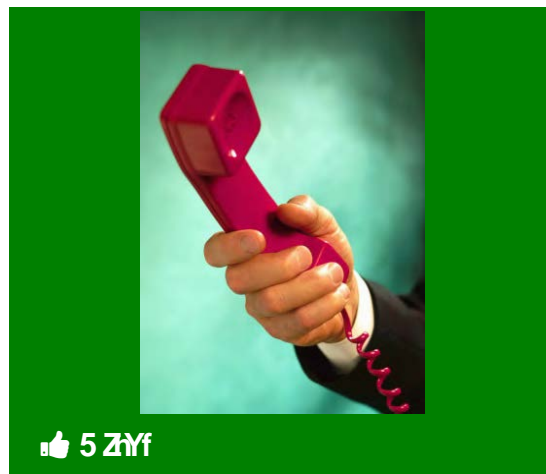
Attic insulation that looks like vermiculite (as opposed to fiberglass, cellulose, or urethane foams) will not be removed or disturbed

CV^Wfj YfgL

Protect workers from toxic exposure



Material identified as vermiculite may contain asbestos



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 assist with cost of reinsulating attic. See link for additional information <http://www.zonoliteatticinsulation.com/claim-form/>

&'\$\$(' %\ !'J Yfa JW`jhY



Do not disturb vermiculite by vacuuming, dusting, or sweeping



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

&'\$\$) 'W- Raw Fuel

DYgJfYX`Ci Ht-a Y.

Work completed safely without injury or hazardous exposure

GdYVZVUHjcbfgL

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

CV^VWj YfgL

Protect worker and occupant health



6 YZ:fY

Fuel leaks need to be repaired by appropriate professional



5 ZYf

Notify occupant of any leaks

Hcc`g.

1. Gas sniffer
2. Bubble solution

&'\$\$) '%W! 'Fuk 'Fi Y



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

&'\$\$) "&W- Asbestos

DYgJfYX`Ci Hwta Y.

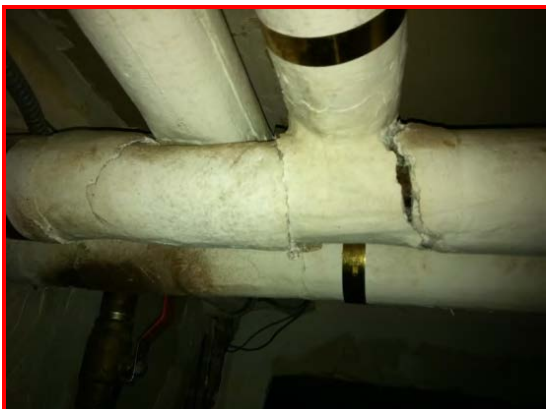
Work completed safely without injury or hazardous exposure

GdYVqZWUjcbfbl

Identify asbestos hazards in boiler and pipe insulation and remediate in accordance with EPA guidelines

CV^Wlj YfbL

Protect workers and occupants from asbestos exposure



I bgUZ

Suspicious pipe insulation may contain asbestos



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

&'\$\$) "&V - Mercury

DYgJfYX`Ci Hwta Y.

Work completed safely without injury or hazardous exposure

GdYVqZWUjcbfbl

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

CV^Wlj YfbL

Protect workers and occupants from mercury exposure



I bgUZ

Mercury thermostats should be replaced and disposed of properly



I bgUZ

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.

('\$\$) "&XZ('% \$%%XZ('%\$' '%/ - Onsite Documentation

DYgfYX'Ci Hwta Y.

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

GdYVjZWUjcbfjL

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

.....CVYVWj YfjL

Document job completion to contract specifications

Confirm amount of insulation installed

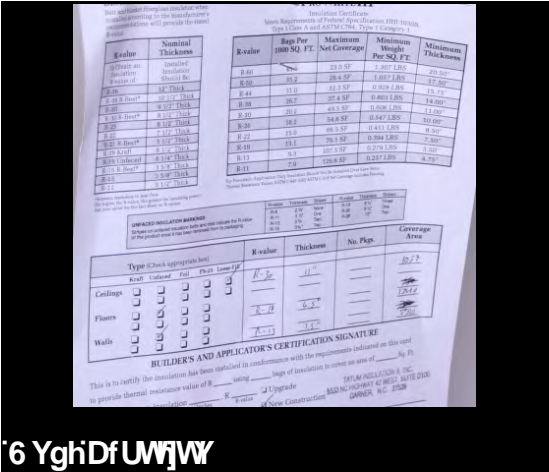
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



6 YghDfUWjVW

Information on insulation installed should be posted nearby



6 YghDfUWjVW

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.

CWV dUbhEXi WUjcb2: cfWYX'5 Jf'gmghYa g' G]b[`Y!: Ua J'm<ca Yg'

Hjhy'	GdYWzWUjcbfjL'	CV^WVj YfjL'	
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	

**CWW dUbh'EXi WUjcb2: cfWYX'5 Jf'gmghYa g'
GJb[`Y!: Ua J'm<ca Yg'**

	HjhY'	GdYWZWUjcbfL'	CV^WUj YfbL'	
	5.3003.7e Blocking air flow	<p>Importance of cleaning dust and debris from return grilles will be explained to occupant</p> <p>Proper placement of interior furnishings with respect to registers will be explained to occupant</p> <p>Negative consequences of closing registers will be explained to occupant</p> <p>Importance of leaving interior doors open as much as possible will be explained to occupant</p>	Ensure occupant does not prevent equipment from operating as designed	

CWW dUbhEXi WUjcb2: cfWYX'5 Jf'gmghYa g' G]b[`Y!: Ua J'm<ca Yg'

	HjhY'	GdYWZWUjcbfjL'	CV^WUj YfbL'	
	5.3003.7f Routine maintenance	<p>Proper filter selection and how to change the filter will be explained to occupant</p> <p>Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant</p> <p>Importance and timing of routine professional maintenance will be explained to occupant</p> <p>There will be no air bypass around the filters and new central forced air HVAC systems will have minimum MERV 6 filtration</p>	Ensure equipment operates as designed	

CWW dUbhEXi WUjcb2: cfWYX'5 Jf'gmghYa g' GJb[`Y!: Ua J'm<ca Yg'

HjhY'	GdYWZWUjcbfjL'	CV^WUj YfbL'	
5.3003.7g Calling heating, ventilation, and air conditioning (HVAC) contractor	<p>Situations when the occupant should contact the HVAC contractor will be explained, including:</p> <ul style="list-style-type: none"> • 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	<p>Occupant will be provided with relevant manuals and warranties</p> <p>The labor warranty will be explained and the occupant will be given a phone number to call for warranty service</p>	Provide manuals and warranties for future servicing	

* 2021e - Occupant education2Ventilation

Desired Outcome:

Fan controls support ventilation strategy

Specification(s):

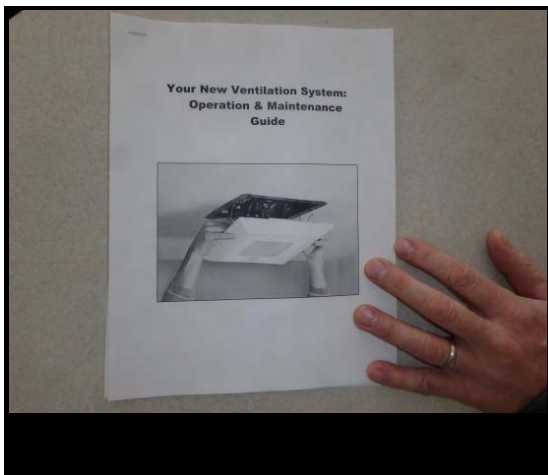
A system operation guide designed for occupants (non-professionals) will be provided to explain how and why to operate system

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

* " \$ \$) "le - Occupant Education 2Dryer Vent Maintenance

DYgJfYX`Ci Ht a Y.

Dryer air exhausted efficiently and safely

GdYVZWUjcbfgL

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)

CV^Wj YfgL

Effectively move air from clothes dryer to outside



I bgUZ

Neglect of clothes dryer maintenance can cause fire hazards



6 YghDf UWjW

Occupants should be taught to clean lint filters and termination fittings

* **\$\$) "1e - Occupant 9 ducation2Dryer 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)

&'\$\$%&'! - Assessmebt

DYgjfYX'Ci Hwta Y.

Accurate information about appliance safe operation is gathered

GdYWZWHjcbfbl

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

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

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

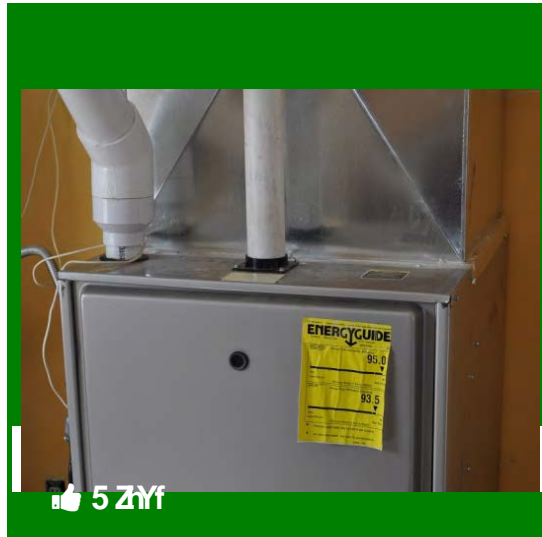
CVYWHj Yfbl

Ensure system does not have potentially fatal problems



Before

Unsafe combustion appliances indicate need for repair or replacement



5 ZYf

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

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

&'\$\$%&U!'5 ggYgga Ybh



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

&'\$\$%W - Fuel Lea_ Detection

DYgJfYX`Ci Hwta Y.

Accurate information about appliance safe operation is gathered

GdYVjZWUjcbfjL

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

CV`Wj YfbL

Detect fuel gas leaks

Determine and report need for repair



6 YZ:fY

Fuel lines should be inspected for leakage



5 ZYf

If leaks are found, notify occupant immediately to facilitate repair

Hcc`g.

1. Gas sniffer
2. Spray bottle

A UHfjUg.

1. Bubble solution

&'&\$%W!': i Y`LYU_`DYhWjcb



Inspect exterior gas and oil lines for leaks and damage



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

2.0201.1c - Venting

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

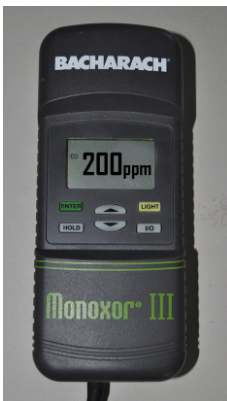
For oil systems that require a draft regulator, the presence and operability of it (that draft regulator) will be verified and tested.

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

Objective(s):

Determine if a regulator is present and working

Determine whether vent system is in good condition and installed properly



Unsafe

if ventilation system puts occupants at risk, it needs immediate attention



Safe

Properly vented appliances make a house healthier and more efficient



Determine if a draft regulator is installed and working



Inspect ventilation systems for damage



Inspect ventilation systems for disconnected pipes



Inspect ventilation systems for inadequate slope



Inspect for missing draft diverter

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

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

&'\$\$%W!

DYgJfYX`Ci Htca Y.

Accurate information about appliance safe operation is gathered

GdYVWZWHjc bfgL

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

CV^WVj YfbL

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

2.0201.2a - Outside Combustion Make-Up Air

Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

Specification(s):

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

Objective(s):

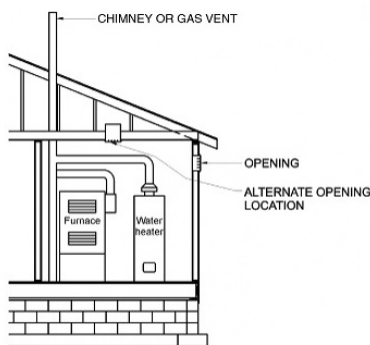
Prevent combustion byproducts from entering the house

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

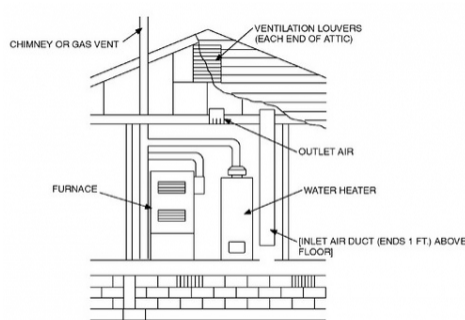
Image 2: For homes with two permanent vertical duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in² per 4,000 Btu/h (550 mm²/kW) of total input rating of all appliances

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



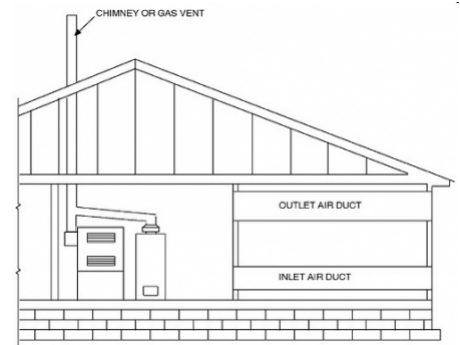
1

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



2

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



3

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

2021-2b - 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

2021b - New Appliances



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

Combustion Safety Testing-General

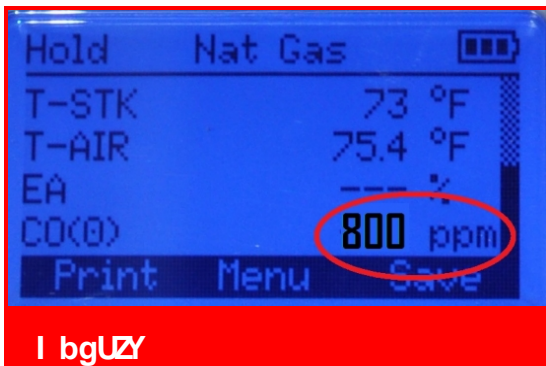
Gas Ovens

Gas ovens will be tested for CO

A clean and tune will be conducted if measured CO in the undiluted flue gases of the oven vent at steady state exceeds 225 ppm as measured

Clean and Tune

Ensure clean burn of gas ovens



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



Test gas oven for carbon monoxide using a combustion gas analyzer

Check

1. Combustion analyzer with probe

For gas range burners: specify clean and tune if the flame has any discoloration, flame impingement, an irregular pattern, or if burners are visibly dirty, corroded, or bent.

2"\$2\$1"2e - 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

&'\$\$%'&Y!'; Ug'RUb[Y'Bi fbYfg



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"2\$1'2f - 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



I nsafe

Unsafe solid fuel burning appliances should be replaced



Safe

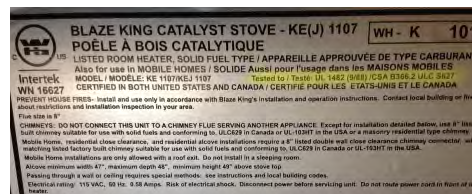
New appliances should be UL-listed and EPA-certified

1. New wood stoves installed on or after May 15, 2015, must meet EPA emission requirements and 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"2\$2\$1"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)

&'&\$%' U!'GdJ`U Y'HYgh

DYgJfYX`Ci Hwta Y.

Accurate information about appliance safe operation is gathered

GdYWZWUhc bfgk

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

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

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

CVYWjj Yfgk

Detect excessive spillage of combustion gases



I bgUZ

Test natural draft furnace or water heater for spillage in excess of 2min



6 YghDf UWjWY

Test all sides of natural draft flues since draft may be uneven

Hcc`g.

1. Smoke pencil
2. Timer

2.0201.3b - Carbon Monoxide (CO) Test in Appliance Vent

Desired Outcome:

Accurate information about appliance safe operation is gathered

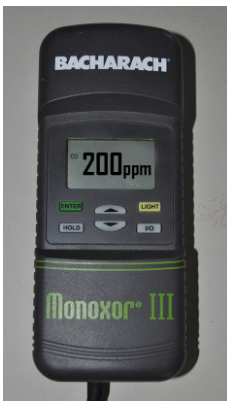
Specification(s):

CO will be tested for in undiluted flue gases of combustion appliances. In conditions with largest negative pressure as determined from Detail 2.0201.1e: If CO levels exceed 400 ppm air-free measurement in furnaces, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)

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

Objective(s):

Measure CO and report excessive levels



I bgUZ

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

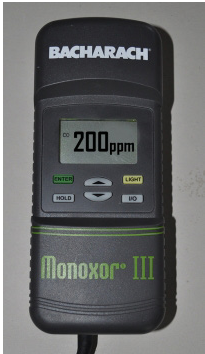


6 YghDf UWFjW

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

Tools:

1. Combustion analyzer with probe



CO levels cannot exceed 200ppm, or 400 ppm air-free CO



Test undiluted flue gases in induced-draft furnaces



Test undiluted flue gases in natural draft furnaces



Test undiluted flue gases in natural draft water heaters



Test accessible exhaust outlets for direct-vent appliances



Test accessible exhaust outlets for power-vented appliances

2.0201.3c - Final Test Out

Desired Outcome:

Accurate information about appliance safe operation is gathered

Specification(s):

Final combustion testing will be conducted at project completion to ensure compliance with the above specifications

Objective(s):

Ensure safe operation of combustion appliance within the whole house system after any repair project

2' \$' \$1 "1b - Smo_e 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

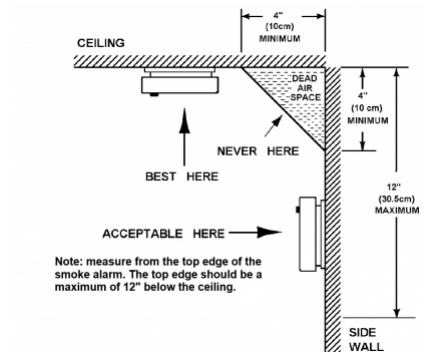
All homes should have UL-217-rated smoke alarms

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

2'5' \$1'1b - Smo_e 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.

&' \$' \$%'&V - CO Detection and Warning Equipment (Battery-Operated)

DYgJfYX'Ci Hwta Y.

Properly installed CO alarms or monitors

GdYVjZWUjcbfbl

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

CVYVWj YfbL

Ensure proper installation



Houses should have carbon monoxide monitors installed near sleeping areas



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. Where sleeping areas are located at opposite ends of the same level, a CO detector must be installed on each end.

Single-station CO alarms will comply with UL 2034 and will be installed in accordance with this code and the 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 per floor 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) ACGIH and NIOSH Standards.

&'\$* \$%%U - Knob and Tube Identification/ Reeuired Inspection

DYgJfYX'Ci Hwta Y.

Live unsafe wiring identified and brought to local codes

GdYVjZVUjcbfbl

Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring

CVYVWj Yfbl

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 NAC 206-206-010 Knob and tube wiring	
Type of wiring system: Roman _____ Knob & Tube _____ Both _____	
After wiring: _____	
1. General Condition: _____	APPROVED _____
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: _____	
1. General Condition: _____	APPROVED _____
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: _____	
1. General Condition: _____	APPROVED _____
2. Wire insulation: _____	Acceptable _____ Unacceptable _____
3. Circuit condition: _____	Acceptable _____ Overloaded _____
4. Fuse size correct: _____	Yes _____ No _____
5. S-type fuses: _____	Breakers _____
6. List measured voltage drop readings for all receptacles on exterior walls. Read at front entry, far corners _____	
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 insulation or the insulation.	
Journeyman's Name (Print) _____	
Journeyman's Signature _____	Date of evaluation _____
Revised 8/2004	

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

Hcc`g.

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.

&'\$* \$%%U!?'bcV'UbX`Ti VY'jXYbhqZWUjcb/ Reeured Inspection



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



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

KNOB AND TUBE
ELECTRICAL SYSTEM INSPECTION FOR INSULATION

Client: _____
Location: _____
Phone/Fax: _____

Ordered by Local Agency: No _____
Refer to NAC 280-454.5(a) Knob and tube wiring _____

Type of wiring system: Floor _____ Knob & Tube _____
Type of wiring: _____

APPROVED: _____
1. General Condition: Acceptable _____ Unacceptable _____
2. Wire insulation: Acceptable _____ Unacceptable _____
3. Circuit condition: Acceptable _____ Overloaded _____
4. Phase wire correct: Yes _____ No _____
5. If "No" item: _____
6. Referred repairs: _____

Under floor wiring: _____
1. General Condition: Acceptable _____ Unacceptable _____
2. Wire insulation: Acceptable _____ Unacceptable _____
3. Circuit condition: Acceptable _____ Overloaded _____
4. Phase wire correct: Yes _____ No _____
5. If "No" item: _____
6. Referred repairs: _____

Wall wiring: _____
1. General Condition: Acceptable _____ Unacceptable _____
2. Wire insulation: Acceptable _____ Unacceptable _____
3. Circuit condition: Acceptable _____ Overloaded _____
4. Phase wire correct: Yes _____ No _____
5. If "No" item: _____
6. List measured voltage drop readings for all receptacles in exterior walls. Read at both ends, for each device. _____

7. Referred repairs: _____

We have observed the visible wiring as extensively as possible and assume no responsibility for unobserved wiring in the wiring system caused by the insulation or the insulation.

Inspector's Signature: _____ Date of evaluation: _____
Printed Name: _____

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

' "%\$%&'W- Sealant Selection

DYgJfYX`Ci Ht-a Y.

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

GdYVjZWUjcbfjL

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

CV^Wj YfbL

Select permanent sealant

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



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



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

Hcc`g.

1. Caulk gun
2. Foam gun

A UHfjUg.

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

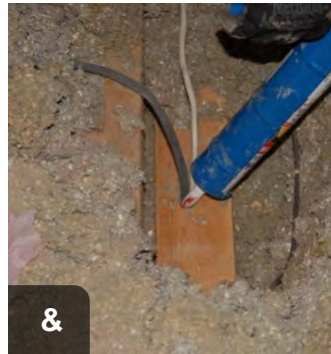
Seal around penetrations in the ceiling made by plumbing pipes and vent stacks, chimneys, ducting, ventilation equipment, electrical wiring, lighting fixtures and top plates to adjacent materials.

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.

' "%\$\$%W! GYUUbhSY YWjcb



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.

' "1\$\$1"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



👎 Before

Gaps around combustion exhaust flues need to be sealed



👍 After

Sealed penetrations and chases should utilize high-temperature materials

Tools:

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

Materials:

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

Use appropriate gloves when working with sheet metal.

High Temperature Application: Attic Air Sealing



1 Prepare work area by removing any insulation and debris



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



3 Apply first ring of caulking to match shape of opening



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



5 Fasten rigid, non-combustible material and apply additional caulking



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

' "%\$%&V - Standard Chase (Interior Walls Covered With Dryall or Plaster)

DYgJfYX'Ci Ht'a Y.

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

GdYVjZWUjcbfL

Entire opening will be spanned with rigid material

Material will be cut to fit and fastened as required

CV'VWj YfL

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

Hcc`g.

1. Drill/screwdriver
2. Caulk gun

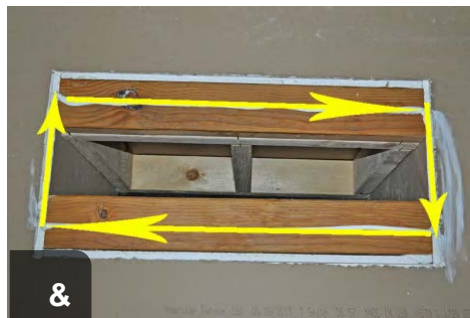
A UHfjUg.

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

' "%\$\$%&V !`GhUxUfX`C\ UgYflbhYf]cf`WU`g`Ccj YfYX`W]h `Dfmk U` cf`P`UghYfL



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

' "%\$%&'W- Non-Standard Chase (Interior Walls Covered With Wood or Paneling)

DYgJfYX'Ci Ht'a Y.

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

GdYVZVUHjcbfbl

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

CV'VWj YfbŁ

Prevent a fire hazard



Paneled drop soffits typically are more combustible than plain drywall



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

Hcc`g.

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

AUHf]Ug.

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

EPS or bead-board are not acceptable materials.

' "%\$%&W! Bcb!SHbXUfX`C\ UgY`f]bhYf]cf`WU`g`Cc j YfYX`W]h WccX`cf`PUbY]b[Ł



Soffit open to attic



Soffit now properly sealed from attic with drywall, sealant and fasteners

' "%\$%&X - Support - Capping Chases Greater Than 24"

DYgJfYX`Ci Hwta Y.

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

GdYVjZWUjcbfjL

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)

CV^VWj YfbL

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

Hcc`g.

1. Drill
2. Saw
3. Tape measure

A UHfjUg.

1. Lumber
2. Drywall
3. Fasteners

' "%\$\$%"&X !'Gi ddcfh- 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

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.



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 now sealed.

' '\$\$%' V - Sealing Methods - Open Wall Top

DYgJfYX'Ci Hwta Y.

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

GdYVjZWUjcbfbl

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

CV^Wij YfbL

Prevent air leakage from wall cavity to attic



Wall cavities are open to attic



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

Hcc`g.

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

A UHf]Ug.

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.

' "%\$\$%" V !`GYU]b[`MYh cXg - Open Wall Top



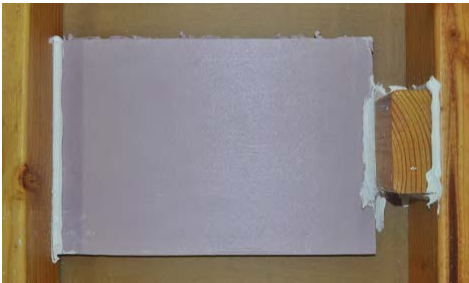
Option 1: Dense pack cavities through wood cap fastened in place



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.

' '\$\$%' Y - Adjacent Framing - Open Wall Top

DYgJfYX`Ci Hwta Y.

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

GdYVjZWUjcbfgk

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

CV^Wij Yfgk

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



6 YZcfY

Balloon framing needs to be capped and sealed to prevent leakage

Hcc`g.

1. Spray foam gun
2. Caulk gun



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

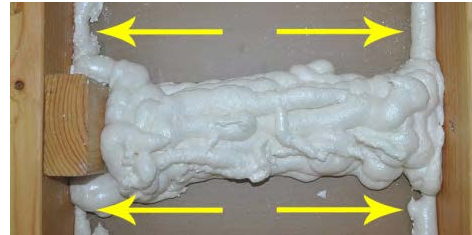
A UHf]Ug.

1. Spray foam (SPF)
2. Caulk

' "%\$\$%" Y!5 X^UWbhFfUa]b[- 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

' '\$\$' ' %/ - Sealing Methods - Dropped Ceiling

DYgJfYX'Ci Hwta Y.

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

GdYVZVUjcbfbl

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

CVYVWj YfbL

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

Hcc`g.

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

A UHf]Ug.

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

' '\$\$' '%V !'GYU]b['MYH cXg - Dropped Ceiling



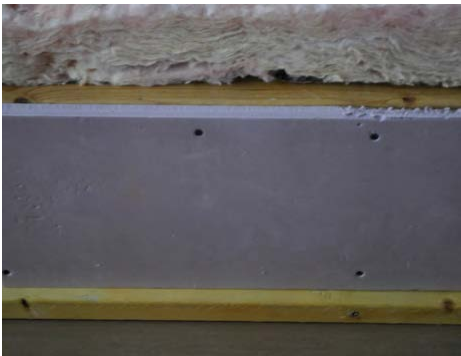
Prepare work area by removing existing insulation and debris



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

' '\$\$' " V - Above Closets and Tubs

DYgJfYX'Ci Ht'a Y.

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

GdYVZ'WUjcbfbl

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

CV'YVlj YfbL

Prevent air leakage from dropped ceiling to attic



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



Capped soffits minimize leakage to and from unconditioned spaces

Hcc`g.

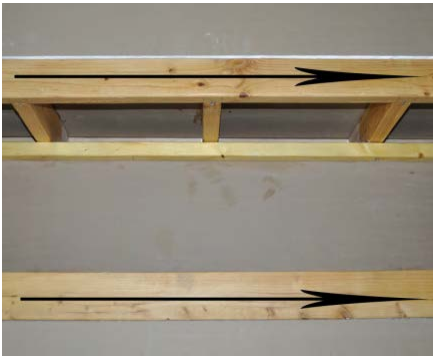
1. Utility knife
2. Saw
3. Tape measure
4. Insulation machine
5. Drill
6. Caulk gun
7. Spray foam gun
8. Smoke pencil

A UHf]Ug.

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)

' '%\$' " V!5 Vcj Y'C`cgYhg'UbX'Ti Vg



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

' ' '\$\$' " Y - Adjacent Framing - Above Closets and Tubs

DYgJfYX'Ci Htca Y.

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

GdYVZVUhc bfgL

All remaining gaps at the top of the dropped ceiling will be sealed

CV'VWjj YfgL

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



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after sealant is applied along adjacent framing

Hcc`g.

1. Caulk gun
2. Spray foam gun

A UHf]Ug.

1. Caulk sealant
2. Spray foam

' '\$\$' " Y! '5 X'UWbhFfUa]b[- 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

' %\$\$' " V - Soffit General

DYgJfYX'Ci Ht'a Y.

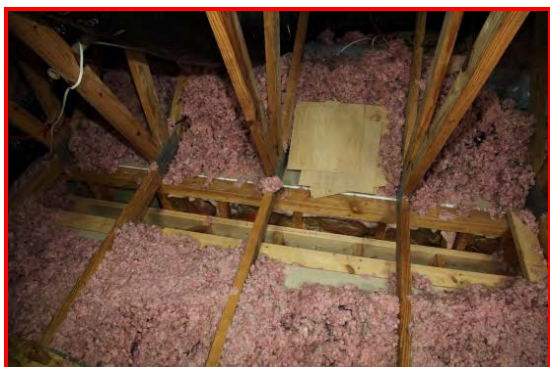
Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

GdYVZVUhc bfgL

Air flow will be blocked at soffit in locations where access allows

CV^VWj YfgL

Provide continuous air barrier across soffit openings



6 YZ:fY

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



5 ZYf

Completely sealed drop soffits and chases minimize heat transfer

Hcc`g.

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

A UHf]Ug.

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.

' '\$\$' ' W- Option 1: Bring Soffit Inside (Seal at Top)

DYgJfYX'Ci Htca Y.

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

GdYVZWHjcbfgL

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

CV'VWjj YfgL

Prevent air leakage from wall to attic

Reduce opening to what can be sealed with sealant

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

Bring soffit into thermal boundary



Standard soffits are often open to the attic and uninsulated

Hcc`g.

1. Drill/screwdriver
2. Caulk gun



Rigid material encloses the soffit into the conditioned living space

A UHf]Ug.

1. Drywall
2. Sealant

' '\$\$' '* W!`CdHcb`%`Bf]b[`ScZ[h]bg]XY`fBYU`UhTcdŁ



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

' %\$\$' " X - Option 2: Leave Soffit Outside (Seal at Bottom or Side)

DYgJfYX'Ci HŁca Y.

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

GdYVZVUhc bfgŁ

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

CV'VWj YfgŁ

Prevent air leakage from wall to soffit

Reduce opening to what can be sealed with sealant

Ensure soffit is outside of the thermal boundary



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



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

How to:

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

' %\$\$' " X !'CdHcb'& 'LYUj Y'ScZlhiOi hg]XY'fBYU'UhBcltca 'cr SiXYL



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

('%%\$%U - Air Barrier System - Non-IC Rated Recessed Light

DYgJfYX'Ci Hwta Y.

Ensure safety from fire and prevent air leakage

GdYVZVUjcbfgL

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

CV^Wj YfgL

Prevent a fire hazard

Prevent air leakage through fixture



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



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

Hcc`g.

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

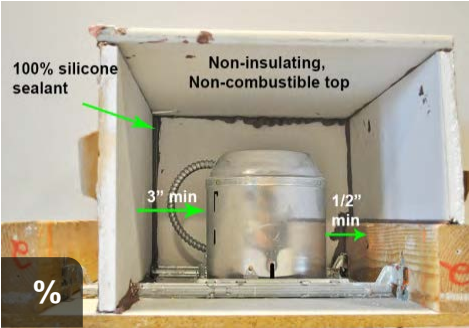
A UHYfjUg.

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

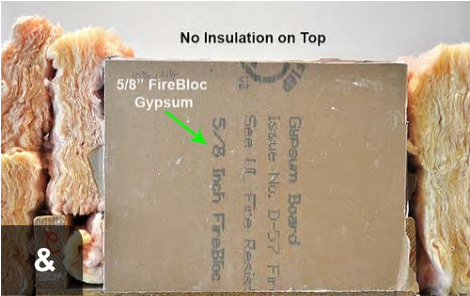
Note: 3" clearance between enclosure and fixture. Enclosure height shall be above surrounding insulation. Top of enclosure shall not be insulated. Enclosure lid may not exceed R value of .5. if this spec cannot be met, replace Non IC rated fixture with Airtight IC-rated fixture or surface-mounted fixture.

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.

('\$\$%U!5 f' BUffjYf' SngHYa - 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

5 Jf '6 Uff]Yf 'GnghYa '! 7 'F UhYX'F YWggYX' @[\ h

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.

5 Jf '6 Uff JYf 'GmghYa '! 7 'F UhYX'F YWggYX' @[\ h



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.

("\$\$\$% "!" - Air Seal and Dam Around Hot Pipe

DYgJfYX`Ci Hwta Y.

Combustible materials kept away from combustion sources

GdYVZVUJcbfgL

Holes, penetrations, and bypasses will be sealed

Dams will be fixed in places that maintain required clearance

CV`YVWj YfgL

Prevent air leakage

Ensure insulation dams maintain clearance



6 YZcfY

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



5 ZYf

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

Hcc`g.

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

A UHfjUg.

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

("%\$\$%" U! 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



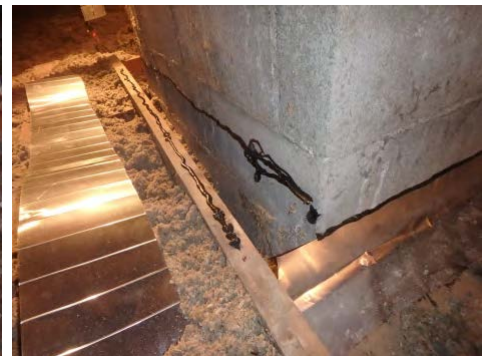
Only construct dam after sealing has been completed properly



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.

4"1\$\$1"4a - Low Attic-Vent Baffles-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):

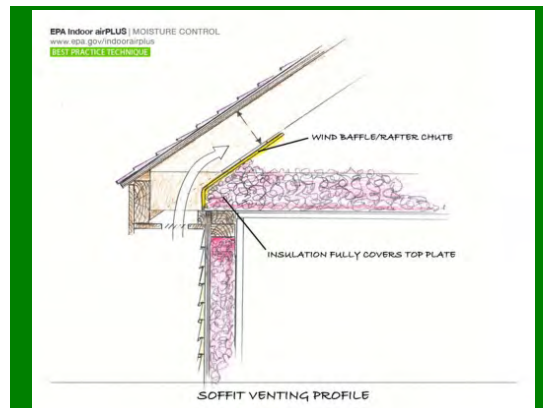
Ensure insulation R-value is not reduced

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.

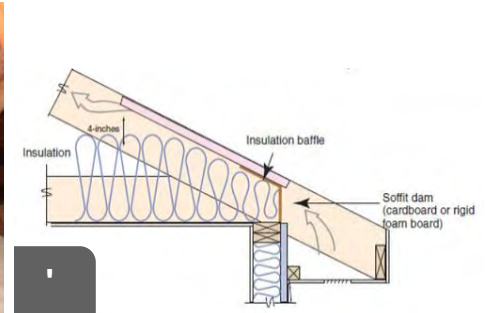
4"1\$\$\$1"4a - Low Attic-Vent Baffles-Installation



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

(\$\$(\$U - Knee Wall Prep for Batts

DYgfYX'Ci Hta Y.

Airtight cavity and properly insulated knee wall

GdYVZVUHcbfgL

All knee walls will have a top and bottom plate or blockers installed using a rigid material

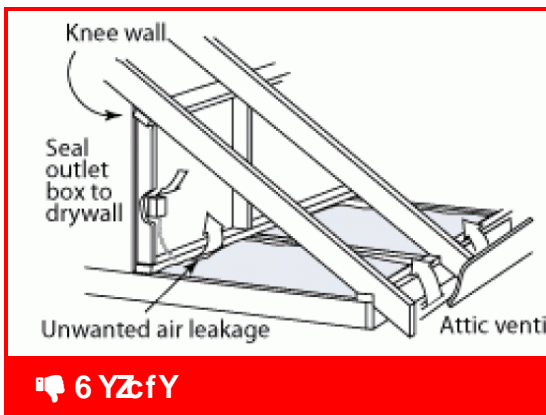
All joints, cracks, and penetrations will be sealed in finished material, including interior surface to framing connections

CV'WVj YfgL

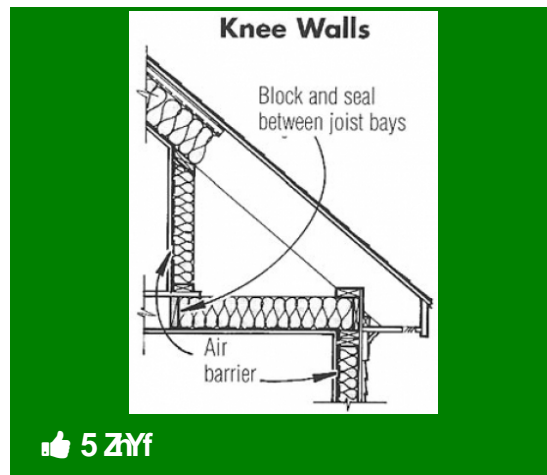
Eliminate bending, sagging, or movement that may result in air leakage

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

Hcc`g.

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

AUHf]Ug.

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

("%\$\$ ("&U!`?bYY`WU``PfYd`Zcf`BUhg



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

("\$\$("&V - Knee Wall - Installation

DYgJfYX`Ci Ht-a Y.

Airtight cavity and properly insulated knee wall

GdYVqZWUjcbfgL

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

CV^Wij YfgL

Eliminate misalignment of existing insulation



Knee wall with batts improperly installed and missing from stud bays



Properly fit insulation filling full volume of stud bay

Hcc`g.

1. Utility knife
2. Tape measure

A UHYjUg.

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.

("%\$\$ ("&V !'Knee Wall - ÷bghU`Uñcb



Where existing insulation is improperly installed, fix it



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



Batts should fill entire volume of knee wall stud bays



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-ENL 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.	Shedface / Zigzag (must be stapled at each joist)	Corrosion resistant 3/8" crown 18AWG	5/8"
Post & Beam over 22" C.C.	Lath	3-ENL 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 22" C.C.	Twine	150 LBS. polyester, polypropylene or nylon	12"	Shedface up to 54" across. If over 54" need center support	Corrosion resistant 3/8" crown 18AWG	5/8"

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

See Appendix B

("0\$\$) "&U - Accessible Floors - Loose-Fill Installation - Preperation

DYgJfYX`Ci Ht-a Y.

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

GdYVZVUjcbfgL

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

CV^VWj YfgL

Access the workspace

Verify uniformity of insulation material

Provide location of electrical boxes for future servicing

Prevent an electrical hazard



6 YZcfY

Accessible attic floors should be air sealed and insulated



5 ZYf

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

Hcc`g.

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

A UHf]Ug.

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

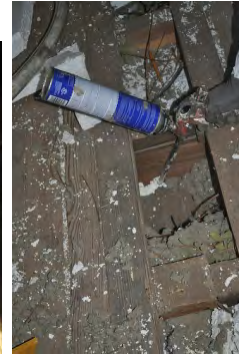
('1\$\$) "&U! Accessible Floors - Loose Fill Installation - DfYdUfUjcb



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

("0\$\$\$) "8W- Accessible Floor - Loose Fill Installation - Installation

DYgJfYX`Ci Htca Y.

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

GdYVZVUHjcbfgL

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

CV`VWj YfgL

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.

Hcc`g.

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

A UHfjUg.

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.

("%\$\$) "&W!`Accessible Floors - Loose Fill -bghU`Uhcb - 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

Nature Blend® Loose Fill Formula									
Coverage Chart for Thermal Acoustical Application									
No. Acres (100 sq. ft. per acre)									
R-Value, 10" D.E.									
R-Value	Depth	Weight	Volume	Weight	Volume	Weight	Volume	Weight	Volume
10" D.E.	10" D.E.	10" D.E.	10" D.E.	10" D.E.	10" D.E.	10" D.E.	10" D.E.	10" D.E.	10" D.E.
13	4.4	4.8	17.4	67.5	0.30	15.8	63.5	0.95	
19	6.1	6.5	27.9	108.8	0.61	25.3	98.8	0.98	
22	6.9	7.2	33.2	130.1	0.73	30.5	120.8	0.87	
26	7.8	7.9	38.4	150.5	0.85	35.8	140.8	0.79	
30	8.2	8.3	47.6	187.0	1.05	44.8	175.2	0.98	
36	11.4	10.3	62.0	248.1	1.36	68.0	270.2	1.30	
40	14.6	12.1	82.0	328.2	1.80	77.7	308.2	1.73	
50	17.7	15.9	101.9	403.9	2.24	96.5	386.2	2.17	

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

("\$\$\$* "%J - Pull-Down Attic Stair - Installation

DYgJfYX`Ci Htca Y.

Pull-down attic stair properly sealed and insulated

GdYVqZWUjcbfbl

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

CV^Wlj YfbL

Achieve uniform R-value

Prevent loose insulation from entering the living area



6 YZcfY

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



5 ZYf

Insulated pull-down stairs cover installed to prevent air leakage

Hcc`g.

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

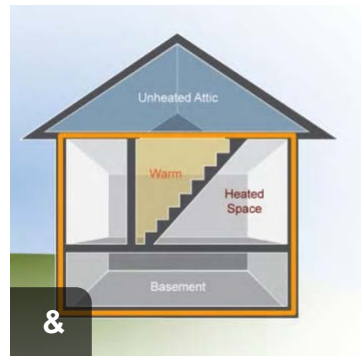
A UHfjUg.

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

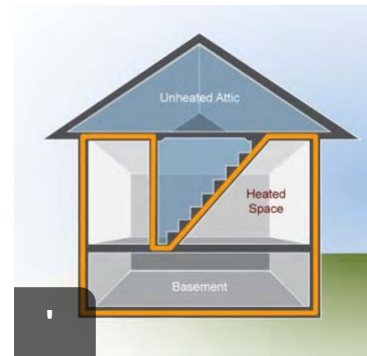
("%\$\$* "%U! Pull-Down Attic Stair - bghU`Ujcb



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 insulation assembly

Attic hatches rough opening will be surrounded with a durable, rigid protective baffle that is higher than the level of the surrounding attic floor insulation

Objective(s):

Achieve uniform R-value on the attic door or hatch

Achieve uniform R-value on the attic floor

Prevent loose attic floor insulation from entering the living area



Uninsulated attic 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.

('\$\$* "&U!`Attic Access Door - bghU`Ujcb



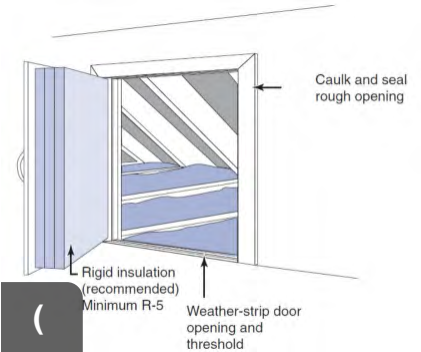
Create hatch cover that matches r-value of surrounding insulation



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

('\$\$) "&XZ('% \$%%XZ('%\$' '%/ - Onsite Documentation

DYgJfYX'Ci Hwta Y.

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

GdYVjZWUjcbfjL

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

CVYVWj YfjL

Document job completion to contract specifications

Confirm amount of insulation installed

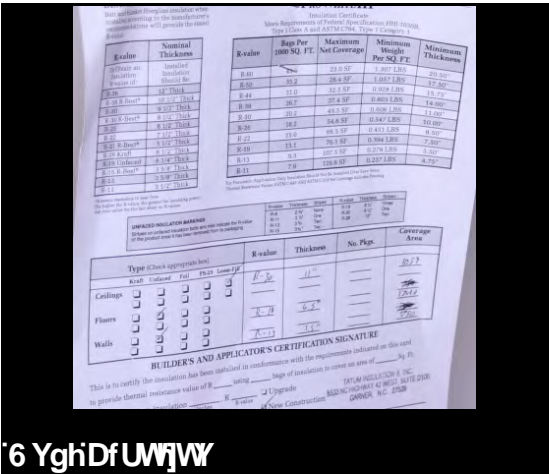
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



6 YghDfUWjVW

Information on insulation installed should be posted nearby



6 YghDfUWjVW

This requirement applies 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.

&'\$%&%' U - Debris Removal

DYgJfYX`Ci Hwta Y.

Clean, safe, and easily accessible crawl space created

GdYVqZWUjcbfbl

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

CV^VWjj Yfbk

Minimize punctures in ground liner

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



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



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

Hcc`g.

1. PPE

Note: axles, tires can be left in place

&'\$(\$' '%/ - Coverage - Ground Moisture Barrier

DYgJfYX`Ci Hwta Y.

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

GdYVqZWUjcbfbl

A ground moisture barrier that covers 100% of the exposed crawl space floor will be installed

CV^Wqj YfbL

Reduce ground moisture entering the crawl space



Uncovered crawl space floors can cause moisture damage



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

A Uhf]Ug.

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 vegetation 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.

&'\$\$%&V - Sign Content - Crawlspace Maintenance

DYgJfYX`Ci Ht-a Y.

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

GdYVZVUjcbfgk

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

CV^VWj Yfgk

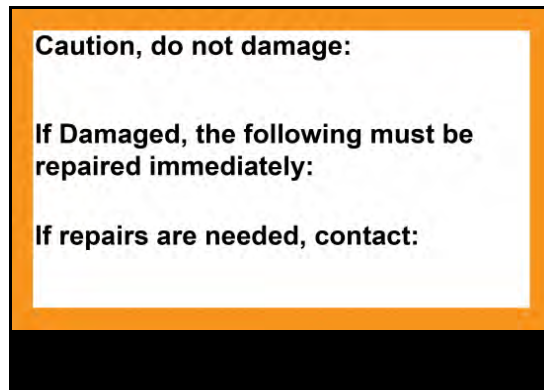
Prevent damage to the crawl space after upgrade

Educate anyone entering the crawl space

Provide occupants with a way to contact the installer



Mount sign where clearly visible to anyone entering crawl space



Be sure sign includes relevant information to aid occupant in repairs

Hcc`g.

1. Printer
2. Staple gun

A UHfJUg.

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.

&'\$\$%&V!'G[[b`CcbhYbh- Crawlspace Maintenance

Cuidado, no dañar:

Si está dañado, estos deben ser reparados inmediatamente:

Si es necesario realizar alguna reparación, ponerse en contacto con:

Hacer la señal en español también

' "14\$2"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



Gaps around floor penetrations allow air and moisture movement



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

'14\$2"1c - Floor Plane Air Sealing: High Temperature Application



1 Prepare work area by removing any insulation and debris



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



Apply first ring of caulking to match shape of opening



4 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"
7 Pellet fuel	Type L vent	per manufacturer's Specification

' "% \$&" V - Pest 9l clusion

DYgJfYX`Ci Hwta Y.

Well-sealed exterior wall prevents leakage and pests

GdYVqZWHjcbfbl

If penetration is greater than ¼ inches, caulking, steel wool, or other pest-proof material will be used to fill the penetration before sealing

CV`VWlj YfbL

Prevent pest entry



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



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

Hcc`g.

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

AUHf]Ug.

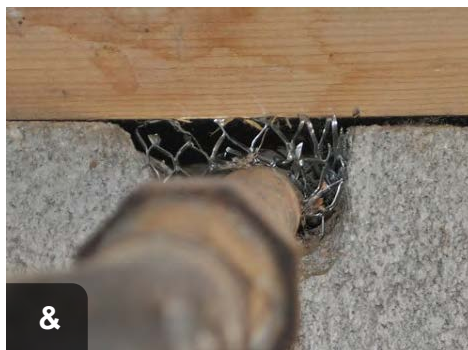
1. Caulk
2. Sprayfoam
3. Metal mesh
4. Rigid backing

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

' "% \$&" V !`DYgh9l Wi g]cb



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"1" \$1"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"1" \$1"1a - Sealing - Floor Plane Air Sealing



Locate gaps around penetrations for plumbing, electrical, etc.



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



Caulk smaller gaps and to hold backer rod in place



open tub chase



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

4'1" \$1"1c - Securing Batt - 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



 Before

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



 After

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, installed in complete contact with underside of floor, and installed without voids, gaps, or compressions.

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

4'11" \$1'1c - 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.

('%'\$%&' - NettingžFabric - Dense Pac_ Floor Insulation

DYgJfYX`Ci Hŧa Y.

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

GdYVŹWUjcbfgŁ

When using netting or fabric, staples will be placed according to manufacturer specifications

Netting or fabric will meet local fire codes

CV`VWj YfgŁ

Secure insulation



Uninsulated floors above unconditioned spaces are an energy drain



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

Hcc`g.

1. Utility knife
2. Scissors
3. Stapler

A UHf]Ug.

1. Fabric netting
2. Staples

('% \$%&V ! 'BYmjb[žFUVf]W- Dense Pac_ 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

(' % \$ % ' & U ! ' D f Y d U f U h c b

DYgJfYX'Ci Hc`a Y.

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



Hcc`g.

1. Vacuum, compressed air, hand broom

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

('0% \$%'&V'!'≠bgi `Ujcb'≠bghU`Ujcb

DYgJfYX'Ci Ht a Y.

Closed crawl spaces insulated to achieve best thermal performance possible

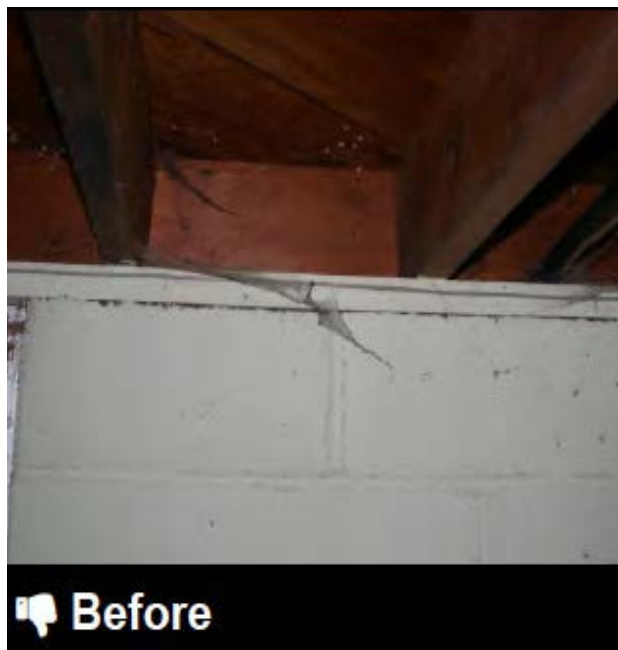
Specification(s):

Insulation and sealant will be installed so as to create a continuous thermal and pressure boundary.

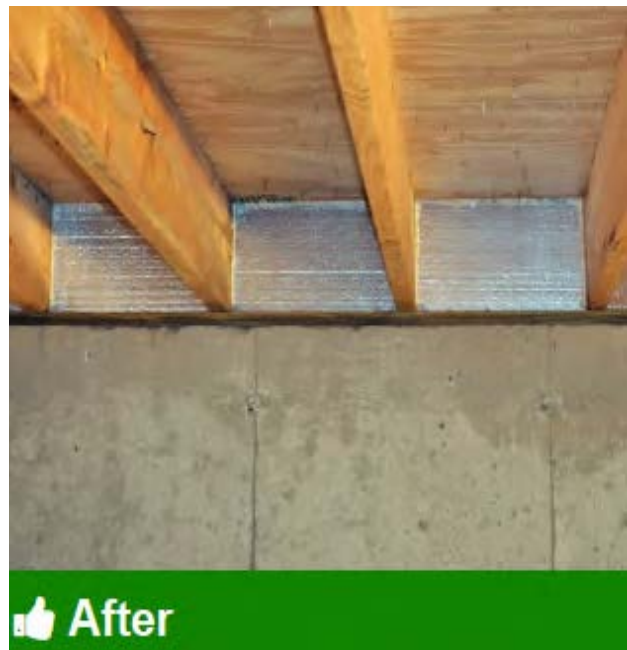
Objective(s):

Improve thermal performance

Prevent moisture condensation on the inside of the band joist



Uninsulated basement rim joist



Basement rim joist insulated and air sealed

Hcc`g.

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

A UHfjUg

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

This Specification is for basement 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.



1
Rim joists in a conditioned basement lack pressure and thermal boundaries.



2
Save time by pre-cutting pieces of rigid foam to fit between floor joists. Gaps will be air sealed.



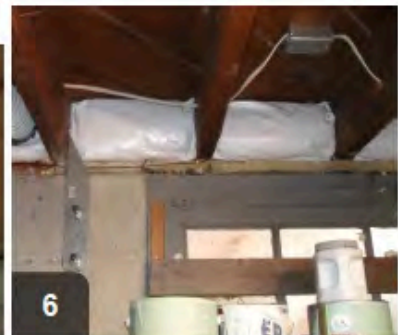
3
Pressure fit rigid insulation into



4
Air seal all seams where insulation meets framing.



5
Cut insulation to fit around utility penetrations in rim joists. Air seal all seams.



6
Fiberglass needs vapor retarder facing. FSK batting or metal building insulation (MBI) are acceptable.

('\$\$) "&XZ('% \$%%XZ('%\$' '%/ - Onsite Documentation

DYgfYX'Ci Ht a Y.

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

GdYVjZWUjcbfjL

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

.....CVYVj YfjL

Document job completion to contract specifications

Confirm amount of insulation installed

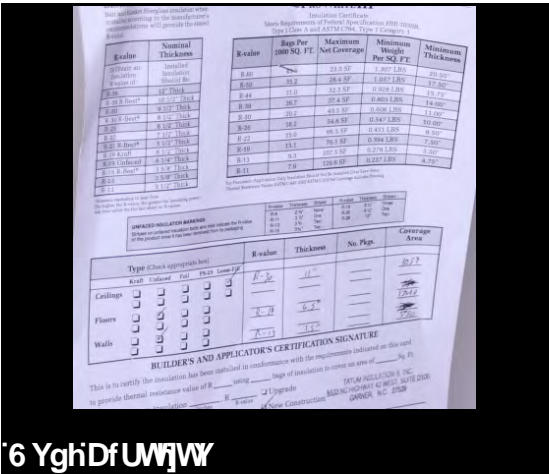
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



6 YghDfUWjVW

Information on insulation installed should be posted nearby



6 YghDfUWjVW

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

This requirement applies 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 - Exterior Dense Pack

Desired Outcome:

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

Specification(s):

Using fill tube, 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)

Hcc`g.

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

A UHf]Ug.

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 is followed. 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

('0/8/\$' '0/!

DYgJfYX'Ci Htca Y.

('\$\$) "&XZ('% \$%&XZ('%\$' '%/ - Onsite Documentation

DYgJfYX`Ci Hwta Y.

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

GdYVjZWUjcbfjL

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

CVYVWj YfjL

Document job completion to contract specifications

Confirm amount of insulation installed

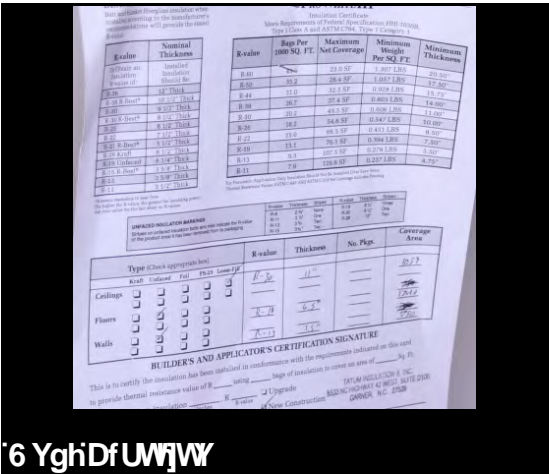
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



6 YghDfUWjVW

Information on insulation installed should be posted nearby



6 YghDfUWjVW

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.

' "% \$%%J - Penetrations

DYgJfYX'Ci Ht-a Y.

Openings from garage sealed to prevent leakage

GdYVZVUjcbfjL

All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed

CV^VWj YfbL

Prevent air leakage and pollutant entry



6 YZcfY

Penetrations between the garage and house can leak hazardous fumes



5 ZYf

Seal penetrations to minimize risks and air leakage

A UYf]Ug.

1. Backer Rod
2. Caulk
3. Spray foam

' ' % \$ % % / ! ' Di Wk cf _ - Ductwor_

DYgJfYX`Ci Ht-a Y.

Openings from garage sealed to prevent leakage

GdYVZVUHjcbfjL

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

CV^VWj YfjL

Prevent air leakage and pollutant entry



6 YZ:fY

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



5 ZYf

Sealed ductwork connections help prevent leakage.

A UHf]Ug.

1. Mesh tape
2. Mastic

' '% \$%%/ '! 'Di Wk cf_



Prepare work area by assessing any safety concerns.



Wrap joint with fiberglass mesh tape.



Apply UL 181 mastic to seal joint.

' % \$ % % X - Garage to House Door

D Y g j f Y X ' C i H w a Y.

Openings from garage sealed to prevent leakage

G d Y V j Z W U h c b f g L

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

C V Y W j j Y f g L

Prevent air leakage and pollutant entry



Daylight visible under door to garage indicates leakage



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

H c c ` g.

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

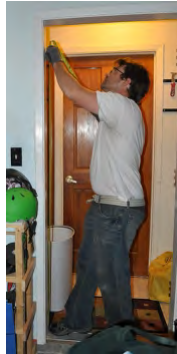
A U h f j U g.

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

' '% \$%%X '!; UfU Y'hc 'Hci gY'Dccf



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

' '1* \$2"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

' "1* \$2'1 - Duct Sealing

Sealing Small Holes

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



Seal with mastic.



Notes:

' "1* \$2 "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.



' 1* \$2'1 - 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.

' "1* \$2'1 - Duct Sealing

Sealing Large Holes

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



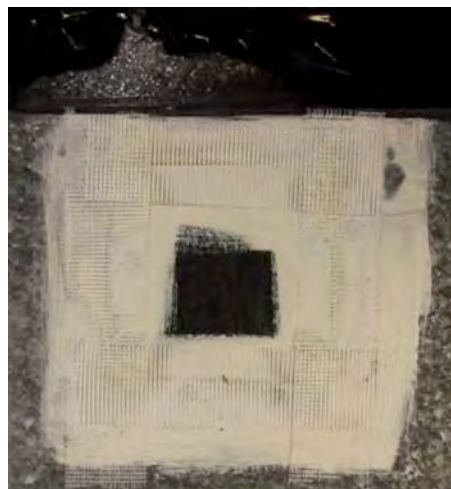
STEP 2: Install rigid duct support material that is at least 1 inch larger than the hole.



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:

' "1* \$2'1 - Duct Sealing

Sealing Large Holes

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



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



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



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



' "1* \$2'1 - 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:

' '1* \$2'1 - 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.



Sealing Large Holes (cont.)

[illegible]

' "1* \$2'1 - Duct Sealing

Sealing Large Holes

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



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



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



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



Sealing Large Holes (cont.)

A photograph of a rectangular opening in a wall, showing a view into a dark, cluttered interior space, possibly a basement or crawlspace. The opening is framed by a rough, light-colored border. The interior is dimly lit, with a bright light source visible in the background, creating a strong contrast. The walls and floor appear to be made of concrete or masonry, and there are various objects and debris scattered throughout the space.

[illegible]

' "% \$%%W- Flel to Metal

DYgJfYX`Ci Hwta Y.

Ducts and plenums properly fastened to prevent leakage

GdYVYzWUjcbfgL

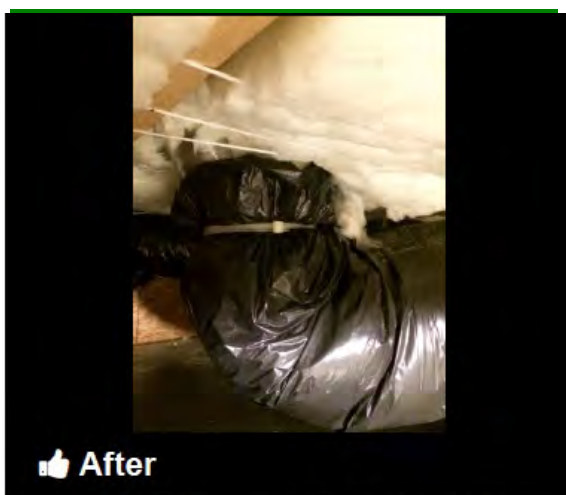
Joints will be fastened with tie bands using a tie band tensioning tool

CV`YWlj YfbL

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.

' '% \$%%W!': `Yl 'hc 'MYHJ



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.

' "1* \$1" a - 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 maximize duct run

Tools:

1. Metal snips
2. Utility knife
3. Drill
4. Stapler

Materials:

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

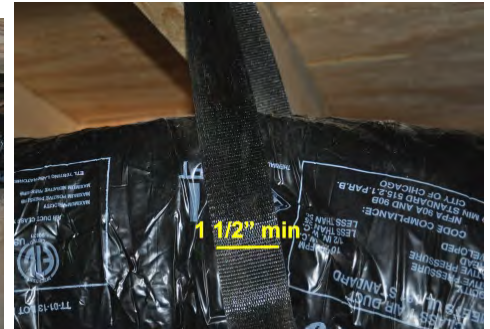
' "1* \$1" a - Support (Applies to All Duct Types)



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

' "% \$&'W- 9l isting Component to 9l isting Component

DYgJfYX`Ci Wta Y.

Ducts and plenums sealed to prevent leakage

GdYVZVUHjcbfgL

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

Fiberglass mesh and mastic will become the primary seal

Seams, cracks, joints, holes, and penetrations larger than $\frac{3}{4}$ " will be repaired using rigid duct material

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

Fiberglass mesh and mastic will be the primary seal

CV`VW]j YfgL

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



Duct to plenum not sealed



Duct to plenum sealed

Hcc`g.

1. Nylon strap tensioning tool

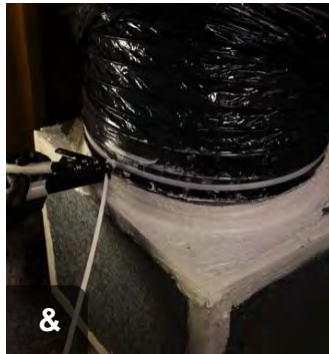
A UhYf]Ug.

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

' '% \$&'%W!'EI]gh]b['Cca dcbYbhlc`9l]gh]b['Cca dcbYbh



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.

' '% \$&'(U - Duct Boot to Interior Surface

DYgJfYX`Ci Ht`a Y.

Ducts and plenums sealed to prevent leakage

GdYVqZWUjcbf`gk

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

CV`YVqj Yf`gk

Prevent air leakage

Prevent a fire hazard



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



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

Hcc`g.

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

A UHf]Ug.

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

' '% \$&'(U!'Di WbVcchlc 'lbhYf]cf 'Si fZUW



Remove grill to expose duct boot and gaps



Use fasteners to close gaps before applying mastic



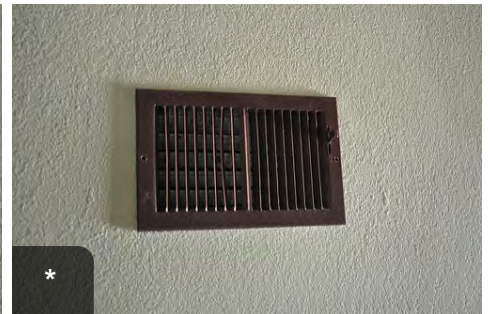
Wet the edges of the drywall to ensure a good bond



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

' "% \$&' W- Air Handler Cabinet

DYgJfYX'Ci Ht-a Y.

Ducts and plenums sealed to prevent leakage

GdYVZWUJcbfgL

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)

CV'WUj YfgL

Reduce air leakage while maintaining accessibility



Unnecessary holes in the air handler cabinet need to be sealed

A UHfjUg.

1. Foil tape



Use removable foil tape to seal holes

' "% \$&'(W! '5 Jf`HUbX`Yf`CUVJbYh



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

' '% \$&'(X - Filter Slot

DYgJfYX`Ci hWta Y.

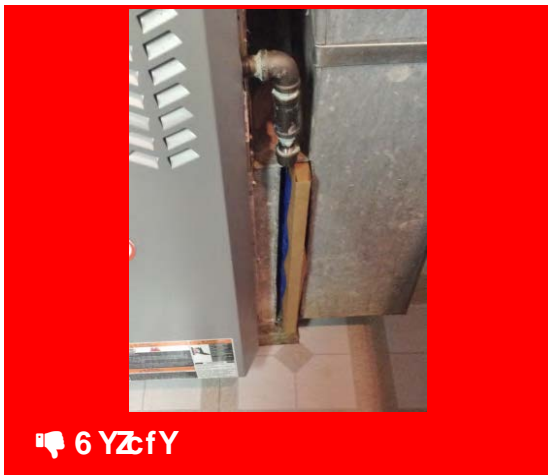
Ducts and plenums sealed to prevent leakage

GdYVYzWUjcbfYk

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

CV^WYj Yfbk

Reduce air leakage while maintaining accessibility



Uncovered filter slots are a point of leakage



Filter slots should be covered

F Yh fb`Di Wg`bg]XY7 ca Vi gh]cb`5 dd`]UbW`NcbY

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 zone depressurization.

F Yhi fb'Di Wg'bg]XY'7 ca Vi gh]cb'5 dd`]UbW'NcbY



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.

F Yh fb'Di Wg'bg]XY'7 ca Vi gh]cb'5 dd`]UbW'NcbY



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

' "% \$&' \$V - Reduce 9l ccess Flel Duct Length

DYgJfYX'Ci Ht'a Y.

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

GdYVqZWUjcbfgL

Excess flex duct will be removed between the takeoff at trunk and floor register boot

CV'YWlj YfbL

Improve air flow



👍 6 YZ:fY

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



👍 5 ZYf

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

' "1* \$2"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.

' 1* \$2'11d - 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

(' % \$ % & U - Selection of Duct Insulation Material

D Y g j f Y X ' C i H W e a Y.

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

G d Y W j Z W U H j c b f g L

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

C V ^ W H j Y f g L

Decrease heat loss and condensation problems



6 Y Z c f Y

Uninsulated ducts in unconditioned spaces are an energy drain



5 Z Y f

Properly insulated ducts operate at much higher rates of efficiency

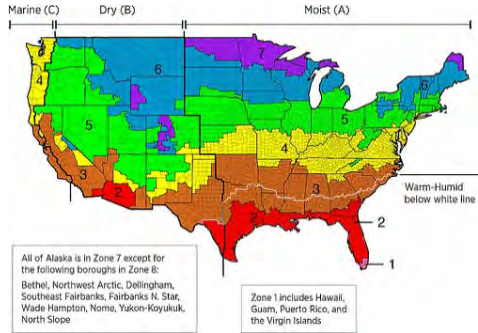
('% \$%'&U!`GY`Wŋcb`cZDi Wŋlbgı `Uŋcb`MUHŋf]U



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.

(' % \$ % & W- Attachment of Duct Insulation

DYgJfYX`Ci Hwta Y.

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

GdYVqZWUjcbfbl

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

CV^Wqj YfbL

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



6 YZcfY

Materials holding insulation in place should not compress or kink duct

Hcc`g.

1. Scissors
2. Metal snips



5 ZYf

Durable materials can be attached without compressing insulation

A UYf]Ug.

1. Nylon twine
2. Wire
3. Tie bands

('% \$%'&X - Taping of the Duct Insulation

DYgJfYX`Ci Hwta Y.

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

GdYVqZWUjcbfbl

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

CV^Wqj Yfbk

Prevent gaps in the vapor barrier of the insulation



6 YZ:fY

Unsecured and sealed insulation around ducts is useless



5 ZYf

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

Hcc`g.

1. Utility knife

A UHf]Ug.

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

6 UH : Ub'bgH`Uhc b

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 3 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 fitting the direction of airflow.

6 1A : 1b`bghU`Uhc b



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 affix to mounting brackets in attic if applicable.



Complete fan mounting and air seal ceiling penetration.

6 ԼԱ՝ ԱնձրհԼ՝ԱղԵԵ



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.

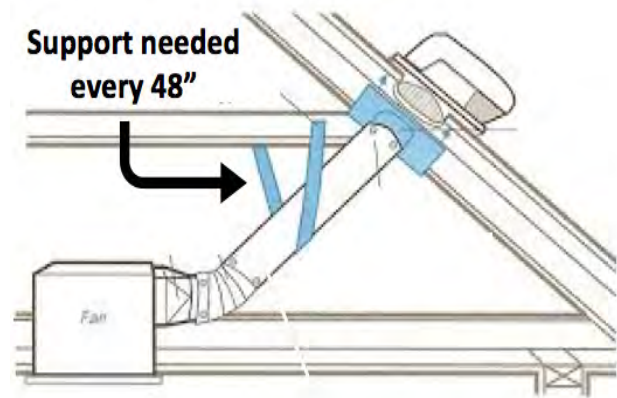


Seal exhaust fan duct seams with mastic of UL181 tape.

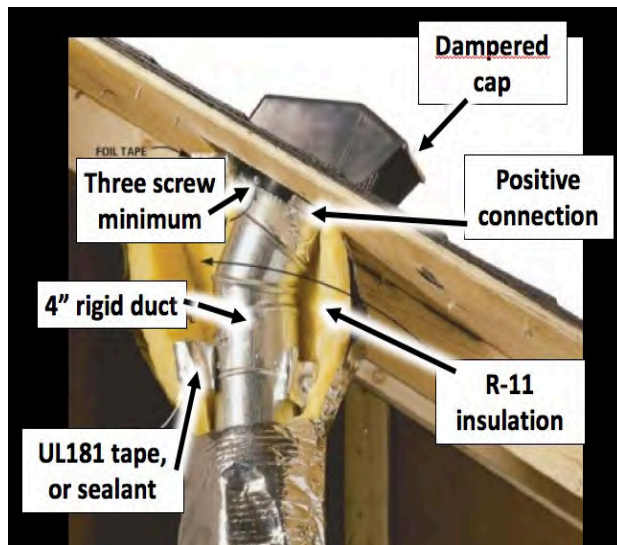
6 1A : 1b'bgH`Uhc b



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



Exhaust fan ducts require support every 48".



Exhaust fan duct assembly showing damp-ered cap with collar.

* " \$ \$ & % ' J - Duct Design and Configuration

D Y g j f Y X ' C i H w e a Y.

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

G d Y V Y Z W U j c b f g k

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

C V ' Y W j j Y f g k

Effectively move the required volume of air



6 Y Z f Y

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



5 Z Y f

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

H c c ` g.

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

A U H f j U g.

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").

* " \$ \$ & ' % \ / - Duct Insulation

DYgJfYX`Ci Htēa Y.

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

GdYVqZWUjcbfbl

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

CV^Wqj Yfbt

Prevent condensation from forming or collecting inside of the ductwork



6 YZ:fY

Uninsulated fan venting



5 ZYf

Insulated fan venting prior to addition of loose fill cellulose.

Hcc`g.

1. Utility knife
2. Metal snips

A UHf]Ug.

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

Exhaust fan venting insulation does not require a vapor barrier.

JYbhj Uhc b'!Di WGi ddcfh

Specification(s):

Metal venting support requirements

- Sections shall be securely connected to each other using a minimum of 3 screws for round ducts and 4 for rectangular.
- 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.
- 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

- Flex duct, existing or installed, shall be insulated to a minimum, effective R-8.
- Flex duct shall be of the proper length for connection between two points without excessive bends or sag.
- 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.
- Support strapping or hangers shall be installed within 1 foot of a joint or connection with a maximum of 4 feet between supports.
- 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

* " \$ \$ & " & U - Hole in Building Shell - Roof Termination

DYgJfYX`Ci Hwta Y.

Securely installed termination fittings with unrestricted air flow

GdYVqZVUHcbfgL

A hole no greater than a 1/4" greater than the fitting will be cut to accommodate termination fitting

CV`VWlj YfbL

Allow for ease of weatherproofing



6 YZcfY

Exhaust fans need exterior ventilation, often through roofs and walls



5 ZYf

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

Hcc`g.

1. Hole saw
2. Drill
3. Tape measure

* " \$ \$ & " & U ! ' < c ` Y] b ` Bi] X] b [` S \ Y ` - 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

* " \$ \$ & " & V - Termination Fitting - Requirements

D Y g j f Y X ' C i H w t a Y.

Securely installed termination fittings with unrestricted air flow

G d Y V j Z W U h c b f g L

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

C V ^ W j j Y f g L

Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation



Termination fittings with no collar are to be avoided



Properly sized ducts with snug connections to collared fittings last longer

H c c ` g.

1. Drill

A U h f j U g.

1. Fasteners

* " \$ \$ & " & V ! ' H Y f a] b U h c b ' F] h j b [- 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

* " \$ \$ & " & X - Weatherproof Installation - Vent Cap

D Y g j f Y X ' C i H w t a Y.

Securely installed termination fittings with unrestricted air flow

G d Y V j Z W U h j c b f g k

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

C V ^ W h j Y f g k

Preserve integrity of the building envelope

Ensure a weather tight and durable termination installation

Ensure unrestricted air flow



6 Y Z c f Y

Holes for termination fitting need to be sealed to weatherproof

H c c ` g.

1. Hole saw
2. Caulk gun
3. Drill



5 Z h f

Termination installation should follow shingling to deter water penetration

A U h f j U g.

1. Fasteners
2. Caulk

* " \$&"&X !'K YUH YfdfccZ]bghU`Ujcb - Vent Cap



Termination fitting is installed to repel water and sealed

* "k \$\$&"&Y - Pest 9I clusion - Ventilation

DYgJfYX`Ci Hwta Y.

Securely installed termination fittings with unrestricted air flow

GdYVZVUHjcbfgL

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

Installation will not inhibit damper operation or restrict air flow

CVYVWj YfgL

Prevent pest entry

Ensure proper air flow



6 YZcfY

Exhaust terminations without screens are an invitation to pest intrusion



5 ZYf

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

* " \$ \$ & " & Z - Termination Location

D Y g j f Y X ' C i H w e a Y.

Securely installed termination fittings with unrestricted air flow

G d Y V y Z W U h j c b f g k

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

C V ^ W U j Y f g k

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

H c c ` g.

1. Measuring tape
2. Hole saw
3. Drill

* * \$ \$ & " & [' ! ' ?] H W Y b ' Y I \ \ U i g h - Kitchen 9I haust

DYgJfYX`Ci Ht a Y.

Securely installed termination fittings with unrestricted air flow

GdYVZVUHjcbfgL

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

CV^WVj YfgL

Prevent a fire hazard



Kitchen exhaust vents should not be made from highly combustible materials



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

* " \$ \$ ' " U - Hole in Building Shell - Sidewall Termination

DYgJfYX`Ci Hwta Y.

Through the wall fans installed to specification

GdYVqZWUjcbfgL

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

CV`WVj YfgL

Allow for ease of weatherproofing



6 YZ:fY

Determine size to cut hole by measuring fan assembly and ducting



5 ZhYf

A snug fit should be ensured to minimize weatherproofing required

Hcc`g.

1. Tape measure
2. Saw

* " \$ \$ ' " U ! ' < c ` Y] b ` Bi] X] b [' S \ Y ` - 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

* " \$ \$ ' " Y - Bac_draft Damper

DYgJfYX'Ci Ht a Y.

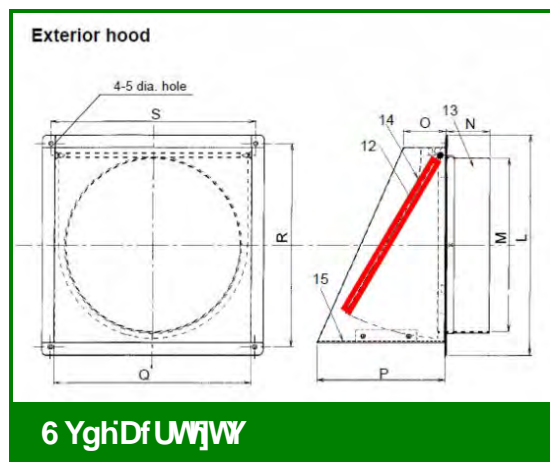
Through the wall fans installed to specification

GdYVZVUjcbfgL

A backdraft damper will be installed between the outlet side of the fan and the exterior

CV^Wj YfgL

Prevent reverse air flow when the fan is off



Damper should be installed to maintain exterior air barrier

* " \$ \$ ' " ^ - Preventing Air Leakage Caused by Exhaust Fans

DYgJfYX'Ci Hwta Y.

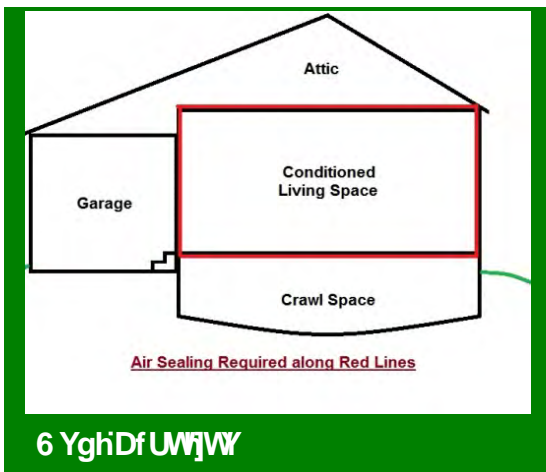
Through the wall fans installed to specification

GdYVqZWUjcbfgL

Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)

CV^Wqj YfgL

Ensure occupant health and safety



The barrier between conditioned and unconditioned spaces should be sealed

See also SWS 3.1501.1 Air Sealing Garage Penetrations.

* " \$ \$) "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



unacceptable dryer venting



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 dampered vent cap. 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:

Judith Darst
WA Department of Commerce

* " \$ \$) " 1a - Clothes Dryer Ducting



1
Dryer vent transition piece: panduit straps, metal collar at wall, foam air sealing



2
Uninsulated dryer venting in unconditioned space



3
Supported and Insulated dryer vent through unconditioned space. Venting slopes downward toward termination.

* " \$ \$) ' % / - Termination Fitting

D Y g j f Y X ' C i H w t a Y.

Dryer air exhausted efficiently and safely

G d Y V j Z W U h c b f g L

Termination fitting manufactured for use with dryers will be installed

A backdraft damper will be included, as described in termination fitting detail

C V Y W j j Y f g L

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



6 Y g h D f U W j W

Termination fittings for dryers should have backdraft dampers

* " \$ \$) ' % ! ' H Y f a] b U] c b ' F] h] b [



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)

* * \$ \$) ' % ! ' 7 ca Vi ghcb' gUZYhm

DYgfYX'Ci Htca Y.

Dryer air exhausted efficiently and safely

GdYVZVUjcbfbl

Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards

CV^Wij Yfbl

Ensure safe operation of combustion appliances

Ensure occupant health and safety



Appliance exhaust, such as that for a dryer, can cause depressurization

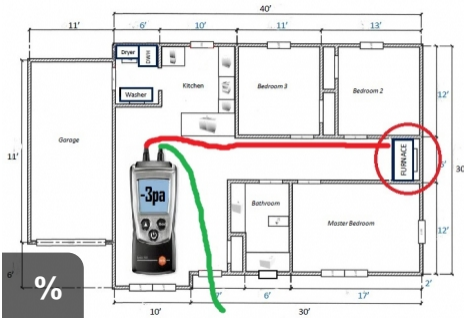


5 ZYf

Test combustion appliances for spillage to confirm they comply with combustion safety standards.

Hcc`g.

1. Manometer



Perform worst case spillage test to ensure new exhaust ventilation isn't causing unsafe conditions



&

If spillage occurs, refer to Annex D on WA Safe combustion safety form.

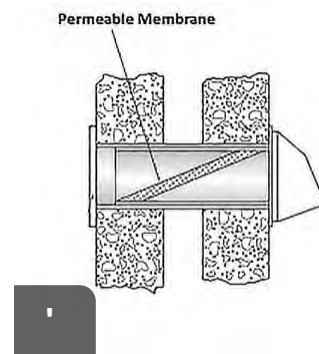
* " \$) ' % ! ' 7 ca Vi ghjcb'SUZYhm



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

* " \$ \$) " & V - Fan Venting - Kitchen Fan

DYgJfYX`Ci Hwta Y.

Kitchen range fan installed to specification

GdYVYzWUjcbfgL

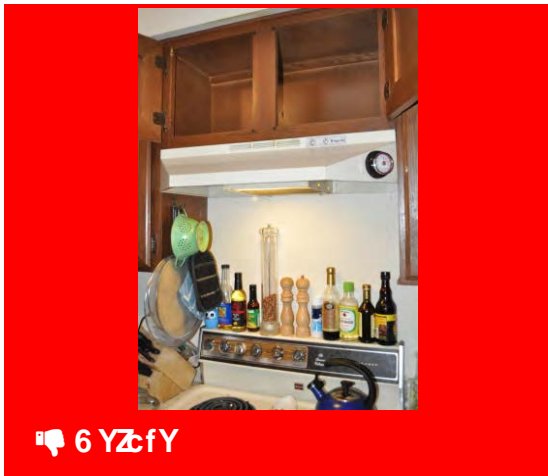
Kitchen range fans will be vented to the outdoors

Recirculating fans will not be used as a ventilating device

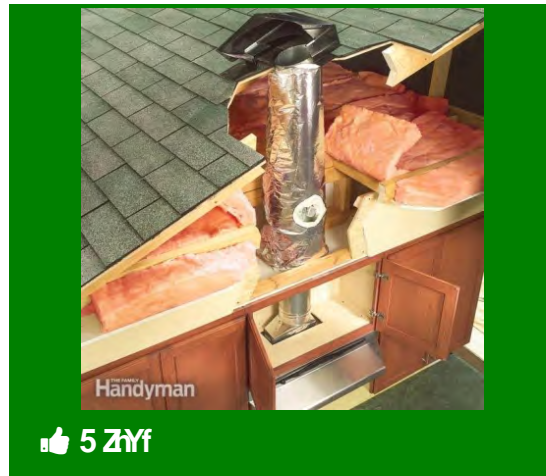
CV^VWj YfgL

Remove cooking contaminants from the house

Preserve integrity of building envelope



Recirculating fans over ranges do not actually remove contaminants.



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

Hcc`g.

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

A UHf]Ug.

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.

* " \$ \$) " & X - Termination Fitting - Kitchen Fan

D Y g j f Y X ' C i H w t a Y.

Kitchen range fan installed to specification

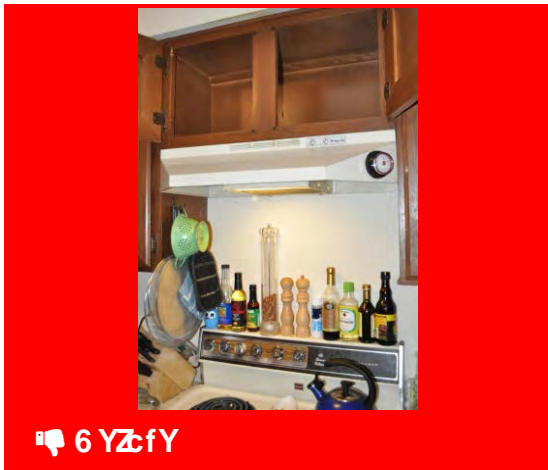
G d Y V j Z W U h j c b f g k

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

C V Y W j j Y f g k

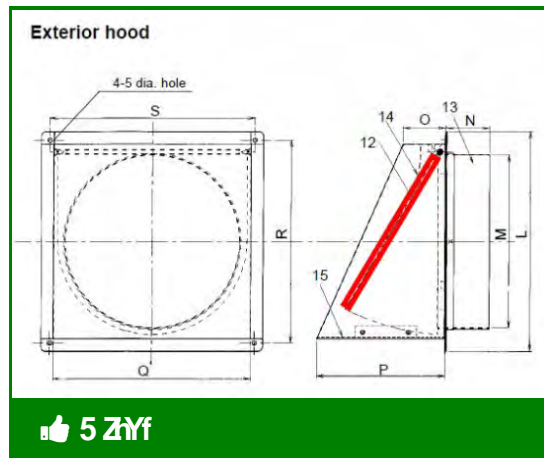
Ensure safe operation of combustion appliances

Ensure occupant health and safety



6 Y Z c f Y

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



5 Z Y f

Exhaust fans should have backdraft dampers

* " \$ \$) "&X!'HYfa]bU]cb`F]h]b[- Kitchen Fan



Backdraft damper on roof mounted exhaust fan



An interior backdraft damper can also be installed for good measure

* " \$ \$) " & Y - Ma_e-l p Air - Kitchen Fan

DYgJfYX`Ci Hwta Y.

Kitchen range fan installed to specification

GdYVjZVUjcbfjL

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

CV^VWj YfjL

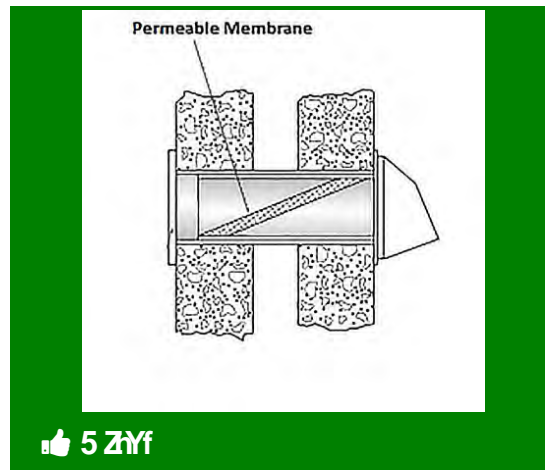
Ensure safe operation of combustion appliances

Ensure occupant health and safety



6 YZ:fY

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



5 ZYf

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

Hcc`g.

1. Drill
2. Hole saw
3. Caulk gun

A UHfjUg.

1. Caulk sealant
2. Fasteners

Air Handler2Pressure Balancing

DYgJfYX`Ci Ht-a Y.

Air circulates freely between rooms

GdYVZVUHjcbfgL

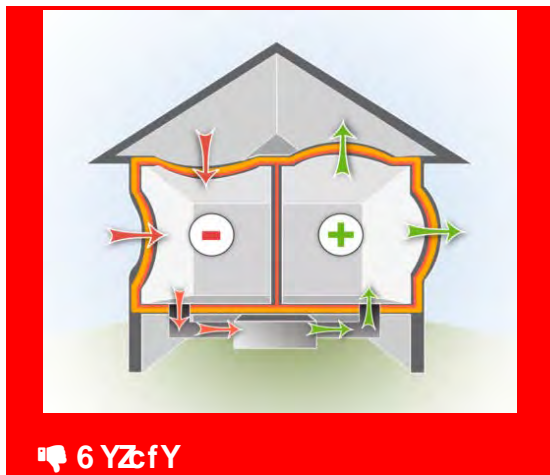
An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)

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

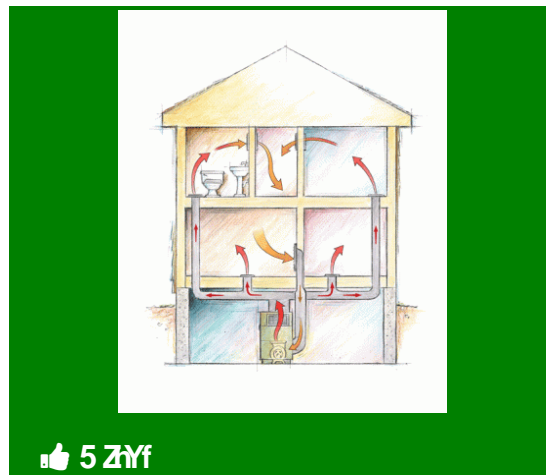
CV^Wlj YfgL

Ensure free flow of air between rooms

Preserve integrity of the building envelope



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



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

Hcc`g.

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

A UHf]Ug.

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

Air Handler2PfYggi fY 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 R/Return	Room WRT main body		
	Pre	Post	

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

6.6201.2a - Balancing Pressure

Desired Outcome:

Air circulates freely between rooms

Specification(s):

An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)

No room will exceed +/- 5 pascals with reference to the common area with all interior doors closed and ventilation systems running

Objective(s):

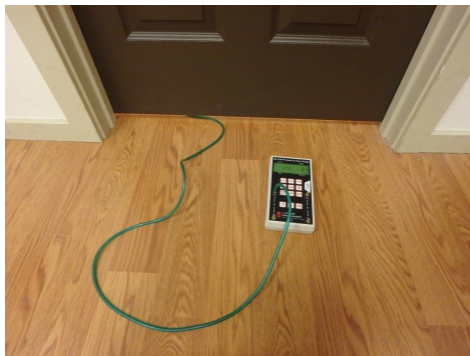
Ensure free flow of air between rooms

Preserve integrity of the building envelope

Tools:

1. Measure room pressures: manometer and probe / hose

Washington variance approved. Pressure limit is +/- 5 pascals



Locate the ventilation system, measure the pressure behind the door with reference to (WRT) main body of the house.

* " &\$&'%X - Manual Override

DYgJfYX`Ci Ht-a Y.

Fan controls support ventilation strategy

GdYVqZWHjcbfgL

A labeled switch for manual override will be included for the ventilation system

CV`YWHj YfgL

Ensure fan controls meet intended ventilation strategy

+", 1\$2"2d - 9mergency Drain Pan

Desired Outcome:

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

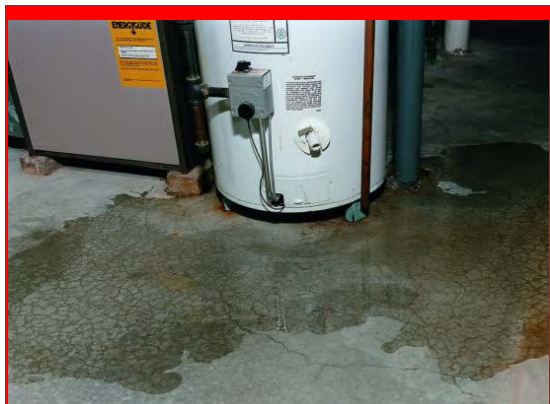
Specification(s):

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.

+", %\$&'&_ - Discharge Temperature - Insulating Tan_ and Supply Lines

DYgJfYX`Ci Htca Y.

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

GdYWZWUhc bfgL

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

CV^Wij YfgL

Ensure safe hot water supply temperature to fixtures



I bgUZ

Water heaters producing water over 120 degrees raise heating costs



GUZ

Water heaters should produce water under 120 degrees to prevent scalding

Hcc`g.

1. Thermometer

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

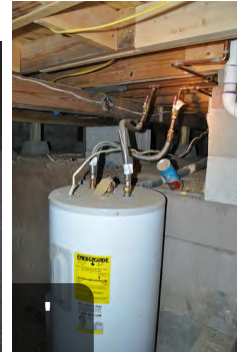
+", %\$&'&_ '!D]gW Uf[Y'TYa dYfUi fY - Insulating Tan_ and Supply Lines



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

+.8103.1c - Thermal efficiency

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

Specification(s):

Water heater storage tanks shall have a minimum R-value of R-24

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

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

Objective(s):

Reduce standby losses from near tank piping and storage tank

Ensure insulation does not make contact with flue gas venting



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



Storage-type water heaters should be wrapped to bring total value to R-24

Tools:

1. Scissors
2. Utility knife
3. Outward clinching staple gun

Materials:

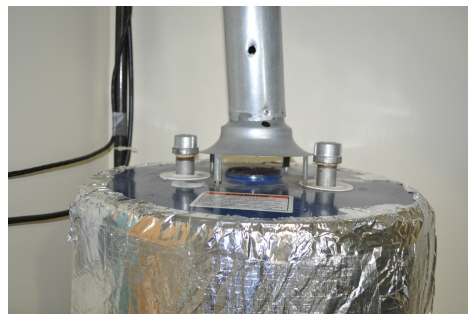
1. Insulation blanket
2. Plastic zip ties
3. Tape
4. Staples

Determine the R-value of the existing water heater by A) searching the internet using the model number or B) measuring the thickness of the existing insulation and multiplying by 3.14 per inch for fiberglass or 6.25 per inch for foam. Add insulating wrap to achieve at least R-24. R-values may be added, so a tank with a factory-installed R-value of R-6 would need an additional R-18 to reach the desired value of R-24.

Maintain 6" clearance between insulation and the draft diverter. Cut out around thermostats, pressure relief valves, and other items listed in the specification.



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



Blanket does not obstruct draft diverter or plumbing pipes and elements



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



Data plate should still be accessible after wrapping



Both hot and cold water pipes should be insulated to R-3 for first 6'

+", 1\$' "1e - Temperature and Pressure Relief Valve

Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

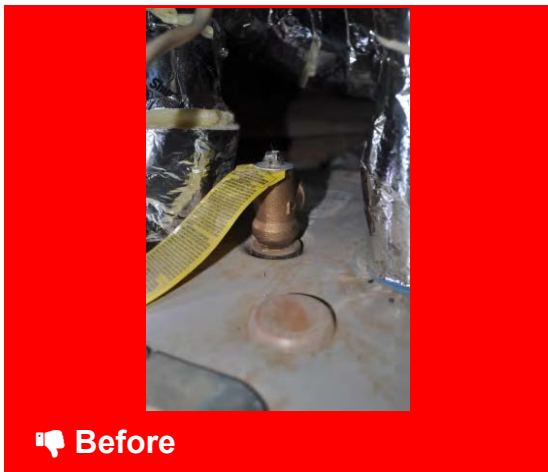
Specification(s):

Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications

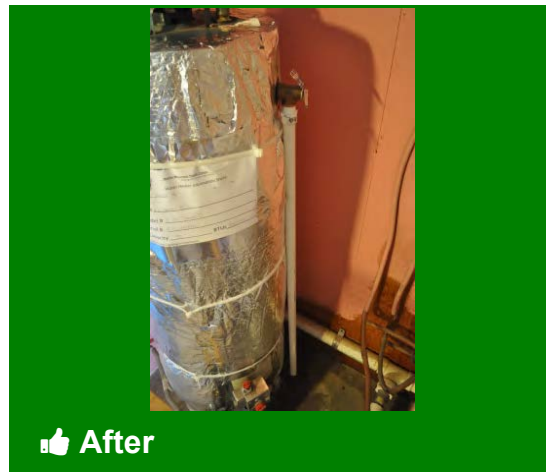
Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC

Objective(s):

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



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



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

Tools:

1. Pipe wrench
2. Hacksaw

Materials:

1. PVC 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.

+, 1\$' "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

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 beginning 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:

- a. Insulation with a lengthwise slit shall be positioned on horizontal pipe so that the slit is on the bottom side of the pipe.
- b. 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 material shall be sealed. Products that are not glued shall be held in place with elasticized tape, wire, or plastic ties. Elasticized tape shall be applied every nine (9) inches on center, and around each joint between separate pieces of material.

If ties are used, they must be made of either galvanized wire or non-slipping plastic. The ties shall be spaced at one inch from each end of the material and thereafter every nine (9) inches on center. Other techniques for attaching pipe insulation may be acceptable if approved in writing by Commerce.

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 fiberglass 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.

K UHf`D]dY`#bgi `U]cb

Hcc`g.

1. Utility knife
2. Tape measure

A UHf]U`g.

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"1\$\$\$2_ - 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 prevent 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" x 2" - 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



Best Practice

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" x 2" - 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" \$2"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" x 2" - Metal Coupler Grounding



Copper grounding rod should be at least 8' long



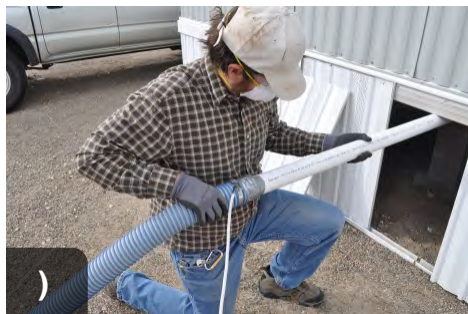
Grounding rod should be driven into the ground so that nearly all of rod is underground



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"2\$4"1b - Air Seal Closet

Desired Outcome:

Isolate combustion water heater closet from conditioned space

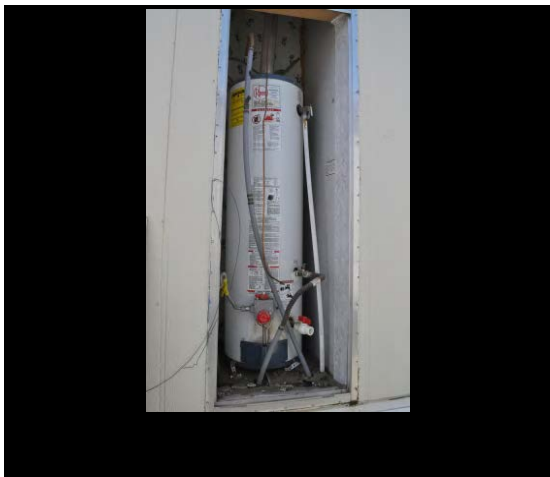
Specification(s):

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

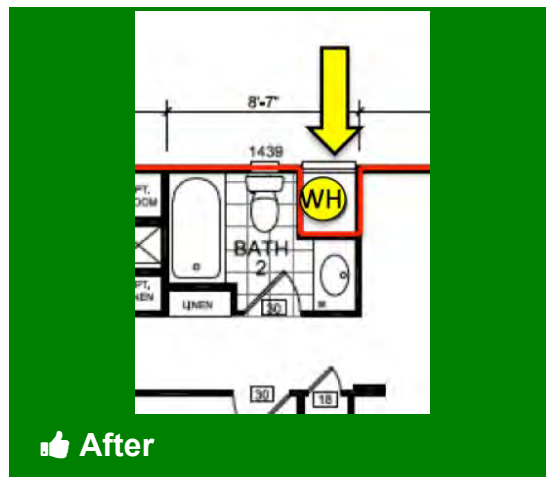
Avoiding frozen pipes must be considered without creating an additional utility burden (e.g., heat tape)

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.



👍 After

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

Tools:

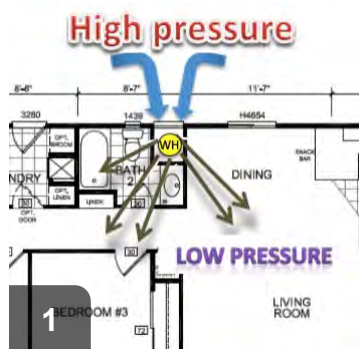
1. Caulk gun
2. Single-component foam gun
3. Manometer, hoses, pressure probes

Materials:

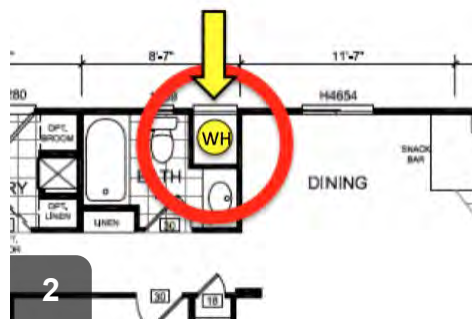
1. Caulk/ foam sealant
2. Water line insulation

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

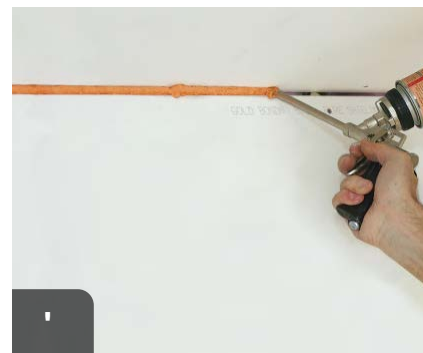
2'2\$4"1b - Air Seal Closet



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.



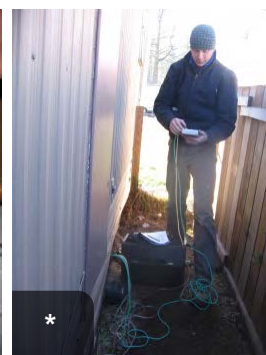
Air seal the water heater closet to eliminate all air pathways from the closet into the living space.



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.

4.1.1.1, a - 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 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



Roof leak, missing cap on vent



Properly connected and sealed roof vent

Tools:

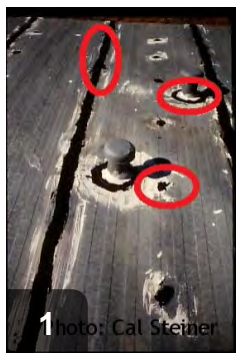
1. Scaffolding and ladders
2. Screw gun
3. Long, flat prybar
4. 5-in-one paint scraper tool
5. Flashlights and headlamps
6. Digital camera

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.

4.1.1.1, a - 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



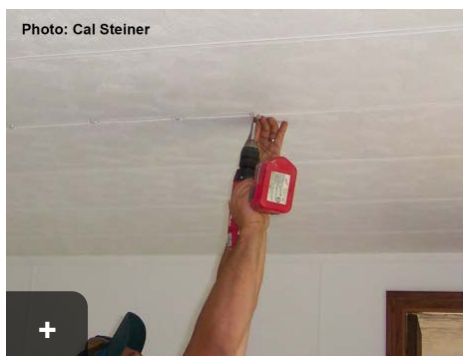
Inspect all patches and repairs, and correct deficiencies if necessary



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:**

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

4'1\$\$\$' ", b - Attic Access'j jUFccZg]XY' @Zh

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

4'1\$\$\$' ", b - Attic Access`j jUFccZgjXY`@Zh



1
Ensure a safe work environment by setting up scaffolding. Work in manageable sections



2
Remove fasteners from the J-channel



3
Cut through putty tape and pry J-channel away from roof seam



4
Work in manageable sections to minimize roof damage. One section of J-channel is a long enough area



5
Remove staples as necessary to lift roof and inspect underneath



6
Place blocks to lift roof and enable inspection of roof cavity for obstructions and other concerns



7
Work in small sections to minimize flexing of roof and risk of wind damage



8
Once visual inspection has shown roof cavity to be viable, begin blowing insulation

4"1\$\$\$" , d - Fiberglass Blown Insulation Installation`j]UFccZg]XY`@Zh

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



In Progress



In Progress

4'1\$\$\$' ", d - Fiberglass Blown Insulation Installation'j jUFccZg]XY' @Zn



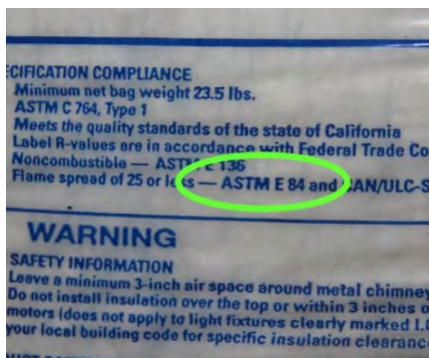
If insulation is roof mounted, blow below it.



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"1\$\$\$" , e - Roof Reattachment'j jUFccZg]XY' @Zh

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 reinstallation



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

4'1\$\$\$' ", e - Roof Reattachment'j]UFccZg]XY' @Zh



1
If J-channel is salvageable, clean thoroughly before applying putty tape



2
Apply putty tape to new or reused J-channel to seal roof seam



3
Using new fasteners, attach J-channel along roof seam and seal as necessary

4.1.1.1 - Verification of Details j jUFccZjXY @zh

Desired Outcome:

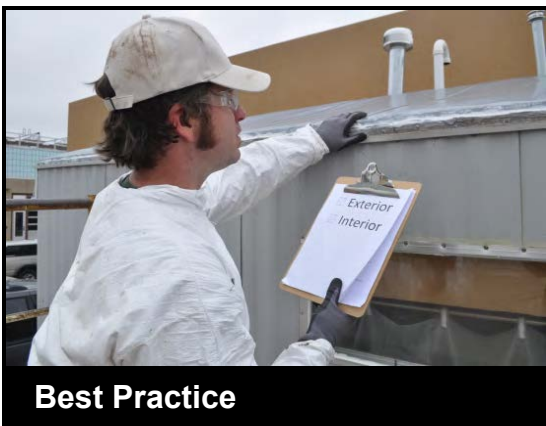
Consistent, uniform thermal boundary and air barrier between the conditioned space and unconditioned space

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

4.1 - a - Attic Ceiling and Roof Verification j JUEI hfjcf 5 WYggZca Hcd cZFccZ

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:

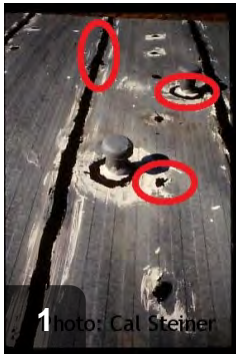
1. 2-1/2" hole saw
2. Power drill
3. Borescope
4. Inspection mirror
5. Flashlight

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.

4'1%%' " - a -'5 HjvZ7 Y] b[žUbX'FccZJ Yf]zVUjcb'j jUEl Hf]cf'5 WwYgg'Zca 'Hcd'cZFccZ



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

4'1\$\$\$' "- b - Attic Access'j jUEI hYf]cf`5 WwYgg`Zca `Hcd`cZFccZ

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

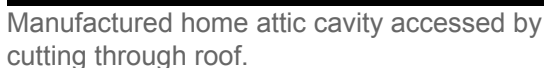
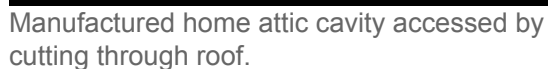
Objective(s):

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



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.

4'1%%\$' "- b - Attic Access'j jUEl hf]cf'5 WYgg'Zca 'Hcd'cZFccZ



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"1\$\$\$' "- d - Fiberglass Blown Insulation Installation`j]U EI hrf]cf`5 VVVgg`Zca`Hcd`cZFccZ

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`1\$`\$' "- d - Fiberglass Blown insulation installation`j jUEI Hf]cf`5 VVWg': fca `Hcd`cZFccZ



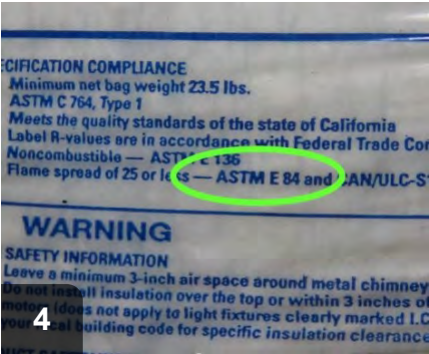
1
If insulation is roof mounted, blow below it.



2
If insulation is ceiling mounted, blow above it.



3
If insulation is mounted at both the ceiling and the roof, blow between it.



4
Insulation meets ASTM E 84.

4'1\$\$' "- e - Patching and Sealing Openings'j JUEl hYf]cf '5 WYgg'Zca 'Hcd'cZFccZ

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):

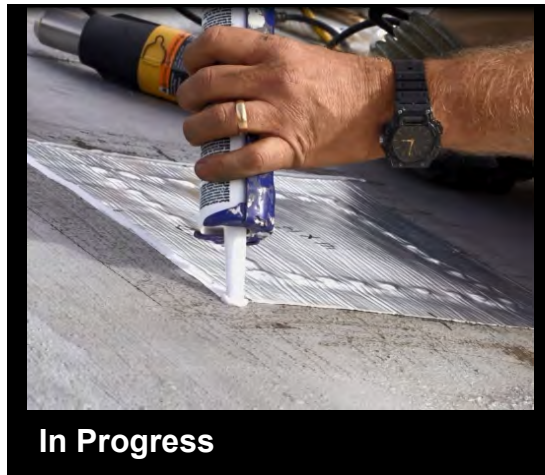
Effectively patch and seal all openings

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

4'1\$\$' "- e - Patching and Sealing Openings'j]UEI Hf]cf '5 WYgg'Zca 'Hcd'cZFccZ



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.



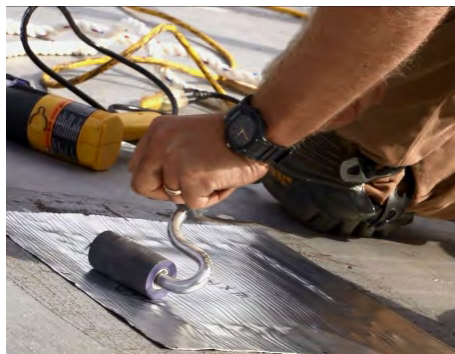
Secure the metal patch to the roof being sure to place mechanical fasteners through the sealant.



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.

4'1\$\$' "- f - Verification of Details'j jU'El Hf]cf'5 Wwgg'Zfca 'Hcd'cZFccZ

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

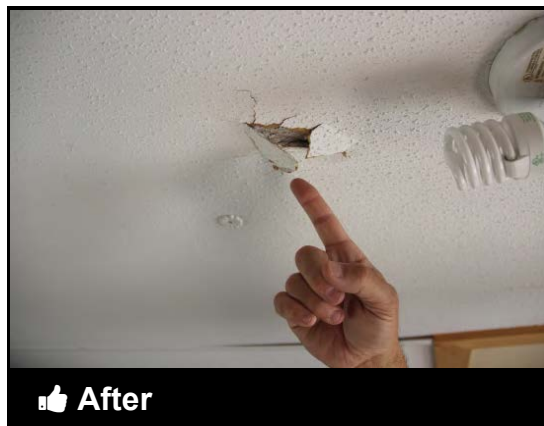
Objective(s):

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

4.1 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

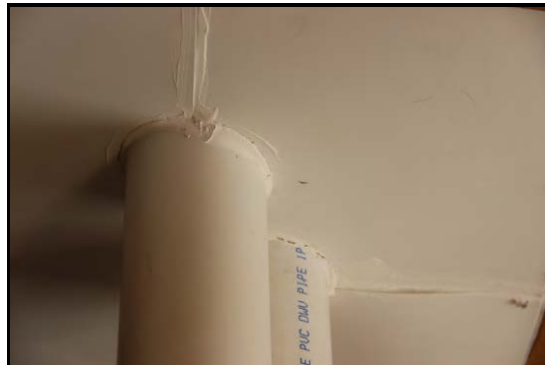
Prevent intrusion of bulk moisture

Prevent damage while installing insulation



Best Practice

The flue of a 90+ efficiency furnace terminates above the snow line and the roof penetrations have been sealed.



Flue penetrations have been sealed correctly from the interior.

4'1\$\$' '1\$a - 5 HjVZ7 Y]]b[žUbX'FccZJ Yf]zVUjcb'j]U=bfY]cf'5 VVYgg'H fci [\ 'A Y7 Y]]b[



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.



Photo Credit: Cal Steiner

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

4'1\$\$' '1\$b - Construction Prep'j]U=bf]cf '5 WYgg'H fci [\ 'H Y'7 Y']b[

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

4'1\$\$' '1\$e - Fiberglass Blown Insulation Installation' j jU=bf]cf '5 WYgg'H fci [\ 'H Y7 Y']b[

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



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

4`1\$\$' `1\$e - Fiberglass Blown Insulation Installation`j]U`bhYf]cf`5 WYgg`H fci [\ `H Y7 Y`]b[



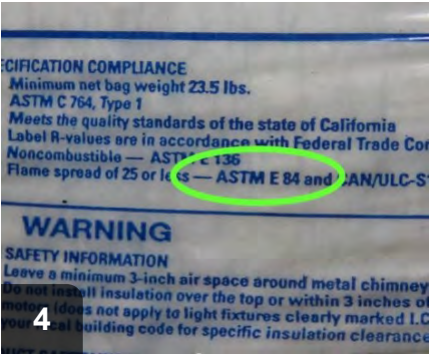
1
If insulation is roof mounted, blow below it.



2
If insulation is ceiling mounted, blow above it.



3
If insulation is mounted at both the ceiling and the roof, blow between it.



4
Insulation meets ASTM E 84.

4'1\$\$' '1\$f - Patching and Sealing Holes'j]U=bfYf]cf '5 VVVgg'H fci [\ 'h Y7 Y']b[

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



Holes should be effectively sealed, as well as aesthetically pleasing.

Tools:

1. color matched plug

Materials:

1. color matched plug

4.1.1.1 - Verification of Details' j]U=bf]cf '5 Wgg'H fci [\ 'H Y7 Y']b[

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

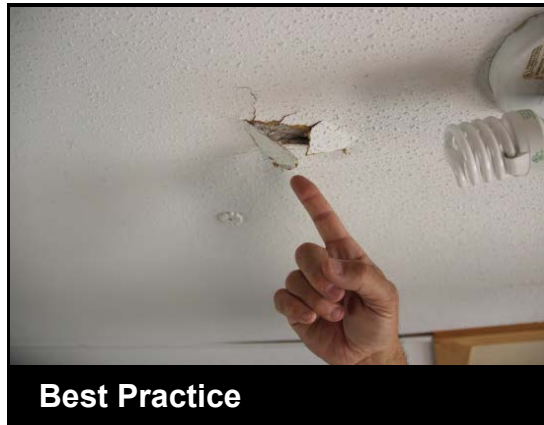
Objective(s):

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.

' "11\$1" c - 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

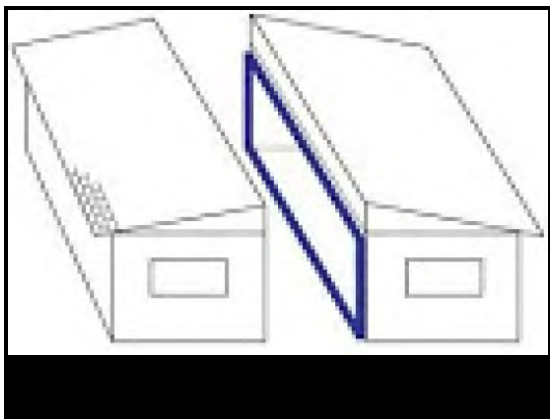
All remaining gaps will be sealed with an approved material

Objective(s):

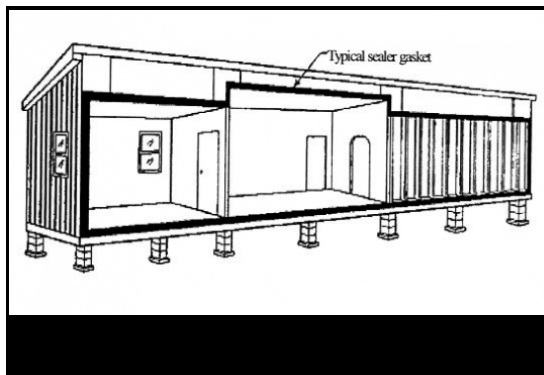
Minimize air leakage

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.

' "11\$1" c - 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.

' '1' \$1"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



Remove floor coverings from damaged area



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).

1" 2d - Floor Repair



1 Mark the joist locations on either side of the damaged area



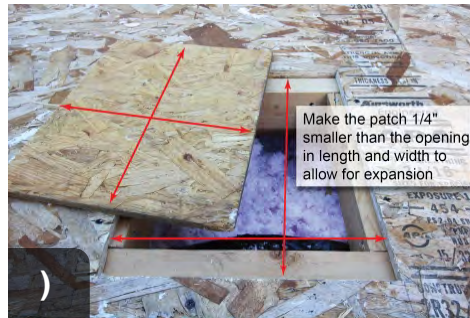
2 Cut out damaged area even with the inside edges of the floor joists



3 Cut four 2X4 blocks to support the patch



4 Install nailers flat against the joists. Finish by toenailing or screwing 2X4s between the joists



5 Make the patch 1/4" smaller than the opening in length and width to allow for expansion.



6 Apply subfloor adhesive to nailers



7 Fasten with 2" deck screws

' "1* \$2", d - Repair Wor_ Access for Plenum

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



👍 After

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.

2. Patch trunk using sheet metal patch, fastened mechanically and sealed with mastic.
3. Always wear hand protection when working with sharp objects.



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. Patch opening in duct with sheet metal and seal. 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.

' "1* \$2"- b - 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:

- Constructed 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.

' 1* \$2"- b - Flel ible Crossover Duct Connections



1
Attach elbow duct and orient in correct direction to minimize duct run



2
Fasten elbow in place with at least three evenly-spaced fasteners



3
Apply mastic at all metal-to-metal connections



4
Apply mastic to all elbow joints and flange



5
Insulate and support crossover duct



6
When clearance requires crossover to contact ground, crossover shall rest on vapor barrier and closed cell rigid foam.



7
All duct sealing and repair will be confirmed with pressure diagnostics.

("% \$&"%&'!`DfYdUfUjcb of Belly Floor Cavity

DYgJfYX`Ci HMa Y.

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 member
- 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 1/4" 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



👎 Before

Damaged rodent barrier ("belly") must be patched prior to insulating, or to reduce air flow if not insulating.



👍 After

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"1' \$2"1b - Preparation of Belly Floor Cavity



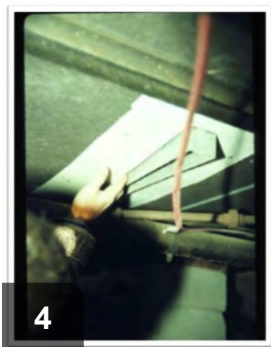
Belly damage: rodent barrier and insulation are damaged, revealing a main supply duct known as a trunk.



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:**

<input type="checkbox"/>	N/A	PREPARATION	
<input type="checkbox"/>	<input type="checkbox"/>	1	All plumbing supply leaks are repaired
<input type="checkbox"/>	<input type="checkbox"/>	2	All plumbing drain leaks are repaired
<input type="checkbox"/>	<input type="checkbox"/>	3	All forced air supply ducts are sealed, including trunk-lines and any jumper ducts
<input type="checkbox"/>	<input type="checkbox"/>	4	Furnace plenum connection to trunk-line duct is sealed
<input type="checkbox"/>	<input type="checkbox"/>	5	Cross over duct is installed or repaired to specification (see Field Guide 3.1602.9b - Crossover ducts)
<input type="checkbox"/>	<input type="checkbox"/>	6	All floor-plain air sealing is complete, including marriage line, hole under the tub, plumbing penetrations, and electrical penetrations
<input type="checkbox"/>	<input type="checkbox"/>	7	All combustion air inlets that are ducted into crawlspace are maintained (they could be for wood stove, pellet stove, water heater, furnace)
<input type="checkbox"/>	<input type="checkbox"/>	8	All belly repairs and patching are complete
<input type="checkbox"/>	<input type="checkbox"/>	9	Belly material is pinned up against floor joists where possible in order to reduce sag and amount of insulation needed

4'1' \$' "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

4'1' \$' '1c - Insulate Floors



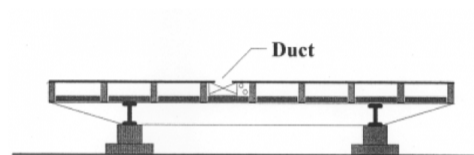
Holes are cut through rodent barrier (belly material) to insert insulation blow hose.



Loose fill insulation is blown into mobile home belly cavity.

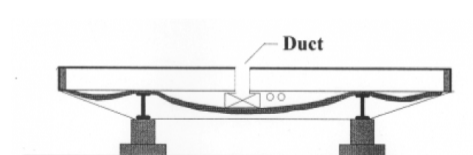


Blow holes in belly material patched.



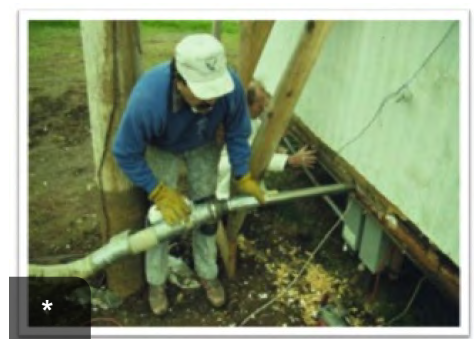
4 Duct Location - Lengthwise Joists

Cross section of belly cavity viewed from end of mobile home with lengthwise joists. Note duct location.



) Duct Location - Crosswise Joists

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"11\$4"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

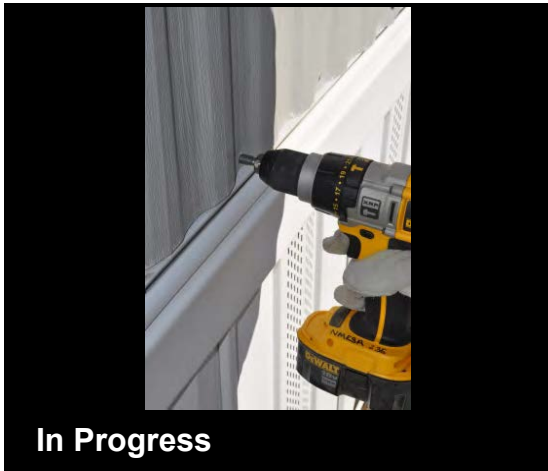
Fasteners will be removed from the bottom of the siding, working upward until the siding can be pulled away from the framing approximately 6" without damaging the siding

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



In Progress

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"11\$4"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"11\$4"1b - 9I terior 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

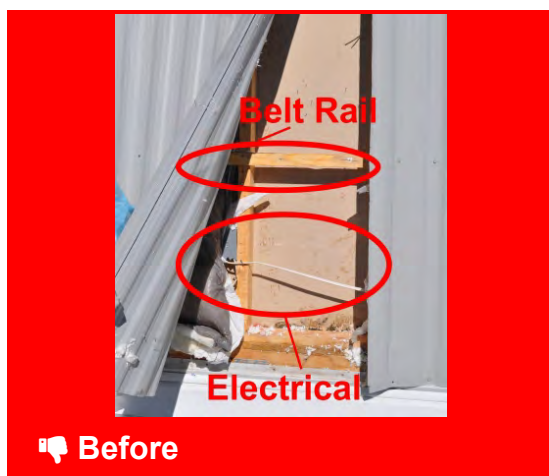
Objects will be removed from the interior surfaces of the walls being insulated

Interior paneling will be repaired as necessary

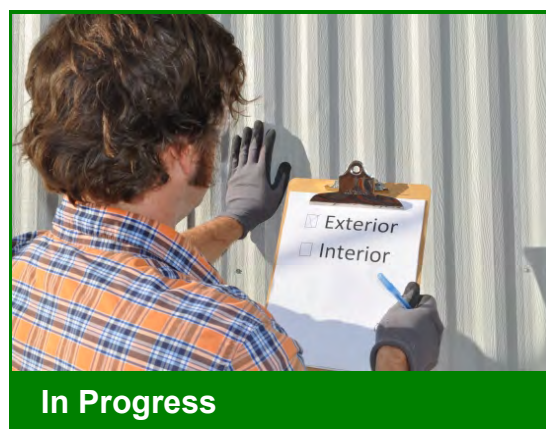
Objective(s):

Prepare wall cavity for insulation

Prevent water leaks from occurring



Take note of obstacles in the wall cavity, such as belt rails and electrical wiring



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"11\$4"1b - 9I terior Wall Cavity Inspection



Obstacles should be noted and planned for--insulation should be tucked behind belt rails



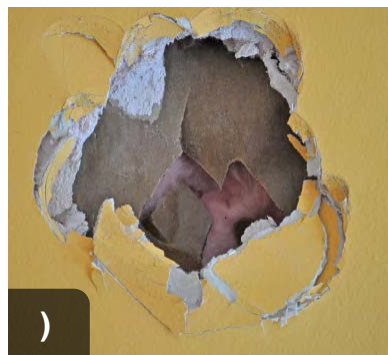
Holes in exterior siding should be patched



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"11\$4"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:

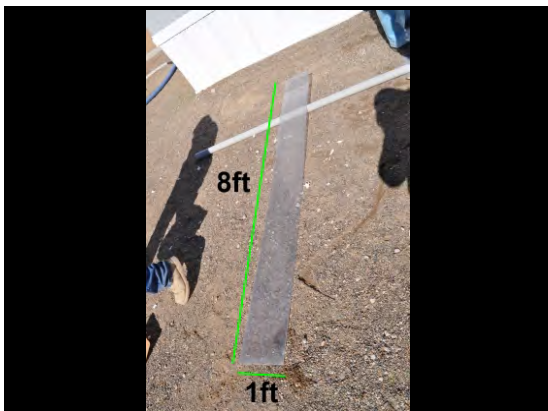
- Approximately 1' x 8' x 1/4" with a 5 degree bend 7' 1/2" from the bottom
- All corners of the Lexan (polycarbonate) will be rounded and all edges will be sanded

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



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"11\$4"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

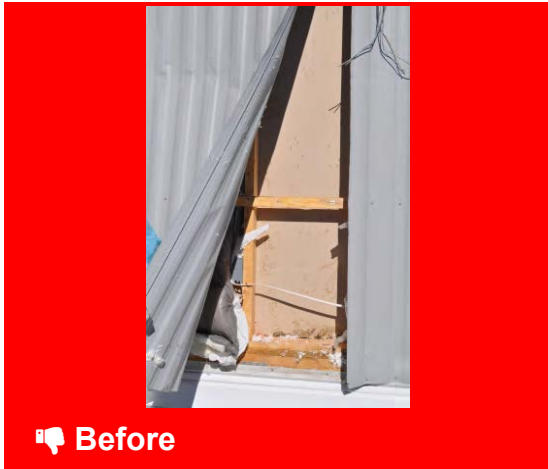
A poly-encased fiberglass batt may be used in place of the fiberglass batt and membrane assembly

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

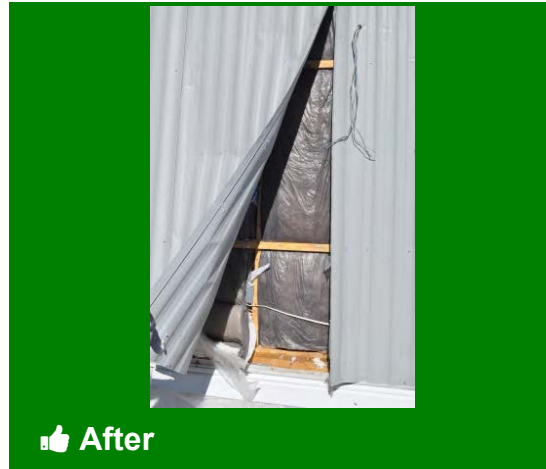
Aid in the installation process



Uninsulated and underinsulated wall cavities can be filled from the exterior with fiberglass batts

Tools:

1. Tape measure
2. Utility knife



Fiberglass batt should fill entire cavity without creating bulging in exterior paneling

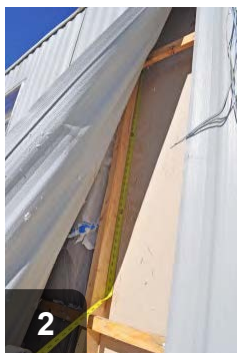
Materials:

1. Fiberglass batts, may be wrapped
2. Vapor barrier appropriate for region

4" R-11 Fiberglass Batt Installation



Uninsulated wall cavity can be accessed from exterior of mobile home through paneling



Measure length of cavity



Measure depth of cavity



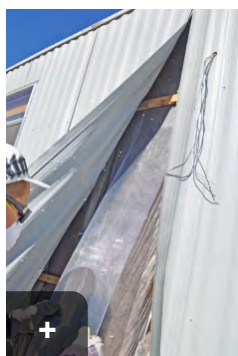
Select appropriate batt thickness and R-value. Wrapped batts provide a built in vapor barrier



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"11\$4"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

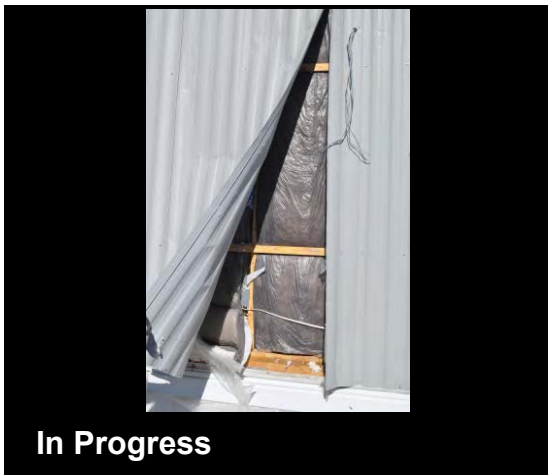
Siding will be reattached with new fasteners

Siding will be reattached without bulges or wrinkles

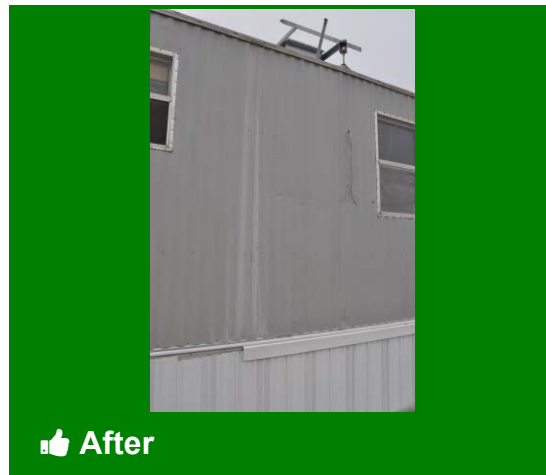
Objective(s):

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'x11\$4'x1f - 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



\$ Client Name: _____ \$ Address: _____				
DfY6`ck Yf`Dccf.				
I"	Client Eligibility Date:			
II"	Audit Date:			
III"	Client Interview Performed?		Yes	No
II"	Pollution Source Survey Completed?		Yes	No
j"	Contaminants present that would either prohibit blower door test completely or require pressurization test:			
ij"	Technician:			
ij"	Date:			
75 @I @HCBG			Pre	In-Progress
%	Calculated total square footage of heated area			
&	Calculated volume of conditioned space			
65 GE@BE7CBDHCBG/`<CI GE'H; <HBEGG`- Blower door			Pre	In-Progress
'	Primary heat source fuel type (example: nat. gas, electric, propane, wood)			
(Windspeed MPH			
)	Outside temperature °F			
*	Blower door location			
+	Baseline without blower door on in pa (stack effect)			
,	Blower door configuration: O=open fan A=ring A B=ring B LF= low flow ring			
-	Total CFM50			
%\$	NCB5 @DFEGGI FEG`- Blower door		Pre	In-Progress
	ATTIC	WRT house		
	CRAWLSPACE	WRT house		
	GARAGE	WRT house		
	OTHER:	WRT house		
	OTHER:	WRT house		
	OTHER:	WRT house		
%&	Location of existing ducts: A=inside B=outside C=inside/outside			
%&	12. Duct Pressure Test - Blower Door			
%	13. Room Pressure - HVAC fan only			
	@WUjcb	S/ Supply R/Return	Fcca`K FH'a Ujb`VcXm	DfYggi fY`DUB.`House WRT Duct
			DfY	ab`Dfc[fYgg
a.			Dcgh	
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				
k.				
l.				
HEGHB;`5 F<5 BD@EF`fk J57`LE: : E7 HG.`< J57`ZUb`cb`m			Pre	In-Progress
%	Dca jUbhDi W@U`HYgh Main Body WRT outside (all interior doors open)			
%	5`Dccfg7`cgYX`EZVh` Main Body WRT outside (all interior doors closed)			
%	Duct location after Wx and Repairs: A=inside B=outside C=inside/outside			
%+	Electric furnace heat rise test (supply°F-return°F) acceptable range:>40°to<70°			
%	Return house to pre test conditions (Check box when done)		<input type="checkbox"/>	<input type="checkbox"/>
BCHEGDC7I AEBH5HCB.				

Appendix A

DfYggi fY'DUb'HYgltg

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.

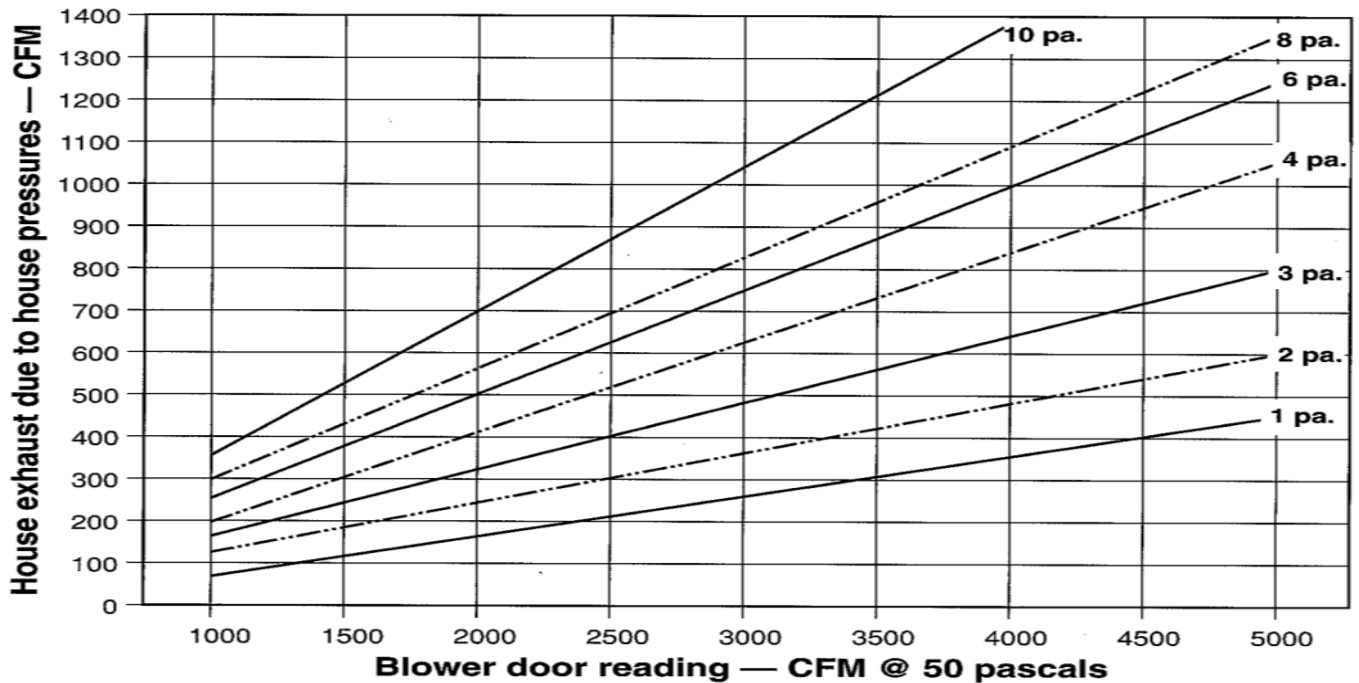
In site built homes with supply and return duct systems enclosed entirely within the thermal and pressure boundaries, pressure pan tests are not required.

Dca]bUbhDi Wt@U_ 'HYgh

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.

5Jf'@U_ q Y7\ Ufh



Revised July 2012

GHUy'cZK Ug\]b[hcbžK YUH Yf]nUjcb'5 gg]ghUbwW'Dfc[fUa '

HYW b]WU'Gi ddcfhDcW a YbhFHGDŁ

D]U[bcgh]WHYghF Ydcfh

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.

DfY'6`ck Yf'Dccf'

I"7`Ybh'E`][JV]ImiXUy.

Enter date Client was determined eligible. Ensure both Client Eligibility and Energy Audit dates are within the Period of Eligibility. See **GYWjcb'% žPeriod of Eligibility**

II"5 i XjhDUy.

Enter date Energy Audit was performed.

III"7`Ybh=bfj jYk`DYfZfa YX3

Answer yes/no

Ij "Dc`i hcb`Gci fW'Gi fj Ym7 ca d`YhYX3

Answer yes/no

j "7 cbhUa]bUbhg'DfYgYbhH Uik ci`X`YjH Yf'dfc\ JVjhV'ck Yf`Xccf`hYgh Wta d`Yh'nžcf`fYei]fY'dfYggi f]nUjcb`hYgh

(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.

j]" HYW b]WUub.

Enter name of Technician performing: Pre, In-Progress, and Post diagnostic testing.

j]]" DUy.

Enter date Technician is performing: Pre, In-Progress, and Post diagnostic testing.

6 UgY]bY7 cbX]h]cbg/ ' <ci gY'H][\ lbYgg' – Blower Door

@bY' + 'Df]a Ufm\ YUhgci fW'Z Y'hmdY'fM Ua d`Y. 'bUh[UgZ'Y'WŁ dfcdUbYžc]žk ccXL'

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.

@bY' , ' 'K]bXgdYYX'AD<'

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).

@bY' - 'Ci hg]XY'hYa dYfUhi fY's: '

Record outside temperature in degrees Fahrenheit

@bY' %\$' '6`ck Yf`Xccf`cWU]cb'

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.

BchY. Blower door set up procedure: follow manufacturer's instructions.

@bY' %%' '6 UgY]bY'k]h ci hV`ck Yf`Xccf`cb']b'dUfghUW`YZZYWL'

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.

@bY' %&' '6`ck Yf`Xccf`WŁbZ[i fU]cb'

C1cdYb'ZUb' '51f]b['5'''61f]b['6'''@1`ck 'Zck 'f]b['

Record which ring or configuration (number of holes unplugged) the blower door was set up in for testing lines 13 through 16.

BchY. 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.

@bY' %' 'HcHU`7 : A) \$'

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.

NcbU'DfYggi fYg' – Blower Door

@bY_ '% 'NcbU`DfYggi fYg`

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).

@bY_ '% '@WU]cb`cZYI]gh]b['Xi Wg.`

5 1=bg]XY''6 1ci hg]XY' '7 1]bg]XY#ci hg]XY'

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.

Di WfDfYggi fY`HYgh– Blower Door`

@bY_ '% 'Di WfDfYggi fY`HYghE`DfYggi fY`DUb`

<ci gY' K F H`Di WfWcW_k]gY`Zca `ZcbhXccfL`

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).

HYgh]b['5]f`< UbX`Yf`EZZWh– 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.

@bY_ '% 'Fcca `DfYggi fY.`

Fcca `K F H`A U]b`6 cXmif]bhYf]cf`Xccfg`WcgYXL`

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.

@bY_ '% 'Dca]bUbhDi Wf@YU_`HYgh`

A U]b`6 cXmK F H`Ci hg]XY`fU`']bhYf]cf`Xccfg`cdYbL`

Record the pressure of the main body of the house WRT outside with all interior doors open.

@bY_ '% '5``Dccfg`7`cgYX`EZZWh`

A U]b`6 cXmK F H`ci hg]XY`fU`']bhYf]cf`Xccfg`WcgYXL`

Now close all the interior doors and record main body WRT outside.

@bY_ &\$'Di W'h'cWUjcb'UZhf'K I 'UbX'fYdUjf.'
5 1]bg]XY''6 1ci hg]XY''7 1]bg]XY#ci hg]XY'

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.

@bY_ &%E`YWF]WZ fbUW\ YUhf]gY`HYgh`
<YUhf]gY'1`gi dd`mš: `E`fYh fbš: `

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.

†5 Wjcb`Yj Y. 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.

@bY_ &&` `FEHI FB`<CI GE`DfY`HYgh7 cbX]h]cbg`

Check box when done.

E1 \ U gh: Ub`HYgh]b[`

@bY_ &` `E1 \ U gh: Ub`HYgh]b[`f5 Wfi U`7 : AŁ

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"crowns 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"crowns 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"crowns 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"crowns 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	<p>Importance of cleaning dust and debris from return grilles will be explained to occupant</p> <p>Proper placement of interior furnishings with respect to registers will be explained to occupant</p> <p>Negative consequences of closing registers will be explained to occupant</p> <p>Importance of leaving interior doors open as much as possible will be explained to occupant</p>	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	<p>Proper filter selection and how to change the filter will be explained to occupant</p> <p>Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant</p> <p>Importance and timing of routine professional maintenance will be explained to occupant</p> <p>There will be no air bypass around the filters and new central forced air HVAC systems will have minimum MERV 6 filtration</p>	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	<p>Situations when the occupant should contact the HVAC contractor will be explained, including:</p> <ul style="list-style-type: none"> • 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	<p>Occupant will be provided with relevant manuals and warranties</p> <p>The labor warranty will be explained and the occupant will be given a phone number to call for warranty service</p>	Provide manuals and warranties for future servicing	2272

7\ YW`jgh`EB7 @CGED`K5 @@7 5J+HM-BGI @5HCB`fDYbgY'DUW`L

Project:

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1 Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	2 Review ventilation strategy and plan any exhaust fan, electrical, or ducting install work before insulating.
<input type="checkbox"/>	<input type="checkbox"/>	3 Put on all personal protection equipment (PPE).
<input type="checkbox"/>	<input type="checkbox"/>	4 Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	5 Identify any exterior lead-based paint hazards and set up RRP-compliant containment accordingly.
<input type="checkbox"/>	<input type="checkbox"/>	6 Assess walls from the interior of home to identify weak plaster, drywall, or panelling.
<input type="checkbox"/>	<input type="checkbox"/>	7 Identify any durability issues such as signs of moisture or pests.
<input type="checkbox"/>	<input type="checkbox"/>	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
<input type="checkbox"/>	<input type="checkbox"/>	9 Remove siding and drill through sheathing to gain access to all wall cavities and probe for obstructions and/or hazards.
<input type="checkbox"/>	<input type="checkbox"/>	10 Install insulation according to the manufacturer's specifications.
<input type="checkbox"/>	<input type="checkbox"/>	11 View completed sections using an IR camera with a blower door operating. Drill and repack any voids or low density areas.
<input type="checkbox"/>	<input type="checkbox"/>	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
<input type="checkbox"/>	<input type="checkbox"/>	13 Clean the work areas.
<input type="checkbox"/>	<input type="checkbox"/>	14 Educate the occupants on the work completed.
<input type="checkbox"/>	<input type="checkbox"/>	15 Post Insulation Certificate and insulation manufacturer's coverage chart.

7\YW\gh: @CCF-BGI @HCB

Project:

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1 Review ventilation strategy and plan any exhaust fan, electrical, or ducting install work before insulating.
<input type="checkbox"/>	<input type="checkbox"/>	2 Put on all personal protection equipment (PPE).
<input type="checkbox"/>	<input type="checkbox"/>	3 Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	4 Identify any durability issues such as signs of moisture or pests.
<input type="checkbox"/>	<input type="checkbox"/>	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
<input type="checkbox"/>	<input type="checkbox"/>	6 Identify areas where insulation will not be installed.
<input type="checkbox"/>	<input type="checkbox"/>	7 Remove existing damaged insulation from the crawlspace and/or basement.
<input type="checkbox"/>	<input type="checkbox"/>	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.
<input type="checkbox"/>	<input type="checkbox"/>	9 Install insulation according to the manufacturer's specifications and Insulation Support Matrix. Verify that all insulation has no gaps, voids, compression or misalignment.
<input type="checkbox"/>	<input type="checkbox"/>	10 Install baffles at foundation venting if needed.
✓	N/A	CLOSE OUT
<input type="checkbox"/>	<input type="checkbox"/>	11 Clean the work areas.
<input type="checkbox"/>	<input type="checkbox"/>	12 Educate the occupants on the work completed.
<input type="checkbox"/>	<input type="checkbox"/>	13 Post Insulation Certificate and insulation manufacturer's coverage chart.

7\ YW`]gh`5HH7`-BGI @5HCB

Project:

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1 Review ventilation strategy and plan any exhaust fan, electrical, or ducting install work before insulating.
<input type="checkbox"/>	<input type="checkbox"/>	2 Put on all personal protection equipment (PPE).
<input type="checkbox"/>	<input type="checkbox"/>	3 Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	4 Identify any durability issues such as signs of moisture or pests.
<input type="checkbox"/>	<input type="checkbox"/>	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.
<input type="checkbox"/>	<input type="checkbox"/>	6 If K&T present, confirm K&T inspection form complete.
<input type="checkbox"/>	<input type="checkbox"/>	7 Confirm all working connections are in junction boxes.
✓	N/A	WORK
<input type="checkbox"/>	<input type="checkbox"/>	8 Flag junction boxes.
<input type="checkbox"/>	<input type="checkbox"/>	9 Install insulation depth measuring sticks.
<input type="checkbox"/>	<input type="checkbox"/>	10 Identify areas where insulation will not be installed.
<input type="checkbox"/>	<input type="checkbox"/>	11 Complete ceiling-plane air sealing: seal all holes between the interior of the house and the attic.
<input type="checkbox"/>	<input type="checkbox"/>	12 Install baffles at low venting.
<input type="checkbox"/>	<input type="checkbox"/>	13 Install insulation dams at attic accesses and around heat producing devices.
<input type="checkbox"/>	<input type="checkbox"/>	14 Install insulation according to the manufacturer's specifications. Verify that all insulation has no gaps, voids, compression or misalignment.
✓	N/A	CLOSE OUT
<input type="checkbox"/>	<input type="checkbox"/>	15 Clean the work areas.
<input type="checkbox"/>	<input type="checkbox"/>	16 Educate the occupants on the work completed.
<input type="checkbox"/>	<input type="checkbox"/>	17 Post Insulation Certificate and insulation manufacturer's coverage chart.

Manufactured Home - Underfloor Insulation Precheck**Project:**

<input type="checkbox"/>	N/A	PREPARATION	
<input type="checkbox"/>	<input type="checkbox"/>	1	All plumbing supply leaks are repaired
<input type="checkbox"/>	<input type="checkbox"/>	2	All plumbing drain leaks are repaired
<input type="checkbox"/>	<input type="checkbox"/>	3	All forced air supply ducts are sealed, including trunk-lines and any jumper ducts
<input type="checkbox"/>	<input type="checkbox"/>	4	Furnace plenum connection to trunk-line duct is sealed
<input type="checkbox"/>	<input type="checkbox"/>	5	Cross over duct is installed or repaired to specification (see Field Guide 3.1602.9b - Crossover ducts)
<input type="checkbox"/>	<input type="checkbox"/>	6	All floor-plain air sealing is complete, including marriage line, hole under the tub, plumbing penetrations, and electrical penetrations
<input type="checkbox"/>	<input type="checkbox"/>	7	All combustion air inlets that are ducted into crawlspace are maintained (they could be for wood stove, pellet stove, water heater, furnace)
<input type="checkbox"/>	<input type="checkbox"/>	8	All belly repairs and patching are complete
<input type="checkbox"/>	<input type="checkbox"/>	9	Belly material is pinned up against floor joists where possible in order to reduce sag and amount of insulation needed

Manufactured Home - Attic Insulation Precheck**Project:**

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

K5 @G!Wta a cb`Uf`YU_ U YXYUJ`g`bWi XYVi hUfYbch`ja]hX`hc.

Project:

✓	N/A	PREPARATION
<input type="checkbox"/>	<input type="checkbox"/>	1 Openings behind and under tubs, showers, and tub/shower enclosures
<input type="checkbox"/>	<input type="checkbox"/>	2 Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
<input type="checkbox"/>	<input type="checkbox"/>	3 Pocket door framing open into floor or attic above and exterior walls
<input type="checkbox"/>	<input type="checkbox"/>	4 Seams and openings in walls and ceilings between attached garages and house
<input type="checkbox"/>	<input type="checkbox"/>	5 All joints seams and penetrations in surfaces without an air retarding membrane
<input type="checkbox"/>	<input type="checkbox"/>	6 Gaps in tongue in groove paneling where angles change at hips, valleys, and where walls meet slants and ceilings
<input type="checkbox"/>	<input type="checkbox"/>	7 Built-in cabinets, dressers or book shelves in knee walls.
<input type="checkbox"/>	<input type="checkbox"/>	8 Common wall openings between dwelling units
<input type="checkbox"/>	<input type="checkbox"/>	9 Rim joist junctions and gaps between sill and foundation, including open block cores
<input type="checkbox"/>	<input type="checkbox"/>	10 Utility penetrations and direct openings through foundation walls
<input type="checkbox"/>	<input type="checkbox"/>	11 Openings in gypsum board including un-taped joints above suspended ceiling and behind cabinets
<input type="checkbox"/>	<input type="checkbox"/>	12 Openings between window and door assemblies and their respective jambs and framing when no interior or exterior trim is present

: @CCF'D@BE!'Wta a cb'Uj'`YU_ U YXYUJ`g]bWi XYVi hUfY'bcH`ja]hX'hc.

Project:

✓	N/A	PREPARATION	
<input type="checkbox"/>	<input type="checkbox"/>	1	Plumbing wet walls, duct chases, duct seams, joints and boot leaks
<input type="checkbox"/>	<input type="checkbox"/>	2	Openings behind and under tubs, showers, and tub/shower enclosures
<input type="checkbox"/>	<input type="checkbox"/>	3	Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
<input type="checkbox"/>	<input type="checkbox"/>	4	Floors open under knee walls, walls open at level changes and gable ends
<input type="checkbox"/>	<input type="checkbox"/>	5	Pocket door framing open into floor or attic above and exterior walls
<input type="checkbox"/>	<input type="checkbox"/>	6	All joints seams and penetrations in surfaces without an air retarding membrane
<input type="checkbox"/>	<input type="checkbox"/>	7	Gaps below baseboard and behind carpet nailing strip at subfloor joint to exterior wall
<input type="checkbox"/>	<input type="checkbox"/>	8	Rim joist junctions and gaps between sill and foundation, including open block cores

5HH7 'l'Wta a cb'Uj'~YU_ U' Y'XYHUJ'g]bWi XY'Vi hUfY'bcH`ja jH'X'hc.

Project:

✓	N/A	PREPARATION
<input type="checkbox"/>	<input type="checkbox"/>	1 Dropped soffits, dropped ceilings and ceiling height changes
<input type="checkbox"/>	<input type="checkbox"/>	2 Plumbing wet walls, duct chases, duct seams, joints and boot leaks
<input type="checkbox"/>	<input type="checkbox"/>	3 Chimney and combustion vent chases
<input type="checkbox"/>	<input type="checkbox"/>	4 Wall tops open into attic, gaps between gypsum ceiling and wall plates
<input type="checkbox"/>	<input type="checkbox"/>	5 Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
<input type="checkbox"/>	<input type="checkbox"/>	6 2 nd story floors open to attached roofs over porches and additions or garages
<input type="checkbox"/>	<input type="checkbox"/>	7 Inside framing open into attic stairs and landings
<input type="checkbox"/>	<input type="checkbox"/>	8 Pocket door framing open into floor or attic above and exterior walls
<input type="checkbox"/>	<input type="checkbox"/>	9 Non-IC recessed light fixtures. IC rated fixtures with no airtight insert
<input type="checkbox"/>	<input type="checkbox"/>	10 Bath and kitchen fans venting into the attic
<input type="checkbox"/>	<input type="checkbox"/>	11 All joints seams and penetrations in surfaces without an air retarding membrane
<input type="checkbox"/>	<input type="checkbox"/>	12 Gaps in tongue in groove paneling where angles change at hips, valleys, and where walls meet slants and ceilings
<input type="checkbox"/>	<input type="checkbox"/>	13 Acoustical tile and suspended ceilings with no solid ceiling above.
<input type="checkbox"/>	<input type="checkbox"/>	14 Missing gypsum behind decorative ceiling light trays or above decorative ceiling beams
<input type="checkbox"/>	<input type="checkbox"/>	15 Built-in cabinets, dressers or book shelves in knee walls.
<input type="checkbox"/>	<input type="checkbox"/>	16 Attic access openings, operable doors and hatches without tight weather-strip
<input type="checkbox"/>	<input type="checkbox"/>	17 Pull down attic access stair or cover
<input type="checkbox"/>	<input type="checkbox"/>	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.

5-F GE5 @B; !Wta a cbUj~YU_U YXYUJg]bWi XYVi hUfYbch~ja jHYX'hc.

Project:

✓	N/A	PREPARATION
<input type="checkbox"/>	<input type="checkbox"/>	1 Dropped soffits, dropped ceilings and ceiling height changes
<input type="checkbox"/>	<input type="checkbox"/>	2 Plumbing wet walls, duct chases, duct seams, joints and boot leaks
<input type="checkbox"/>	<input type="checkbox"/>	3 Chimney and combustion vent chases
<input type="checkbox"/>	<input type="checkbox"/>	4 Openings behind and under tubs, showers, and tub/shower enclosures
<input type="checkbox"/>	<input type="checkbox"/>	5 Wall tops open into attic, gaps between gypsum ceiling and wall plates
<input type="checkbox"/>	<input type="checkbox"/>	6 Annular space at wiring, pipe penetrations through plates, and at ceiling fixtures
<input type="checkbox"/>	<input type="checkbox"/>	7 Floors open under knee walls, walls open at level changes and gable ends
<input type="checkbox"/>	<input type="checkbox"/>	8 2 nd story floors open to attached roofs over porches and additions or garages
<input type="checkbox"/>	<input type="checkbox"/>	9 Inside framing open into attic stairs and landings
<input type="checkbox"/>	<input type="checkbox"/>	10 Pocket door framing open into floor or attic above and exterior walls
<input type="checkbox"/>	<input type="checkbox"/>	11 Seams and openings in walls and ceilings between attached garages and house
<input type="checkbox"/>	<input type="checkbox"/>	12 Non-IC recessed light fixtures. IC rated fixtures with no airtight insert
<input type="checkbox"/>	<input type="checkbox"/>	13 Bath and kitchen fans venting into the attic
<input type="checkbox"/>	<input type="checkbox"/>	14 All joints seams and penetrations in surfaces without an air retarding membrane
<input type="checkbox"/>	<input type="checkbox"/>	15 Gaps in tongue in groove paneling where angles change at hips, valleys, and where walls meet slants and ceilings
<input type="checkbox"/>	<input type="checkbox"/>	16 Acoustical tile and suspended ceilings with no solid ceiling above.
<input type="checkbox"/>	<input type="checkbox"/>	17 Missing gypsum behind decorative ceiling light trays or above decorative ceiling beams
<input type="checkbox"/>	<input type="checkbox"/>	18 Built-in cabinets, dressers or book shelves in knee walls.
<input type="checkbox"/>	<input type="checkbox"/>	19 Gaps below baseboard and behind carpet nailing strip at subfloor joint to exterior wall
<input type="checkbox"/>	<input type="checkbox"/>	20 Common wall openings between dwelling units
<input type="checkbox"/>	<input type="checkbox"/>	21 Attic access openings, operable doors and hatches without tight weather-strip
<input type="checkbox"/>	<input type="checkbox"/>	22 Pull down attic access stair or cover
<input type="checkbox"/>	<input type="checkbox"/>	23 Rim joist junctions and gaps between sill and foundation, including open block cores
<input type="checkbox"/>	<input type="checkbox"/>	24 Utility penetrations and direct openings through foundation walls
<input type="checkbox"/>	<input type="checkbox"/>	25 Openings in gypsum board including un-taped joints above suspended ceiling and behind cabinets
<input type="checkbox"/>	<input type="checkbox"/>	26 Openings between window and door assemblies and their respective jambs and framing when no interior or exterior trim is present
<input type="checkbox"/>	<input type="checkbox"/>	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.



ASHRAE 62.2 Ventilation, Pre-Weatherization Conditions ** Your input goes in the green squares. **

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 62.2-2016 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.

Input location below:

Calculating $A_{v1} \cdot Z_f \cdot U_{HLM} \cdot YX \cdot X_k \cdot Y \cdot [i \cdot b] \cdot g$.

Total square footage of dwelling unit envelope:

Total square footage of walls shared with garage or attached dwelling unit:

Dk Y" b[i b]hg gHLM YX. ☐

Pre-Weatherization Notes:

Project Identifier		Pre-Weatherization blower door reading (CFM50)	
Audit Date		People (not less than one)	
Auditor Inspector		Bedrooms (not less than one)	7.5
Conditioned Square Footage			0.0
Q _{tot} (per ASHRAE calculation 4.1a)			7.5
Room	Room Exists? (y/n)	Window cfm	Operable Window? (y/n)
Kitchen		0	
Bath 1		0	
Bath 2		0	
Bath 3		0	
Intermittent Required		Intermittent Measured Fan (cfm)	Continuous Required
Continuous Measured Kitchen = ach		Continuous Measured Kitchen = ach	Deficits (cfm)
Total Deficit		0.0	
Deficit / 4		0.0	

Needed Ventilation Estimate (prior to infiltration credit) cfm

Blower Door CFM50	Dwelling Unit Height (ft)	Actual Infiltration Estimate (Q _{inf})
0		0.0

Q _{inf}	0.0
Required mechanical ventilation (CFM), Q _{AB}	None

ASHRAE 62.2 Ventilation Requirements - Post Weatherization (FINAL)

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 62.2-2016 standard.

This lower section of the worksheet is for recording data and 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		People (not less than one)	0
Auditor Inspector		Bedrooms (not less than one)	0
Conditioned Square Footage			0.0
Q _{tot} (per ASHRAE calculation 4.1a)			7.5
Room	Room Exists? (y/n)	Window cfm	Operable Window? (y/n)
Kitchen	0	0	
Bath 1	0	0	
Bath 2	0	0	
Bath 3	0	0	
Intermittent Required		Intermittent Measured Fan (cfm)	Continuous Required
Continuous Measured Kitchen = ach		Continuous Measured Kitchen = ach	Deficits (cfm)
Total Deficit		0.0	
Deficit / 4		0.0	

Needed Ventilation (prior to infiltration credit) cfm

Blower Door CFM50	Dwelling Unit Height (ft)	Actual Infiltration (Q _{inf})
		0.0

Q _{inf}	0.0
Required mechanical ventilation (CFM), Q _{fan}	8

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.

Post-Weatherization (Final) Project Notes:

GHUy'cZK Ug\]b[hcbžK YU\ Yf]nUjcb'5 gg]gHUbW'Dfc[fUa '

HYW b]WU'Gi ddcfhDcW a Ybh

A YW Ub]WU'J Ybh]Ujcb'K cf_g\ YYh'

ASHRAE 62.2-2016

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 62.2-2016, refer to the Intermittent Calculation sheet of this tool, or 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.

The lower portion of the Mechanical Ventilation Worksheet is for recording post-weatherization conditions and documenting compliance with ASHRAE 62.2-2016.

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 62.2-2016 section 4.1.1*

Line #3 Bedrooms

Enter the number of bedrooms. Not to be less than one. *Per ASHRAE 62.2-2016 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 62.2-2016 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)*.03 *Per ASHRAE 62.2-2016 section 4.1.1*

Line #5 Total Ventilation Required (Q_{tot})

This is a calculated value as defined as Q_{tot} in ASHRAE 62.2-2016 section 4.1. This value will be at, or below the value shown in ASHRAE 62.2-2016 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 inputs are “y” for Kitchen and Bath 1 (as it is assumed that each dwelling unit being considered will have one of each), though this input is easily changed if necessary.

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 62.2-2016 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 = $10 \times 12 \times 8 = 960$ cubic feet, Hourly fan flow = $22 \times 60 = 1320$ cubic feet per hour, $1320/960 = 1.375$ ach.

If kitchen ventilation is provided by a range hood, it is required to have a flow of at least 100 CFM. Any other mechanical ventilation in the kitchen (such as a downdraft fan) must have a flow of 300 CFM.

According to the ASHRAE 62.2-2016 standard, there are two types of kitchens: enclosed and nonenclosed. An *enclosed* kitchen is defined as one that has permanent openings to interior adjacent spaces that do not exceed a total of 60 square feet. An *enclosed* kitchen is required to have mechanical ventilation that provides at least 5 air changes per hour (ACH), whether through the use of a range hood or other mechanical ventilation.

A *nonenclosed* kitchen has permanent openings to interior adjacent spaces in excess of a total of 60 square feet. A *nonenclosed* kitchen is more highly connected to the main body of the home, so there is no ACH criterion to fulfill. A *nonenclosed* kitchen is required, as is an enclosed kitchen, to have mechanical ventilation which provides 100 CFM (if delivered by a range hood) or 300 CFM (if delivered by a other mechanical ventilation, such as a range hood).

Line #7 through #9 Bath 1, 2 or 3

Enter only rooms meeting the definition of a bathroom on these lines. ASHRAE 62.2-2016 defines a bathroom as “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 lines 18 and 36.*

Line #10 Total Deficit

This line represents the existing deficit in local ventilation per ASHRAE 62.2-2016 Normative Appendix A *especially section A3.1*.

Line #11 Required Additional Airflow

The additional airflow required is the total deficit divided by four (per ASHRAE 62.2-2016 Normative Appendix A *especially section A3.3*). 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 (Q_{inf})

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.

Dwelling unit height is defined in ASHRAE 62.2-2016 as the “vertical distance between the lowest and highest above-grade points within the pressure boundary” (in feet).

Select a city from the drop-down menu on the left side of the worksheet which most accurately reflects the location and climatic conditions for the building being considered. This selection determines the WSF (weather and shielding factor, from Normative Appendix B) used to complete the calculation of Q_{inf}. *Note: Portland Oregon is included to more accurately address conditions in southwest Washington.*

The third box on this line is the calculation of Q_{inf}. According to ASHRAE 62.2-2016, Addendum i:

$$Q_{inf} = CFM@50 * 0.052 * WSF * [(dwelling\ unit\ height / reference\ height)^{.4}]$$

where dwelling unit height is as defined above, and the reference height is 8.2 feet.

Line #14 Assumed Infiltration (hidden columns)

ASHRAE 62.2-2016 assumes an infiltration rate of 2CFM per square foot of the building. 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 (hidden columns)

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 #15 Calculating A_{ext} for attached dwelling units

This line is also the beginning of the section used to calculate A_{ext} (a term used for horizontally attached dwelling units only). The complete calculation for Q_{fan} is given in ASHRAE 62.2-2016 equation 4.6 as

$$Q_{fan} = Q_{tot} - (Q_{inf} \times A_{ext})$$

where

$$A_{ext} = \frac{\text{(Exterior envelope surface area that is not attached to garages or other dwelling units)}}{\text{(Total envelope surface area)}}$$

and modifies the infiltration credit proportionately. (Note that A_{ext} should be calculated even for dwelling units attached only via garage demising walls.) A_{ext} is always equal to 1 for detached dwelling units, making this calculation only necessary for attached dwelling units.

If the dwelling unit under consideration is vertically attached (shares any part of its floor or ceiling with another dwelling unit), check the box in this section. No infiltration credit is given for stacked dwelling units ($Q_{inf} = 0$).

Line #16 Infiltration Credit (hidden columns)

The infiltration credit allowed is $\frac{1}{2}$ 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, 100 or 300 CFM for kitchens, and 20 CFM for 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 below, 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 in laundry rooms, $\frac{1}{2}$ baths, water closets, whole building, etc.) sum all CFM and enter it here. If continuous 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 62.2-2016. 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".

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 #2-5 above. For user convenience, values will transfer from original entries. If people, bedrooms, or square footage have changed, 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 utilizing 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 #31 Final Blower Door CFM50 and Actual Infiltration (Q_{inf})

Enter the post weatherization blower door number in CFM50 and the dwelling unit height. The actual building infiltration will be calculated automatically using the new CFM50 according to the same calculations as in line #13 (see above).

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 62.2-2016 method to determine flow value).

Line #37 Continuous Ventilation Required

This line is the continuous ventilation still needed to meet ASHRAE 62.2-2016. 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

Hyfa g:

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.-H₂O) 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.

Appendix G

Multifamily Homes

The NREL MF SWS applies to all buildings containing more than 5 units. View the MF SWS online at <https://sws.nrel.gov> for more information