



# Retrofitting North Dakota



**Standard Work Specifications**

**Field Guide for**

**Single-Family Homes**

**created by**

**North Dakota Department of Commerce**



## Directions for using ND Standard Work Specifications and Field Guide.

There are two separate documents in one file. The Standard Work Specifications (SWS) followed by the Field Guide. The first document is the Standards Work Specifications (SWS). This document contains standards and regulations. The Field Guide is a “how to” on achieving said standard.

Note: You will notice at the end of the SWS some standards from the ND Field Standards are in the document as they do not have existing SWS for those measures.

### Using the Standard Work Specifications

Clicking on any number in the SWS title numbers in the Table of Contents will link you directly to that corresponding specification. Although this will link you directly with the specification be sure to verify as there is more than one specification on each page. It may be near the top or bottom of the page depending on where the SWS lies within the page.

For each SWS be sure to read the title, specification and objectives fully. One title can have many specifications and objectives under its heading. As you see below the SWS for Fuel Leak Detection has three specifications and two objectives. **IMPORTANT:** If the specification is toward the bottom of the page it may continue to the following page. Continue scrolling to the next page to see if additional specifications and objectives exist.

Title	Specification	Objective
2.0201.1b Fuel leak detection	Inspect and test for gas or oil leakage at connections of natural gas, propane piping, or oil systems	Detect fuel gas leaks
	If leaks are found, immediate action will be taken to notify occupant to help ensure leaks are repaired	Determine and report need for repair
	The report will specify repair for leaks and replacement for hazardous or damaged gas or oil connectors and pipes	

While working in the SWS document you will notice that within the spec some title numbers will be underlined. By clicking on the underlined numbers it will link you to that corresponding page in the Field Guide.

You will notice that any link will always have a finger pointer  symbol.

Remember that there are many title numbers that can link to the same Field Guide page. In many cases the specification number will not correspond with the title number of the Field Guide page. Many of the Field Guide pages were identical so by linking the same information allowed for a shorter version. Be sure the information from the specification and Field Guide page makes sense.

Notice that the words Field Guide are underlined on the first page. This is your direct link to the Field Guide. The heading numbers (these will not have a letter behind them) will also link you to the Field Guide table of contents

Note: **There is not a field guide page for every specification.**

### Using the Field Guide

The Field Guide begins on page 73.

Every title number in the Field Guide Table of Contents is linked to that corresponding field guide page. Remember again that many titles have the same Field Guide page. You will notice after the noted title and specification it will tell you to “see” a certain specification this is just for informational purposes as clicking the specification number will bring you to the related field guide page.

Updates have been made to diagnostic sheets along with the insulation certificate. Just remember that jobs estimated may not contain these forms.

This is a working document so please contact me if you have questions, find any broken links, or see something that doesn't make sense.

**North Dakota Standard Work Specifications - Single  
Family Homes  
7/13/2015**

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## Health and Safety

### Safe Work Practices

#### 2.0100.1

Topic

Subtopic

Desired Outcome

Note

#### Global Worker Safety

Safe Work Practices

Safe Work Practices

Work completed safely without injury or hazardous exposure

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

Single-Family Homes

#### Title

#### Specification(s)

#### Objective(s)

2.0100.1a Prevention through design

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

Prevent worker injuries  
Reduce risk exposure to toxic substances and physical hazards

2.0100.1b Hand protection

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

Minimize skin contact with contaminants  
Protect hands from sharp objects

2.0100.1c Respiratory protection

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)

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

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

2.0100.1d Electrical safety

An electrical safety assessment will be performed  
All electric tools will be protected by ground-fault circuit interrupters (GFCI)

Avoid electrical shock and arc flash hazards

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

2.0100.1e Carbon monoxide (CO)

All homes will have a carbon monoxide alarm  
Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)

Protect worker and occupant health

2.0100.1f Protective clothing

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)

Protect worker from skin contact with contaminants

Minimize spread of contaminants

2.0100.1g Confined space safety

Access and egress points will be located before beginning work

Prevent build-up of toxic or flammable contaminants

	Inspection will be conducted for frayed electrical wires Adequate ventilation will be provided Use of toxic material will be reduced	Provide adequate access and egress points Prevent electrical shock
2.0100.1h Power tool safety	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, safety guards, 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	Prevent power tool injuries
2.0100.1i Chemical safety	Hazardous materials will be handled in accordance with manufacturer specifications or MSDS standards to eliminate hazards associated with volatile Appropriate personal protective equipment (PPE) will be provided Workers will be trained on how to use PPE Workers will be expected to always use appropriate PPE during work	Prevent worker exposure to toxic substances
2.0100.1j Ergonomic safety	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	Prevent injuries from awkward postures, repetitive motions, and improper lifting
2.0100.1k Hand tool safety	Hand tools will be used for intended purpose	Prevent hand tool injuries
2.0100.1l Slips, trips, and falls	Caution will be used around power cords, hoses, tarps, and plastic sheeting  Precautions will be taken when ladders are used, when working at heights, or when balancing on joists Walk boards will be used when practical Appropriate footwear and clothing will be worn	Prevent injuries due to slips, trips, and falls
2.0100.1m Heat and thermal stress	Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided 911 will be dialed when necessary	Prevent heat stroke, heat stress, and cold stress related injuries
2.0100.1n Fire safety	Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply) Use of flammable material will be reduced and fire-rated materials will be used	Prevent a fire hazard
2.0100.1o Asbestos-containing materials (ACM)	Assess potential asbestos hazard; if unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material and to sample and test as needed If suspected ACM is in good condition, do not disturb If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s) For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair in accordance with federal, state, and local requirements; only a licensed or When working around ACM, do not: Dust, sweep, or vacuum ACM debris Saw, sand, scrape, or drill holes in the material Use abrasive pads or brushes to strip materials Asbestos abatement or repair work should be completed prior to blower door testing; exercise appropriate caution when conducting blower door testing where friable asbestos or vermiculite attic insulation is present to avoid drawing asbestos fibers into the living space (i.e., use positively pressurized blower door testing) unless the material has been tested and found not to contain asbestos	Protect workers and occupants from potential asbestos hazards
2.0100.1p Lead paint assessment	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	Protect workers and occupants from potential lead hazards
<b>2.0103.1</b> Topic Subtopic Desired Outcome	<b>Air Sealing Worker Safety</b> Safe Work Practices Air Sealing Work completed safely without injury or hazardous exposure	
Single-Family Homes <b>Title</b>	<b>Specifications</b>	<b>Objective(s)</b>
2.0103.1a Worker safety	All worker safety specifications in Global Worker Safety section will be followed	Prevent injury  Minimize exposure to health and safety hazards
<b>2.0104.1</b> Topic Subtopic Desired Outcome	<b>Insulation Worker Safety</b> Safe Work Practices Insulation Work is completed safely without injury or hazardous exposure	

Single-Family Homes <b>Title</b> 2.0104.1a Worker safety	<b>Specification(s)</b> Follow all worker safety specifications in Global Worker Safety section	<b>Objective(s)</b> Prevent injury  Minimize exposure to health and safety hazards
2.0104.1b Vermiculite	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	Protect workers from toxic exposure
<b>2.0105.1</b> Topic Subtopic Desired Outcome	<b>Combustion Worker Safety</b> Safe Work Practices Heating and Cooling Equipment Work completed safely without injury or hazardous exposure	
Single-Family Homes <b>Title</b> 2.0105.1a Worker safety	<b>Specification(s)</b> All worker safety specifications in Global Worker Safety section will be followed	<b>Objective(s)</b> Prevent injury  Minimize exposure to health and safety hazards
2.0105.1b Carbon monoxide (CO)	Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)	Protect worker and occupant health
2.0105.1c Raw fuel	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	Protect worker and occupant health
<b>2.0105.2</b> Topic Subtopic Desired Outcome	<b>Heating and Cooling Worker Safety</b> Safe Work Practices Heating and Cooling Equipment Work completed safely without injury or hazardous exposure	
Single-Family Homes <b>Title</b> 2.0105.2a Worker safety	<b>Specification(s)</b> Follow all worker safety specifications in Global Worker Safety section	<b>Objective(s)</b> Prevent injury  Minimize exposure to health and safety hazards
2.0105.2b Mercury	When replacing existing thermostats, identify and dispose of any mercury containing thermostats in accordance with Environmental Protection Agency (EPA) guidance	Protect workers and occupants from mercury exposure
<b>2.0110.1</b> Topic Subtopic Desired Outcome	<b>Material Selection, Labeling, and Safety Data Sheets (SDSs)</b> Safe Work Practices Material Safety Occupant and worker risk from hazardous materials minimized	
Single-Family Homes <b>Title</b> 2.0110.1a Material selection	<b>Specification(s)</b> Materials that do not create long-term health risks for occupants and workers will be used	<b>Objective(s)</b> Improve indoor air quality in the living space
2.0110.1b Material labels	Manufacturer specifications will be followed	Reduce risk of exposure to harmful substances Follow safety procedures
2.0110.1c Safety Data Sheets (SDSs)	SDSs will be provided onsite and available during all work	Assess exposure risk Prepare a response in case of emergency
<b>2.0111.2</b> Topic Subtopic Desired Outcome	<b>Crawl Spaces—Pre-Work Qualifications</b> Safe Work Practices Basements and Crawl Spaces Site properly prepared for upgrade	
Single-Family Homes <b>Title</b> 2.0111.2a Fuel leaks	<b>Specification(s)</b> Fuel leaks will be repaired and inspected in accordance with the ND State Building Code	<b>Objective(s)</b> Ensure site is safe and ready for upgrade
2.0111.2b Electrical hazards	Electrical hazards will be eliminated and inspected in accordance with ND State Electrical Code	Ensure site is safe and ready for upgrade
2.0111.2d Plumbing and water leaks	Plumbing leaks will be repaired before crawl space upgrade in accordance with the local building code.	Prepare site for upgrade
2.0111.2g Appliance and heating, ventilation, and air conditioning (HVAC) system repairs and change outs	Crawl space upgrades (e.g., sealing and insulation) are to be undertaken after appliance and HVAC system work has been completed and inspected	Prepare site for upgrade
2.0111.2i Non-correctable standing water	Spaces with non-correctable standing water will not be considered for a closed crawl space	Prevent possible damage to house
<b>2.0111.3</b> Topic	<b>Crawl Spaces—Debris Removal</b> Safe Work Practices	

Subtopic	Basements and Crawl Spaces	
Desired Outcome	Clean, safe, and easily accessible crawl space created	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
2.0111.3a Debris removal	Under floor grade will be cleared of all vegetation and organic material that may puncture ground cover. Debris that can cause injury or puncture ground covers will be removed as needed from the crawl space. Care will be taken to prevent punctures during installation.	Minimize punctures in ground liner
		Minimize habitat for pests (Integrated Pest Management—IPM) and contaminant sources
2.0111.3b Debris disposal	Debris will be properly disposed of according to type and jurisdiction	Protect environment from damage
<b>Combustion Safety</b>		
<b>2.0201.1</b>	<b>Combustion Appliance Zone (CAZ) Testing</b>	
Topic	Combustion Safety	
Subtopic	Combustion Safety Testing-General	
Desired Outcome	Accurate information about appliance safe operation is gathered	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
2.0201.1a Assessment	Emergency problems (e.g., gas leak, ambient CO levels that exceed 35 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested Determine if combustion and dilution air is adequate for proper combustion and venting of all equipment within the CAZ Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance	Ensure system does not have fatal problems Ensure combustion appliance has adequate combustion and dilution air
2.0201.1b Fuel leak detection	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	Detect fuel gas leaks Determine and report need for repair
2.0201.1c Venting	Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards	Determine if a draft regulator is present and working and if vent system is in good condition and installed properly
2.0201.1e Depressurization test	Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof.	Measure combined effect of mechanical system fans on combustion zone
2.0201.1f Spillage test	If a combustion appliance spillage exceeds two minutes on a warm vent or five minutes on a cold vent during pressure testing, specify measures to mitigate	Detect excessive spillage of combustion gasses
2.0201.1g Carbon monoxide (CO) test in appliance vent	CO will be tested for in undiluted flue gases of combustion appliances If CO levels exceed levels in the chart on the page in the field guide, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications) If the outlet of the exhaust is accessible, include a CO test on all sealed-combustion, direct vent, and power-vented appliances (without atmospheric chimneys)	Measure CO and report excessive levels
2.0201.1i Combustion safety testing at completion of retrofitting home	At the conclusion of each work day in which envelope or duct sealing measures have been performed, depressurization and spillage testing will be performed.	Ensure work completed in home has not adversely affected the operation of combustion appliances
<b>2.0201.2</b>	<b>Combustion Safety</b>	
Topic	Combustion Safety	
Subtopic	Combustion Safety Testing-General	
Desired Outcome	Buildup of dangerous combustion byproducts in the living space prevented	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
2.0201.2a Outside combustion make-up air	When combustion air is needed air will be provided from the exterior of the structure.	Prevent combustion byproducts from entering the house
2.0201.2b New appliances	New appliance will be installed in accordance with manufacturer specifications, and additional applicable codes Replacement equipment venting will be assessed to ensure other existing equipment is not adversely affected	Prevent combustion byproducts from entering the house
2.0201.2c CO detection and warning equipment	CO detection or warning equipment will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in accordance with ASHRAE 62.2 and authority having local jurisdiction	Alert occupant to CO exposure

2.0201.2f	Solid fuel burning appliances	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	Ensure safe operations of solid fuel burning appliances
<b>2.0202.1</b>			
<b>Unvented Space Heaters: Propane, Natural Gas, and Kerosene Heaters</b>			
Topic		Combustion Safety	
Subtopic		Unvented Space Heaters	
Desired Outcome		Elimination of combustion byproducts	
Single-Family Homes			
<b>Title</b>		<b>Specification(s)</b>	<b>Objective(s)</b>
2.0202.1a	Removal	When un-vented combustion heaters exist they will be required to be removed before weatherization work can take place.	Eliminate sources of combustion byproduct within a living space
2.0202.1b	Occupant education	Occupant will be educated on potential hazards of unvented combustion appliances (primary or secondary) within a living space	Inform occupant about possible hazards associated with combustion byproducts and moisture
<b>2.0203.1</b>			
<b>Combustion Air for Natural Draft Appliances</b>			
Topic		Combustion Safety	
Subtopic		Vented Gas Appliances	
Desired Outcome		Sufficient air provided in the Combustion Appliance Zone (CAZ)	
Single-Family Homes			
<b>Title</b>		<b>Specification(s)</b>	<b>Objective(s)</b>
2.0203.1a	Required combustion air	Combustion air will be provided in accordance with ND State Building Code and authority having jurisdiction	Determine if existing conditions meet the combustion air calculation
2.0203.1b	Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with ND State Building Code and authority having jurisdiction	Ensure adequate combustion air for operation of the appliance
<b>2.0203.2</b>			
<b>Combustion Flue Gas—Orphaned Water Heaters</b>			
Topic		Combustion Safety	
Subtopic		Vented Gas Appliances	
Desired Outcome		Flue gasses successfully removed from the house	
Single-Family Homes			
<b>Title</b>		<b>Specification(s)</b>	<b>Objective(s)</b>
2.0203.2a	Spillage testing	If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate	Ensure appliance is not spilling longer than two minutes One Minute/BPI
2.0203.2b	Flue gas removal (chimney liner or approved methods)	A chimney liner will be installed in accordance with the ND State Building Code or applicable NFPA standard	Allow water heater to vent properly Prevent damage to the chimney
2.0203.2c	Retesting spillage	If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate	Ensure appliance is not spilling longer than two minutes One minute
2.0203.2d	Required combustion air	The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with ND State Building Code and authority having jurisdiction	Determine if existing conditions meet the combustion air calculation
2.0203.2e	Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with the ND State Building Code or authority having jurisdiction	Ensure adequate combustion air for operation of the appliance
2.0203.2f	Occupant health and safety	All homes will have a functioning CO alarm If CO levels in interior living spaces exceed outdoor levels, investigate potential sources and take appropriate action to reduce them (e.g., have a qualified professional tune, repair or replace improperly operating combustion appliances; apply weather stripping or conduct air sealing between the garage or crawl space and the home)	Ensure occupant health and safety Ensure indoor CO levels do not exceed outdoor CO levels
2.0203.2g	Occupant education	Occupants will be educated on the operation and maintenance of the CO alarm  Completed work on combustion appliances and recommended maintenance will be reviewed with occupant Occupant will be provided information regarding the health effects and risk of high CO concentrations; EPA describes possible expanded actions, and offers client education information in an appendix to the protocols	Ensure occupant can operate and maintain installations  Inform occupant regarding possible CO hazards
<b>2.0203.3</b>			
<b>Draft Regulation—Category I Appliance</b>			
Topic		Combustion Safety	
Subtopic		Vented Gas Appliances	

Desired Outcome	Build-up of flue gasses prevented with proper drafting	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
2.0203.3a Assessment	The presence of an operable draft regulator will be verified	Determine if a regulator is present and working and if vent system is in good condition and installed properly
	Combustion venting systems will be inspected for damage, leaks, disconnections, and other safety hazards	
2.0203.3b Installation (if action is required)	A draft regulator will be installed, if necessary	Install regulator in accordance with manufacturer specifications
	Manufacturer specifications for installation will be followed (e.g., size, type, location)	
2.0203.3c Retesting spillage	If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate	Ensure appliance is not spilling longer than two minutes
2.0203.3d Occupant health and safety	All homes will have a functioning CO alarm If CO levels in interior living spaces exceed outdoor levels, potential sources will be investigated and appropriate action taken to reduce them (e.g., have a qualified professional tune, repair, or replace improperly operating combustion appliances; apply weather stripping or conduct air sealing between the garage or crawl space and the home)	Ensure occupant health and safety Ensure indoor CO levels do not exceed outdoor CO levels
2.0203.3e Occupant education	Occupants will be educated on the operation and maintenance of the CO alarm  Completed work on combustion appliances and recommended maintenance will be reviewed with occupant Occupant will be provided information regarding the health effects and risk of high CO concentrations; EPA provides possible expanded actions and offers client education information in an appendix to the protocols	Ensure occupant can operate and maintain installations  Inform occupant regarding possible CO hazards

**Safety Devices**

**2.0301.1**

Topic

Subtopic

Desired Outcome

Note

**Smoke Alarm**

Safety Devices

Combustion Safety Devices

Properly installed smoke alarms

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

Single-Family Homes

**Title**

2.0301.1b Smoke alarm (battery operated)

**Specification(s)**

Smoke detectors will be installed within 15 feet of all bedrooms and a minimum of one on each floor. They will either be mounted on the ceiling or within 12 inches of the ceiling if wall mounted.

**Objective(s)**

Ensure proper installation

**2.0301.2**

**Carbon Monoxide Alarm or Monitor**

Topic Safety Devices  
 Subtopic Combustion Safety Devices  
 Desired Outcome Properly installed CO alarms or monitors  
 Note The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

Single-Family Homes

**Title** **Specification(s)** **Objective(s)**

2.0301.2b CO detection and warning equipment (battery operated) 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 Ensure proper installation

**Moisture**

**2.0401.1**  
 Topic Air Sealing Moisture Precautions  
 Subtopic Moisture  
 Air Sealing  
 Desired Outcome Ensure durability of repairs and reduce potential for occupant exposure to mold and other moisture-related hazards

Single-Family Homes

**Title** **Specification(s)** **Objective(s)**  
 2.0401.1a Moisture precautions for attics Roof leaks will be repaired before performing attic air sealing or insulation Ensure durability of repairs

Moisture sources in the house that can generate moisture into the attic will be identified and removed or reduced Reduce potential for occupant exposure to mold and other moisture-related hazards  
 Prevent moisture from communicating from within the conditioned space into unconditioned attic space when economically feasible

2.0401.1b Moisture precautions for crawl spaces Exposed earth will be covered with a continuous, durable, sealed Class 1 vapor retarder Vapor retarder A material that slows the passage of water vapor and contains a perm rating above 1 a minimum of 6 mils in thickness Ensure durability of repairs

All accessible penetrations between the crawl space or basement and outside will be sealed  
 Holes between the crawl space or basement and the living space will be sealed

2.0401.1c Moisture precautions for the living space Moisture sources in the home will be identified and removed or reduced Ensure durability of repairs

Local ventilation will be installed where appropriate (e.g., baths, kitchens) and vented to outside according to ASHRAE 62.2-2013  
 Unvented combustion appliances that are not listed to ANSI Z21.11.2 will be removed Reduce potential for occupant exposure to mold and other moisture-related hazards

2.0401.1d Moisture precautions for exterior water Before air sealing basement or crawl space walls near wet areas, surface water pooling near the foundation will be addressed by: Repairing, modifying or replacing gutters and downspouts Reduce potential for occupant exposure to mold and other moisture-related hazards

**2.0401.2**  
 Topic Vented Crawl Space—Venting  
 Subtopic Moisture  
 Air Sealing  
 Desired Outcome Pollutants effectively vented

Single-Family Homes

**Title** **Specification(s)** **Objective(s)**  
 2.0401.2a Venting Venting will be performed in accordance with the ND State Building Code and authority having jurisdiction. Provide ventilation for pollutant sources (e.g., moisture, radon, soil gases)

**2.0403.1**  
 Topic Vented Crawl Spaces—Ground Moisture Barrier  
 Subtopic Moisture  
 Vapor Barriers  
 Desired Outcome Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

Single-Family Homes

**Title** **Specification(s)** **Objective(s)**  
 2.0403.1a Material Integrity Care will be taken to prevent punctures during installation Protect ground moisture barrier from damage during other crawl space work

2.0403.1b Coverage A ground moisture barrier that covers 100% of the exposed crawl space will be installed where accessible. Reduce ground moisture entering the crawl space

2.0403.1c Material specification A ground moisture barrier with a rating of no more than 0.1 perm will be used Ensure crawl space is accessible for service and maintenance without damaging the integrity of the ground moisture barrier  
 A minimum expected service life of 10 years will be ensured  
 A ground moisture barrier will be used that meets tear and puncture resistance of 6 mil or the current ASTM standard for puncture and tear resistance

2.0403.1d Overlap seams When seams exist, they will be overlapped a minimum of 12" using "reverse" or "upslope lapping" technique Keep water under the liner  
 Reduce the likelihood of damage at seams

2.0403.1e Fastening A ground moisture barrier will be fastened if there is significant slope, wind acting on the ground cover, or if the crawl space is used regularly for storage or to access appliances.. Prevent movement of the ground moisture barrier  
 A minimum expected service life of 10 years will be ensured

**2.0403.2**  
 Topic Closed Crawl Spaces—Ground Moisture Barriers  
 Subtopic Moisture  
 Vapor Barriers

Desired Outcome	Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
2.0403.2a Material Integrity	Care will be taken to prevent punctures during installation	Protect ground moisture barrier from damage during other crawl space work
2.0403.2b Coverage	An air barrier and ground moisture barrier, covering 100% of the exposed crawl space floor, where applicable and accessible, will be installed <i>in accordance with ASTM E1643 and manufacturer's recommendations</i>  A ground moisture barrier will be fastened if there is significant slope, wind acting on the ground cover, or if the crawl space is used regularly for storage or to access appliances..	Reduce ground vapor entering the crawl space  Create a continuous and durable connection between the wall and ground air and moisture barriers
2.0403.2c Material specification	A ground moisture barrier with a rating of no more than 0.1 perm will be used  A minimum expected service life of 10 years will be ensured  A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM D1745	Reduce ground vapor entering the crawl space  Ensure crawl space is accessible for service and maintenance without destroying the integrity of the moisture barrier
2.0403.2d Overlap seams	When seams exist, they will be overlapped a minimum of 12" with "reverse" or "upslope lapping" technique For wall to floor connection, the wall moisture barrier will be installed under the ground moisture barrier  The air barrier and ground moisture barrier will be fastened to the ground to prevent movement in accordance with ASTM E1643 and manufacturer's recommendations  A minimum expected service life of 10 years will be ensured	Keep water under the liner  Prevent movement and uplift of the air barrier and ground moisture barrier
2.0403.2f Sealing seams	A durable sealant compatible with the air barrier and ground moisture barrier will be used A minimum expected service life of 10 years will be ensured	Maintain continuous air barrier and ground moisture barrier
2.0403.2g Air barrier, ground moisture barrier penetrations, including fastener penetrations	A durable sealant, compatible with the air barrier and ground moisture barrier, will be used Physical attachments will be provided where practical (e.g., masonry columns, footings) A minimum expected service life of 10 years will be ensured	Maintain continuous air barrier and ground moisture barrier
2.0403.2h Drainage	The air barrier and ground moisture barrier will not interfere with the established drainage pattern	Ensure proper drainage
2.0403.2i Drainage points	Interior drainage collection points will be accessible from above and below the air barrier and ground moisture barrier	Remove water above and below the air barrier and ground moisture barrier
<b>Electrical</b>		
<b>2.0601.1</b>	<b>Knob and Tube Wiring</b>	
Topic	Electrical	
Subtopic	Knob and Tube Wiring	
Desired Outcome	Live unsafe wiring identified and brought to local codes	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
2.0601.1a Knob and tube identification	Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring	Ensure occupant safety
2.0601.1b Live wire testing	Non-contact testing method will be used to determine if wiring is live	Protect occupant safety  Preserve the integrity and safety of the house
2.0601.1c Isolation and protection	Live knob and tube will not be covered or surrounded; required by the ND State Electrical Code. A dam that does not cover the top will be created to separate insulation from the wire path	Ensure occupant safety
2.0601.1d Replacement	Exposed wiring will be replaced with new appropriate wiring in accordance with the NEC and local codes Old wiring will be rendered inoperable by licensed electrician in accordance with the NEC and local codes	Ensure occupant safety  Preserve the integrity and safety of the house
<b>Occupant Education and Access</b>		
<b>2.0701.1</b>	<b>Crawl Spaces—Providing Access</b>	
Topic	Occupant Education and Access	
Subtopic	Basements and Crawl Spaces	
Desired Outcome	Access to the closed crawl space is controlled and the ground moisture barrier is protected to maintain the integrity of the system	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
2.0701.1a Access	Crawl space will be accessible in accordance with the ND State Building Code  Access to mechanical equipment located in the crawl space will be in accordance with ND State Building Code	Provide crawl space access  Maintain integrity of the crawl space system

Service and maintenance of the crawl space and equipment will be performed without risk of damage to the thermal barrier, air barrier, and ground moisture barrier in accordance with the ND State Building Code

2.0701.1b Lock

A lockable access will be provided if access is from the exterior

Control access and prevent intruders

**Air Sealing**

**Attics**

**3.1001.1**

Topic

Subtopic

Desired Outcome

**Penetrations and Chases**

Attics

Penetrations and Chases

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

Single-Family Homes

**Title**

3.1001.1a Pre-inspection

**Specification(s)**

An inspection will be conducted for mold, water leaks, and water damage before sealing a chase  
Repairs will be completed before work

**Objective(s)**

Repair moisture-related issues

3.1001.1b Backing and infill

Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the hole  
The infill or backing will not bend, sag, or move once installed

Minimize hole size to ensure successful use of sealant

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

Ensure sealant does not fall out

Select permanent sealant

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

3.1001.1c Sealant selection

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

Prevent a fire hazard

3.1001.1d High temperature application

Only non-combustible sealant will be used in contact with chimneys, vents, and flues  
Local codes will be referenced

**3.1001.2**

Topic

Subtopic

Desired Outcome

**Chase Capping**

Attics

Penetrations and Chases

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

Single-Family Homes

**Title**

3.1001.2a Pre-inspection

**Specification(s)**

An inspection will be conducted for mold, water leaks, and water damage before sealing a chase  
Repairs will be completed before work begins

**Objective(s)**

Repair moisture-related issues

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

Entire opening will be spanned with rigid material

Reduce opening to what can be sealed with sealant

Material will be cut to fit and fastened as required

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

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 the ND State Building Code

Prevent a fire hazard

3.1001.2d Support

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)

Ensure seal stays in place and does not sag

3.1001.2e Joint seal

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Provide airtight, durable seal that does not move, bend, or sag

3.1001.2f Adjacent framing

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

Ensure airtight seal from one finished side of the chase to the other

**3.1001.3**

Topic

Subtopic

Desired Outcome

**Walls Open to Attic—Balloon Framing and Double Walls**

Attics

Penetrations and Chases

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

Single-Family Homes

**Title**

3.1001.3a Pre-inspection

**Specification(s)**

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit  
Repairs will be completed before work begins

**Objective(s)**

Repair moisture-related issues

3.1001.3b Sealing methods

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

Prevent air leakage from wall cavity to attic

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

3.1001.3c Support

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)

Ensure seal stays in place and does not sag

3.1001.3d	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1001.3e	Adjacent framing	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	Ensure airtight seal from one finished side of the wall assembly to the other
<b>3.1001.4</b>		<b>Non-Insulation Contact (IC) Recessed Light</b>	
Topic		Attics	
Subtopic		General Preparation	
Desired Outcome		Ensure safety from fire and prevent air leakage	
Single-Family Homes			
<b>Title</b>		<b>Specification(s)</b>	<b>Objective(s)</b>
3.1001.4a	Air barrier system	A fire-rated air barrier system (i.e., equivalent to 5/8 fire code gypsum wallboard) will be used to separate non-IC rated recessed lights from insulation, using one of the methods below: A fire-rated airtight closure taller than surrounding attic insulation will be placed over non-IC rated recessed lights OR The non-IC rated light fixture will be replaced with an airtight and IC-rated fixture OR The fixture(s) may be replaced with surface mounted fixture and opening sealed.	Prevent a fire hazard  Prevent air leakage through fixture
3.1001.4b	Enclosure top	The top-fire rated enclosure material will have an R-value of 0.5 or less  The top of the enclosure will be left free of insulation	Prevent heat build up
3.1001.4c	Clearance	The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast	Keep an air space around the fixture
3.1001.4d	Sealants and weather stripping	Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only	To prevent air leakage, completely adhere the sealant to all surfaces to be sealed
<b>3.1002.1</b>		<b>Interior with Sloped Ceiling</b>	
Topic		Attics	
Subtopic		Open Stairwells	
Desired Outcome		Stairwells sealed to prevent air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes			
<b>Title</b>		<b>Specification(s)</b>	<b>Objective(s)</b>
3.1002.1a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing an open stairwell Repairs will be completed before work begins	Repair moisture-related issues
3.1002.1b	Standard void over stairwell (15-minute fire-rated material; e.g., gypsum lined)	Entire opening will be spanned with rigid material  Material will be cut to fit and fastened as required	Prevent air leakage from wall to attic  Reduce opening to what can be sealed with sealant
3.1002.1c	Non-standard void over stairwell (surfaces around void are not 15-minute fire-rated (e.g., bookcases, chest of drawers), or lined with paneling)	Material will be used that can be exposed to the interior of the house	Support load as required (e.g., wind, insulation) Prevent a fire hazard
3.1002.1d	Support	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)	Ensure seal stays in place and does not sag
3.1002.1e	Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1002.1f	Perimeter sealing	Air barrier will be extended on all four sides from finished ceiling or existing framing to the new barrier Access will be gained as needed (e.g., pull flooring)	Create a continuous air barrier
<b>3.1002.2</b>		<b>Stairwell to Attic—Door at Bottom with No Ceiling Above</b>	
Topic		Attics	
Subtopic		Open Stairwells	
Desired Outcome		Stairwell sealed to prevent air leakage and moisture movement between the attic and the conditioned space	
Single-Family Homes			
<b>Title</b>		<b>Specification(s)</b>	<b>Objective(s)</b>
3.1002.2a	Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing an open stairwell Repairs will be completed before work begins	Repair moisture-related issues
3.1002.2b	Option 1: bring stairwell inside	Materials will be installed in line with the ceiling level with an airtight and operable insulated panel weighing no more than 15 pounds, or a pre-fabricated kit may be used for repeated access OR	Prevent air leakage through stairwell between conditioned space and attic  Ensure the insulated panel is lightweight and easy for the occupant to use on an ongoing basis

	Airtight seal will be provided between level of new closure or cap and interior ceiling around perimeter Access will be gained as needed (e.g., pull flooring)	Support insulation  Bring the stairwell inside of the thermal boundary Ensure the new closure ties into the existing air barrier on all sides
3.1002.2c Option 2: keep stairwell outside	An air barrier will be created and insulation material will be continuously installed across all surfaces of stairwell, including weather-stripped and insulated doors OR  All cavities between stairs and conditioned space will be insulated and tested to resist air flow (e.g., walls, floors, landings, under stairs) Door will be weatherstripped and insulated OR A combination of the above methods can be used	Prevent air leakage  Provide continuous thermal boundary  Maximize thermal performance
3.1002.2d Support	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)	Ensure seal stays in place and does not sag
3.1002.2e Joint seal	Continuous, airtight seals will be provided around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1002.2f Perimeter sealing	Air barrier will be extended on all four sides from finished ceiling or from existing framing to the new barrier Access will be gained as needed (e.g., pull flooring)	Create a continuous air barrier
<b>3.1002.3</b> Topic Subtopic Desired Outcome	<b>Stairwell to Attic—Door at Top with Finished Ceiling Above</b> Attics Open Stairwells Stairwell is sealed to prevent air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1002.3a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing an open stairwell Repairs will be completed before work begins	Repair moisture-related issues
3.1002.3b Option 1: bring stairwell inside	An airtight seal will be provided between level of new closure or cap and interior ceiling around perimeter Access will be gained as needed (e.g., pull flooring) OR An air barrier will be created and insulation material will be continuously installed across all surfaces of stairwell, including weather-stripped and insulated doors OR All cavities between stairs and conditioned space will be insulated and tested to resist air flow (e.g., walls, floors, landings, under stairs) Door will be weatherstripped and insulated OR A combination of the above methods can be used	Reduce air leakage  Provide continuous thermal boundary Maximize thermal performance
3.1002.3c Support	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)	Ensure seal stays in place and does not sag
3.1002.3d Joint seal	Continuous, airtight seals will be provided around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1002.3e Perimeter sealing	Air barrier will be extended on all four sides from finished ceiling or existing framing to the new barrier Access will be gained as needed (e.g., pull flooring)	Create a continuous air barrier
<b>3.1003.1</b> Topic Subtopic Desired Outcome	<b>New Ceiling Below Original—Old Ceiling Intact or Repairable</b> Attics Dropped Ceilings and Soffits Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1003.1a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.1b Sealing methods	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	Prevent air leakage from dropped ceiling to attic
3.1003.1c Support	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)	Ensure seal stays in place and does not sag
3.1003.1d Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag

3.1003.1e Adjacent framing	All remaining gaps will be sealed at the top of the dropped ceiling  OR All remaining gaps at the top of the chase will be sealed	Provide airtight framing from one finished side of the dropped ceiling to the other
<b>3.1003.2</b> Topic Subtopic Desired Outcome	<b>Ceiling Leaks Not Repairable—No Air Barrier Above</b> Attics Dropped Ceilings and Soffits Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1003.2a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.2b Sealing methods	Ceiling or roof and wall air and thermal barriers will be connected with a rigid airtight connection around the perimeter  OR If ceiling will support an air barrier and insulation, a rigid airtight barrier (e.g., gypsum) will be attached to current ceiling either above or below  OR Intermediate framing will be used to support air and thermal barrier  OR Rigid airtight thermal barrier will be installed at the roof sheathing Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage from dropped ceiling to attic
3.1003.2c Support	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)	Ensure seal stays in place and does not sag
3.1003.2d Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1003.2e Adjacent framing	All remaining gaps will be sealed at the top of the dropped ceiling  OR All remaining gaps at the top of the chase will be sealed	Provide airtight framing from one finished side of the dropped ceiling to the other
<b>3.1003.3</b> Topic Subtopic Desired Outcome	<b>Above Closets and Tubs</b> Attics Dropped Ceilings and Soffits Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1003.3a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.3b Above closets and tubs	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	Prevent air leakage from dropped ceiling to attic
3.1003.3c Support	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)	Ensure seal stays in place and does not sag
3.1003.3d Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
3.1003.3e Adjacent framing	All remaining gaps at the top of the dropped ceiling will be sealed	Provide airtight framing from one finished side of the dropped ceiling to the other
<b>3.1003.4</b> Topic Subtopic Desired Outcome	<b>3-D Walls</b> Attics Dropped Ceilings and Soffits Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1003.4a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit  Repairs will be completed before work begins	Repair moisture-related issues
3.1003.4b Sealing methods	Entire opening will be spanned with rigid material installed in line with the ceiling level Material will be cut to fit and fastened as required  OR	Prevent air leakage from dropped ceiling to attic

	<p>Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate</p> <p>OR</p> <p>Wall below openings will be dense packed</p> <p>OR</p> <p>Wall below openings will be bridged and sealed with SPF</p> <p>Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference</p>	
3.1003.4c Support	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)	Ensure seal stays in place and does not sag
3.1003.4d Joint seal	Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections Pre-fabricated units may be used when meeting the desired outcome	Provide airtight, durable seal that does not move, bend or sag
3.1003.4e Adjacent framing	All remaining gaps will be sealed at the top of the dropped ceiling	Provide airtight framing from one finished side of the dropped ceiling to the other
	OR	
	All remaining gaps at the top of the chase will be sealed	
<b>3.1003.5</b>	<b>Dropped Ceiling with Light Boxes and Fixtures</b>	
Topic	Attics	
Subtopic	Dropped Ceilings and Soffits	
Desired Outcome	Sealed light boxes safely prevent air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1003.5a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit	Repair moisture-related issues
3.1003.5b Light boxes (e.g., fluorescent lights)	Repairs will be completed before work begins An airtight seal will be provided around perimeter between light box enclosure and interior ceiling All seams and penetrations of the enclosure will be sealed Access will be gained as needed (e.g., pull flooring) Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference	Prevent air leakage
3.1003.5c Non-insulation contact (IC) rated recessed lights	Insulation will be kept at least 3" away from the top and side of any fixtures	Prevent light fixture from overheating
	If dropped ceiling is to be filled with insulation, then a sealed rigid barrier enclosure will be installed to maintain a 3" clearance on all sides from combustible materials Top of rigid barrier enclosure will be sealed with non-insulating rigid material (e.g., gypsum or equivalent perm rating and R-value)	Bring light fixture inside of the air barrier
<b>3.1003.6</b>	<b>Dropped Soffits</b>	
Topic	Attics	
Subtopic	Dropped Ceilings and Soffits	
Desired Outcome	Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1003.6a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit Repairs will be completed before work begins	Repair moisture-related issues
3.1003.6b Soffit general	Air flow will be blocked at soffit in locations where access allows	Provide continuous air barrier across soffit openings
3.1003.6c Option 1: bring soffit inside (seal at top)	Entire opening will be spanned with rigid material in line with the ceiling level	Prevent air leakage from wall to attic
	Material will be cut to fit and fastened as required	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
3.1003.6d Option 2: leave soffit outside (seal at bottom or side)	Each stud bay will be spanned with rigid material will be cut to fit and fastened as required	Prevent air leakage from wall to soffit
	OR	Reduce opening to what can be sealed with sealant
	Backing at each stud bay will be provided and will be sealed	Ensure soffit is outside of the thermal boundary
	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	
3.1003.6e Soffits containing non-IC rated recessed lights	Insulation will be kept at least 3" away from the top and side of any fixtures	Prevent light fixture from overheating
	If dropped soffit is to be filled with insulation, then a sealed rigid barrier enclosure will be installed to maintain a 3" clearance around the entire fixture	Bring light fixture inside of the air barrier
	Top of rigid barrier enclosure will be sealed with non-insulating rigid material (e.g., gypsum or equivalent perm rating and R-value)	
<b>3.1004.1</b>	<b>Cathedralized Attic Air Sealing (Insulation Installed at Roof Deck)</b>	
Topic	Attics	

Subtopic	Cathedralized Attic Ceilings	
Desired Outcome	Cathedralized attics sealed to prevent air leakage	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1004.1a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a cathedralized ceiling Repairs will be completed before work begins	Repair moisture-related issues
3.1004.1b Backing and infill	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space  The infill or backing will not bend, sag, or move once installed	Minimize hole size to ensure successful use of sealant  Ensure closure is permanent and supports any load (e.g., wind, insulation) Ensure sealant does not fall out
3.1004.1c Sealant selection	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	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials
<b>3.1005.1</b>	<b>Tongue and Groove Ceilings</b>	
Topic	Attics	
Subtopic	Other Ceiling Materials	
Desired Outcome	Tongue and groove ceilings sealed to prevent air leakage and moisture movement between the attic and conditioned space	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1005.1a Pre-inspection	An inspection will be conducted for mold, water leaks, and water damage before sealing a tongue and groove ceiling Repairs will be completed before work	Repair moisture-related issues
3.1005.1b Backing	Backing will be installed behind tongue and groove ceilings	Prevent air leakage and allow for sealants
3.1005.1c Sealant selection	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction No sealant will be allowed to be visible in the living space	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials Ensure ceiling remains aesthetically pleasing
<b>Windows and Doors</b>		
<b>3.1201.1</b>	<b>Double-Hung Wood Windows</b>	
Topic	Windows and Doors	
Subtopic	Maintenance, Repair, and Sealing	
Desired Outcome	Windows operable and weather tight; improved energy efficiency performance of fenestration	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1201.1a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1201.1b Weather stripping	Existing weather stripping and sash sealant will be removed  Surface where the sill meets the sash will be cleaned Seal between the fixed components of the window (e.g., jambs, sill) will be continuous and complete while maintaining the operability of the window  Continuous and complete weather stripping will be installed on the bottom of the lower sash where it makes contact with the sill and at the top of the upper sash where it makes contact with the upper part of the window frame	Form a complete seal from the outer edge of the sash to the jamb Maintain operability of the window
3.1201.1c Sash locks	Locks will be installed so that the rails of the upper and lower sashes are flush and in full contact No gaps will be visible between the two sashes Locks will be installed to achieve compression of the two sashes	Form a secure connection between the two sashes
3.1201.1d Replacement sills	Beveled sill will be flush with interior wall and sloped to the exterior  Seams will be continuously and completely sealed with sealant to the jambs and to the frame Sill will be water-sealed and primed	Form a complete seal from the bottom of the lower sash to the sill Maintain operability of the window  Allow for drainage to the exterior
3.1201.1e Sash replacement	Lower sash will have the same bevel on the bottom rail as the sill  Sash will be water-sealed and primed	Ensure sash remains in a fixed position when open or partially open Maintain operability of the window
3.1201.1f Adjust stops	Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window	Form a complete seal between the jamb, sash, and stop  Maintain operability of the window
3.1201.1g Replace stops	Stops will be installed to keep the window securely in place  Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window	Form a complete seal between the jamb, sash, and stop  Maintain operability of the window
<b>3.1201.2</b>	<b>Single-Unit Window and Fixed Frame with Wood Sash</b>	
Topic	Windows and Doors	

Subtopic	Maintenance, Repair, and Sealing	
Desired Outcome	Windows operable and weather tight; improved energy efficiency performance of fenestration	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1201.2a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be	Protect worker and occupant from potential lead hazards
3.1201.2b Operable windows	All egress windows will be operable as required by local codes	Maintain operability of egress windows
3.1201.2c Air infiltration	Details that reduce air infiltration will be repaired, replaced, sealed, or installed (e.g., new latch for meeting rail connection, pulley seals, rope caulking for other cracks, interior storm windows) State Energy Conservation Code or local code requirements for air leakage should be met (whichever is more stringent)	Reduce air infiltration
3.1201.2d Water infiltration	Details that reduce water infiltration will be repaired, replaced, or installed (e.g., replace missing glazing compound on sash, exterior caulking, exterior storm windows)	Reduce water infiltration
3.1201.2e Occupant education and maintenance	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain window	Ensure long-term weather tightness
<b>3.1201.3</b>	<b>Exterior Doors</b>	
Topic	Windows and Doors	
Subtopic	Maintenance, Repair, and Sealing	
Desired Outcome	Doors operable and weather tight	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1201.3a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1201.3b Door operation and fit	Door will be adjusted to properly fit the jamb and allow for ease of operation	Ensure proper operation of the door
3.1201.3c Air infiltration	Details that reduce air infiltration will be repaired, replaced, sealed, or installed in accordance with State Energy Conservation Code or local code—whichever is more stringent (e.g., weather stripping, door bottoms, trim replacement with foam)	Reduce air infiltration
3.1201.3d Water infiltration	Details that reduce water infiltration will be repaired, replaced, sealed, or installed (e.g., adjust threshold, caulk jamb to threshold, caulk trim, flashing)	Reduce water infiltration
3.1201.3e Occupant education and maintenance	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain weather stripping and caulk around door and trim	Ensure long-term weather tightness
<b>3.1201.4</b>	<b>Pocket Door</b>	
Topic	Windows and Doors	
Subtopic	Maintenance, Repair, and Sealing	
Desired Outcome	Pocket door sealed top and back to prevent leakage	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1201.4a Backing and infill	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the hole  The infill will not bend, sag, or move once installed	Minimize hole size to ensure successful use of sealant  Ensure closure is permanent and supports any load (e.g., wind, insulation) Ensure sealant does not fall out
3.1201.4b Sealant selection	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 Sealant will be used in accordance with OSHA/manufacturer safety protocol for worker and occupant safety Manufacturer MSDS sheet will be followed for worker safety	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials
<b>3.1202.1</b>	<b>Fixed Frame with Wood Sash—Older House</b>	
Topic	Windows and Doors	
Subtopic	Repairing/Replacing Cracked and Broken Glass	
Desired Outcome	Glass complete and intact; improved energy efficiency performance of fenestration	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1202.1a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1202.1b Broken glass removal	Putty and push points will be removed Broken or cracked glass will be removed	Safely remove old glass

3.1202.1c Sash preparation	Opening will be cleaned	Prepare opening for new glass
3.1202.1d New glass installation	Glass will be sized 1/8" to 3/16" smaller than opening to allow for movement of frame Safety glass will be installed in accordance with local codes Push points will be provided on each side to secure glass in frame  Glazing compound will be added in accordance with manufacturer specifications	Ensure glazing compound will adhere to sash  Install, seal, and secure new glass in place Allow glazing compound to harden to ensure secure installation
<b>3.1202.2</b> Topic Subtopic Desired Outcome	<b>Single-Unit Window, Mounted on Rough Opening—Newer House</b> Windows and Doors Repairing/Replacing Cracked and Broken Glass Glass complete and intact; improved energy efficiency performance of fenestration	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1202.2a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1202.2b Broken glass removal	Window stops and damaged glass will be removed	Safely remove old glass
3.1202.2c Opening preparation	Opening will be cleaned Glazing tape will be removed or replaced	Prepare opening for new glass
3.1202.2d New glass installation	Replacement glass will be sized to original width, height, and depth Stops will be replaced or installed  Wood stops will be sealed to glass with appropriate sealant Glass will be selected with comparable tint and coating (color and look)  Tempered glass will be installed as required by local codes Glazing compound will be added in accordance with manufacturer specifications	Install, seal, and secure new glass in place Allow glazing compound to harden to ensure secure installation
<b>3.1203.1</b> Topic Subtopic Desired Outcome	<b>Replacement Window in Existing Window Frame</b> Windows and Doors Replacement Replacement window provides weather tight fit; improved energy efficiency performance of fenestration	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1203.1a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1203.1b Opening preparation	Interior stops, sashes, parting strips, and pulleys will be removed  Opening will be cleaned	Provide a clean opening for replacement window unit
3.1203.1c Replacement window installation	Replacement window will be installed in accordance with manufacturer specifications, ensuring that the exterior stops are caulked	Ensure replacement window operates properly  Ensure replacement window has a weather tight fit
3.1203.1d Safety	Egress windows and safety glass will be installed in accordance with local codes	Meet all codes when replacing windows
3.1203.1e Occupant education and maintenance	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain window	Ensure long-term weather tightness
<b>3.1203.2</b> Topic Subtopic Desired Outcome	<b>Single-Unit Window, Mounted on Rough Opening—Newer House</b> Windows and Doors Replacement Replacement window provides weather tight fit; improved energy efficiency performance of fenestration	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
3.1203.2a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards
3.1203.2b Opening preparation	Replacement window will be laid out with trim  Exterior trim will be removed or exterior siding will be cut back to fit new window with trim	Provide a clean and properly flashed opening for replacement window unit

	Existing window will be removed Window opening will be flashed in accordance with accepted industry standards	
3.1203.2c Replacement unit preparation	Mounting detail will be determined based on depth of window and location of window liner	Allow for good fit and finish of replacement window
3.1203.2d Replacement window installation	Replacement windows will be installed in accordance with manufacturer specifications and will be integrated with flashing Gaps between the new window and existing frame will be sealed with low-expanding foam	Ensure replacement window operates properly Ensure replacement window is weather tight
3.1203.2e Safety	Egress windows and safety glass will be installed in accordance with local codes	Meet all codes when replacing windows
3.1203.2f Occupant education and maintenance	Occupant will be notified of changes or repairs made and will be educated on how to operate and maintain window	Ensure long-term weather tightness

## Basements and Crawlspace

### Basements Connected to Crawlspace

#### 3.1401.1

Topic

Subtopic

Desired Outcome

#### Basements Connected to Crawl Spaces—Sealing and Insulating

Basements and Crawl Spaces

Basements Connected to Crawl Spaces

Crawl spaces and basements separated using appropriate methods that define spaces and allow for treatment in accordance with specifications

Single-Family Homes

#### Title

3.1401.1a Conditioned basements with vented crawl spaces

#### Specification(s)

Crawl space will be separated from the conditioned basement with a continuous air barrier, ground moisture barrier, and thermal boundary

#### Objective(s)

Create separation and define spaces

Enable treatment of crawl spaces and basements by referenced specifications  
Increase house durability and energy efficiency

3.1401.1b Conditioned basements with closed crawl spaces

Crawl space will be separated from the conditioned basement with a continuous air barrier and ground moisture barrier

Create separation and define spaces

Enable treatment of crawl spaces and basements by referenced specifications  
Increase house durability and energy efficiency

3.1401.1c Unconditioned basements with vented crawl spaces

Vented crawl space will be separated from the unconditioned basement with a continuous air barrier and ground moisture barrier

Create separation and define spaces

Enable treatment of crawl spaces and basements by referenced specifications  
Increase house durability and energy efficiency

3.1401.1d Unconditioned basements with closed crawl spaces

Unconditioned basement will be treated as an extension of the closed crawl space

Create separation and define spaces

Enable treatment of crawl spaces and basements by referenced specifications  
Increase house durability and energy efficiency

### Crawlspace

#### 3.1402.1

Topic

Subtopic

Desired Outcome

#### Crawl Spaces—Sealing Floor Penetrations

Basements and Crawl Spaces

Crawl Spaces

Air leakage prevented and indoor air quality protected

Single-Family Homes

#### Title

3.1402.1a Backing and infill

#### Specification(s)

Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration

#### Objective(s)

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

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

Ensure sealant does not fall out

3.1402.1b Sealant selection	<p>Sealants will be used to fill holes no larger than recommended by manufacturer specifications Sealants will be compatible with their intended surfaces</p> <p>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</p>	<p>Create a permanent seal</p> <p>Ensure sealant meets or exceeds the performance characteristics of the surrounding materials</p>
3.1402.1c High temperature application	<p>Only non-combustible materials will be used in contact with chimneys, vents,</p>	<p>Prevent a fire hazard</p>
<p><b>3.1402.2</b> Topic Subtopic Desired Outcome</p> <p>Single-Family Homes Title Vent closure</p>	<p><b>Closed Crawl Spaces—Air Sealing Foundation Vents</b> Basements and Crawl Spaces Crawl Spaces Air and moisture penetration through the existing vent into the crawl space blocked</p> <p><b>Specification(s)</b> Vent opening will be permanently closed and sealed</p>	<p><b>Objective(s)</b> Prevent air and moisture penetration</p>
<p><b>3.1402.3</b> Topic Subtopic Desired Outcome</p> <p>Single-Family Homes Title</p>	<p><b>Closed Crawl Spaces—Air Sealing Exterior Wall</b> Basements and Crawl Spaces Crawl Spaces Well-sealed exterior wall prevents leakage and pests</p> <p><b>Specification(s)</b> Penetrations will be sealed with a durable material</p>	<p><b>Objective(s)</b> Prevent air and moisture penetration into crawl space</p>
3.1402.3a Seal penetrations	<p>A minimum expected service life of 10 years will be ensured</p>	
3.1402.3b Pest exclusion	<p>If penetration is greater than ¼", caulking, steel wool, or other pest-proof material will be used to fill the penetration before sealing</p>	<p>Prevent pest entry</p>
<p><b>3.1402.4</b> Topic Subtopic Desired Outcome</p> <p>Single-Family Homes Title</p>	<p><b>Closed Crawl Spaces—Air Sealing Brick Curtain Wall with Piers</b> Basements and Crawl Spaces Crawl Spaces Well-sealed exterior wall prevents leakage and pests</p> <p><b>Specification(s)</b> Penetrations will be sealed with a durable material, including the following:  Sealing rain screen to crawl space connection Re-venting exterior weep holes with wicking rope A minimum expected service life of 10 years will be ensured</p>	<p><b>Objective(s)</b> Reduce moisture vapor and water from entering the crawl space through the rain screen Decrease probability of rot</p>
3.1402.4a Seal penetrations		
3.1402.4b Pest exclusion	<p>If penetration is greater than ¼", a pest-proof material will be used to fill the penetration before sealing</p>	<p>Prevent pest entry</p>
<p><b>3.1402.5</b> Topic Subtopic Desired Outcome</p> <p>Single-Family Homes Title</p>	<p><b>Closed Crawl Spaces—Attached Crawl Spaces Under Unconditioned Spaces</b> Basements and Crawl Spaces Crawl Spaces Closed, attached crawl spaces sealed but accessible</p> <p><b>Specification(s)</b> A continuous air and vapor barrier between the attached crawl space under unconditioned spaces and the closed crawl space will be maintained</p>	<p><b>Objective(s)</b> Prevent air and moisture penetration</p>
3.1402.5a Separate crawl spaces		
3.1402.5b Entry point	<p>Access openings through the floor will be a minimum of 18" by 24" or as constrained by existing framing members Openings through a perimeter wall will be not less than 16" by 24" When any portion of the through-wall access is below grade, an area way not less than 16" by 24" or as constrained by existing framing members</p> <p>Under-floor spaces containing appliances will be provided with an unobstructed access large enough to remove the largest appliance but not less than 30" high and 22" wide or more than 20' long measured along the center line of the passageway from the opening to the appliance</p> <p>A level service space at least 30" deep and 30" wide will be present at the front or service side of the appliance If the depth of the passageway or the service space exceeds 12" below the adjoining grade, the walls of the passageway will be lined with concrete or masonry extending 4" above the adjoining grade in accordance with ND State Building Code The rough-framed access opening dimensions will be a minimum of 22" by 30" and large enough to remove the largest appliance</p>	<p>Provide access to attached crawl space for inspections</p>

**Special Considerations****3.1488.1**

Topic

Subtopic

Desired Outcome

**Skirting Post and Pier Foundations**

Basements and Crawl Spaces

Special Considerations

Protective skirting effectively installed to retard damage from natural causes such as wind, water, and pests

Single-Family Homes

**Title**

3.1488.1a Skirting

**Specification(s)**

Any materials making contact with the ground will be rated for ground contact

**Objective(s)**

Minimize pests, wind, water, and freezing of pipes under house

Skirting will be continuous around the perimeter and enclose the entire floor area below the conditioned living space

3.1488.1b Flashing

Skirting will be flashed to prevent the entrance of water

Prevent water from entering space under house

3.1488.1c Fastening

Entire skirting will be mechanically fastened

Ensure lasting upgrade

**Attached Garages****Garage Openings****3.1501.1**

Topic

Subtopic

Desired Outcome

**Penetrations, Cracks, and Doors Between Garage and House**

Attached Garages

Garage Openings

Openings from garage sealed to prevent leakage

Single-Family Homes

**Title**

3.1501.1a Penetrations

**Specification(s)**

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

**Objective(s)**

Prevent air leakage and pollutant entry

3.1501.1b Ductwork

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

Prevent air leakage and pollutant entry

3.1501.1c Cracks

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

Prevent air leakage and pollutant entry

3.1501.1d Garage to house door

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

Prevent air leakage and pollutant entry

3.1501.1e Glass

Broken glass panes in doors will be replaced, pointed, and glazed where needed

Prevent air leakage and pollutant entry

3.1501.1f Carbon monoxide (CO) alarm

CO alarms will be installed in accordance with ASHRAE 62.2, applicable codes and manufacturer specifications

Warn occupants of CO exposure from attached garage

3.1501.1g Occupant education

Occupant will be educated on need to keep door from garage to house closed and not to warm up vehicles or use any gas engine appliances or grills in the garage, even if the main door is left open

Reduce risk of CO poisoning inside of garage and adjacent rooms

**Ducts****Duct Preparation****3.1601.1**

Topic

Subtopic

Desired Outcome

**Preparation and Mechanical Fastening**

Ducts

Duct Preparation

Ducts and plenums properly fastened to prevent leakage

Single-Family Homes

**Title**

3.1601.1a Preparation

**Specification(s)**

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

**Objective(s)**

Gain access while maintaining insulation value

If asbestos insulation was used, it will not be disturbed; consult with an asbestos abatement expert for removal  
Surrounding insulation will be cleared to expose joints being sealed  
Duct surface to accept sealant will be cleaned  
Insulation will be returned or replaced with equivalent R-value

Achieve proper adhesion for airtight seal

3.1601.1b Metal to metal

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

Ensure durable joints

3.1601.1c Flex to metal

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

Ensure durable joints

3.1601.1d Duct board to duct board

Joints will be fastened with clinch stapler

Ensure durable joints

3.1601.1e Flexible duct to duct board

Metal take-off collar will be used and attached in accordance with the ND State Building Code

Ensure durable joints

3.1601.1f Metal plenum to air handler cabinet

Plenum will be mechanically fastened

Ensure durable joints

3.1601.1g Duct board plenum to air handler cabinet

Termination bar or metal strip will be fastened with screws

Ensure durable joints

Duct board will be installed between the screw and the termination bar

3.1601.1h Boot to wood

Screws or nails will be used to fasten boot to wood

Ensure durable joints

3.1601.1i Boot to gypsum

Boot hanger will be fastened to adjacent framing with screws or nails  
Boot will be connected to boot hanger with screws  
Integral snap boots will be installed

Ensure durable joints

3.1601.1j Flex to duct board	Take-offs will be in accordance with the ND State Building Code	Ensure durable joints
<b>3.1601.3</b> Topic Subtopic Desired Outcome	<b>Support</b> Ducts Duct Preparation Ducts and plenums properly supported	
Single-Family Homes <b>Title</b> 3.1601.3a Support (applies to all duct types)	<b>Specification(s)</b> Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 1/2" 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	<b>Objective(s)</b> Eliminate falling and sagging
<b>Duct Sealing</b> <b>3.1602.1</b> Topic Subtopic Desired Outcome	<b>Air Sealing Duct System</b> Ducts Duct Sealing Ducts and plenums sealed to prevent leakage	
Single-Family Homes <b>Title</b> 3.1602.1a New component to new component sealant selection	<b>Specification(s)</b> Any closure system used will be in accordance with the ND State Building Code	<b>Objective(s)</b> Ensure effectiveness of air sealing system
3.1602.1b New component to existing component	Seams, cracks, joints, holes, and penetrations less than 1/4" will be sealed using fiberglass mesh and mastic Mastic alone will be acceptable for holes less than 1/4" that are more than 10' from air handler Seams, cracks, joints, holes, and penetrations between 1/4" and 1/2" will be sealed in two stages: They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing They will be sealed using fiberglass mesh and mastic	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (mastic and fiberglass mesh) to the duct Reinforce seal Support mastic and fiberglass mesh during curing
3.1602.1c Existing component to existing component	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 1/4" 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	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
<b>3.1602.3</b> Topic Subtopic Desired Outcome	<b>Proprietary Spray Application</b> Ducts Duct Sealing Ducts and plenums sealed to prevent leakage	
Single-Family Homes <b>Title</b> 3.1602.3a Internal or external application	<b>Specification(s)</b> Installation of sealant will be applied in accordance with manufacturer specifications as well as UL 181M, NFPA 90A, and NFPA 90B	<b>Objective(s)</b> Reduce duct leakage
<b>3.1602.4</b> Topic Subtopic Desired Outcome	<b>Air Sealing System Components</b> Ducts Duct Sealing Ducts and plenums sealed to prevent leakage	
Single-Family Homes <b>Title</b> 3.1602.4a Duct boot to interior surface	<b>Specification(s)</b> All gaps between boot and interior surface that defines conditioned air space will be air sealed Gypsum edge will be wetted before applying water-based sealant Sealants will be continuous and be in accordance with the ND State Building Code	<b>Objective(s)</b> Prevent air leakage Prevent a fire hazard
3.1602.4b Wooden plenums and building cavities	Accessible connections and joints will be made airtight using approved material	Ensure ducts and plenums will not leak
3.1602.4c Air handler cabinet	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)	Reduce air leakage while maintaining accessibility
3.1602.4d Filter slot	A pre-manufactured or site manufactured durable filter slot cover will be installed	Reduce air leakage while maintaining accessibility
<b>3.1602.5</b> Topic Subtopic Desired Outcome	<b>Return—Framed Platform</b> Ducts Duct Sealing The return duct installed to prevent air leakage	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>

3.1602.5a	Preparation	Debris and dirt will be cleaned out of the return platform	Allow for the application of rigid materials and sealants
3.1602.5b	Infill and backing	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space  Backing or infill will not bend, sag, or move once installed  Material will be rated for use in return duct systems	Minimize hole size to ensure successful use of sealant  Ensure closure is permanent and supports any load (e.g., return air pressure) Ensure sealant does not fall out
3.1602.5c	Sealant selection	Sealants will be continuous and be in accordance with ND State Building Code	Select permanent sealant  Ensure sealant meets or exceeds the performance characteristics of the surrounding materials
<b>3.1602.7</b>		<b>Return and Supply Plenums in Basements and Crawl Spaces</b>	
Topic		Ducts	
Subtopic		Duct Sealing	
Desired Outcome		Connections between the crawl space/unconditioned basements and living space eliminated to improve indoor air quality (IAQ) and efficiency of the distribution system	
Single-Family Homes			
<u>Title</u>		<u>Specification(s)</u>	<u>Objective(s)</u>
3.1602.7a	Supply plenums (includes conditioned crawl spaces)	Basements and crawl spaces that are used as heating and cooling supply plenums will not be allowed	Improve IAQ in the living space  Eliminate connection between the crawl space/unconditioned basements and living space Achieve energy impacts
3.1602.7b	Return plenums	Basements and crawl spaces that are used as heating and cooling return plenums will not be allowed	Improve IAQ in the living space  Eliminate connection between the crawl space and living space Achieve energy impacts
<b>Insulation</b>			
<b>Attics</b>			
<b>4.1001.1</b>		<b>Non-Insulation Contact (IC) Recessed Light</b>	
Topic		Attics	
Subtopic		General Preparation	
Desired Outcome		Ensure safety from fire and prevent air leakage	
Single-Family Homes			
<u>Title</u>		<u>Specification(s)</u>	<u>Objective(s)</u>
4.1001.1a	Air barrier system	A fire-rated air barrier system (i.e., equivalent to 5/8 fire code gypsum wallboard) will be used to separate non-IC rated recessed lights from insulation, using one of the methods below: A fire-rated airtight closure taller than surrounding attic insulation will be placed over non-IC rated recessed lights OR The non-IC rated light fixture will be replaced with an airtight and IC- rated fixture OR The fixture(s) may be replaced with surface mounted fixture and opening sealed. OR Air sealing measures as approved by the authority having jurisdiction	Prevent a fire hazard  Prevent air leakage through fixture
4.1001.1b	Enclosure top	The top-fire rated enclosure material will have an R-value of 0.5 or less  The top of the enclosure will be left free of insulation	Prevent heat build up
4.1001.1c	Clearance	The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast	Keep an air space around the fixture
4.1001.1d	Sealants and weather stripping	Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only	To prevent air leakage, completely adhere the sealant to all surfaces to be sealed
<b>4.1001.2</b>		<b>Knob and Tube Wiring</b>	
Topic		Attics	
Subtopic		General Preparation	
Desired Outcome		Insulation kept away from contact with live wiring	
Note		The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes			
<u>Title</u>		<u>Specification(s)</u>	<u>Objective(s)</u>
4.1001.2a	Identifying knob and tube wiring	Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring	Determine if knob and tube wiring exists
4.1001.2b	Testing to determine if live	Non-contact testing method will be used to identify live wiring	Ensure safety of occupants, workers, and house

4.1001.2c Isolate or replace	<p>Live knob and tube will not be covered or surrounded; required by the ND State Electrical Code</p> <p>A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring</p> <p>A dam that does not cover the top will be created to separate insulation from the wire path</p> <p>OR</p> <p>Knob and tube wiring will be replaced with new appropriate wiring by a licensed electrician in accordance with local codes</p> <p>Remaining knob and tube wiring will be rendered inoperable by licensed electrician in accordance with local codes</p>	<p>Plan where remediation is needed</p> <p>Ensure work can be completed safely</p> <p>Protect occupant and house</p> <p>Ensure future work can be done safely</p> <p>Prevent the overheating of the wiring</p>
<p><b>4.1001.3</b></p> <p>Topic</p> <p>Subtopic</p> <p>Desired Outcome</p> <p>Single-Family Homes</p> <p><u>Title</u></p> <p>4.1001.3a Verify attic prep</p>	<p><b>Fireplace Chimney and Combustion Flue Vents</b></p> <p>Attics</p> <p>General Preparation</p> <p>Combustible materials kept away from combustion sources</p> <p><u>Specification(s)</u></p> <p>Holes, penetrations, and bypasses will be sealed</p> <p>Dams will be fixed in places that maintain required clearance</p>	<p><u>Objective(s)</u></p> <p>Prevent air leakage</p> <p>Ensure insulation dams maintain clearance</p>
4.1001.3b Required clearance	<p>A rigid dam having a height greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion flue vent and dam</p> <p>Chimney vents will have an airspace clearance to combustibles in accordance with the ND State Building Code</p>	<p>Ensure dam material does not bend, move, or sag</p> <p>Prevent a fire hazard</p>
4.1001.3c Safety	<p>Insulation will not be allowed between a heat-generating appliance and a dam unless material is rated for contact with heat generating sources</p>	<p>Prevent a fire hazard</p>
4.1001.3d Occupant education	<p>Documentation of material and R-value will be provided to occupant</p>	<p>Provide occupant with documentation of installation</p>

<p><b>4.1001.5</b> Topic Subtopic Desired Outcome</p>	<p><b>Dense Pack Preparation</b> Attics General Preparation Proper material density achieved safely and cleanly</p>	<p><b>Objective(s)</b> Prevent damage to house Provide thorough access to allow 100% coverage</p>
<p>Single-Family Homes <b>Title</b> 4.1001.5a Preparation</p>	<p><b>Specification(s)</b> Lead safety procedures will be followed Cavities will be free of hazards, intact, and able to support dense pack pressures All escape openings will be blocked for material</p> <p>Access will be gained and each cavity will be probed, locating all attic floor joists and blockers Interior will be masked and dust controlled during drilling when accessing from interior, shrouds and containment devices are recommended Electricity supply will be confirmed and will support blowing machine power demand Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed Hose outlet pressure will be at least 80" of water column (IWC) or 2.9 pounds per square inch (psi) for cellulose insulation; for other types of dense pack insulation, check manufacturer specifications for blowing machine set up</p>	<p>Use proper equipment and process to achieve consistent density, prevent settling, and retard air flow through cavities</p>
<p><b>4.1001.6</b> Topic Subtopic Desired Outcome</p>	<p><b>Unvented Roof Deck—Preparation for Spray Polyurethane Foam</b> Attics General Preparation Backstop provided to prevent SPF from entering soffit areas</p>	<p><b>Objective(s)</b> Ensure proper bonding of SPF to substrate surfaces</p>
<p>Single-Family Homes <b>Title</b> 4.1001.6a Surface preparation</p>	<p><b>Specification(s)</b> Underside of roof deck will be prepared by sealing penetrations</p> <p>Roof deck will be free of contaminants to ensure adhesion of foam</p>	
<p>4.1001.6b Installation of insulation dams</p>	<p>Dams will be fastened to underside of roof deck and outside edge of exterior Installation will allow for the highest possible R-value above the top plate of the exterior wall</p>	<p>Ensure insulation R-value is not reduced Minimize waste of SPF</p> <p>Ensure continuous insulation and air seal of exterior wall top plate and roof deck</p>
<p>4.1001.6c Elimination of attic venting</p>	<p>All gable vents, ridge vents, and roof vents will be covered with suitable backstop material to provide substrate for SPF application</p>	<p>Remove ventilation points when converting from vented to unvented attic</p>
<p>4.1001.6d Removal of existing insulation and vapor retarder</p>	<p>All existing attic floor insulation and vapor retarder will be removed</p>	<p>Ensure the new conditioned space is coupled with the house</p>
<p><b>4.1001.7</b> Topic Subtopic Desired Outcome</p>	<p><b>Vented Roof Deck—Preparation for SPF</b> Attics General Preparation Backstop or substrate provided to prevent SPF from entering soffit areas while ensuring required attic ventilation is provided</p>	
<p>Single-Family Homes <b>Title</b> 4.1001.7a Surface preparation</p>	<p><b>Specification(s)</b> All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents</p> <p>Moisture content of all wood substrate materials will be checked to ensure it is below 20%</p>	<p><b>Objective(s)</b> Ensure proper bonding of SPF to substrate surfaces</p>
<p>4.1001.7b Installation of vent chutes</p>	<p>Vent chutes will be installed between all rafters or trusses to ensure a continuous ventilation path between the eave or soffit area and the ridge or roof vent Vent chutes will penetrate dams as needed</p>	<p>Allow ventilation of underside of roof deck sheathing while creating an unvented, conditioned attic space</p>
<p>4.1001.7c Installation of insulation dams</p>	<p>Dams will be fastened to underside of roof deck and outside edge of exterior wall top plate to prevent SPF insulation from entering soffit area</p> <p>Installation will allow for the highest possible R-value above the top plate of the exterior wall</p>	<p>Ensure insulation R-value is not reduced Minimize waste of SPF</p> <p>Provide a ventilation path from eave or soffit to ridge vent when a vented roof deck is required Ensure continuous insulation and air seal of top plate and roof deck</p>

4.1001.7d	Removal of existing insulation and vapor retarder	All existing attic floor insulation and vapor retarder will be removed	Ensure the new conditioned space is coupled with the house
<b>4.1002.1</b>	<b>Topic</b>	<b>Above Roof Deck Insulation: Preparation</b>	
	Subtopic	Attics	
	Desired Outcome	Above Roof Deck Insulation Roof covering removed and replaced to expose roof deck for installation of above roof deck insulation	
Single-Family Homes			
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1002.1a	Roof covering removal	Existing roof covering will be removed	Expose existing roof deck to prepare for installation of above roof deck insulation
4.1002.1b	Roof covering replacement	New roof covering will be installed in accordance with manufacturer specifications and local building code requirements after installation of above roof deck insulation	Install roof covering correctly Meet local code requirements
<b>4.1002.2</b>	<b>Topic</b>	<b>Above Roof Deck Insulation: Installation</b>	
	Subtopic	Attics	
	Desired Outcome	Above Roof Deck Insulation Properly installed roof deck insulation	
Single-Family Homes			
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1002.2a	Sealing	Holes, gaps, and penetrations in existing roof deck will be sealed	Prevent air leaks
4.1002.2b	Installation	Insulation will be installed according to manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions	Install insulation properly
4.1002.2c	Occupant education	Insulation will be installed to prescribed R-value Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1003.1</b>	<b>Topic</b>	<b>Pitched/Vaulted/Cathedralized Ceilings—Loose Fill Over</b>	
	Subtopic	Attics	
	Desired Outcome	Attic Ceilings Reduce the rate of heat transfer through cathedral or vaulted ceiling	
Single-Family Homes			
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1003.1a	Ventilation	Venting will be continuous, if applicable	Ensure capacity to increase R-value while not altering ventilation
4.1003.1b	Lighting	Existence of rated insulation contact can lights, which allow for insulation encapsulation, will be verified	Prevent a fire hazard
4.1003.1c	Installation	Non-insulation contact rated can lights will not be insulated When using cellulose, stabilized product is preferred when available On roof pitches less than 6/12, loose fill cellulose can be used; on roof pitches greater than 6/12, install Insulweb baffles of the same height as the insulation every 6' across slope to prevent the loose fill insulation from sliding downward, or dense pack cellulose above Insulweb stapled to the bottom (underside) of the rafters Loose fill fiberglass will only be used on a slope less than or equal to a 6/12 pitch or the slope application approved by the manufacturer, whichever is less (dense packed fiberglass at slopes greater than 6/12 may be used)  Roof cavities will be insulated with loose fill according to manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Ensure appropriate material and application Insulate to prescribed R-value
4.1003.1d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1003.2</b>	<b>Topic</b>	<b>Pitched/Vaulted/Cathedralized Ceilings—Dense Pack Over</b>	
	Subtopic	Attics	
	Desired Outcome	Attic Ceilings Insulation reduces heat transfer through ceiling and closed attic sections as well as framing cavities inaccessible to other treatments	
Single-Family Homes			
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1003.2a	Fill slant ceilings	Using fill tube, 100% of each cavity will be filled to a consistent density:  Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density of 2.2 pounds per cubic foot  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	Ensure complete and consistent coverage throughout ceiling plane Eliminate voids and settling Minimize framing cavity air flows
<b>4.1003.3</b>	<b>Topic</b>	<b>Unvented Flat Roof with Existing Insulation</b>	
		Attics	

Subtopic	Attic Ceilings	
Desired Outcome	Insulation reduces heat flow through unvented roof	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1003.3a Ventilation	Code compliant ventilation will be installed before insulation	Reduce possibility of moisture issues
4.1003.3b Installation	Roof cavities will be blown with loose fill insulation (or roof cavities will be dense packed with insulation) without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1003.3c Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1003.4</b>	<b>Cape Cod Side Attic Roof—Dense Pack Installation</b>	
Topic	Attics	
Subtopic	Attic Ceilings	
Desired Outcome	Consistent, uniform thermal boundary between conditioned and unconditioned space	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1003.4a Vapor barrier removal	Vapor barriers will be removed from existing attic floor	Ensure the new conditioned space is coupled with the house
4.1003.4b Netting, fabric, rigid sheathing	When using netting or fabric, staples will be placed in accordance with manufacturer specifications, whichever is more stringent Netting or fabric will meet local fire codes Rigid materials will close the cavity	Secure insulation
4.1003.4c Installation	Roof cavities will be dense packed with loose fill insulation in accordance with manufacturer density specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1003.4d Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
4.1003.4e Occupant education	Documentation of material and R-value will be provided to occupants	Provide occupant with documentation of installation
<b>4.1003.5</b>	<b>Unvented Roof Deck—Spray Polyurethane Foam Installation</b>	
Topic	Attics	
Subtopic	Attic Ceilings	
Desired Outcome	Reduced heat transfer and air leakage through roof and closed attic sections as well as framing cavities inaccessible to other treatments	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1003.5a Installation	Insulation will be installed to prescribed R-value in accordance with manufacturer specifications SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto roof sheathing between rafters or trusses  When desired, underside of rafters or trusses will be covered with SPF to provide layer of continuous insulation Upper vent openings will be covered with SPF, including ridge, roof, and gable that are covered with a substrate In colder climates (IECC Zones 5-8), SPF will be installed to a thickness of least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the underside of the SPF	Ensure complete and consistent coverage throughout roof plane Eliminate cracks, gaps, and voids  Improve structural integrity of roof deck (closed cell SPF only) Ensure alignment of insulation and air barrier
4.1003.5b Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
4.1003.5c Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1003.6</b>	<b>Vented Roof Deck—Spray Polyurethane Foam Installation</b>	
Topic	Attics	
Subtopic	Attic Ceilings	
Desired Outcome	Reduced heat transfer and air leakage through roof and closed attic sections as well as framing cavities inaccessible to other treatments	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1003.6a Installation	Insulation will be installed at the ceiling level to prescribed R-value in accordance with manufacturer specifications SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto roof sheathing between rafters or trusses  In colder climates (IECC Zones 5-8), SPF will be installed to a thickness of least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the underside of the SPF	Ensure complete and consistent coverage throughout ceiling plane Eliminate cracks, gaps, and voids  Ensure alignment of insulation and air barrier
4.1003.6b Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
4.1003.6c Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1003.7</b>	<b>Ignition and Thermal Barriers—Spray Polyurethane Foam</b>	
Topic	Attics	
Subtopic	Attic Ceilings	

Desired Outcome	Meet building code requirements for fire protection of spray polyurethane foam	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1003.7a Identify fire safety requirements	Meet or exceed local fire safety requirements for installation of SPF foam  Consult local codes to ensure installation complies with fire safety requirements If code requirements are unclear, consult local code officials for clarification	Ensure SPF installed in attic meets fire safety requirements
4.1003.7b Installation of ignition barrier	If attic is to be used only for the service of utilities, foam will be separated from the attic space using a suitable ignition barrier covering or coating  Check manufacturer specifications and/or local codes for appropriate ignition barrier coatings/materials	Protect SPF insulation in the attic to minimize possibility of ignition and combustion
4.1003.7c Installation of thermal barrier	If attic is to be used for storage or occupancy, spray foam will be separated from the attic space using thermal barrier material (e.g., ½" gypsum wallboard)  Consult manufacturer specifications and local codes for approved ignition/thermal barrier, materials, or coatings	Protect SPF insulation in the attic to minimize possibility of ignition and combustion
4.1003.7d Occupant education	Documentation of ignition or thermal barrier material installation and limitations on attic use, if any, will be provided	Provide occupant with documentation of installation
<b>4.1004.1</b> Topic Subtopic Desired Outcome	<b>Preparation for Dense Packing</b> Attics Knee Walls Airtight cavity and insulated knee wall	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1004.1a Backing	All knee walls will have top and bottom plate or blockers installed using rigid materials When knee wall floor and walls are being insulated, the floor joist running under the knee wall will be air sealed If fabric is used before dense packing, it will be secured according to manufacturers specifications or with furring strips every wall stud If rigid material is used, material will be installed to cover 100% of the surface of the accessible knee wall area If foam sheathing is used, sheathing will be listed for uncovered use in an attic or covered with a fire barrier	Eliminate bending, sagging, or movement that may result in air leakage Prevent air leakage through the top or bottom of the knee wall Ensure material will not tear under stress from wind loads or insulation
4.1004.1b Installation	All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates Insulation that is blown behind fabric or air barrier material will be blown dense to a minimum specification of 3.5 pounds per cubic foot for cellulose  Follow manufacturer's requirements for fiberglass dense pack applications	Eliminate misalignment of existing insulation Prevent insulation from settling or moving
<b>4.1004.2</b> Topic Subtopic Desired Outcome	<b>Preparation for Batt Insulation</b> Attics Knee Walls Airtight cavity and properly insulated knee wall	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1004.2a Knee wall prep for batts	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	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
4.1004.2b Installation	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	Eliminate misalignment of existing insulation
4.1004.2c Backing knee wall	If rigid material is used, material will be installed to cover 100% of the surface of the knee wall If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier	Prevent insulation from settling or moving
<b>4.1004.3</b> Topic Subtopic Desired Outcome	<b>Strapping for Existing Insulation</b> Attics Knee Walls Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1004.3a Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage
4.1004.3b Installation	Insulation will be installed in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions	Insulate to prescribed R-value

4.1004.3c	Attachment	Strapping material will have a minimum expected service life of 20 years	Maintain alignment
4.1004.3d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1004.4</b>	<b>Knee Wall Without Framing</b>		
Topic	Attics		
Subtopic	Knee Walls		
Desired Outcome	Consistent uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value		
Single-Family Homes			
<b>Title</b>	<b>Specification(s)</b>		<b>Objective(s)</b>
4.1004.4a	Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage
4.1004.4b	Flat cavity present	Gap between framing and existing air barrier will be insulated	Create a flat insulated surface
4.1004.4c	Installation	A rigid insulated sheathing will be mechanically fastened to code required R-value Seams will be sealed	Insulate to prescribed R-value
4.1004.4d	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1004.5</b>	<b>Knee Walls and Gable End Walls—Preparation for and Installation of Spray Polyurethane Foam (SPF)</b>		
Topic	Attics		
Subtopic	Knee Walls		
Desired Outcome	Airtight and insulated knee and gable end walls		
Single-Family Homes			
<b>Title</b>	<b>Specification(s)</b>		<b>Objective(s)</b>
4.1004.5a	Installation of backing	Knee walls will have a top and bottom plate or blockers installed using a rigid material A suitable backstop material attached to the back of the knee wall will be used to support the application of SPF If foam sheathing is used as a backstop, sheathing will be listed for uncovered use in an attic or covered with an ignition barrier, thermal barrier, or approved alternate assembly	Provide a backstop or substrate for application of SPF
4.1004.5b	Installation	Insulation will be installed to prescribed R-value Using SPF application, SPF will be applied to desired thickness onto substrate material from top to bottom plate between studs using pass thickness maximum in accordance with manufacturer specifications  In colder climates (IECC Zones 5-8), the SPF will be installed to a thickness of at least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the interior of the SPF	Eliminate cracks, gaps, and voids Minimize framing cavity air flows  Minimize moisture migration and unwanted condensation in insulation (vapor retarders)
			Ensure alignment of insulation and air barrier
<b>4.1005.1</b>	<b>Accessible Floors—Batt Installation</b>		
Topic	Attics		
Subtopic	Attic Floors		
Desired Outcome	Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow		
Single-Family Homes			
<b>Title</b>	<b>Specification(s)</b>		<b>Objective(s)</b>
4.1005.1a	Preparation	Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces All electrical junctions will be flagged to be seen above the level of the insulation Open electrical junction boxes will have covers installed	Access the workspace Provide location of electrical junctions for future servicing Prevent an electrical hazard
4.1005.1b	Installation	Batt insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions  Insulation will be installed to the prescribed R-value	Insulate to prescribed R-value
4.1005.1c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1005.2</b>	<b>Accessible Floors—Loose Fill Installation</b>		
Topic	Attics		
Subtopic	Attic Floors		
Desired Outcome	Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow		
Single-Family Homes			
<b>Title</b>	<b>Specification(s)</b>		<b>Objective(s)</b>
4.1005.2a	Preparation	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	Access the workspace Verify uniformity of insulation material Provide location of electrical boxes for future servicing Prevent an electrical hazard

4.1005.2b	Air barrier	Existence of air barrier material in line with the knee walls will be installed or verified when dense packing	Hold dense pack in place
4.1005.2c	Installation	Air barrier material will not bend, sag, or move once dense packed All insulation will be installed to the depth indicated on the manufacturer coverage chart for desired R-value	Reduce heating and air conditioning costs  Improve comfort Minimize noise
4.1005.2d	Onsite documentation	A signed and dated attic card will be provided that includes:  Insulation type Installed thickness and settled thickness Coverage area  R-value Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications  Confirm amount of insulation installed in attic  Ensure ability to match bags required for total area completed
<b>4.1005.3</b>		<b>Accessible Floors—Batt Insulation Over Existing Insulation</b>	
	Topic	Attics	
	Subtopic	Attic Floors	
	Desired Outcome	Insulation controls heat transfer through ceiling	
	Single-Family Homes		
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1005.3a	Preparation	Existing insulation will be in contact with the air barrier prior to installing additional insulation on top	Ensure proper performance of insulation
4.1005.3b	Installation	If the top of the existing insulation is below the top of the framing, new batts will be installed parallel with framing members If the top of the existing insulation is above the top of the framing, new batts will be installed perpendicular to framing members	Ensure uniform depth of insulation in continuous contact with existing insulation Eliminate voids and gaps
4.1005.3c	Insulation	Batts will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1005.3d	Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.3e	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1005.4</b>		<b>Accessible Floors—Loose Fill Over Existing Insulation</b>	
	Topic	Attics	
	Subtopic	Attic Floors	
	Desired Outcome	Insulation controls heat transfer through ceiling	
	Single-Family Homes		
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1005.4a	Preparation	Existing insulation will be in contact with the air barrier prior to installing additional insulation on top  Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier All electrical junction boxes will be flagged to be seen above the level of the insulation Open electrical junction boxes will have covers installed Insulation dams and enclosures will be installed as required	Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing Prevent an electrical hazard
4.1005.4b	Installation	The correct depth and number of bags will be blown in accordance with manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1005.4c	Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.4d	Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
<b>4.1005.5</b>		<b>Enclosed Bonus Room Floor Over Unconditioned Space—Dense Pack Installation</b>	
	Topic	Attics	
	Subtopic	Attic Floors	
	Desired Outcome	A consistent thermal boundary between conditioned and unconditioned space controls the heat flow	
	Single-Family Homes		
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1005.5a	Air barrier	Existence of air barrier material in line with the knee walls will be installed or verified when dense packing Air barrier material will not bend, sag, or move once dense packed	Hold dense pack in place
4.1005.5b	Fill floors	Each cavity will be 100% filled to consistent density: Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density per the manufacturer's recommendations The number of bags installed will be confirmed and will match the number required on the coverage chart	Eliminate voids and settling Minimize framing cavity air flows

	Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	
4.1005.5c Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.5d Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460	Post documentation onsite to allow verification
<b>4.1005.6</b> Topic Subtopic Desired Outcome	<b>Enclosed Attic Storage Platform Floor—Dense Pack Installation</b> Attics Attic Floors Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1005.6a Fill floors	Each cavity will be 100% filled to consistent density: Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density of 2.2 pounds per cubic foot The number of bags installed will be confirmed and will match the number required on the coverage chart	Eliminate voids and settling Minimize framing cavity air flows
4.1005.6b Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1005.6c Onsite documentation	Documentation will be posted as required by federal specification 16m CFR 460	Post documentation onsite to allow verification
<b>4.1005.7</b> Topic Subtopic Desired Outcome	<b>Attic Floor—Preparation and Installation of Spray Polyurethane Foam (SPF)</b> Attics Attic Floors Consistent, thermal boundary and air barrier between conditioned and unconditioned space controls the heat flow and air leakage	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1005.7a Preparation	Subfloor or drywall will be removed to access cavities as necessary (e.g., beneath attic knee walls) All electrical junctions will be flagged to be seen above the level of the insulation Open electrical junction boxes will have covers installed	Access the workspace Provide location of electrical junctions for future servicing Prevent an electrical hazard
4.1005.7b Installation	Insulation will be installed to prescribed R-value SPF will be applied to desired thickness onto attic floor to ceiling material below between attic floor joists using pass thickness maximum as indicated by manufacturer	Insulate to prescribed R-value
4.1005.7c Safety	Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat-generating sources	Prevent a fire hazard
4.1005.7d Onsite documentation	Documentation will be posted as required by federal specification 16 CFR 460  A signed and dated attic card will be provided that includes: Insulation type Installed thickness Coverage area Insulation R-value	Post documentation onsite to allow verification
4.1005.7e Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1006.1</b> Topic Subtopic Desired Outcome	<b>Pull-Down Stairs</b> Attics Attic Openings Pull-down attic stair properly sealed and insulated	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1006.1a Installation	Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly Pull-down stair assembly will be insulated to the same R-value as 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	Achieve uniform R-value Prevent loose insulation from entering the living area
4.1006.1b Sealing	Entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space Pull-down stair frame will be caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, or solid material that allows attic door operation	Prevent air leakage
4.1006.1c Durability	Completed measure will meet a minimum expected service life of 20 years	Ensure a minimum expected service life

4.1006.1d Occupant education	The purpose of the entire measure (insulation, air seal, protective barrier, proper attic stair operation) will be communicated to occupant	Educate occupant on how to use the hatch to ensure integrity of insulated and sealed assembly throughout service life
<b>4.1006.2</b>	<b>Access Doors and Hatches</b>	
Topic	Attics	
Subtopic	Attic Openings	
Desired Outcome	Attic access door properly sealed and insulated	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1006.2a Installation	Access hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly Attic hatches rough opening will be surrounded with a durable protective baffle that is higher than the level of the surrounding attic floor insulation	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
4.1006.2b Sealing	Access hatch frames will be sealed using caulk, gasket, weatherstrip, or otherwise sealed with an air barrier material, suitable film, or solid material  Options will include installing a latch or lock or frictionally engaged components of a pre-fabricated unit above the opening that do not require a latch The measure must include a protective baffle or insulation barrier	Prevent air leakage
4.1006.2c Attachment	Insulation will be permanently attached and in complete contact with the air barrier	Insulate to prescribed R-value
4.1006.2d Durability	Completed measure will meet a minimum expected service life of 20 years	Ensure a minimum expected service life
4.1006.2e Occupant education	Purpose of insulation and proper hatch operation will be communicated to occupant	Educate occupant on how to use the hatch to ensure integrity of insulated and sealed assembly throughout service life
<b>4.1006.3</b>	<b>Whole-House Fan</b>	
Topic	Attics	
Subtopic	Attic Openings	
Desired Outcome	Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1006.3a Installation	Sides of fan insulation box assembly will be insulated to the same R-value as adjoining insulated assembly	Insulate to prescribed R-value
4.1006.3b Air sealing	Fan insulation box frame will be continuously weatherstripped to ensure a tight fit Fan insulation box will be constructed to a depth to protect the fan housing and motor from insulation	Prevent air leakage
4.1006.3c Attachment	Non-compressible insulation will be permanently attached in contact with fan insulation box Appropriate adhesive or mechanical fastener will be used	Ensure continuous alignment with air barrier
4.1006.3d Durability	Material integrity will meet a minimum expected service life of 20 years	Ensure a minimum expected service life
4.1006.3e Occupant education	Purpose of insulation will be communicated to occupant	Educate occupant on how to use the whole-house fan to ensure integrity of the fan insulated assembly throughout service life
<b>4.1088.1</b>	<b>Attic Ventilation</b>	
Topic	Attics	
Subtopic	Special Considerations	
Desired Outcome	Properly restored vents minimize moisture and ice dams	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1088.1a Air barrier and thermal boundary	Attic ventilation will be recommended or installed after:  The presence of an effective air barrier and thermal boundary between the attic and the living space is verified Appropriate attic sealing and proper insulation is specified as part of the scope of work Local code requires attic ventilation during weatherization or retrofits	Ensure presence of continuous air barrier and thermal boundary
4.1088.1b Vent type	Attic vent types will be made of corrosion-resistant material for their specific location (e.g., exterior soffit, gable end, roof ) and material and intended use (e.g., metal vent on metal roof ) Attic-powered ventilators will not be used	Ensure vent meets proper performance characteristics for location and roofing type
4.1088.1c Vent location	Placement of attic vents will be considered for proper air flow and prevention of entry of wind driven rain or snow	Encourage proper air flow  Minimize entry of wind driven rain or snow
4.1088.1d Ventilation baffling	Baffling for attic soffit vents will be installed to:  Ensure proper air flow Prevent wind washing of insulation Allow maximum insulation coverage Ensure baffle terminates above insulation	Ensure vent allows proper air flow without compromising insulation performance

4.1088.1e	Ventilation screens	All attic ventilation will have screens with non-corroding wire mesh with Existing vents that are not screened will be covered with non-corroding wire mesh with openings of 1/16" to 1/4" Ensure net free area requirements are met Additional vents or larger vents can be added if screen size is smaller than designated	Prevent pest entry
<b>4.1088.2</b>	<b>Radiant Barrier</b>	<b>Radiant Barrier</b>	
Topic	Attics		
Subtopic	Special Considerations		
Desired Outcome	Radiant heat flow reduced		
Single-Family Homes			
<u>Title</u>	<u>Specification(s)</u>	<u>Objective(s)</u>	
4.1088.2a	Stapling	An air space no less than ¼" will be maintained between the barrier and the bottom of the roof deck	Ensure performance of radiant barrier
4.1088.2b	Ventilation	A minimum of 3" clearance from soffit vents and ridge vents will be maintained	Allow for air flow behind barrier
4.1088.2c	Gable walls	Radiant barrier will apply to gable walls while maintaining a ¼" air space  Radiant barrier will not block gable vents	Ensure performance of radiant barrier
4.1088.2d	Porch and garage attic spaces	Radiant barrier will be installed to separate the attic above conditioned space from adjacent attics Radiant barrier will be installed to withstand local wind loads	Reduce radiant heat entry Ensure durability
<b>4.1088.3</b>	<b>Skylights</b>	<b>Skylights</b>	
Topic	Attics		
Subtopic	Special Considerations		
Desired Outcome	Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value		
Single-Family Homes			
<u>Title</u>	<u>Specification(s)</u>	<u>Objective(s)</u>	
4.1088.3a	Sealing	Holes and penetrations will be sealed Bypasses will be blocked and sealed	Prevent air leakage
4.1088.3b	Installation	Insulation will be installed in accordance with manufacturer specifications and will be in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions  Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1088.3c	Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1088.4</b>	<b>Parapet Walls—Dense Pack</b>	<b>Parapet Walls—Dense Pack</b>	
Topic	Attics		
Subtopic	Special Considerations		
Desired Outcome	Properly installed insulation reduces heat flow through parapet wall		
Single-Family Homes			
<u>Title</u>	<u>Specification(s)</u>	<u>Objective(s)</u>	
4.1088.4a	Access	Proper access in wall exterior or interior containment area will be ensured  Lead safety procedures in houses built before 1978 will be followed in accordance with EPA Healthy Indoor Environment Protocols for Home Energy Upgrades	Protect worker and occupant health
4.1088.4b	Installation	Dense pack insulation will be installed in accordance with manufacturer specifications at void area	Seal wall
<b>4.1088.5</b>	<b>Parapet Walls—Spray Polyurethane Foam (SPF)</b>	<b>Parapet Walls—Spray Polyurethane Foam (SPF)</b>	
Topic	Attics		
Subtopic	Special Considerations		
Desired Outcome	Properly installed insulation reduces heat flow through parapet wall		
Single-Family Homes			
<u>Title</u>	<u>Specification(s)</u>	<u>Objective(s)</u>	
4.1088.5a	Access	Proper access in wall exterior or interior containment area will be ensured  Lead safety procedures in houses built before 1978 will be followed in accordance with EPA Healthy Indoor Environment Protocols for Home Energy Upgrades	Protect worker and occupant health
4.1088.5b	Installation	SPF insulation will be installed in accordance with manufacturer specifications at void area	Seal and insulate wall
<b>Walls</b>			
<b>4.1101.1</b>	<b>Exterior Wall Dense Packing</b>	<b>Exterior Wall Dense Packing</b>	
Topic	Walls		
Subtopic	Preparation		
Desired Outcome	Walls properly prepared to receive dense pack insulation		

Single-Family Homes

**Title**

4.1101.1a Preparation

**Specification(s)**

Lead and asbestos safety procedures will be followed  
Cavities will be free of hazards, intact, and able to support dense pack pressures  
Drilling hazards (e.g., wiring, venting, fuel piping) will be located  
Blocking will be installed around:

All openings to inside crawl space and basement for fibrous material

High temperature fire-rated materials  
Wiring and electrical hazards  
Heat sources  
Access to exterior wall cavities will be gained, sheathing will be drilled as interior will be masked and dust controlled during drilling when accessing from interior  
Electricity supply will be confirmed and will support blowing machine power demand  
Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed  
Hose outlet pressure will be at least 80 IWC or 2.9 psi for cellulose insulation; for other types of dense pack insulation, check manufacturer specification for blowing machine set up

**Objective(s)**

Prevent damage to house  
Provide a clean work space  
  
Provide thorough access to allow 100% coverage  
Ensure proper equipment and process results in consistent density  
Prevent settling and retard air flow through cavities  
  
Protect worker and occupant health

4.1101.1b Exterior dense pack

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

Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot  
Loose fiber glass material will be installed and will be specifically approved for air flow resistance to a minimum density of 1.5 to 2 pounds per cubic foot  
  
The number of bags installed will be confirmed and will match the number required on the coverage chart  
Insulation density will be verified by bag count, core sampling, or infrared camera with the blower door at 50 pascals to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

Eliminate voids and settling  
  
Minimize framing cavity air flows

**4.1101.2**

Topic  
Subtopic  
Desired Outcome

**Exterior Wall Insulating Sheathing**

Walls  
Preparation  
Wall cladding removed and replaced to expose wall sheathing for installation of insulating wall sheathing

Single-Family Homes

**Title**

4.1101.2a Wall cladding removal

**Specification(s)**

Existing cladding will be removed

Lead and asbestos safety procedures will be followed

4.1101.2b Wall cladding replacement

New cladding will be installed in accordance with manufacturer specifications and local codes after exterior wall insulation is installed

**Objective(s)**

Expose existing wall sheathing to prepare for installation of insulating sheathing  
  
Install wall cladding correctly  
  
Meet local codes

**4.1101.3**

Topic  
Subtopic  
Desired Outcome

**Exterior Wall Spray Polyurethane Foam (SPF)—Masking and Surface Preparation**

Walls  
Preparation  
Finished surfaces are protected and SPF has a suitable surface to adhere to

Single-Family Homes

**Title**

4.1101.3a Surface protection

**Specification(s)**

Finished surfaces that should not be covered with SPF (e.g., windows, doors) will be identified  
Surfaces will be covered or sealed with appropriate material (e.g., plastic film, masking tape) to protect from SPF overspray

**Objective(s)**

Prevent overspray and potential damage to finished surfaces

4.1101.3b Substrate repair

Cracks, gaps, and holes in the substrate will be covered or sealed in accordance

Prevent waste of SPF  
Prevent overspray into adjacent areas

4.1101.3c Substrate cleaning

All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation  
Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt  
Grease and oil will be removed using appropriate cleaners or solvents

Ensure proper bonding of SPF to substrate surfaces

**4.1101.4**

Topic  
Subtopic  
Desired Outcome

**Exterior Wall Spray Polyurethane Foam (SPF)—Electrical System Considerations**

Walls  
Preparation  
Outlet, junction, switch, and light fixture boxes and existing wiring are protected from SPF

Single-Family Homes <b>Title</b> 4.1101.4a Box protection	<b>Specification(s)</b> All front and back openings of all outlet, switch, and light fixture boxes will be covered with masking tape  All electrical junction boxes will be accessible after the installation of SPF  Open electrical junction boxes will have covers installed	<b>Objective(s)</b> Prevent SPF from covering any switches and outlets and from entering the inside of any electrical box
<b>4.1102.1</b> Topic Subtopic Desired Outcome	<b>Open Wall Insulation—General</b> Walls Open Cavity Walls Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value	
Single-Family Homes <b>Title</b> 4.1102.1a Sealing	<b>Specification(s)</b> Holes and penetrations will be sealed Bypasses will be blocked and sealed	<b>Objective(s)</b> Prevent air leakage
4.1102.1b Installation	Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions  Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1102.1c Pre-drywall verification	Verification of complete installation without gaps, voids, compressions, misalignments, or wind intrusions will be provided	Install insulation correctly
4.1102.1d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1102.2</b> Topic Subtopic Desired Outcome	<b>Open Wall—Spray Polyurethane Foam (SPF) Installation</b> Walls Open Cavity Walls Exterior walls are insulated and sealed	
Single-Family Homes <b>Title</b> 4.1102.2a Installation	<b>Specification(s)</b> Interior cladding or interior finish material will be removed on areas to be insulated SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer SPF will be applied onto exterior sheathing or interior finish materials between studs and top/bottom plates	<b>Objective(s)</b> Insulate and seal exterior walls
4.1102.2b Vapor retarders	If vapor retarder is needed, it will be applied in proper location In colder climates (IECC Zones 5-8), the SPF used will be installed to a thickness of at least Class II vapor retarder or have at least Class II vapor retarder coating or covering in direct contact with the inside surface of the SPF	Minimize water vapor condensation in walls
4.1102.2c Fire protection	SPF will be separated from the occupied interior spaces of the building with a thermal barrier (typically ½" or thicker gypsum wallboard or approved alternate assembly) Check local codes for fire protection requirements	Provide necessary fire protection for combustible SPF insulation
<b>4.1103.1</b> Topic Subtopic Desired Outcome	<b>Dense Pack Exterior Walls</b> Walls Enclosed Walls Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b> 4.1103.1a Exterior dense pack	<b>Specification(s)</b> 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	<b>Objective(s)</b> Eliminate voids and settling  Minimize framing cavity air flows
<b>4.1103.2</b> Topic Subtopic Desired Outcome	<b>Additional Exterior Wall Cavities</b> Walls Enclosed Walls Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments	
Single-Family Homes <b>Title</b> 4.1103.2a Location of cavities	<b>Specification(s)</b> Details remaining in or between completed wall sections will be located and accessed	<b>Objective(s)</b> Ensure the last gaps and framing edges in the thermal boundary, roof-wall joints, floor-wall joints, etc., are found and finished
4.1103.2b Sealing	Backing will be provided and all newly uncovered openings will be sealed with air barriers, foam, or mastic, maintaining all required clearances	Ensure the air barrier is connected across all accessible house elements

4.1103.2c Dense packing	Using fill tube, 100% of each cavity will be filled to a consistent density:  Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit airflow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using 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	Eliminate voids and settling  Minimize framing cavity air flows
4.1103.2d Quality assurance	Completed wall sections will be viewed using infrared camera with blower door operating Any voids or low density areas will be drilled and re-packed	Establish air barrier and thermal boundary  Confirm no voids or hidden air flows remain
4.1103.2e Close holes	Installation holes will be plugged as follows:  Exterior holes will be weather barrier patched Interior holes will be coated and patched to match original interior surface  All construction debris and dust will be collected and removed	Ensure house is returned to watertight and clean condition
<b>4.1103.3</b> Topic Subtopic Desired Outcome	<b>Insulated Sheathing and Insulated Siding Installation</b> Walls Enclosed Walls Properly installed insulated wall sheathing and insulated siding	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1103.3a Sealing	Holes, gaps, and penetrations in existing sheathing will be sealed	Prevent air leaks
4.1103.3b Location of wall framing	Wall studs and other framing will be located and marked	Provide secure attachment of insulating sheathing
4.1103.3c Installation	Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Install insulation properly
4.1103.3d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>Floors</b> <b>4.1301.1</b> Topic Subtopic Desired Outcome	<b>Standard Floor System—Batt Installation</b> Floors Accessible Floors Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1301.1a Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage
4.1301.1b Installation	Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions If kraft-faced batts are used, they will be installed with kraft facing to subfloor  Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.1c Securing batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor
4.1301.1d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1301.2</b> Topic Subtopic Desired Outcome	<b>Standard Floor System—Loose Fill with Netting</b> Floors Accessible Floors Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1301.2a Sealing	Sealing the floor system will be completed before insulating	Ensure airtight envelope Prevent leakage
4.1301.2b Netting, fabric	When using netting or fabric, staples will be placed according to manufacturer specifications Netting or fabric will meet local fire codes	Secure insulation
4.1301.2c Installation	Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications Insulation will be installed to prescribed R-value  Insulation will be in continuous contact with air barrier	Insulate to prescribed R-value  Ensure a continuous thermal boundary between conditioned and unconditioned space
4.1301.2d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
4.1301.3 Topic Subtopic Desired Outcome	<b>Standard Floor System—Loose Fill with Rigid Barrier</b> Floors Accessible Floors Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	

Single-Family Homes <b>Title</b> 4.1301.3a Sealing	<b>Specification(s)</b> Sealing the floor system will be completed before insulating	<b>Objective(s)</b> Ensure airtight envelope Prevent leakage
4.1301.3b Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.3c Installation	Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.3d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1301.4</b> Topic Subtopic Desired Outcome	<b>Dense Pack Floor System with Rigid Barrier</b> Floors Accessible Floors Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b> 4.1301.4a Sealing	<b>Specification(s)</b> Sealing the floor system will be completed before insulating	<b>Objective(s)</b> Ensure airtight envelope Prevent leakage
4.1301.4b Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.4c Installation	Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.4d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1301.5</b> Topic Subtopic Desired Outcome	<b>Cantilevered Floor—Batt Installation</b> Floors Accessible Floors Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b> 4.1301.5a Air barrier	<b>Specification(s)</b> Air barrier will be installed between joists and sealed  Air barrier will be placed to the most interior edge of the top plate of the wall below	<b>Objective(s)</b> Separate cantilevered floor from conditioned floor space  Allow for insulation
4.1301.5b Installation	Air barrier will be insulated between joist from top plate of the wall below to subfloor above Cantilevered subfloor will be insulated in complete contact with the floor without gaps, voids, compressions, misalignments, or wind intrusions If kraft-faced batts are used, they will be installed with kraft facing to the air barrier Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.5c Attachment	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor and air barrier
4.1301.5d Exterior soffit	Exterior soffit material will be installed and sealed	Cover and protect insulation
4.1301.5e Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1301.6</b> Topic Subtopic Desired Outcome	<b>Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier</b> Floors Accessible Floors Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b> 4.1301.6a Subfloor preparation	<b>Specification(s)</b> Sealing between house and crawl space will be completed before insulating	<b>Objective(s)</b> Ensure airtight envelope  Prevent leakage
4.1301.6b Installation	Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions If kraft-faced batts are used, they will be installed with kraft facing to subfloor  Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.6c Secure batts	Batts will be secured with physical fasteners	Ensure insulation remains in contact with subfloor
4.1301.6d Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly  Seams and penetrations will be sealed	Protect insulation
4.1301.6e Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1301.7 Topic Subtopic Desired Outcome	Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier Floors Accessible Floors Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1301.7a Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Prevent air leakage
4.1301.7b Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.7c Installation	Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.7d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1301.8</b>	<b>Pier Construction Subfloor Installation—Dense Pack with Rigid Barrier</b>	
Topic Subtopic Desired Outcome	Floors Accessible Floors Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1301.8a Subfloor preparation	Sealing between house and crawl space will be completed before insulating	Prevent air leakage
4.1301.8b Rigid air barrier	A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly Seams and penetrations will be sealed	Relocate air barrier
4.1301.8c Installation	Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications Insulation will be installed to prescribed R-value	Insulate to prescribed R-value
4.1301.8d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation
<b>4.1301.9</b>	<b>Open Floors Over Unconditioned Space and Cantilevered Floors, Floors Over Garages, Floors Over Unconditioned Crawl Spaces—Spray Polyurethane</b>	
Topic Subtopic Desired Outcome	Floors Accessible Floors Floors over unconditioned spaces (e.g., basements, garages) insulated and sealed	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
4.1301.9a Preparation	All floor areas will be open and accessible for SPF application  Cracks, gaps, and holes will be covered or sealed per manufacturer guidelines with appropriate material Insulation dams or end blockers will be installed where needed All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents	Prepare all substrate surfaces for the application of SPF
4.1301.9b Installation	Insulation will be installed to prescribed R-value according to manufacturer specifications SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer, onto subfloor between floor joists and all rim/band joists When desired, underside of joists will be covered with SPF to provide layer of continuous insulation	Insulate and seal floors
4.1301.9c Fire protection	SPF will be separated from the interior occupied space of the building with a 15-minute thermal barrier (typically ½" or thicker gypsum wallboard or approved ignition barrier coating) Check local codes for fire protection requirements	Provide necessary fire protection for combustible SPF insulation
<b>Basements And Crawlspaces</b>		
<b>4.1401.1</b>	<b>Band/Rim Joists—Spray Polyurethane Foam (SPF) Installation</b>	
Topic Subtopic Desired Outcome	Basements and Crawl Spaces Band/Rim Joists Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below	

Single-Family Homes <b>Title</b> 4.1401.1a Preparation	<b>Specification(s)</b> All band/rim joist areas will be open and accessible for SPF application  All surfaces where SPF is applied will be clean, dry, and free of contamination and degradation Substrate surfaces will be wiped, blown, or vacuumed to be free of excessive dust and dirt Grease and oil will be removed using appropriate cleaners or solvents  Moisture content of all wood substrate materials will be checked to ensure it is below 20%	<b>Objective(s)</b> Prepare all substrate surfaces for the application of SPF
4.1401.1b Installation	SPF will be applied to desired thickness, using pass thickness maximum in accordance with manufacturer specifications, onto subfloor between floor joists and all rim/band joists When applied to first floor, SPF will be continuous from subfloor surface, over band/rim joist and sill plate, and in contact with foundation below When applied to second story floor or above, SPF will be continuous from subfloor surface, over band/rim joist, and in contact with top plate below	Insulate and seal floors
4.1401.1c Fire protection	If SPF exceeds a thickness of 3", all SPF will be separated from the occupied interior space of the building with an approved thermal barrier material (typically ½" or thicker gypsum wallboard or an approved thermal barrier coating) Application to rim/band joist up to 3" can be left exposed if the foam is Class I  Local codes will be confirmed and followed for fire protection requirements	Provide necessary fire protection for combustible SPF insulation
<b>4.1402.1</b> Topic Subtopic Desired Outcome	<b>Closed Crawl Spaces—Wall Insulation</b> Basements and Crawl Spaces Basements and Crawl Space Walls Closed crawl spaces insulated to achieve best thermal performance possible	
Single-Family Homes <b>Title</b> 4.1402.1a Insulation selection	<b>Specification(s)</b> Where the crawl space is dry, fiberglass insulation may be used. A non-absorbent, fire-rated insulation with a minimum life expectancy of 10 years may be used in other situations.	<b>Objective(s)</b> Improve thermal performance
4.1402.1b R-value	The ND Field Standard Section 5325 Foundation Insulation will be followed for required R-values	Improve thermal performance
4.1402.1c Termite inspection gap	Where termite pressure exists, a 3" inspection gap will be maintained from the top of the insulation to the bottom of any wood	Allow for termite detection
4.1402.1d Attachment	Insulation will be attached with a durable connection equal to or better than manufacturer specifications, whichever is more durable A minimum expected service life of 10 years will be ensured	Maintain insulation performance without compromising the air or vapor barrier
4.1402.1e Band joist and wood foundation walls	A vapor-diffuse insulation will be installed Where termite pressure exists, removable band joist insulation will be installed	Improve thermal performance Allow for termite inspection and drying of wood materials
4.1402.1f Band joist and wood foundation walls (cold climates)	Insulation will be installed with a vapor barrier on the warm side of the insulation Where termite pressure exists, removable band joist insulation will be installed	Improve thermal performance Prevent moisture condensation on the inside of the band joist or wood walls Allow for termite inspection and drying of wood materials
<b>4.1402.2</b> Topic Subtopic Desired Outcome	<b>Basement Wall Insulation—No Groundwater Leakage</b> Basements and Crawl Spaces Basements and Crawl Space Walls Basement insulation improves thermal performance and ensures sufficient drying potential	
Single-Family Homes <b>Title</b> 4.1402.2a R-value	<b>Specification(s)</b> The ND Field Standard Section 5325 Foundation Insulation will be followed for required R-values	<b>Objective(s)</b> Improve thermal performance of the basement and living space
4.1402.2b Air barrier	A continuous air barrier will be installed on the warm side of the insulation	Prevent condensation on the basement wall
4.1402.2c Vapor permeability	When absorbent insulation materials are installed, assembly will remain vapor permeable to the interior in all climate zones except Zone 7	Provide drying potential to the basement

**Ducts**

**4.1601.1**

Topic

Subtopic

Desired Outcome

**Insulating Flex Ducts**

Ducts

Insulating Ducts

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

Single-Family Homes

**Title**

4.1601.1a Removal of existing flexible ducting

**Specification(s)**

All accessible low R-value flexible ducting will be removed from premises

**Objective(s)**

Ensure installation of proper R-value ducts

4.1601.1b Selection of new flexible ducting

All flexible ducting will have a minimum of R-8

Minimize thermal conductance of the duct system

4.1601.1c Sizing of new flex

Duct sizing procedures will be conducted when replacing flex duct

Improve comfort in rooms  
Improve fan performance

4.1601.1d Installation of flex

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

Prevent sags, drops, or other bends that may interfere with correct air flow

4.1601.1e Interior liner attachment

Interior liner of the flex-to-metal connection will be fastened with tie bands

Create a strong, secure attachment

4.1601.1f Sealing of interior liner

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

Create an airtight connection

4.1601.1g Attachment of exterior liner

Liner will be pulled up onto the metal duct as far as possible before securing

Create a strong, durable attachment

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

4.1601.1h Sealing of all accessible ducts

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

Minimize duct leakage

4.1601.1i Insulation of all fittings

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

Minimize thermal conductance of the duct system

4.1601.1j Completeness of vapor barrier

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

Ensure a complete vapor barrier

**4.1601.2**

Topic

Subtopic

Desired Outcome

**Insulating Metal Ducts**

Ducts

Insulating Ducts

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

Single-Family Homes

**Title**

4.1601.2a Selection of duct insulation material

**Specification(s)**

Duct insulation on all ducts located in unconditioned spaces will be a minimum of R-8, in accordance with local code, or buried under attic insulation, whichever is greater, and have an attached vapor retarder  
Hot humid and warm coastal regions will not bury ducts

**Objective(s)**

Decrease heat loss and condensation problems

4.1601.2b Duct sealing

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

Minimize duct leakage

4.1601.2c Attachment of duct insulation	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	Ensure a secure connection between the duct system and the duct insulation
4.1601.2d Taping of the duct insulation	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	Prevent gaps in the vapor barrier of the insulation
<b>Insulation - Additional Resources</b>		
<b>4.9901.1</b>	<b>General Information on Spray Polyurethane Foam (SPF)</b>	
Topic	Insulation—Additional Resources	
Subtopic	Materials	
Desired Outcome	To provide general information on spray polyurethane foam	
Single-Family Homes		
<b>Title</b>		
4.9901.1a Low-Pressure SPF	<b>Specification(s)</b> Low-pressure SPF systems are two-component polyurethane foam products. They are typically delivered to the job site in pressurized canisters (~250 psi), dispensed through unheated hoses through a disposable mixing nozzle system, and applied as a froth-like material to substrate. This type of SPF product is typically used for large sealing and small-scale insulation products.	<b>Objective(s)</b> To provide general information on spray polyurethane foam
4.9901.1b High-Pressure SPF	High-pressure SPF systems are two-component polyurethane foam products. They are typically delivered to the job site in unpressurized drums or totes, and dispensed by a proportioner pump where heat and pressure are added. These chemicals travel through heated hoses to a spray gun where the material is aerosolized during application. This type of SPF product is typically used for larger insulation applications.  Once installed, there is essentially no difference in product performance between low- and high-pressure foams. It should be noted that the main differences between the delivery methods are in capital equipment investment, application rate, and PPE requirements.  Applicators should obtain training from the suppliers of SPF to help assure installation quality and use of all equipment as well as safe handling, use, and disposal of all chemicals used in the process. Spray Polyurethane Foam Alliance (SPFA) also offers additional training and accreditation for high-pressure SPF applicators.	To provide general information on spray polyurethane foam
4.9901.1c Manufacturer Installation Instructions	In addition to the guidelines above, SPF applicators should follow all manufacturer installation instructions for the product being used. These instructions include product-specific documents, such as application instructions, SDSs, and evaluation reports.	To provide general information on spray polyurethane foam
<b>5.3001.1</b>		
Topic	<b>Load Calculation and Equipment Selection</b>	
Subtopic	Forced Air	
Desired Outcome	Design Equipment sized properly and operates efficiently	
Single-Family Homes		
<b>Title</b>		
5.3001.1a Load calculation	<b>Specification(s)</b> Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications	<b>Objective(s)</b> Properly size equipment for load
5.3001.1b Equipment selection	Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications	Ensure equipment is able to heat, cool, and dehumidify the house
5.3001.1c Air filtration	New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass around the filters	Particle removal to protect equipment and help maintain indoor air quality
<b>Heating and Cooling</b>		
<b>Forced Air</b>		
<b>5.3001.2</b>		
Topic	<b>Ductwork and Termination Design</b>	
Subtopic	Forced Air	
Desired Outcome	Design Efficient air flow to all rooms ensured by proper ductwork	
Single-Family Homes		
<b>Title</b>		
5.3001.2a Duct design	<b>Specification(s)</b> Duct design will be performed in accordance with ANSI/ACCA Manual D and manufacturer specifications	<b>Objective(s)</b> Maximize air flow
5.3001.2b Termination design	Termination design will be performed in accordance with ANSI/ACCA Manual T and manufacturer specifications	Maximize air flow  Ensure occupant comfort
5.3001.2c Air filtration	New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass around the filters	Particle removal to protect equipment and help maintain indoor air quality
<b>5.3002.1</b>		
Topic	<b>Preparation for New Equipment</b>	
Subtopic	Forced Air	
Desired Outcome	Site Preparation Existing equipment removed safely and lawfully	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	

Single-Family Homes <b>Title</b> 5.3002.1a Access	<b>Specification(s)</b> A code compliant walkway and service platform will be installed in attics, if not present Walkway and platform will be above the level of insulation (if practical)	<b>Objective(s)</b> Ensure new equipment can be installed and serviced Maintain adequate insulation level
5.3002.1b Utility disconnect	Electricity and fuel will be turned off prior to starting removal of old appliance	Protect workers and occupants from injury
5.3002.1c Refrigerant recovery	Refrigerant will be recovered in accordance with 40 CFR 608 (EPA) by a licensed contractor	Comply with Safe Handling of Refrigerant Law Protect workers and occupants from injury
5.3002.1d Equipment disconnection	Refrigerant lines, plumbing, ducts, electric, control wires, vents, and fuel supply will be disconnected	Ensure equipment can be removed
5.3002.1e Removal	Equipment will be removed (e.g., furnace, air handler, evaporator, condensing unit) Equipment will be removed from space without damaging property and disturbing or compressing the insulation Equipment will be disposed of in accordance with local laws and regulations, recycling materials when feasible	Provide room to install new equipment and work safely Comply with applicable disposal laws
<b>5.3003.1</b> Topic Subtopic Desired Outcome	<b>Data Plate Verification</b> Forced Air System Assessment and Maintenance Data for commissioning and future service work is recorded	
Single-Family Homes <b>Title</b> 5.3003.1a Data plate verification	<b>Specification(s)</b> Equipment will be visually inspected  Information will be recorded from the equipment data plates indoors and outdoors	<b>Objective(s)</b> Ensure technician has equipment data necessary for commissioning and future service work
<b>5.3003.10</b> Topic Subtopic Desired Outcome Note	<b>Condensate Drainage of Heating and Air Conditioning Equipment</b> Forced Air System Assessment and Maintenance Equipment and condensate drain operate as designed The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b> 5.3003.10a Connection	<b>Specification(s)</b> Connections in condensate drain system will be watertight	<b>Objective(s)</b> Ensure condensate drain connections do not leak
5.3003.10b Insulation	Condensate drainlines will be insulated with a minimum 1" of insulation with a vapor retarder when there is potential for condensation or freezing on the drainline	Ensure condensate drain connections do not leak
5.3003.10c Overflow protection: upflow	Secondary drain pan and float switch will be installed when overflow could damage finished surfaces OR Float switch in the primary condensate drain for upflow systems will be installed when overflow could damage finished surfaces	Ensure condensate drain connections do not leak
5.3003.10d Pumps	Condensate drain pumps will be installed when condensate cannot be drained by gravity Power source for pump will be installed Operation and drainage of pump will be verified	Ensure condensate drain connections do not leak
5.3003.10e Vents and traps	Vents and traps will be installed on condensate drainlines Trap supplied with the equipment will be used and manufacturer specifications will be followed	Ensure condensate drain operates as designed Ensure condensate drain does not leak air
5.3003.10f Drain pan	Condensate from all cooling coils or evaporators shall be conveyed from the drain pan outlet to an approved place of disposal Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than 1/8 unit vertical in 12 units horizontal (1% slope) Condensate shall not discharge into a street, alley, or other areas where it would cause a nuisance	Prevent water damage from drain system malfunction
5.3003.10g Float switch	All secondary drain pans will have a float switch and be drained away through a drainline	Prevent water overflowing the pan and draining onto the ceiling below
5.3003.10h Termination	Condensate drain will be terminated in accordance with local codes	Ensure condensate does not leak to the house Ensure condensate drain does not freeze
<b>5.3003.2</b> Topic Subtopic Desired Outcome  Note	<b>Combustion Analysis of Oil-Fired Appliances</b> Forced Air System Assessment and Maintenance Analysis on critical components and operations completed in accordance with industry and manufacturer specifications The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b> 5.3003.2a Oil system: nozzle size	<b>Specification(s)</b> Nozzle size will be correct for design input and within equipment firing rate of the heating system manufacturer	<b>Objective(s)</b> Ensure equipment operates as designed  Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable

5.3003.2c	Oil system: steady state efficiency (SSE)	Measurement will be verified in accordance with manufacturer specifications	Ensure equipment operates as designed  Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2d	Oil system: smoke test (This test must be conducted before any combustion testing is completed)	Smoke spot reading will be in accordance with burner manufacturer specifications  If smoke test is more than actionable levels, specify a clean and tune	Ensure equipment operates as designed  Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2e	Net stack temperature	Net stack temperature will be measured and verified in accordance with manufacturer specifications	Ensure equipment operates as designed  Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2f	Carbon dioxide and oxygen	Measurement will be verified in accordance with industry manuals and manufacturer specifications	Ensure equipment operates as designed  Ensure equipment operates safely Ensure equipment operates efficiently Ensure equipment is durable
5.3003.2h	CO in flue gas	Undiluted flue gases will be checked with a calibrated combustion analyzer  If CO levels exceed levels in the chart on the page in the field guide, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)	Ensure equipment operates as designed  Ensure equipment operates safely  Ensure equipment operates efficiently Ensure equipment is durable
<b>5.3003.3</b>	<b>Topic</b>	<b>Evaluating Air Flow</b>	
	<b>Subtopic</b>	Forced Air	
	<b>Desired Outcome</b>	System Assessment and Maintenance Air flow is properly tested	
	<b>Note</b>	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
	<b>Single-Family Homes</b>		
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
5.3003.3a	Total air flow	Total system air flow will be measured by: Temperature rise Flow plate Fan depressurization device (e.g., Duct Blaster, DucTester)	Ensure equipment operates as designed Ensure equipment operates efficiently  Ensure equipment provides comfort Ensure equipment operates safely Ensure equipment is durable
<b>5.3003.6</b>	<b>Topic</b>	<b>Evaluating Sequence of Operation</b>	
	<b>Subtopic</b>	Forced Air	
	<b>Desired Outcome</b>	System Assessment and Maintenance Sequence of operation of the system verified	
	<b>Single-Family Homes</b>		
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
5.3003.6a	Verification	The sequence of operation of the system will be verified in accordance with the manufacturer installation, operation, and maintenance manual	Ensure system components function and operate in the correct sequence
<b>5.3003.7</b>	<b>Topic</b>	<b>Occupant Education</b>	
	<b>Subtopic</b>	Forced Air	
	<b>Desired Outcome</b>	System Assessment and Maintenance Occupants understand their role and responsibility in the safe, effective, and efficient operation of the equipment	
	<b>Single-Family Homes</b>		
	<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
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
5.3003.7e	Blocking air flow	Importance of cleaning dust and debris from return grilles will be explained to occupant Proper placement of interior furnishings with respect to registers will be explained to occupant Negative consequences of closing registers will be explained to occupant  Importance of leaving interior doors open as much as possible will be explained to occupant	Ensure occupant does not prevent equipment from operating as designed

5.3003.7f Routine maintenance	Proper filter selection and how to change the filter will be explained to occupant Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant Importance and timing of routine professional maintenance will be explained to occupant	Ensure equipment operates as designed
5.3003.7g Calling heating, ventilation, and air conditioning (HVAC) contractor	Situations when the occupant should contact the HVAC contractor will be explained, including: Fuel odors Water draining from secondary drainline Emergency heat indicator always on for a heat pump system System blowing cold air during heating season and vice versa Icing of the evaporator coil during cooling mode Outside unit never defrosts Unusual noises Unusual odors	Notify occupant to contact installer when system is not operating as designed
5.3003.7h Carbon monoxide (CO)	A carbon monoxide (CO) alarm will be installed	Occupant will be made aware of operation of CO alarm
5.3003.7i Warranty and service	Occupant will be provided with relevant manuals and warranties  The labor warranty will be explained and the occupant will be given a phone number to call for warranty service	Provide manuals and warranties for future servicing
<b>5.3003.9</b> Topic Subtopic Desired Outcome	<b>Heating and Cooling Controls</b> Forced Air System Assessment and Maintenance Heating and cooling controls installed and set properly	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
5.3003.9a Removal of mercury- based thermostats	Mercury based thermostat will be removed safely and disposed of in accordance with EPA regulations	Protect workers and occupants from injury  Protect environment from damage
5.3003.9b Removal of existing controls	Existing controls will be removed in accordance with EPA lead-safe work rules	Protect workers and occupants from injury  Protect environment from damage
5.3003.9c Penetrations	Penetrations for control wiring will be sealed with a durable sealant (e.g., caulk, silicone, foam)	Ensure controls operate as designed  Minimize infiltration and exfiltration from house
5.3003.9d Thermostat location	Thermostats will be installed to reflect the temperature of the zone in which they are installed Thermostats will not be exposed to extreme temperatures, radiant heat sources, and drafts	Ensure controls operate as designed
5.3003.9e Blower speed	Blower speed will be set for equipment in accordance with manufacturer specifications	Ensure equipment has correct air flow
5.3003.9f Thermostat selection: heat pump	A thermostat with equipment supplementary heat lockout that can interface with an outside temperature sensor will be selected	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load
5.3003.9g Heat pump: supplementary heat	Supplementary heat will be used on air-to-air heat pumps with conditions that allow for a balance point of less than 30°F  Supplementary heat lockout will be installed and set to manufacturer specifications	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load
5.3003.9h Heat pump: low ambient compressor lockout	For air-to-air heat pumps, low ambient compressor lockout will be set to 0°F outdoor temperature or to manufacturer specifications	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load
5.3003.9i Heat pump: outside temperature sensor	An outdoor temperature sensor will be installed in accordance with manufacturer specifications	Ensure equipment operates as designed
5.3003.9j Heat pump: supplementary heat wiring	Supplementary heat will be wired onto second-stage heating terminal in accordance with manufacturer specifications	Do not operate supplementary heat in stage one heating
5.3003.9k Thermostat: installer programming	The installer options will be set to match the thermostat to the equipment and control board settings	Ensure equipment operates as designed
5.3003.9l Time delay settings	Time delay for equipment will be set in accordance with manufacturer specifications and as appropriate for the climate zone (e.g., no time delay for hot humid climates)	Maximize transfer of heat without adversely affecting indoor humidity levels
5.3003.9m Humidistat: location	Humidistat will be installed to reflect humidity of the zone in which it is installed Humidistat will be installed in a dry location	Ensure controls operate as designed
5.3003.9n Occupant education	Occupants will be educated on proper use of thermostat including:  Proper use of setbacks for air conditioners and heat pumps Allowing occupant comfort to determine setback for combustion heating appliances Using emergency heat appropriately	Ensure equipment and controls operate as designed  Provide comfort throughout house

## Hydronic Heating (Hot Water and Steam)

### 5.3101.1

Topic  
Subtopic  
Desired Outcome

**Heat Load Calculation—Whole House**  
Hydronic Heating (Hot Water and Steam)  
Design  
A properly sized heating appliance selected

Single-Family Homes

#### Title

5.3101.1a Heating load calculation

#### Specification(s)

Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications

#### Objective(s)

Enable proper sizing of the heating appliance

5.3101.1b Equipment selection

Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications

Ensure equipment is able to heat the house

### 5.3101.2

Topic  
Subtopic  
Desired Outcome

**Space Load Calculation—Heat Emitter Sizing**  
Hydronic Heating (Hot Water and Steam)  
Design  
Heat emitter selected provides adequate heat output

Single-Family Homes

#### Title

5.3101.2a Space load calculation

#### Specification(s)

Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) and manufacturer specifications

#### Objective(s)

Enable proper sizing of the heating appliance

### 5.3104.1

Topic  
Subtopic  
Desired Outcome

**Controls—Thermostat Replacement**  
Hydronic Heating (Hot Water and Steam)  
Equipment Maintenance, Testing, and Repair  
Thermostat replaced when appropriate

Single-Family Homes

#### Title

5.3104.1a Visual inspection

#### Specification(s)

Thermostats will be visually located

#### Objective(s)

Determine if existing thermostats need to be replaced

Verify anticipator setting, if appropriate for thermostat model  
Replacement will be recommended if a digital, double setback thermostat is not present

5.3104.1b Mercury assessment

Thermostats containing mercury will be identified and disposed of in accordance with EPA guidance

Protect workers and occupants from mercury exposure

5.3104.1c Removal (if removal is recommended)

Heating system will be de-energized before removal  
Thermostat will be removed  
Compatibility will be verified (e.g., voltage, wiring condition, location) and documented  
Location of existing thermostat will be assessed for appropriateness (e.g., central to the house, out of direct sunlight, away from supply air, protected from abnormal radiant surface temperatures)

Proper removal of thermostat

5.3104.1d Installation

Location for new thermostat will be determined

Achieve comfort and energy savings for the occupant

Compatibility with new thermostat will be verified (e.g., voltage, wiring, condition, location)  
Replacement will be recommended if a digital, double setback thermostat is not present  
Heating system will be re-energized and cycled  
Thermostat will be programmed to occupant lifestyle choices

5.3104.1e Disposal

Thermostats will be disposed of in accordance with EPA guidelines and local regulations

Prevent mercury from entering the environment

5.3104.1f Occupant education

Occupant will be involved in the initial programming of thermostat and educated on common settings and programming  
On new installs, occupants will be encouraged to save the manual and keep it accessible

Educate occupant on best use

### 5.3104.2

Topic  
Subtopic  
Desired Outcome  
Note

**Maintenance: Gas Boiler Service Inspection**  
Hydronic Heating (Hot Water and Steam)  
Equipment Maintenance, Testing, and Repair  
Boiler service improves safety, efficiency, and performance  
The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

Single-Family Homes

#### Title

5.3104.2a Visual inspection

#### Specification(s)

The following conditions will be assessed by a licensed contractor:

#### Objective(s)

Observe general conditions to determine needed repairs or maintenance

Water, steam, and fuel leaks  
Damaged or missing pipe insulation  
Venting issues—draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence)  
Corrosion (e.g., rust, mineral deposits)  
General condition of components

5.3104.2b Appliance gas valve

When replacement is necessary, gas valve will be removed and replaced according to manufacturer specifications

Provide gas to burner when there is a call for heat

Control volume of gas for burner  
Ensure the safe shut off of gas at the end of a call for heat

5.3104.2c Ignition system

Components of ignition system will be repaired or replaced in accordance with manufacturer specifications

Do not allow flow of main burner gas without proof of ignition

5.3104.2d Main gas burners

Problems that may interfere with flame (e.g., dust, debris, misalignment) will be cleaned, vacuumed, and adjusted

Produce combustion in a safe, clean, and efficient manner

5.3104.2e Venting	Flue gases will be removed from the venting system in accordance with The ND State Building Code or per manufacturer specifications	Ensure the safety and durability of the venting system
5.3104.2f Flue gas testing	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T-2012 If combustion is not in compliance with BPI-1100-T-2012, diagnostics and adjustments will be done to meet manufacturer specifications or local codes	Confirm that combustion occurs safely with maximum efficiency
5.3104.2g Combustion efficiency checks	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with accepted protocol to determine if acceptable boiler efficiency is being maintained If boilers are found to be out of compliance, a combustion analysis will be administered and minimum stack temperature will be in accordance with manufacturer specifications	Increase the operational efficiency of the system Improve occupant comfort
5.3104.2h Occupant health	All homes will have a carbon monoxide (CO) alarm	Ensure ambient CO does not exceed acceptable levels after completion of work
5.3104.2i Occupant education	Occupants will be educated on the operation and maintenance of the carbon monoxide (CO) alarm  Completed work and recommended maintenance will be reviewed	Ensure occupant is informed of the safe and efficient operation and maintenance of the work performed
<b>5.3104.3</b> Topic Subtopic Desired Outcome Note	<b>Maintenance: Checklist</b> Hydronic Heating (Hot Water and Steam) Equipment Maintenance, Testing, and Repair Thorough maintenance improves safety, efficiency, and performance The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
5.3104.3a Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the (Standard Work Specifications for Single Family Housing) or other equivalent practice	Identify potential health and safety issues
5.3104.3b Visual inspection	The following conditions will be inspected:  Water, steam, and fuel leaks Damaged or missing pipe insulation Venting issues—draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) Corrosion (e.g., rust, mineral deposits) General condition of components	Observe general conditions to determine needed repairs or maintenance
5.3104.3c Pipe insulation inspection	Pipe insulation will be inspected, including: Integrity—complete coverage, no holes or tears Damage—holes or tears Complete coverage—insulation missing If asbestos is suspected, occupants will be notified and asbestos will not be disturbed Required repair or replacement will be performed in accordance with the following conditions: Materials will be approved for steam heating pipes Materials will be approved for hot water heating pipes Insulation will completely cover pipe Pipe insulation will be installed in accordance with manufacturer specifications	Minimize heat loss Improve performance of the system
5.3104.3d Check system pressure	Check system pressure will be verified  Check system pressure will be 1 pound per square inch gauge (psig) per 28" of system height	Keep system operating within pressure parameters
5.3104.3e Purge system	Devices that are under performing or have need of purging will be purged as needed	Remove air from the system to maximize performance
5.3104.3f Automatic fill	Automatic fill valve will be inspected to ensure it maintains system pressure  If pressure is not maintained, replacement will be made in accordance with the following criteria: Valve will be replaced and include backflow prevention; existing backflow protection shall be tested to verify operation Components will be installed in accordance with manufacturer specifications  Correct system pressure will be verified	Maintain optimal system pressure to maximize performance
5.3104.3g Gauge glass	Gauge glass will be inspected for erosion, cracks, or drying  Damaged gauge glass on boiler will be replaced in accordance with manufacturer specifications Gauge glass that is coated with dirt or sediment, making it difficult to observe the water level of the boiler, will be removed, cleaned, and replaced	Ensure gauge glass is in safe operating condition to allow observation of water level in boiler

5.3104.3h Low water cut-off: float type	<p>Operation of low-water cutoff on steam boilers will be observed by opening blow-off valve</p> <p>If combustion is not extinguished, remediation will be accomplished by the following procedure:</p> <p>Electricity will be disconnected from boiler</p> <p>Problem will be diagnosed</p> <p>Low-water cutoff will be repaired, serviced, or replaced in accordance with manufacturer specifications</p> <p>A blow-down valve will be added, if not already present</p> <p>Boiler will be retested for proper operation</p> <p>Operation of low-water cutoff on hot water boilers is applicable only if proper test setup is available on-site, to avoid draining the system</p> <p>Occupants will be educated on the correct method to drain the low water cutoff weekly (must drain once per week to remove sediment from float chamber of low-water cutoff)</p>	<p>Ensure safe minimum water level of the boiler</p> <p>Maintain safe operation of the low water cut-off on ongoing basis</p>
5.3104.3i Low water cut-off: immersion	An immersion low-water cutoff will be installed and operable	Ensure safe minimum water level of the boiler
5.3104.3j Expansion tank: non-bladder and bladder	<p>An expansion tank will be installed and operable</p> <p>Tanks that leak or have excessive corrosion will be replaced, and non-bladder tanks will include an expansion tank drain</p> <p>Tank will be installed in accordance with manufacturer specifications</p> <p>Expansion tanks will be properly supported with strapping</p> <p>Tanks that are full of water will be drained; after expansion tank is drained, re-</p> <p>Expansion tanks with bladders will have air charged to the manufacturer pressure specifications while water is not present in the tank</p> <p>Bladder tanks that have water inside of the air bladder will be replaced in accordance with manufacturer specifications</p>	Absorb water expansion of the system
5.3104.3k Flush or skim steam boiler	Manufacturer specifications for flushing or skimming steam boiler will be followed	Ensure boiler produces dry steam
5.3104.3l System temperature or pressure gauge	<p>The temperature or pressure gauge will be inspected for erosion, cracks, or dirt</p> <p>Damaged temperature or pressure gauges will be replaced in accordance with manufacturer specifications</p>	Allow for accurate observation of system temperature and pressure
5.3104.3m Circulators	<p>Non-working motors that cannot be serviced will be replaced with a new motor</p> <p>New motors will be installed in accordance with manufacturer specifications</p> <p>Oil-lubricated circulators will be installed in proper alignment with the pump coupler and will be supported so they do not sag</p> <p>Bearings will have free movement without binding</p> <p>Shaft seals will not leak</p> <p>Bearings in inoperable, water-lubricated circulators will be freed, if possible, before replacement with a new circulation pump</p>	Ensure circulation of water at designated velocity in system without leaks in the circulators
5.3104.3n Zone valves	<p>Zone valves will be inspected for the following conditions:</p> <p>Leaking water</p> <p>Not responding to a call for heat</p> <p>New equipment will be replaced in accordance with manufacturer specifications</p>	Ensure proper zonal control of the system for comfort and efficiency
5.3104.3o Condensate	<p>If boiler is 90% efficient or more, condensate discharge will be an acceptable pH level, in accordance with local code, and will be drained to the exterior of the house, away from the foundation</p> <p>Condensate pumps will be installed, if needed, to ensure proper drainage</p>	Bring the condensate to an acceptable pH and discharge to appropriate location
5.3104.3p Temperature, pressure valves, and air vents	<p>Occupant will be informed that air vents have potential to cause moisture problems if not operating properly</p> <p>Occupant will be reminded to call for maintenance if vents discharge steam or have moisture issues</p>	Maintain efficient operation of the system
5.3104.3q Maintenance records	<p>Keeping records of all maintenance will be recommended to occupants</p> <p>Copies or access to installation and operation manuals will be provided</p>	Provide a history of system installation and maintenance to improve future maintenance or repair
5.3104.3r Occupant health and safety	All homes will have a carbon monoxide (CO) alarm	Ensure occupant health and safety
5.3104.3s Occupant education	<p>Completed work will be reviewed</p> <p>Occupants will be educated on the safe and efficient operation and maintenance of the system</p>	Ensure occupant is informed of the safe, efficient operation and maintenance of the system

## Ventilation

### Exhaust

#### 6.6002.1

Topic

Subtopic

Desired Outcome

### Ducts

Exhaust

Components

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

Single-Family Homes

#### Title

6.6002.1a Duct design and configuration

#### Specification(s)

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

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

#### Objective(s)

Effectively move the required volume of air

6.6002.1b Duct insulation

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

Prevent condensation from forming or collecting inside of the ductwork

6.6002.1c Duct support	Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 1/2" wide material Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction Metal ducts will be supported by 1/2" or wider 18-gauge strapping or 12 gauge or thicker galvanized wire no less than 10' apart	Effectively move the required volume of air Preserve the integrity of the duct system Eliminate falling and sagging
6.6002.1d Duct connections	Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Effectively move the required volume of air Preserve the integrity of the duct system
6.6002.1e Duct materials	Flexible materials will be UL 181 listed or Air Diffusion Council approved  Rigid, kitchen fans gauges shall meet code requirements or authority having jurisdiction	Effectively move the required volume of air Preserve the integrity of the duct system
<b>6.6002.2</b> Topic Subtopic Desired Outcome	<b>Terminations</b> Exhaust Components Securely installed termination fittings with unrestricted air flow	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6002.2a Hole in building shell	A hole no greater than a 1/4" greater than the fitting will be cut to accommodate termination fitting	Allow for ease of weatherproofing
6.6002.2b Termination fitting	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	Effectively move the required volume of air to the outside Preserve integrity of the building envelope Ensure durable installation
6.6002.2c Duct to termination connection	Duct will be connected and sealed to termination fitting as follows:  Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material Fasteners will not inhibit damper operation	Effectively move the required volume of air to the outside Preserve integrity of the building envelope Ensure durable installation
6.6002.2d Weatherproof installation	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	Preserve integrity of the building envelope Ensure a weather tight and durable termination installation Ensure unrestricted air flow
6.6002.2e Pest exclusion	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	Prevent pest entry Ensure proper air flow
6.6002.2f Termination location	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	Prevent exhaust from reentering house
6.6002.2g Kitchen exhaust	Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust	Prevent a fire hazard
<b>6.6002.3</b> Topic Subtopic Desired Outcome	<b>Exhaust-Only Ventilation—Fan Intake Grille Location</b> Exhaust Components Exhaust grille location optimizes either primary or local ventilation	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6002.3a Primary whole house ventilation	Fan intake grille will be installed in a central location within the main body of the house Ensure it is accessible for filter change and cleaning	Provide whole house air exchange
6.6002.3b Local ventilation	Fan intake grille will be installed in the space where odor, moisture vapor, or other contaminants are generated	Remove contaminated air at the source

<b>6.6003.1</b>	<b>Surface-Mounted Ducted</b>	
Topic	Exhaust	
Subtopic	Fans	
Desired Outcome	Surface-mounted ducted fans installed to specification	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6003.1a Hole through interior surface	A hole no greater than a 1/4" greater than the assembly will be cut to accommodate fan assembly	Minimize repair work
6.6003.1b Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and state electrical and mechanical codes	Ensure a secure installation Prevent an electrical hazard
6.6003.1c Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications	Ensure short duct run to achieve optimum air flow Ensure a secure installation  Ensure fan housing does not shake, rattle, or hum when operating
6.6003.1d Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off
6.6003.1e Duct to fan connection	Duct-to-fan outlet will be connected and sealed as follows: Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened according to manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Exhaust to outside
6.6003.1f Fan housing seal	Gaps and holes in fan housing will be sealed with caulk or other sealants in accordance with manufacturer recommendations Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage through fan housing  Ensure a permanent seal Prevent a fire hazard
6.6003.1g Fan to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage between house and fan
6.6003.1h Air flow	Air flows in cubic feet per minute (CFM) will be measured and adjusted to meet the whole house upgrade design requirements	Exhaust sufficient air from desired locations to outside
6.6003.1i Preventing air leakage caused by exhaust fans	Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety
6.6003.1j Combustion safety	Pressure effects will be assessed and corrected on all combustion appliances	Ensure safe operation of combustion appliances
<b>6.6003.2</b>	<b>Inline</b>	
Topic	Exhaust	
Subtopic	Fans	
Desired Outcome	Inline fans installed to specification	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6003.2a Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6003.2b Access	Fan and service switch will be accessible for maintenance according to The ND State Electrical Code	Fan and service switch will be accessible for maintenance
6.6003.2c Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications  Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by installing ducting from intake grille	Ensure short duct run to achieve optimum air flow Ensure fan is installed securely  Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise
6.6003.2d Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off
6.6003.2e Duct connections	Ducts will be connected and sealed to the intake fan and termination fitting as follows: Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Exhaust from desired location to outside  Preserve integrity of the duct system and building envelope

6.6003.2f Boot to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around intake housing Prevent a fire hazard
6.6003.2g Air flow	Air flows in CFM will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside
6.6003.2h Preventing air leakage caused by exhaust fans	Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety
6.6003.2i Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief	Ensure safe operation of combustion appliances
<b>6.6003.3</b> Topic Subtopic Desired Outcome Note	<b>Through the Wall</b> Exhaust Fans Through the wall fans installed to specification The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6003.3a Hole in building shell	A hole no greater than a 1/4 inch greater than the assembly will be cut to accommodate fan assembly	Allow for ease of weatherproofing
6.6003.3b Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and state electrical and mechanical codes	Prevent an electrical hazard
6.6003.3c Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely according to manufacturer specifications	Install mounting fan securely Ensure fan housing does not shake, rattle, or hum when operating
6.6003.3d Weatherproof installation	Exterior termination fitting will be flashed or weather sealed Water will be directed away from penetration Termination fitting installation will not inhibit damper operation Manufacturer specifications will be followed	Preserve integrity of the building envelope Ensure a weather tight and durable installation Ensure unrestricted air flow
6.6003.3e Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off
6.6003.3f Fan housing seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage through fan housing Ensure a permanent seal to the building air barrier
6.6003.3g Fan to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around intake housing Prevent a fire hazard
6.6003.3h Insulation	All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local code Exception: If system operates continuously, fan housing need not be insulated	Preserve integrity of the duct system
6.6003.3i Air flow	Air flows in CFM will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside
6.6003.3j Preventing air leakage caused by exhaust fans	Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety
6.6003.3k Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.	Ensure safe operation of combustion appliances
6.6003.4 Topic Subtopic Desired Outcome Note	Multi-Port System Exhaust Fans Multi-port fans installed to specification The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6003.4a Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6003.4b Access	Fan and access switch shall be accessible for maintenance according to The ND State Electrical Code	Achieve designed exhaust flow from desired locations to the outside
6.6003.4c Fan mounting	Fan outlet will be oriented toward the final termination location  Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications  Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by ducting from intake grilles	Ensure short duct runs to achieve optimum air flows  Ensure mounting is installed securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise
6.6003.4d Backdraft dampers (required in intermittent systems)	A backdraft damper will be installed between the fan and the exterior unless the system operates continuously A backdraft damper will be installed in any duct serving any room with a separate exhaust (e.g., dryer)	Prevent reverse air flow when the system is off Prevent spread of contaminants between rooms

6.6003.4e	Combining intake ducts	All individual exhaust intake ducts will be combined on the upstream side of fan (e.g., Y-fitting, T-fitting, collector box) with the exception of dryer, kitchen, and garage	Exhaust air from desired locations to outside
6.6003.4f	Duct connections	Ducts will be connected and sealed to applicable intakes, collector box, fan, and termination fitting Ducts will be connected and sealed as follows:  Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance to manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Exhaust air from desired locations to outside  Preserve integrity of the duct system and building envelope
6.6003.4g	Insulation	All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local code Exception: If system operates continuously, fan housing need not be insulated	Preserve integrity of the duct system
6.6003.4h	Boot to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around boot Ensure a permanent seal to the building air barrier Prevent a fire hazard
6.6003.4i	Air flow	Air flows in CFM will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside
6.6003.4j	Preventing air leakage caused by exhaust fans	Air leakage into the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety
6.6003.4k	Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances
<b>6.6003.5</b>	<b>Garage Exhaust Fan</b>		
Topic	Exhaust		
Subtopic	Fans		
Desired Outcome	Contaminants properly removed from house		
Single-Family Homes			
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>	
6.6003.5a	Ventilation for garage will be exhaust only and provide a minimum installed capacity of 100 CFM of ventilation per vehicle bay and will vent directly outdoors Garage exhaust fan will be wired for continuous operation or installed with automatic controls that activate the fan whenever the garage is occupied and for at least 15 minutes after the garage has been vacated	Remove contaminants from garage  Reduce contaminant migration from garage to house	
	If a ducted fan (not through-the-wall) is used, measure and verify the minimum air flow and adjust as necessary	Ensure occupant health and safety	
6.6003.5b	Air leakage between the house and garages will be prevented by sealing and weather stripping	Ensure occupant health and safety  Reduce conditioned air being drawn from the house  Reduce contaminant migration from garage to house	
6.6003.5c	Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief	Ensure safe operation of combustion appliances  Ensure occupant health and safety
<b>6.6005.1</b>	<b>Clothes Dryer</b>		
Topic	Exhaust		
Subtopic	Appliance Exhaust Vents		
Desired Outcome	Dryer air exhausted efficiently and safely		
Single-Family Homes			
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>	
6.6005.1a	Clothes dryer ducting	Preserve integrity of building envelope  Effectively move air from clothes dryer to outside	
	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		

6.6005.1b Termination fitting	Termination fitting manufactured for use with dryers will be installed  A backdraft damper will be included, as described in termination fitting detail	Preserve integrity of building envelope  Effectively move air from clothes dryer to outside
6.6005.1c Make-up air	Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction	Preserve integrity of building envelope  Effectively move air from clothes dryer to outside
6.6005.1d Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances  Ensure occupant health and safety
6.6005.1e Occupant education	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)	Effectively move air from clothes dryer to outside
<b>6.6005.2</b> Topic Subtopic Desired Outcome Note	<b>Kitchen Range</b> Exhaust Appliance Exhaust Vents Kitchen range fan installed to specification The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6005.2a Wiring	Wiring will be installed in accordance with local regulations or the ND State Electrical Code in the absence of such regulations or where those regulations are not as stringent as the ND State Electrical Code Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6005.2b Fan venting	Kitchen range fans will be vented to the outdoors	Remove cooking contaminants from the house
6.6005.2c Fan ducting	Recirculating fans will not be used as a ventilating device Kitchen range fans will be ducted to the outdoors As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications Ducting will be connected and sealed as follows: Metal-to-metal will be fastened with a minimum of three equally spaced screws Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes For down-draft exhaust systems, PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Preserve integrity of building envelope Preserve integrity of building envelope Effectively move air from range to outside
6.6005.2d Termination fitting	Termination fitting will be installed including a backdraft damper, as described in termination fitting detail	Ensure safe operation of combustion appliances  Ensure occupant health and safety
6.6005.2e Make-up air	Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction	Ensure safe operation of combustion appliances  Ensure occupant health and safety
6.6005.2f Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances
6.6005.2g Occupant education	Occupant will be instructed to keep grease filters and termination fitting clean	Ensure occupant health and safety Effectively move air from kitchen range to outdoors
<b>Supply</b> <b>6.6102.1</b> Topic Subtopic	<b>Outside Air Ventilation Supply Ducts</b> Supply Components	
Desired Outcome	Ventilation supply ducts effectively move the required amount of air and prevent condensation	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6102.1a Duct design and configuration	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	Effectively move the required volume of air
6.6102.1b Duct insulation	Ventilation supply ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Prevent moisture condensation
6.6102.1c Duct insulation	Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 1/2" wide material Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction Metal ducts will be supported by 1/2" or wider 18-gauge strapping or 12 gauge or thicker galvanized wire no less than 10' apart	Effectively move the required volume of air  Preserve integrity of the ventilation supply duct system  Eliminate falling and sagging

6.6102.1d Duct connections	<p>All connections will have a contact overlap of at least 1" Ducts will be connected and sealed as follows:</p> <p>Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool Flexible duct between the cable tie and end of metal or PVC duct will be screwed PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications Outdoor air ventilation supply ducts attached to the return side of forced air systems will be: Attached as close to the heating, ventilation, and air conditioning (HVAC) systems fan as possible while remaining in compliance with manufacturer specifications Set up to provide filtration of outdoor ventilation air before reaching the HVAC system (for minimum MERV 6 filter)</p> <p>All joints and connections in ductwork will be fastened and sealed with UL181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus-embedded-fabric systems</p>	Effectively move the required volume of air Preserve integrity of the ventilation supply duct system and building envelope
6.6102.1e Duct materials	Flexible air duct material will meet UL 181, NFPA 90A/90B, International Mechanical Code, or the Uniform Mechanical Code	Effectively move the required volume of air Preserve integrity of the duct system and building envelope
6.6102.1f Outdoor air intake location	<p>Outdoor air intake will be installed in accordance with the following: A minimum of 6" from grade A minimum of 10' from contaminant sources or exhaust outlets Above local snow or flood line A minimum of 18" above an asphalt based roof Never on a flat roof As required by authority having jurisdiction</p>	Prevent contaminants from entering house Ensure unrestricted air flow
<b>6.6102.2</b> Topic Subtopic Desired Outcome	<b>Intakes</b> Supply Components Intake optimizes air flow while limiting the entry of insects, debris, and contaminants	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6102.2a Hole in building shell	A hole no greater than a 1/4" greater than the fitting will be cut to accommodate intake fitting	Ensure a weather tight installation
6.6102.2b Intake fitting	<p>Collar will be at least the same diameter as the duct; if collar is larger than duct, a rigid metal transition will be used Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable</p>	Effectively draw the required volume of air from the outdoors Preserve integrity of the building envelope Ensure durable installation
6.6102.2c Occupant education	<p>Intake fitting will be labeled "ventilation air intake" Occupant will be instructed to keep yard debris and other contaminants clear of the intake</p>	Ensure unrestricted air flow
6.6102.2d Damper (if applicable)	<p>The damper will be installed to open in the direction of the desired flow Damper will close when system is off</p>	Ensure unrestricted air flow
6.6102.2e Connection to intake fitting	<p>Duct to intake fitting will be connected and sealed as follows: Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool Flexible duct between tie band and end of metal or PVC duct will be screwed into place PVC-to-PVC materials will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material Ensure fasteners do not inhibit intake damper operation</p>	Preserve integrity of the building envelope Ensure a weather tight and durable intake installation Ensure unrestricted air flow
6.6102.2f Weatherproofing	<p>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</p>	Preserve integrity of the building envelope Ensure a weather tight and durable intake installation Ensure unrestricted air flow
6.6102.2g Pest exclusion	<p>Corrosion resistant screen, louver, or grille material no less than 1/4" and no greater than 1/2" hole size in any direction will be used, or as specified by authority having jurisdiction Screen will be installed so it does not inhibit intake damper operation</p>	Prevent pest entry Ensure unrestricted air flow

6.6102.2h Intake location	Intake will be installed according to the following: A minimum of 6" from grade A minimum of 10' from contaminant sources or exhaust outlets Above local snow or flood line A minimum of 18" above an asphalt based roof Never on a flat roof As required by authority having jurisdiction	Prevent contaminants from entering house Ensure unrestricted air flow
<b>6.6102.3</b>	<b>Intake for Ventilation Air to Forced Air System Used for Heating or Cooling</b>	
Topic	Supply	
Subtopic	Components	
Desired Outcome	Intake reduces pollutant entry, is easily maintained, has proper flow, and enhances house durability	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6102.3a Forced air system requirements	Existing forced air system leakage to outside will be less than 10% of the air handler flow when measured at 25 pascals with reference to outside  Any portion of the return located inside the combustion appliance zone will be air sealed	Reduce migration of pollutants
6.6102.3b Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications and local and state electrical and mechanical codes	Prevent an electrical hazard
6.6102.3c Access	Motorized damper and service switch will be accessible for maintenance in accordance with required code or authority having jurisdiction	Ensure accessibility for maintenance
6.6102.3d Mounting intake duct	Ventilation duct will be attached as close to the HVAC system's fan as possible while remaining in compliance with HVAC manufacturer specifications  Filtration of ventilation air will be provided before passing through the thermal conditioning components Duct will be connected to intake fitting Connection and seal will be performed according to supply duct detail	Ensure short duct run to achieve optimum air flow  Preserve integrity of the duct system and building envelope
6.6102.3e Motorized damper	A motorized damper or equivalent technology will be installed between the intake fitting and the return side of the air handler Air flow will be provided by sequenced operation of the damper or equivalent technology	Prevent air flow when none is desired
6.6102.3f Intake filter	An accessible filter will be installed Filter will be able to remove contaminants consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 62.2 Filter or air cleaning systems that intentionally produce ozone will not be allowed	Ensure occupant health and safety Preserve integrity of the building envelope
6.6102.3g Occupant education	Occupant will be educated on how and when to change filter	Protect occupant health and safety Preserve integrity of the building envelope
<b>6.6103.1</b>	<b>Inline or Multi-Port</b>	
Topic	Supply	
Subtopic	Fans	
Desired Outcome	Inline or multi-port fan installed in accordance with specifications	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6103.1a Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6103.1b Access	Fan and service switch will be accessible for maintenance, service, and replacement in accordance with applicable code or authority having jurisdiction	Ensure accessibility for maintenance
6.6103.1c Fan mounting	Fan will be oriented with inlet toward the fan intake fitting Fan will be oriented so the equivalent length of the duct run is as short as possible  Fan will be securely mounted in accordance with manufacturer specifications  Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by ducting from supply register or grilles	Ensure short duct run to achieve optimum air flow Ensure fan is mounted securely  Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise
6.6103.1d Damper (required for intermittent operation)	Damper will be installed to open in the direction of the desired flow  Damper will close when system is off	Ensure unrestricted air flow
6.6103.1e Duct connections	Ducts will be connected and sealed to the intake fitting, fan, and register or grilles as follows: Metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool	Provide desired air flow  Preserve integrity of the duct system and building envelope

	<p>Flexible duct between the cable tie and end of metal or PVC duct will be screwed</p> <p>PVC-to-PVC materials will be fastened with approved PVC cement</p> <p>Other specialized duct fittings will be fastened in accordance with manufacturer specifications</p> <p>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</p>	
6.6103.1f Filter	<p>An accessible filter will be installed between the intake fitting and the fan</p> <p>Contaminant removal will be consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 62.2</p> <p>Filter or air cleaning systems that intentionally produce ozone will not be allowed</p>	<p>Ensure occupant health and safety</p> <p>Preserve integrity of the building envelope</p>
6.6103.1g Occupant education	Occupant will be educated on how and when to change filter	Ensure occupant health and safety
6.6103.1h Boot to interior surface seal	<p>All gaps between boot and interior surface will be air sealed</p> <p>Gypsum edge will be wetted before applying water-based sealant</p> <p>Sealants will be continuous and be in accordance with ND State Building Code</p>	<p>Prevent air leakage around intake housing</p> <p>Ensure a permanent seal to the building air barrier</p> <p>Prevent a fire hazard</p>
<b>6.6188.1</b>	<b>Removing Supply Vents from Garages</b>	
Topic	Supply	
Subtopic	Special Considerations	
Desired Outcome	Safe removal of supply garage vents	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6188.1a Removal of supply/return in garage	<p>Supply run feeding the register will be truncated as near to the supply plenum as possible</p> <p>If directly connected to the plenum, it will be truncated at the plenum</p> <p>If connected to a Y or T branch system, it will be truncated at the Y or T</p> <p>Return grille located in garage will be removed in the same manner as supply</p>	Minimize surface area of duct
6.6188.1b Patching of the hole in the duct system created by removal	<p>All holes in sheet metal ducts will be patched with sheet metal and secured with sufficient screws to hold the patch flat without gaps</p> <p>Holes left in any Y or T will be capped with sheet metal caps and fastened with at least three screws</p>	Ensure a secure and strong patch
6.6188.1c Sealing of the patch	All patches will be sealed with mastic meeting UL 181M and in accordance with manufacturer specifications	Ensure an airtight patch
6.6188.1d Removal of discarded ducts	All abandoned ductwork will be removed from work area	Provide a clean work site
6.6188.1e Patching of the register hole in garage	Hole created by the removal of the register and boot will be patched and taped using material meeting local codes	Prevent a fire hazard
6.6188.1f External static pressure testing	<p>Units will be tested for external static pressure (ESP) before and after work</p> <p>If there is a significant rise in ESP, air flow testing will be required</p>	Ensure correct fan performance
<b>Whole Building Ventilation</b>		
<b>6.6201.1</b>	<b>Installed System Air Flow</b>	
Topic	Whole Building and Local Ventilation	
Subtopic	Air Flow Requirements	
Desired Outcome	Installed system air flow meets required standard	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6201.1a Separate exhaust for all baths and kitchens plus primary ventilation	Air flows will be measured and adjusted to meet the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction. See informative Appendix A for calculation information and examples.	Provide sufficient flows in accordance with current ventilation standards
6.6201.1b Separate exhaust for all baths and kitchens sufficient to meet primary ventilation requirements	Air flows will be measured and adjusted to meet the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction. See informative Appendix A for calculation information and examples.	Provide sufficient flows per current ventilation standards
6.6201.1c Single additional fan to meet all ventilation requirements	Air flows will be measured and adjusted to meet the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction. See informative Appendix A for calculation information and examples.	Provide sufficient flows in accordance with current ventilation standards
<b>6.6201.2</b>	<b>Primary Ventilation Air Flow between Rooms</b>	
Topic	Whole Building Ventilation	
Subtopic	Air Flow Requirements	
Desired Outcome	Air circulates freely between rooms	
Single-Family Homes		
<b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
6.6201.2a Balancing pressure	<p>An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)</p> <p>No room will exceed +/- 3 pascals with reference to the outdoors with all interior doors closed and ventilation systems running</p>	<p>Ensure free flow of air between rooms</p> <p>Preserve integrity of the building envelope</p>
<b>6.6202.1</b>	<b>Controls</b>	
Topic	Whole Building Ventilation	
Subtopic	Components	
Desired Outcome	Fan controls support ventilation strategy	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	

Single-Family Homes

<u>Title</u>	<u>Specification(s)</u>	<u>Objective(s)</u>
6.6202.1a Primary ventilation fan (whole-house volume)	<p>Controls will be used that can meet the following conditions:</p> <p>Run fan continuously or intermittently depending upon the intended schedule of operation</p> <p>Operate fan to produce the intended flow for each intended flow setting</p>	<p>Deliver intended air exchange</p> <p>Ensure fan controls meet intended ventilation strategy</p>
6.6202.1b Local exhaust—local fan	<p>Controls will be used that meet the following conditions:</p> <p>Run fan continuously or intermittently depending on the intended schedule of operation</p> <p>Run fan for intended time for timed operation</p> <p>Operate fan to produce the intended flow for each intended flow setting</p>	<p>Deliver intended air exchange</p> <p>Ensure fan controls meet intended ventilation strategy</p>
6.6202.1c Wiring	<p>Wiring will be installed in accordance with original equipment manufacturer specifications, and local and state electrical and mechanical codes</p>	<p>Prevent an electrical hazard</p> <p>Ensure fan controls meet intended ventilation strategy</p>
6.6202.1d Manual override	<p>A labeled switch for manual override will be included for the ventilation system</p>	<p>Ensure fan controls meet intended ventilation strategy</p>
6.6202.1e Occupant education	<p>A system operation guide designed for occupants (non-professionals) will be provided to explain how and why to operate system</p> <p>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</p>	<p>Educate occupants about system operation and importance</p> <p>Deliver intended air exchange</p>
<b>6.6202.2</b>	<p><b>Heat Recovery Ventilator (HRV) and Energy Recovery Ventilator (ERV) Installation</b></p> <p>Whole Building Ventilation</p> <p>Components</p> <p>HRV and ERV systems installed to specifications</p> <p>The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.</p>	
Topic		
Subtopic		
Desired Outcome		
Note		
Single-Family Homes		
<u>Title</u>	<u>Specification(s)</u>	<u>Objective(s)</u>
6.6202.2a Wiring	<p>Wiring will be installed in accordance with original equipment manufacturer specifications, and local and state electrical and mechanical codes</p>	<p>Prevent an electrical hazard</p>
6.6202.2b Access	<p>Fans, service switch, filters, drain, and drain pan will be accessible for maintenance in accordance with authority having jurisdiction</p>	<p>Maintain designed air flows and system performance</p>
6.6202.2c Fan mounting	<p>Fan will be securely mounted in accordance with manufacturer specifications</p> <p>Fan will be oriented so the equivalent length of the duct run is as short as possible; calculate "equivalent length" in accordance with ANSI/ACCA Manual D – 2009 (Residential Duct Systems)</p> <p>Fan will be isolated from the building framing unless specifically designed to be directly attached</p>	<p>Ensure occupant health and safety</p> <p>Ensure short duct runs achieve optimum air flows</p> <p>Ensure fan is mounted securely</p> <p>Ensure fan housing or building framing does not shake, rattle, or hum when operating</p> <p>Minimize noise</p>
6.6202.2d Backdraft dampers (required for intermittent operation)	<p>A backdraft damper will be installed between the heat recovery ventilator (HRV) or energy recovery ventilator (ERV) and the exterior, unless the system operates continuously</p> <p>Outdoor air intakes and exhausts will be equipped with automatic or gravity dampers that close when the ventilation system is not operating</p>	<p>Prevent reverse air flow when the system is off</p>
6.6202.2e Installation of fittings	<p>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</p> <p>Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable</p>	<p>Achieve the desired air flows to and from the designated locations</p> <p>Ensure unrestricted air flow</p> <p>Preserve integrity of the building envelope</p>
6.6202.2f Duct connections	<p>Ducts will be connected to applicable registers or grilles, collector box, HRV or ERV, intake fitting, and termination fitting</p> <p>Ducts will be connected and sealed as follows:</p> <p>Metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws</p> <p>Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool</p> <p>Flexible duct between tie band and end of metal or PVC duct will be screwed into place</p> <p>PVC-to-PVC materials will be fastened with approved PVC cement</p> <p>Other specialized duct fittings will be fastened in accordance with manufacturer specifications</p> <p>In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material</p>	<p>Achieve the desired air flows to and from the desired locations</p> <p>Preserve integrity of the duct system and building envelope</p>
6.6202.2g Duct layout	<p>Air to be exhausted to the outdoors will not be taken directly from the forced air system</p> <p>Supply ducts attached to the return side of forced air systems will be:</p> <p>Attached as close to the HVAC system's fan as possible while remaining in compliance with manufacturer specifications</p> <p>Set up to provide filtration of outdoor ventilation air before reaching the HVAC system with minimum MERV 6 filter</p> <p>Connected to the intake fitting</p> <p>Connected and sealed in accordance with the supply duct detail</p>	<p>Achieve the desired air flows to and from the desired locations</p> <p>Preserve integrity of duct system and house</p> <p>Ensure occupant health and safety</p>

6.6202.2h Insulation	Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes	Preserve integrity of the duct system by eliminating condensation
6.6202.2i Sealant selection	Gap between registers or grilles and interior surface will be sealed Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around registers or grilles Ensure a permanent seal Prevent a fire hazard
6.6202.2j Balance and flow	Air flows will be measured and adjusted to match to the system's intent	Achieve the desired air flows to and from the desired locations
6.6202.2k Occupant education	Occupant will be educated on how and when to change filter and clean drain pan, if applicable, according to manufacturer specifications	Ensure occupant health and safety  Preserve integrity of system
<b>6.6288.1</b> Topic Subtopic Desired Outcome	<b>Sound-Rating Limits</b> Whole Building Ventilation Special Considerations Systems operate as quietly as possible	
Single-Family Homes <b>Title</b> 6.6288.1a Primary ventilation system or any continuously operating fan	<b>Specification(s)</b> System shall be rated for sound in accordance with current ASHRAE 62.2 Standard	<b>Objective(s)</b> Minimize noise
6.6288.1b Intermittent local ventilation system	Local ventilation will be rated for sound at a maximum of 3 sone, unless their maximum rated airflow exceeds 400 cfm, in accordance with current ASHRAE 62.2 Standard	Minimize noise
<b>Additional Resources</b> <b>6.9901.1</b> Topic Subtopic Desired Outcome Note	<b>Supplemental Ventilation Information—ASHRAE 62.2</b> Additional Resources Codes and Standards Resources To provide supplemental ventilation information—ASHRAE 62.2 Adjustments to primary ventilation fan flow rate, including infiltration credit and ASHRAE Standard 62.2-2013, Appendix A (calculation for alternative compliance for existing houses using a single fan).	
Single-Family Homes <b>Title</b> 6.9901.1a Ventilation fan flow rate	<b>Specification(s)</b> Adjustments to primary ventilation fan flow rate, including infiltration credit and ASHRAE Standard 62.2-2013, Appendix A. For alternative compliance for existing houses using a single fan, please see Appendix A (calculation for alternative compliance for existing houses using a single fan).	<b>Objective(s)</b> To provide supplemental ventilation information—ASHRAE 62.2
<b>Baseload</b> <b>Plug Load</b> <b>7.8001.1</b> Topic Subtopic Desired Outcome	<b>Refrigerator and Freezer Replacement</b> Plug Load Refrigerators/Freezers Energy efficient appliance installed	
Single-Family Homes <b>Title</b> 7.8001.1a Selection	<b>Specification(s)</b> Appliance shall be ENERGY STAR® rated Appliance will fit in the available space without blocking access to light switches, cabinets, etc. Appliance will carry a minimum one-year warranty that will provide a replacement appliance if repeated issues relating to health, safety, or performance occur	<b>Objective(s)</b> Ensure occupant satisfaction with appliance
7.8001.1b Installation	Appliance will be installed in accordance with manufacturer specifications and local codes Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Energy-related appliance controls will be demonstrated to the occupant  Specific information on the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant	Achieve intended appliance function  Preserve food at low energy use  Educate occupant on how to operate and maintain the appliance
7.8001.1c Decommissioning	Appliances replaced by new units will be recycled or disposed of in accordance with federal, state, or local regulations Appliances infested with pests will be enclosed before moving	Prevent reuse of inefficient equipment and components  Protect the environment
<b>7.8003.1</b> Topic Subtopic Desired Outcome	<b>Lighting Upgrade</b> Plug Load Lighting Energy used for lighting reduced while maintaining adequate and safe lighting levels	

Single-Family Homes

**Title**

7.8003.1b Selection

**Specification(s)**

All bulbs, fixtures, and controls will be appropriate for the intended application (e.g., enclosed, orientation, dimmable, potential for breakage, indoor, and outdoor)

All bulbs, fixtures, and controls will be selected to provide the brightness and light quality required in that application (e.g., task lighting, trip-and-fall hazards, nightlights)

Selected equipment should have the highest level of efficiency within a technology [e.g., compact fluorescent lamp (CFL), LED]

All bulbs, fixtures, and controls will be ENERGY STAR® rated where applicable

When possible, bulbs, fixtures, and controls will be selected that will facilitate the use of future lighting technologies (e.g., LEDs)

Light/lamp wattage should not exceed rated wattage of fixture

Bulb replacements will be chosen based on expected durability, light quality, and lifetime energy use of the bulb

All bulbs, fixtures, and controls will be UL-approved and installed in accordance with local code(s) and NFPA 70 National Electric Code

**Objective(s)**

Provide improved lighting quality at lower energy use

Select equipment that will not be an unnecessary barrier to future technologies

Avoid inferior products and unsatisfied occupants

**7.8102.1**

Topic

Subtopic

Desired Outcome

**Water Heater Selection**

Water Heating

Installation and Replacement

Safe, reliable, and efficient hot water source selected that meets occupant needs at lowest possible cost of ownership and operation

Single-Family Homes

**Title**

7.8102.1a Selection parameters

**Specification(s)**

Equipment will provide sufficient, affordable, safe, and healthy hot water for the occupant in accordance with ND State Building Code

Potential for solar hot water heating or other renewable energy systems will be assessed in selecting the hot water equipment

Potential for health and safety hazards (e.g., backdrafting, flame rollout, obstructions) will be assessed in selecting equipment and the cost of remedying such problems will be included in any cost and benefit calculations

If combustion equipment is selected, a low nitrogen oxide burner will be included

Equipment will be functional at high efficiency under all load conditions

Standby losses will be reduced to maximum potential

Fuel type will be selected based on affordability to occupant

Equipment will be freeze resistant or installed in a conditioned space

Efficiency of equipment will be maintained throughout life of system

Occupant control of hot water temperature will be provided on the equipment

The following will be determined from the occupant:

Lifestyle

Current and future needs

Space considerations

Fuel options

Health and safety considerations

Appliance options

Maintenance and operation costs

Return on investment concerns

**Objective(s)**

Save energy and water

Protect the environment

Identify appliance options based on the needs and wants of the occupant

7.8102.1b Product selection

Water heater will be selected based on performance requirements of the occupant, available fuel sources, energy efficiency, and total life cycle cost

In very cold climates, on-demand water heaters will be sized to meet the demand of water flow at very low water intake temperatures

When evaluating an existing thermal solar water heating system, a solar expert should be consulted

The proper installation and maintenance of solar hot water systems is provided in the Uniform Solar Energy Code (USEC) and 2012 IRC Chapter 23

Ensure equipment meets the occupant's expectations while providing efficient energy and water use

**7.8102.2**

Topic

Subtopic

Desired Outcome

**Storage-Type Appliance**

Water Heating

Installation and Replacement

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

Note

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

Single-Family Homes

**Title**

7.8102.2a Hazardous material removal

**Specification(s)**

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

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

**Objective(s)**

Remediate health hazards using EPA-certified contractors

7.8102.2b Equipment removal

Accepted industry procedures and practices will be followed to:

Remove old water heater and associated components in accordance with The ND State Building Code or authority having jurisdiction

Seal any unused chimney openings and penetrations in accordance with The ND State Building Code or authority having jurisdiction

Remove unused oil tank, lines, valves, and associated equipment in accordance with The ND State Building Code or authority having jurisdiction

Ensure the safety of the workers and occupants  
Preserve integrity of the building

Remove old equipment in a timely and efficient manner

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

7.8102.2c	New equipment installation	<p>New water heater and associated components will be installed to accepted industry standards, in accordance with the The ND State Building Code and manufacturer specifications</p> <p>The system will be installed to be freeze resistant</p> <p>Any existing water leaks will be repaired before installation begins</p> <p>Any penetrations to the exterior of the home created by the installation of the equipment will be sealed</p>	<p>Ensure the safety of the workers and occupants</p> <p>Preserve integrity of the building</p> <p>Remove old equipment in a timely and efficient manner</p>
7.8102.2d	Emergency drain pan	<p>An emergency drain pan will be installed with sides that extend a minimum of 4" above floor if leakage would cause damage to the home and in accordance with The ND State Building Code</p> <p>A ½" drainline or larger will be connected to tapping on pan and terminated in accordance with The ND State Building Code</p>	<p>Collect and safely dispose of water escaping from the storage tank</p>
7.8102.2e	Expansion tank	<p>A potable water expansion tank will be installed on the cold water side where required by the ND State Plumbing Code</p> <p>A direct connection with no valves between the storage tank and expansion tank will be installed in accordance with the ND State Plumbing Code, authority having jurisdiction, and according to manufacturer specifications</p>	<p>Protect the storage tank from expansion</p>
7.8102.2f	Temperature and pressure relief valve	<p>Correct temperature and pressure relief valve will be installed in compliance with The ND State Building Code and according to manufacturer specifications</p> <p>Temperature and pressure relief valve discharge tube will be installed in accordance with The ND State Building Code</p>	<p>Discharge excessive energy (pressure or temperature) from storage tank to safe location</p>
7.8102.2g	Dielectric unions	<p>Dielectric unions will be installed in accordance with the The ND State Building Code, authority having jurisdiction, and according to manufacturer specifications</p>	<p>Break the stray voltage electrical circuit through the storage tank</p>
7.8102.2h	Backflow prevention	<p>Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes</p>	<p>Protect water supply from contamination</p>
7.8102.2i	Thermal efficiency	<p>If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications</p> <p>If additional insulation is installed, it will be installed based on fuel type, making sure not to obstruct draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates</p> <p>The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications</p> <p>Pipe insulation must remain 3" from gas water heater vent</p> <p>Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer</p>	<p>Reduce standby loss from near tank piping and storage tank</p> <p>Ensure insulation does not make contact with flue gas venting</p>
7.8102.2j	Fuel supply	<p>Electric or fossil fuel supply components will be installed to accepted industry standards as per NFPA 31 and 54, or The ND State Electrical Code) for electric components, or authority having jurisdiction</p>	<p>Provide sufficient fuel to the water heater, burner, or element</p>
7.8102.2k	Discharge temperature	<p>Discharge temperature will be set not to exceed 120° or as prescribed by local code</p>	<p>Ensure safe hot water supply temperature to fixtures</p>
7.8102.2l	Commissioning of system	<p>The following will be checked once the system has been filled and purged:</p> <p>Safety controls</p> <p>Combustion safety and efficiency</p> <p>Operational controls</p> <p>Fuel and water leaks</p> <p>Local code requirements</p> <p>Commissioning will be in compliance with manufacturer specifications and relevant industry standards</p>	<p>Ensure safe system function</p> <p>Keep cost of ownership as low as possible</p>
7.8102.2m	Occupant safety	<p>Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction</p> <p>Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels</p> <p>Completed work will be reviewed</p>	<p>Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate</p>
7.8102.2n	Occupant education	<p>Occupants will be educated on the safe and efficient operation and maintenance of the system, including:</p> <p>Adjustment of water temperature and target temperature in accordance with local code</p> <p>Periodic drain and flush</p> <p>Expansion tank and backflow preventer (no occupant maintenance required)</p> <p>Periodic inspection, maintenance, or replacement</p>	<p>Ensure occupant is informed of the safe, efficient operation and maintenance of the system</p>
<b>7.8102.3</b>	<b>Topic</b>	<b>On-Demand Appliance</b>	
	<b>Subtopic</b>	Water Heating	
	<b>Desired Outcome</b>	Installation and Replacement	
		Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership	
<b>Note</b>		The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	

Single-Family Homes

**Title**

7.8102.3a Hazardous material removal

**Specification(s)**

Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified  
Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator  
Occupants will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)

**Objective(s)**

Remediate health hazards using EPA-certified contractors

7.8102.3b Equipment removal

Accepted industry procedures and practices will be followed to:  
Remove old water heater and associated components in accordance with The ND State Building Code  
Seal any unused chimney openings and penetrations in accordance with The ND State Building Code  
Remove unused oil tank, lines, valves, and associated equipment in accordance with The ND State Building Code  
All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards

Ensure the safety of the workers and occupants  
Preserve integrity of the building

Remove old equipment in a timely and efficient manner

7.8102.3c New equipment installation

A new water heater and associated components will be installed to accepted industry standards, in accordance with the The ND State Building Code, authority having jurisdiction and manufacturer specifications

Ensure the safety of the workers and occupants

Preserve integrity of the building  
Remove old equipment in a timely and efficient manner

7.8102.3d Emergency drain pan

An emergency drain pan will be installed with sides that extend a minimum of 4" 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 The ND State Building Code

Collect and safely dispose of water escaping from the storage tank

7.8102.3e Temperature and pressure relief valve

Correct temperature and pressure relief valve will be installed in compliance with The ND State Building Code and according to manufacturer specifications

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

Temperature and pressure relief valve discharge tube will be installed in accordance with The ND State Building Code

7.8102.3f Dielectric unions

Dielectric unions will be installed to accepted industry standards, in accordance with the The ND State Building Code and according to manufacturer specifications

Break the stray voltage electrical circuit through the storage tank

7.8102.3g Backflow prevention and pressure regulator

Backflow prevention will be installed in accordance with manufacturer specifications  
House water pressure and volume will be verified as sufficient to be in accordance with manufacturer specifications  
All applicable codes will be followed

Protect the water supply from contamination

Provide for sufficient volume and pressure

7.8102.3h Thermal efficiency

Any accessible hot water lines at the appliance will be insulated to meet The ND State Building Code or local requirements, whichever is greater.

Reduce line losses

7.8102.3i Required combustion air

Recommendations will be made to install all on-demand appliances as sealed combustion  
If not possible:  
Combustion and ventilation (excess air) requirements of gas-fired appliances, including provision of outside and inside air to account for building tightness, will be provided  
The minimum required volume shall be 50 cubic feet per 1,000 Btu/h in accordance with The ND State Building Code  
If needed, additional combustion air will be provided in accordance with The ND State Building Code

Ensure adequate combustion air for operation of the appliance

7.8102.3j Venting of flue gases

Combustion byproducts will be removed in accordance with The ND State Building Code, authority having jurisdiction, and manufacturer specifications

Ensure the safety and durability of the venting system

7.8102.3k Flue gas testing

Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T-2012  
If combustion is not in compliance with BPI-1100-T-2012, diagnostics and adjustments will be done to manufacturer specifications or local codes

Confirm that combustion is occurring safely with maximum efficiency

7.8102.3l Electric and fossil fuel supply

Electric or fossil fuel supply components will be installed to accepted industry standards as per The ND State Building Code, NFGC and NFPA 31 and 54 for gas and oil, or The ND State Electrical Code for electric

Provide sufficient fuel to the water heater burner or element

Energy input required by the appliance will be in accordance with manufacturer specifications  
All on-demand appliances will be installed per manufacturer recommendations/specifications.

7.8102.3m Cold water supply

The volume and pressure of the water supplied to the appliance will be in accordance with manufacturer specifications

Provide sufficient volume and pressure of water to the appliance

7.8102.3n Discharge temperature

Discharge temperature will be set in accordance with manufacturer instructions and in compliance with local codes  
Use extreme caution when temperature setting is above 120°F

Ensure safe hot water supply temperature to fixtures

7.8102.3o Commissioning of system	The following will be checked once the system has been connected and filled:  Safety controls Combustion safety and efficiency Operational controls Fuel and water leaks Cycle unit Local code requirements Manufacturer specifications and all relevant industry standards will be met in commissioning	Ensure system functions safely with lowest possible cost of ownership
7.8102.3p Ambient carbon monoxide (CO)	All homes will have a CO alarm	Ensure occupant health and safety
7.8102.3q Occupant education	Completed work will be reviewed  Occupants will be educated on the safe and efficient operation and maintenance of the system, including: Adjustment of water temperature and target temperature in accordance with local code Operation of backflow preventer and pressure regulator (no occupant maintenance required) Importance of keeping operating manuals accessible	Ensure occupant is informed of the safe, efficient operation and maintenance of the system
<b>7.8103.1</b> Topic Subtopic Desired Outcome Note	<b>Storage-Type Appliance</b> Water Heating Maintenance/Inspection Safe, reliable, and efficient operation of the appliance maintained The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
7.8103.1a Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice Electrical components will be verified to comply with The ND State Electrical Code (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)	Identify potential health and safety issues
7.8103.1b Visual inspection	Inspection will be conducted to show compliance with the ND State Building Code, including but not limited to: Water or fuel leaks Damaged wiring Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) Corrosion (e.g., rust, mineral deposits) General condition of components	Determine needed repairs or maintenance
7.8103.1e Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with The ND State Building Code and according to manufacturer specifications  Temperature and pressure relief valve discharge tube will be installed in accordance with The ND State Building Code	Discharge excessive energy (pressure or temperature) from storage tank to safe location
7.8103.1f Maintenance records	Occupants will be advised to keep records of all maintenance done to their system  Copies of or access to installation and operation manuals will be provided	Provide a history of system installation and maintenance to improve chance of successful future maintenance or repair
7.8103.1g Occupant safety	Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels	Ensure occupant life safety  Inform occupant regarding possible CO hazards
7.8103.1h Occupant education	Completed work will be reviewed  Occupants will be educated on the safe and efficient operation and maintenance of the system, including: Adjustment of water temperature and target temperature in accordance with local code Periodic drain and flush Periodic inspection, maintenance, or replacement of anode rod	Ensure occupant is informed of the safe, efficient operation and maintenance of the system
<b>7.8103.2</b> Topic Subtopic Desired Outcome Note	<b>On-Demand Appliance</b> Water Heating Maintenance/Inspection Safe, reliable, and efficient operation of the appliance maintained The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes <b>Title</b>	<b>Specification(s)</b>	<b>Objective(s)</b>
7.8103.2a Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice Electrical components will be verified to comply with The ND State Electrical Code (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)	Identify potential health and safety issues

7.8103.2b Visual inspection	<p>Inspection will be conducted to show compliance with the The ND State Building Code, including but not limited to:</p> <ul style="list-style-type: none"> <li>Water or fuel leaks</li> <li>Damaged or missing pipe insulation and tank insulation, where applicable</li> <li>Damaged wiring</li> <li>Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence)</li> <li>Corrosion (e.g., rust, mineral deposits)</li> <li>General condition of components</li> </ul>	Determine needed repairs or maintenance
7.8103.2c Temperature and pressure relief valve	<p>Correct temperature and pressure relief valve will be installed in compliance with The ND State Building Code and according to manufacturer specifications</p> <p>Temperature and pressure relief valve discharge tube will be installed in accordance with The ND State Building Code</p>	Discharge excessive energy (pressure or temperature) from storage tank to safe location
7.8103.2d Flue gas testing	<p>Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T-2012</p> <p>If combustion is not in compliance with BPI-1100-T-2012, diagnostics and adjustments will be done to manufacturer specifications or local codes</p>	Perform combustion testing
7.8103.2e Required combustion air	<p>If sealed combustion has not been installed:</p> <p>Combustion and ventilation (excess air) requirements of gas-fired appliances, including provision of outside and inside air to account for building tightness, will be provided</p> <p>The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with The ND State Building Code</p> <p>If needed, additional combustion air will be provided in accordance with The ND State Building Code</p>	Ensure adequate combustion air for operation of the appliance
7.8103.2f Venting of flue gases	<p>Condition of venting will be inspected in accordance with The ND State Building Code for gas water heaters or NFPA 31 for oil water heaters</p>	Verify proper venting of flue gases
7.8103.2g Fuel supply	<p>Condition of fuel supply components will be checked in accordance with NFPA 31 for oil, NFPA 54 for gas, NFPA 58 for propane, or NFPA 70 The ND State Electrical Code for electric, and authority having jurisdiction</p>	Verify sufficient fuel to the water heater burner and element
7.8103.2h Cold water supply	<p>Water supplied to the appliance will be of sufficient volume and pressure to be in accordance with manufacturer specifications</p>	Verify sufficient volume and pressure of water to the appliance
7.8103.2i Discharge temperature	<p>Discharge temperature will be set not to exceed 120°F or in accordance with local code, whichever is lower</p>	Ensure safe hot water supply temperature to fixtures
7.8103.2j Test the system safety and operation	<p>The following will be tested:</p> <ul style="list-style-type: none"> <li>Safety controls (e.g., water, air pressure switches)</li> <li>Combustion safety and efficiency</li> <li>Operational controls</li> <li>Fuel and water leaks</li> <li>Unit runs through complete cycle</li> <li>Local code requirements</li> <li>Manufacturer specifications and all relevant industry standards will be met</li> </ul>	Ensure system functions safely with lowest possible cost of ownership
7.8103.2k Maintenance records	<p>Occupants will be advised to keep records of all maintenance done to their system</p> <p>Copies of or access to installation and operation manuals will be provided</p>	Improve chance of successful future maintenance or repair
7.8103.2l Occupant health and safety	<p>All homes will have a carbon monoxide (CO) alarm</p>	Ensure occupant health and safety
7.8103.2m Occupant education	<p>Completed work will be reviewed</p> <p>Occupants will be educated on the safe and efficient operation and maintenance of the system, including:</p> <ul style="list-style-type: none"> <li>Adjustment of water temperature</li> <li>Target temperature in accordance with local code</li> </ul>	Ensure occupant is informed of the safe, efficient operation and maintenance of the system

## 2312 Required Subgrantee Deferral of Services Policy

There are some situations in which a subgrantee should not or may choose not to weatherize an otherwise eligible unit. In order to deal with these situations each subgrantee must develop an approved policy which, when implemented, allows weatherization staff to defer services because of conditions and/or circumstances that may be hazardous to their health or safety or that of the client's.

The following is a model deferral of services policy intended to list the more common conditions and situations a subgrantee may encounter while delivering weatherization services. This list is not intended to be all inclusive of those instances in which a subgrantee may choose not to weatherize a unit. In some instances, corrective measures by the client/owner may allow program services to proceed. At a minimum, the subgrantee deferral of services policy should contain the following:

1. *Procedure:* If a subgrantee cannot or chooses not to weatherize a dwelling unit it must notify the client and owner/authorized agent in writing and include the following items:

- a. The nature and extent of the problem(s) and how the problem(s) relate to the determination to not weatherize the unit;
- b. Any corrective action required before weatherization services can be initiated;
- c. A time limit for correcting problems so that weatherization services may be rescheduled;
- d. The right of appeal; and
- e. All correspondence justifying the decision to "defer services" must be kept in the client file.

2. *Withholding of Weatherization Services:* A subgrantee may withhold weatherization services under the following conditions:

- a. A dwelling unit is vacant.
- b. A dwelling unit is for sale.
- c. A dwelling unit is scheduled for demolition.
- d. A dwelling unit is found to have serious structural problems that would make weatherization impossible or impractical.
- e. A dwelling unit is deemed by the auditor or foreman to pose a threat to the health or safety of the crew or subcontractor.
- f. The Health and Safety assessment done at the time of the initial audit shows that meeting the requirements will be too costly or that the requirements cannot be met.
- g. A mobile home is improperly installed (for example, inadequate supports).
- h. A dwelling unit is uninhabitable (for example, such as a burned out apartment).
- i. When there are minor children in the dwelling but no adult client or adult agent of the client at the time of the estimate or at any other time subgrantee personnel must enter the dwelling.
  - i. An adult client or adult agent of the client need not be present if the estimator or crew foreman feel satisfied with a signed note from an adult client or adult agent of the client stating their permission to enter the dwelling occupied by the minor children.
- j. The client is uncooperative with the weatherization subgrantee, either in demanding that certain work be done and refusing higher priority work which is needed, or by being abusive to the work crew or subcontractor, or by being unreasonable in allowing access to the unit, every attempt should be made to

explain the program and the benefits of the work. If this fails, work should be suspended and the State Weatherization Office consulted.

k. Obvious discrepancies are found between the information supplied by the client on the application and observed conditions at the time of weatherization. The subgrantee must resolve these discrepancies before weatherization work can continue.

l. If , at any time prior to the beginning or work (materials installed in a unit), the subgrantee determines that the client is no longer eligible or subgrantee personnel believe that circumstances may have changed, the unit shall not be weatherized until updated information can be obtained from the client.

m. There are rats, bats, roaches, reptiles, insects, animals or other vermin that are inappropriately or not properly contained on the premises.

n. There are health and safety hazards that must be corrected before weatherization services may begin including, but not limited to:

- i. The presence of animal feces and/or other excrement,
- ii. Disconnected waste water pipes,
- iii. Hazardous electrical wiring, or
- iv. Unvented combustion appliances.

o. There are illegal drugs or illegal activities occurring on the premises.

p. The client or owner is physically or verbally abusive to subgrantee personnel.

q. The dwelling unit or parts thereof are being remodeled and weatherization work is not coordinated with a housing rehabilitation program.

r. The eligible household moves from the dwelling unit where weatherization activities and services are in progress. In such a case, the subgrantee must determine whether to complete the work and the circumstances must be documented in the client file.

s. There are unusual situations, which in the judgment of the subgrantee staff, must be corrected before proceeding with weatherization.

- i. No utility hookups (It is apparent that utilities have been shut off).
- ii. Lack of cooperation from client.
- iii. Dwelling units undergoing remodeling, or which have untreated

areas that directly affect the weatherization process, shall not be weatherized.

t. If for any reason a worst-case draft test cannot be done in a dwelling requiring a worst-case draft.

### **4320 Domestic Hot Water Pipes**

1. Insulate the first 9 feet of hot water pipe and the first 3 feet of cold water pipe with ¾ inch pipe insulation except on gas water heaters.
2. Closed cell foam, high temperature rated insulation or elastomeric pipe insulation should be used that has a flame spread rating no greater than 25.
3. Maintain a minimum of 6 inches between pipe insulation and all heat sources.
4. Domestic hot water pipes running through unconditioned spaces must be insulated if accessible.

### **4330 Water Heater Blankets**

The installation of water heater blankets on electric water heaters in conditioned spaces is recommended unless this will void the warranty. Gas water heaters should not be insulated.

Water heaters located in unconditioned areas should be moved to a conditioned area, if possible. If the water heater cannot be moved, the heater and distribution pipes, both hot and cold, must be insulated.

### **4331 Water Heater Blanket Materials**

1. The water heater blanket must be fiberglass batt insulation with a protective covering.
2. An R-11 water heater blanket is preferred on all tanks not labeled with a prohibition to installing additional insulation to that already installed by the manufacturer.
3. A water heater blanket must be secured to the water heater with at least two (2) straps with buckles. The installed straps must not excessively compress the water heater blanket.

### **4332 Installation**

1. The water heater tank must be inspected to determine the type of water heater (gas, electric, other), and whenever possible, the amount of existing insulation.
2. If there are signs that the water heater is leaking, this problem must be solved before insulation is added.
3. Electric water heaters outside the living space, including mobile home water heaters in exterior closets, must be insulated if the total existing tank insulation is less than R-11.
4. A water heater blanket must not be installed when a temperature and pressure relief valve does not exist or when the existing temperature and pressure relief valve is leaking
5. A water heater blanket must not cover the following:
  - a. The temperature and pressure relief valve on an electric unit.
  - b. The drain valve on an electric unit.
  - c. The electrical line attaches to an electric unit. Insulation must be kept at least three inches away from where this electrical line attaches to the water heater.

### **5121 Insulation Coverage and Density For Attics**

1. Insulate uninsulated open-joint attics to R-50 in all dwelling heated with any fuel but electric resistance and to R-60 for electric resistance heat. Add insulation to other areas as necessary or as directed by the approved audit software program.
2. Using the WxPro Audit Software to calculate the number of bags is the preferred method for determining the proper amount of material to be installed into an attic area at a given R-value.
3. Where the combined material and labor costs can be reduced, it is preferred that dropped soffits and similar construction details be filled with cellulose insulation.
4. When a vapor barrier is installed with the insulation, the barrier should be installed on the warm side of the insulation and never more than 1/3 of the R-value away from the warm-side surface.
5. Add necessary insulation to eliminate voids and areas of incomplete coverage. Cut or pull back existing fiberglass batts two feet from the soffit and blow and dense pack the perimeter. Prepare floored areas or other restricted zones with existing insulation for high-density application.
6. Cellulose must be blown in site built attics unless circumstances warrant blown fiberglass. This use of fiberglass must be documented in the file

### **5122 GHW-Wall Dense Packing**

1. Lead and asbestos safety procedures will be followed
2. Cavities will be free of hazards, intact, and able to support dense pack pressures
3. Drilling hazards (e.g., wiring, venting, fuel piping) will be located
4. Blocking will be installed around:
  - a. All openings to inside crawl space and basement for fibrous material
  - b. High temperature fire-rated materials
  - c. Wiring and electrical hazards
  - d. Heat sources
5. Access to exterior wall cavities will be gained, sheathing will be drilled as needed and probed to locate each cavity, wall studs, and blockers
6. Interior will be masked and dust controlled during drilling when accessing from interior
7. Electricity supply will be confirmed and will support blowing machine power demand
8. Blowing machine pressure test will be performed with air on full, feed off, agitator running, and gate closed
  - a. Hose outlet pressure will be at least 80 IWC or 2.9 psi for cellulose insulation; for other types of dense pack insulation, check manufacturer specification for blowing machine set up
9. Using fill tube, 100% of each cavity will be filled to a consistent density:
  - a. Using the WxPro Audit Software to calculate the number of bags is the preferred method for determining the proper amount of material to be installed into an attic area at a given R-value.
  - b. Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot
  - c. Loose fiber glass material will be installed and will be specifically approved for air flow resistance to a minimum density of 1.5 to 2 pounds per cubic foot
10. Insulation density will be verified by bag count, core sampling, or infrared camera with the blower door at 50 pascals to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

### **5324 Rim Joist Insulation**

1. Rim Joist insulation must be a minimum of R-10.
2. Fiberglass, rigid, or foam insulation may be used for this application. Whichever is used must result in a Savings-to-Investment Ratio equal to or greater than the current State-approved value.
3. If there is significant air leakage, the band or rim joist area must be properly sealed before the insulation is installed.
4. The insulation must be secured in a permanent manner.

## 5325 Foundation Insulation

1. Route any exhaust fans to the outside using damper vents, smooth-bore rigid pipe, and an appropriate termination fixture.
2. If necessary, repair or replace exterior doors or door components to reduce air leakage. If necessary, replace all missing glass and repair or replace window components to reduce air leakage.
3. Foundation walls should be insulated so that no portion above grade is left uninsulated.
4. Fiberglass insulation must be covered with ½" drywall living areas.
5. Mechanical fasteners must be used to secure perimeter insulation in a permanent manner.
6. Basement wall insulation must be a minimum of R-7.5 and exterior basement wall insulation must be a minimum of R-5
  - a. Where moisture is a problem in basements and an approved moisture mitigation technique is used to insulate the interior walls, an R-Value of 5 is acceptable.
7. Interior-wall installation
  - a. Stud out wall and insulate with fiberglass or use rigid insulation glued and fastened.
  - b. An alternative method for installing perimeter insulation is to attach metal-building insulation at the floor above the rim, so that the blanket extends from the floor above four feet down the foundation wall. It should be run horizontally in a continuous manner to eliminate as many seams as possible. The blanket may be slit at each floor joist to allow installation in a manner that minimizes gaps around the joist. The bottom of this fiberglass batt insulation should be air sealed to the wall with a strip of wood nailed to the foundation or by sealing the vinyl facing to the wall with adhesive caulk.
  - c. Other insulation types and methods may be used with the approval of the DCS.
8. Exterior-wall installation
  - a. Foundation insulation may be installed on the exterior, but this requires digging a one-foot deep trench around the foundation. If this method is used, the rigid insulation must be extruded polystyrene at least one-inch thick with an R-5 and it must be protected from sunlight and exterior mechanical damage by an appropriate rigid material.

## **6210 Storm Windows**

1. Interior storm windows shall be installed whenever feasible in mobile homes.
2. Exterior storm windows shall be installed whenever feasible in site-built homes.
- 3 .A one half-inch to two-inch air space between the prime window and the installed storm window is preferred.
4. Storm windows shall be installed over single-pane windows, and according to cost-effectiveness as determined by the approved North Dakota energy audit software.
5. Allowable storm windows include:
  - a. Rigid framed single- and double-strength glass.
  - b. Rigid and flexible framed Plexiglas.
  - c. Framed and unframed plastic "kits" with a minimum thickness of six mils.
6. Repairs to prime windows must be done to keep moisture out before an interior storm window may be installed over the prime window.
7. Storm windows must be securely fastened in place; installed straight, plumb, and level, and without distortion.
8. Storm windows may be installed as a replacement for non-repairable existing storm windows when determined to be cost-effective by the approved North Dakota energy audit program.
9. Metal storm windows should not come in contact with frames or fasteners constructed of dissimilar metals.
10. Subgrantee installed storm windows in kitchens; baths and other high moisture areas must be operable if they provide the only source of ventilation into the space.
  1. Operable storm windows shall move freely.

## **6340 Door Replacements**

1. Individual replacement doors may only be installed if the cost of the repair is justified by the approved audit software.
2. Pre-hung replacement doors may be installed if determined to be more cost-effective than the repair of the existing door and frame, or the installation of a door that is not pre-hung.
3. The cost of the purchase and installation of all hardware and the material associated with the replacement of a door must be included in the calculation of the SIR used to justify the door replacement.
4. Replacement doors may include one light (pane of glass) if the replaced door had one or more lights. The cost any other extra features must be borne by the client.

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- 4.1005.1a Preparation - See 4.1005.2a
- 4.1005.1b Installation - See 4.1005.2a
- 4.1005.1c Occupant education - See 4.1001.3d

**4.1005.2 Accessible Floors—Loose Fill Installation**

- 4.1005.2a Preparation
- 4.1005.2b Air barrier
- 4.1005.2c Installation
- 4.1005.2d Onsite documentation

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

- 4.1005.3e Occupant education - See 4.1001.3d

**4.1005.4 Accessible Floors—Loose Fill Over Existing Insulation**

- 4.1005.4d Onsite documentation - See 4.1005.2d

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

- 4.1005.5a Air barrier
- 4.1005.5b Fill floors
- 4.1005.5c Safety
- 4.1005.5d Onsite documentation - See 4.1005.2d

## **4.1006 Attic Openings**

### **4.1006.1 Pull-Down Stairs**

4.1006.1a Installation

4.1006.1b Sealing

### **4.1006.2 Access Doors and Hatches**

4.1006.2a Installation

4.1006.2b Sealing - See 4.1006.2a

4.1006.2c Attachment

## **4.1088 Special Considerations**

### **4.1088.3 Skylights**

4.1088.3b Installation of Skylight Insulation In Attics

4.1088.3c Occupant education - See 4.1001.3d

## **4.11 Walls**

### **4.1102 Accessible Walls**

#### **4.1102.1 Open Wall Insulation—General**

4.1102.1a Sealing

4.1102.1b Installation

4.1102.1c Pre-drywall verification

4.1102.1d Occupant education - See 4.1001.3d

#### **4.1103.1 Enclosed Walls**

4.1103.1a Exterior Dense Pack

4.1103.1b Onsite Documentation. See 4.1005.2d

4.1103.1c Dense Packing. See 4.1103.1a

#### **4.1103.2 Additional Exterior Wall Cavities**

4.1103.2a Location of cavities

4.1103.2b Sealing

4.1103.2d Quality assurance

4.1103.2e Close holes

## **4.13 Floors**

### **4.1301 Accessible Floors**

#### **4.1301.1 Standard Floor System—Batt Installation**

4.1301.1a Sealing - See 3.1402.1a

4.1301.1b Installation

4.1301.1c Securing batts

4.1301.1d Occupant education - See 4.1001.3d

#### **4.1301.2 Standard Floor System—Loose Fill with Netting**

4.1301.2a Sealing - See 3.1402.1a

4.1301.2b Netting, fabric

4.1301.2c Installation

4.1301.2d Occupant education - See 4.1001.3d

**4.1301.3 Standard Floor System—Loose Fill with Rigid Barrier**

- 4.1301.3a Sealing - See 3.1402.1a
- 4.1301.3b Rigid air barrier
- 4.1301.3c Installation
- 4.1301.3d Occupant education - See 4.1001.3d

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

- 4.1301.4a Sealing - See 3.1402.1a
- 4.1301.4b Rigid air barrier - See 4.1301.3b
- 4.1301.4c Installation - See 4.1301.: e
- 4.1301.4d Occupant education - See 4.1001.3d

**4.1301.5 Cantilevered Floor—Batt Installation**

- 4.1301.5a Air Barrier for Cantilevered Floor - Batt Installation
- 4.1301.5b Installation
- 4.1301.5c Attachment
- 4.1301.5d Exterior Soffit
- 4.1301.5e Occupant education - See 4.1001.3d

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

- 4.1301.6a Subfloor preparation - See 3.1402.1a
- 4.1301.6b Installation - See 4.1301.1b
- 4.1301.6c Secure batts - See 4.1301.1c
- 4.1301.6d Rigid air barrier - See 4.1301.3b
- 4.1301.6e Occupant education - See 4.1001.3d

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

- 4.1301.7a Subfloor preparation - See 3.1402.1a
- 4.1301.7b Rigid air barrier - See 4.1301.3b
- 4.1301.7c Installation - See 4.1301.3c
- 4.1301.7d Occupant education - See 4.1001.3d

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

- 4.1301.8a Subfloor preparation - See 3.1402.1a
- 4.1301.8b Rigid air barrier - See 4.1301.3b
- 4.1301.8c Installation
- 4.1301.8d Occupant education - See 4.1001.3d

**4.14 Basements and Crawl Spaces**

**4.1402 Basements and Crawl Space Walls**

**4.1402.2 Basement Wall Insulation—No Groundwater Leakage**

- 4.1402.2a R-value
- 4.1402.2b Air barrier
- 4.1402.2c Vapor permeability

**4.16 Ducts**

**4.1601 Insulating Ducts**

**4.1601.2 Insulating Metal Ducts**

- 4.1601.2a Selection of duct insulation material
- 4.1601.2b Duct sealing - See 3.1501.1b
- 4.1601.2c Attachment of duct insulation
- 4.1601.2d Taping of the duct insulation - See 4.1601.2a

## **5 Heating and Cooling**

### **5.30 Forced Air**

#### **5.3003 System Assessment and Maintenance**

##### **5.3003.2 Combustion Analysis of Oil-Fired Appliances**

5.3003.2a Oil system: nozzle size

5.3003.2b Fuel pressure

5.3003.2c Oil system: steady state efficiency (SSE)

5.3003.2d Oil system: smoke test (This test must be conducted before any combustion testing is completed)

5.3003.2e Net stack temperature

5.3003.2f Carbon dioxide and oxygen

5.3003.2g Excess air

## **6 Ventilation**

### **6.60 Exhaust**

#### **6.6002 Components**

##### **6.6002.1 Ducts**

6.6002.1a Duct design and configuration

6.6002.1b Duct insulation - See 4.1601.2a

6.6002.1c Duct support - See 4.1601.2c

6.6002.1d Duct Connections

6.6002.1e Duct Materials

##### **6.6002.2 Terminations**

6.6002.2a Hole in building shell

6.6002.2b Termination fitting

6.6002.2d Weatherproof installation

6.6002.2c Duct to Termination Connection

6.6002.2e Pest exclusion

6.6002.2f Termination location

6.6002.2g Kitchen exhaust

#### **6.6003 Fans**

##### **6.6003.3 Through the Wall**

6.6003.3a Hole in building shell

6.6003.3b Wiring

6.6003.3c Fan Mounting

6.6003.3d Weatherproof Installation of fans through the wall

6.6003.3e Backdraft damper

6.6003.3f Fan Housing Seal

6.6003.3g Fan to Interior Surface Seal

6.6003.3i Air Flow

6.6003.3j Preventing air leakage caused by exhaust fans

6.6003.3k Combustion Safety

**6.6005 Appliance Exhaust Vents**

**6.6005.1 Clothes Dryer**

- 6.6005.1a Clothes dryer ducting
- 6.6005.1b Termination fitting
- 6.6005.1d Combustion safety
- 6.6005.1e Occupant education

**6.6005.2 Kitchen Range**

- 6.6005.2b Fan Venting
- 6.6005.2c Fan ducting
- 6.6005.2d Termination fitting
- 6.6005.2e Make-up air
- 6.6005.2f Combustion safety

**6.62 Whole Building Ventilation**

**6.6201 Air Flow Requirements**

**6.6201.2 Primary Ventilation Air Flow between Rooms**

- 6.6201.2a Balancing pressure

**7 Baseload**

**7.81 Water Heating**

**7.8102 Installation and Replacement**

**7.8102.2 Storage-Type Appliance**

- 7.8102.2e Expansion tank
- 7.8102.2f Temperature and pressure relief valve
- 7.8102.2k Discharge temperature

**7.8103 Maintenance/Inspection**

**7.8103.1 Storage-Type Appliance**

- 7.8103.1a Health and safety
- 7.8103.1e Temperature and pressure relief valve

## 2.0100.1b

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

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

### Objective(s):

Minimize skin contact with contaminants

Protect hands from sharp objects



Recognize potential risks



Wear appropriate hand protection

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## 2.0100.1c

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

If the risk of airborne contaminants cannot be prevented, proper respiratory protection will be provided and worn (e.g., N-95 or equivalent face mask)

When applying low pressure 2-component spray polyurethane foam, air purifying masks with an organic vapor cartridge and P-100 particulate filter will be used

When applying high-pressure SPF insulation, supplied air respirators (SARs) will be used

Consult SDSs for respiratory protection requirements

### Objective(s):

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



Workers need to properly protect their airways when retrofitting



Retrofits can have multiple different respiratory protection requirements

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## 2.0100.1d

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

An electrical safety assessment will be performed

All electric tools will be protected by ground-fault circuit interrupters (GFCI)

Three-wire type extension cords will be used with portable electric tools

Worn or frayed electrical cords will not be used

Water sources (e.g., condensate pans) and electrical sources will be kept separate

Metal ladders will be avoided

Special precautions will be taken if knob and tube wiring is present

Aluminum foil products will be kept away from live wires For arc flash hazards, ND State Electrical Code will be consulted

### Objective(s):

Avoid electrical shock and arc flash hazards



Inspect house for unsafe electrical situations



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

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## 2.0100.1e

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

All homes will have a carbon monoxide alarm

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

### Objective(s):

Protect worker and occupant health

### Tools:

1. CO meter



**Unsafe**

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



**Best Practice**

Alarms should be mounted near sleeping areas--such as the one marked in red



**Best Practice**

Install carbon monoxide alarms

2.0105.1b; 2.0201.2c; 2.0301.2a; 3.1501.1f

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Paraphrased from ND State Building Code: An approved CO alarm will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in dwelling units within which fuel-fired appliances are installed and in dwelling units that have attached garages. CO detectors will comply with UL 2075. Single-station CO alarms will comply with UL 2034 and will be installed in accordance with this code and the manufacturer's installation instructions. Per WPN 14-01, full compliance with ASHRAE 62.2.2013 and NFPA 720 is required.

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## 2.0100.1f

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

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)

### Objective(s):

Protect worker from skin contact with contaminants

Minimize spread of contaminants



Workers should be aware of work required and dress appropriately



Ensure workers have proper protective equipment for work environment

2.0105.2d

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## 2.0100.1g

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Access and egress points will be located before beginning work

Inspection will be conducted for frayed electrical wires

Adequate ventilation will be provided

Use of toxic material will be reduced

**Objective(s):**

Prevent build-up of toxic or flammable contaminants

Provide adequate access and egress points

Prevent electrical shock



Locate all access and egress points of confined spaces before entering

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## 2.0100.1j

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Appropriate PPE will be used (e.g., knee pads, bump caps, additional padding)

Proper equipment will be used for work

Proper lifting techniques will be used

### Objective(s):

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



Workers will take precautions to protect themselves on the job site



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

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## 2.0100.1m

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

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

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## 2.0100.1p

### Desired Outcome:

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

### Specification(s):

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

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

### Objective(s):

Protect worker and occupant from potential lead hazards

### Tools:

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



### Best Practice

In homes built before 1978, test paint before beginning renovation

EPA RRP certification required to conduct Lead Paint assessment.

3.1201.2a; 3.1201.3a; 3.1202.1a; 3.1202.2a; 3.1203.1a; 3.1203.2a

3.1201.1a

## 2.01001.1d - Lead paint assessment



**1**  
Clean tools and sample site to prevent contamination



**2**  
Cut sample site at an angle to expose all older paint layers



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



**4**  
Check swab for reaction



**5**  
Red indicates lead positive. White indicates lead negative.



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



**7**  
Lead in calibration card should test positive and turn red



**8**  
Record test results to maintain documentation

## 2.0105.1c

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Raw fuel leaks will be monitored for before entering building spaces

If leaks are found, testing will be discontinued and condition reported to occupant immediately

### Objective(s):

Protect worker and occupant health

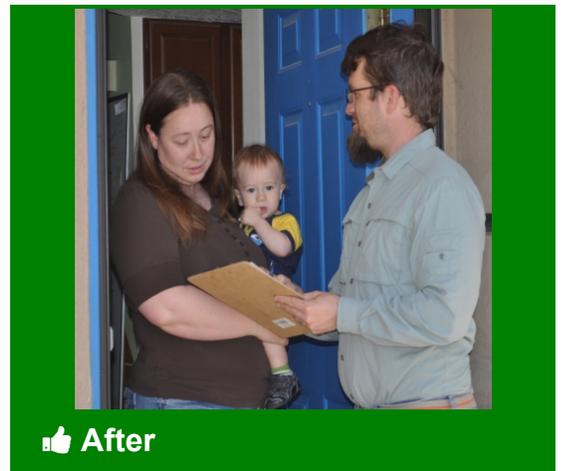
### Tools:

1. Gas sniffer
2. Bubble solution



**Before**

Fuel leaks need to be repaired by appropriate professional



**After**

Notify occupant of any leaks

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## 2.0105.2b

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

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

### Objective(s):

Protect workers and occupants from mercury exposure



**Unsafe**

Mercury thermostats should be replaced and disposed of properly



**Unsafe**

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

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

## 2.0111.2a

### Desired Outcome:

Site properly prepared for upgrade

### Specification(s):

Fuel leaks will be repaired and inspected in accordance with the 2012 IRC

### Objective(s):

Ensure site is safe and ready for upgrade

### Tools:

1. Combustion gas detector
2. Testing solution



**Unsafe**

Fuel leaks need to be repaired



**Safe**

Repairs need to be tested and verified to no longer leak

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Paraphrased from ND State Building Code: Leakage will be located using an *approved* combustible gas detector, a noncorrosive leak detection fluid or an equivalent nonflammable solution.

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Matches, candles, open flames or other methods that could provide a source of ignition cannot be used. Where leakage or other defects are located, the affected portion of the *pipng system* will be repaired or replaced and retested.

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2.0201.1b

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## 2.0111.3a

### Desired Outcome:

Clean, safe, and easily accessible crawl space created

### Specification(s):

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

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

### Objective(s):

Minimize punctures in ground liner

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

### Tools:

1. Rake
2. PPE

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



Rake up and clear away trash and overgrowth.

## 2.0201.1a

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

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

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

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

### Objective(s):

Ensure system does not have fatal problems

Ensure combustion appliance has adequate combustion and dilution air



**Before**

Unsafe combustion appliances indicate need for repair or replacement



**After**

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

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## 2.0201.1c

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

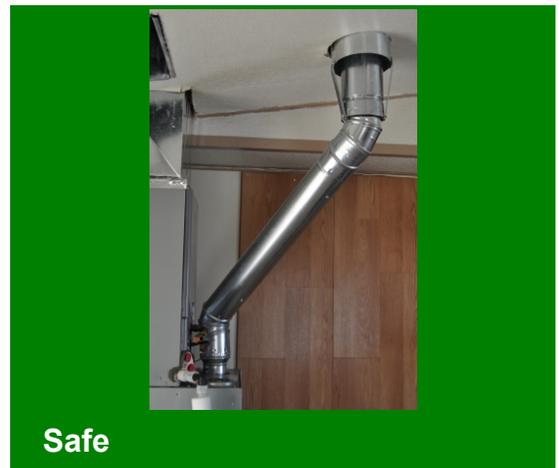
Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards

### Objective(s):

Determine if a draft regulator is present and working and if vent system is in good condition and installed properly



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



Properly vented appliances make a house healthier and more efficient

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## 2.0201.1c - Venting



Determine if a draft regulator is installed and working



Inspect ventilation systems for damage



Inspect ventilation systems for disconnected pipes



Inspect ventilation systems for inadequate slope



Inspect for missing draft diverter

## 2.0201.1e - Depressurization test

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof.

### Objective(s):

Measure combined effect of mechanical system fans on combustion zone

### Tools:

1. Manometer



### Best Practice

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

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## 2.0201.1e - Depressurization test



**1**  
Place manometer reference hose to exterior of house



**2**  
Attach test hose to be used in the interior of the house



**3**  
Place test hose by combustion appliance



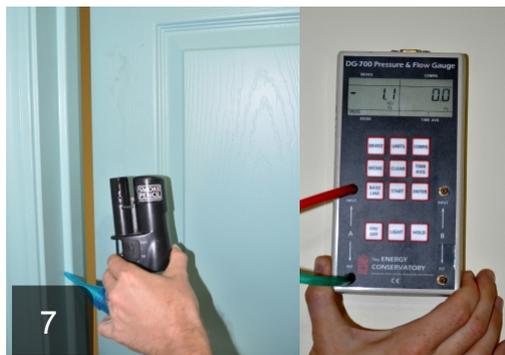
**4**  
Close all interior doors unless there is an exhaust fan or return duct existing



**5**  
Turn on interior exhaust fans, including any clothes dryers



**6**  
Take a reading with the air handler on and with the air handler off and determine which is worst case



**7**  
Take a reading with the CAZ door closed and open and determine which is worst case

## 2.0201.1f - Spillage test

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

If a combustion appliance spillage exceeds two minutes on a warm vent or 5 minutes on a cold vent during pressure testing, specify measures to mitigate

### Objective(s):

Detect excessive spillage of combustion gasses

### Tools:

1. Smoke pencil
2. Timer



### Unsafe

Test natural draft furnace or water heater for spillage in excess of 2 minutes for warm vents and 5 minutes for cold vents



### Best Practice

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

## 2.0201.1g

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

CO will be tested for in undiluted flue gases of combustion appliances

If CO levels exceed levels in the chart below, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)

If the outlet of the exhaust is accessible, include a CO test on all sealed-combustion, direct vent, and power-vented appliances (without atmospheric chimneys)

### Objective(s):

Measure CO and report excessive levels

### Tools:

1. Combustion analyzer with probe

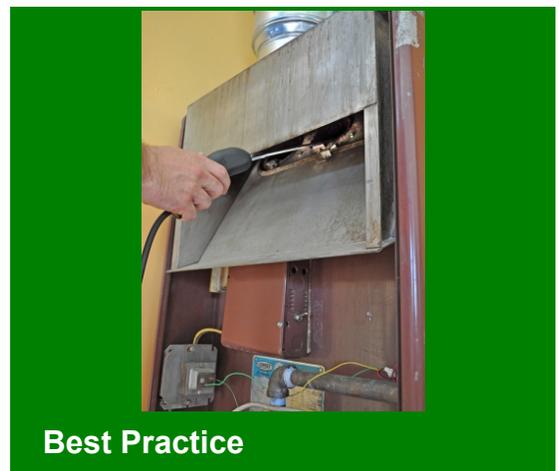
#### CO Thresholds for Fossil-Fuel Fired Combustion Appliances

Appliance	Threshold Limit
Central Furnace (all categories)	400 ppm air free
Boiler	400 ppm air free
Floor Furnace	400 ppm air free
Gravity Furnace	400 ppm air free
Wall Furnace (BIV)	200 ppm air free
Wall Furnace (Direct Vent)	400 ppm air free
Vented Room Heater	200 ppm air free
Unvented Room Heater	200 ppm air free
Water Heater	200 ppm air free
Oven/Broiler	225 ppm as measured
Clothes Dryer	400 ppm air free
Refrigerator	25 ppm as measured
Gas Log (gas fireplace)	25 ppm as measured in vent
Gas Log (installed in wood burning fireplace)	400 ppm air free in firebox



**Unsafe**

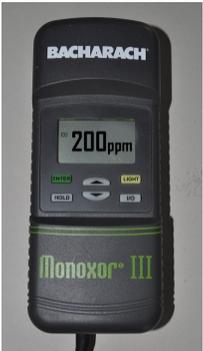
CO levels cannot exceed levels in the chart below, unless to manufacturer specs



**Best Practice**

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

## 2.0201.1g - Carbon monoxide (CO) test in appliance vent



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



Test undiluted flue gases in induced-draft furnaces



Test undiluted flue gases in natural draft furnaces



Test undiluted flue gases in natural draft water heaters.



Test accessible exhaust outlets for direct-vent appliances



Test accessible exhaust outlets for power-vented appliances

## 2.0201.1i

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

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

### Objective(s):

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

### Tools:

1. Manometer
2. Smoke pencil
3. Timer

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

## 2.0201.2a

### **Desired Outcome:**

Buildup of dangerous combustion byproducts in the living space prevented

### **Specification(s):**

Where applicable, combustion air will be provided from the outside and installed in accordance with the 2012 IRC for the type of appliance installed

### **Objective(s):**

Prevent combustion byproducts from entering the house

Image 1: For homes with one permanent opening, see ND State Building Code: a minimum free area of 1 in<sup>2</sup> per 3,000 Btu/h (734 mm<sup>2</sup>/kW) of total input rating of all appliances

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Image 2: For homes with two permanent vertical duct openings, see ND State Building Code: a minimum free area of 1 in<sup>2</sup> per 4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating of all appliances

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Image 3: For homes with two permanent horizontal duct openings, see ND State Building  
Code: a minimum free area of 1 in<sup>2</sup> per 2,000 Btu/h (1,100 mm<sup>2</sup>/kW) of total input rating of all  
appliances

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## 2.0201.2d

### Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

### Specification(s):

Gas ovens will be tested for CO

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

### Objective(s):

Ensure clean burn of gas ovens

### Tools:

1. Combustion analyzer with probe

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



Test gas oven for carbon monoxide using a combustion gas analyzer

## 2.0201.2e

### Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

### Specification(s):

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

### Objective(s):

Ensure clean burn and operation of gas range burners



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



A properly operating gas range burner should have an even blue flame

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## 2.0201.2f

### Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

### Specification(s):

If the solid fuel burning appliance is the primary heat source and has signs of structural failure replace solid fuel burning appliance with UL-listed and EPA - certified appliances if the existing appliance is not UL-listed

### Objective(s):

Ensure safe operations of solid fuel burning appliances



Unsafe solid fuel burning appliances should be replaced



New appliances should be UL-listed and EPA-certified

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

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## 2.0203.2a

### Desired Outcome:

Flue gasses successfully removed from the house

### Specification(s):

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

### Objective(s):

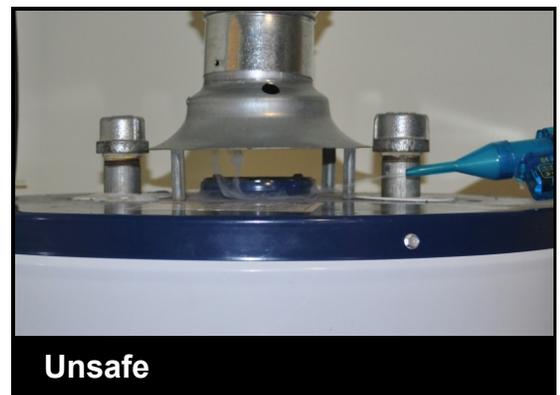
Ensure appliance is not spilling longer than two minutes

### Tools:

1. Smoke pencil



Orphaned water heaters have oversized flues after a furnace is removed



Spillage should not exceed 2 minutes, if present

2.0203.2c

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## 2.0203.2b

### Desired Outcome:

Flue gasses successfully removed from the house

### Specification(s):

A chimney liner will be installed in accordance with the 2012 IRC or applicable NFPA standard

### Objective(s):

Allow water heater to vent properly

Prevent damage to the chimney



Unlined masonry chimney



Flue liner with rain cap

### Tools:

1. hammer drill
2. disposable brushes
3. tin snips
4. 5/16" nut driver
5. pulling cone
6. rope
7. caulking gun
8. tape measure
9. 4 1/2" angle grinder with metal cutoff wheel

### Materials:

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

Connect chimney liner to appliance in accordance with applicable codes.

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



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



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



3 Measure and mark the flexible chimney liner at 4 inches above the chimney



4 Cut the flexible chimney liner to length



5 Install top plate over opening and attach it to the liner



6 Fasten the rain cap to the chimney liner



7 Seal around penetrations in chimney with refractory (furnace) cement



8 Connect appliance vent to the chimney liner



9 Use refractory (furnace) cement to seal metal water heater or furnace vents to the masonry chimney

## 2.0301.1b

**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 ND State Building Code: 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 with could provide access.

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## 2.0301.1b - Smoke alarm (battery operated)



Ceiling mounted smoke alarms can be battery-operated



Wall mounted smoke alarms must be mounted within 12 inches of the ceiling

## 2.0301.2b

### Desired Outcome:

Properly installed CO alarms or monitors

### Specification(s):

Battery operated CO detection or warning equipment will be installed in accordance with ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction

### Objective(s):

Ensure proper installation



All houses should have carbon monoxide monitors installed near sleeping areas



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

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Per WPN 14-01, full compliance with ASHRAE 62.2.2013 and NFPA 720 is required.

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## 2.0403.1b

### Desired Outcome:

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

### Specification(s):

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

### Objective(s):

Reduce ground moisture entering the crawl space

### Materials:

1. Plastic sheeting (at least 4 mil)
2. Furring strips
3. Fasteners



Uncovered crawl space floors can cause moisture damage



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

2.0403.1d; 2.0403.2b; 2.0403.2d; 2.0403.2e; 2.0403.2f

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## 2.0403.1c

### Desired Outcome:

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

### Specification(s):

A ground moisture barrier with a rating of no more than 0.1 perm will be used

A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745

Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home (5 years), and it will need replacing to remain effective

### Objective(s):

Ensure crawl space is accessible for service and maintenance without damaging the integrity of the ground moisture barrier

### Materials:

1. Plastic sheeting (at least 4 mil)
2. Furring strips
3. Fasteners



After

Barrier must be at least 4 mil, able to withstand puncture and last 10 yrs

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The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of <0.5 (which translates to 4mil or thicker). From 2007 IRC definition of vapor retarders: Class I:  $\leq 0.1$  perm (called impermeable), Class II: 0.1 to 1.0 perm (called semi-impermeable), Class III: 1.0 perm to 10 perms (called semi-permeable).

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2.0403.2c

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## 2.0403.1e

### Desired Outcome:

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

### Specification(s):

Ground moisture barrier will be fastened to ground with durable fasteners or ballast(s) and extend a minimum of 6" up the foundation wall

### Objective(s):

Prevent movement of the ground moisture barrier

### Tools:

1. Stapler
2. Drill

### Materials:

1. Plastic sheeting (at least 4 mil)
2. Furring strips
3. Fasteners



Fastening of moisture barrier is required and must last at least 10 years



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

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## 2.0601.1c

### Desired Outcome:

Live unsafe wiring identified and brought to local codes

### Specification(s):

Live knob and tube will not be covered or surrounded; required by the ND State Electrical Code or authority having jurisdiction

A licensed electrical contractor will inspect and certify wiring to be safe and place a warning at all entries to the attic about the presence of knob and tube wiring

A dam that does not cover the top will be created to separate insulation from the wire path

### Objective(s):

Ensure occupant safety

Preserve the integrity and safety of the house

### Tools:

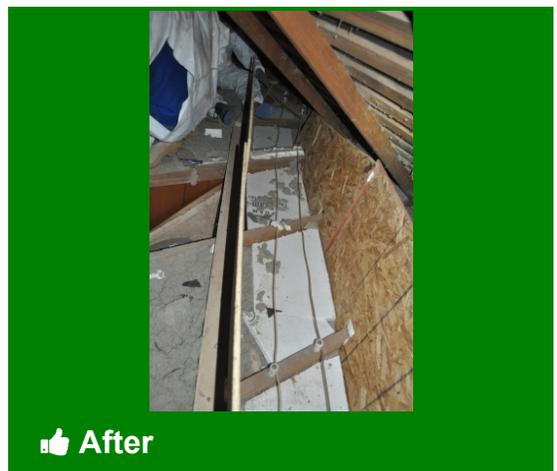
1. Drill
2. Tape measure
3. Non-contact wire tester

### Materials:

1. Plywood
2. Drywall
3. Fasteners



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



Dams should be installed to hold back loose fill insulation

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

Check your local codes.

2.0601.1a; 2.0601.1b; 2.0601.1d; 4.1001.2a; 4.1001.2b; 4.1001.2c

### 3.1001.1d

**Desired Outcome:**

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

**Specification(s):**

Only non-combustible sealant will be used in contact with chimneys, vents, and flues

Local codes will be referenced

**Objective(s):**

Prevent a fire hazard

**Tools:**

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

**Materials:**

- 1. High-temperature caulking
- 2. 26-gauge steel sheeting



Gaps around combustion exhaust flues need to be sealed



Sealed penetrations and chases should utilize high-temperature materials

Minimum of a 3" Clearance to all Combustibles

3.1402.1c

### 3.1001.1d - High temperature application



1 Prepare work area by removing any insulation and debris



2 Use high-temperature caulking (600F min)



3 Apply first ring of caulking to match shape of opening



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



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



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

## 3.1001.2a

### Desired Outcome:

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

### Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a chase

Repairs will be completed before work begins

### Objective(s):

Repair moisture-related issues



Investigate under insulation in chases to verify they are undamaged



Water damage in chase due to hole to the outside

### Tools:

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

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

## 3.1001.2a - Pre-inspection



1 Locate and expose chases to prepare for inspection and capping/sealing



2 Clear away insulation and debris to allow inspection



3 Carefully investigate areas with high potential for water leaks

### 3.1001.2b

**Desired Outcome:**

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

**Specification(s):**

Entire opening will be spanned with rigid material

Material will be cut to fit and fastened as required

**Objective(s):**

Reduce opening to what can be sealed with sealant

**Tools:**

- 1. Drill/screwdriver
- 2. Caulk gun

**Materials:**

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



Unsealed standard chases covered with drywall can be leakage points



The air barrier is maintained by capping chases with rigid material

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## 3.1001.2c

### Desired Outcome:

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

### Specification(s):

Material will be used that can be exposed to the interior of the house and meet the flame and smoke spread indexes as required in ND State Building Code

### Objective(s):

Prevent a fire hazard

### Tools:

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

### Materials:

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



Paneled drop soffits typically are more combustible than plain drywall



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

EPS or bead-board are not acceptable materials.

3.1003.6c

### 3.1001.2d

**Desired Outcome:**

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

**Specification(s):**

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

**Objective(s):**

Ensure seal stays in place and does not sag

**Tools:**

- 1. Drill
- 2. Saw
- 3. Tape measure

**Materials:**

- 1. Lumber
- 2. Drywall
- 3. Fasteners



**Before**

Spans greater than 24 inches require additional bracing before capping



**After**

Support should prevent cap from sagging or moving

3.1001.3c; 3.1003.1c; 3.1003.2c; 3.1003.3c; 3.1003.4c

## 3.1001.2e

### Desired Outcome:

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

### Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

### Objective(s):

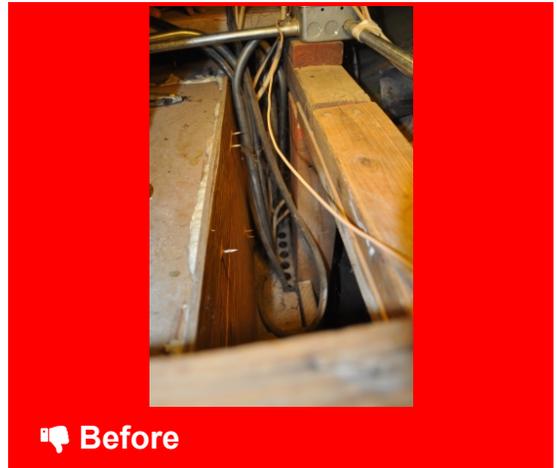
Provide airtight, durable seal that does not move, bend, or sag

### Tools:

1. Spray foam gun
2. Caulk gun

### Materials:

1. Spray foam
2. Caulk



**Before**

Chases need to be capped and sealed to prevent leakage



**After**

Chase is sealed along all cracks, gaps, and penetrations

Always wear protective gloves when working with sealants.

3.1001.2f; 3.1003.6b; 3.1003.6d

## 3.1001.3b

### Desired Outcome:

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

### Specification(s):

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

Material will be cut to fit and fastened as required

OR

Wall below openings will be dense packed

OR

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

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

### Objective(s):

Prevent air leakage from wall cavity to attic

### Tools:

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

### Materials:

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



🗨 Before

Wall cavities are open to attic



👍 After

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

### 3.1001.3b - Sealing methods



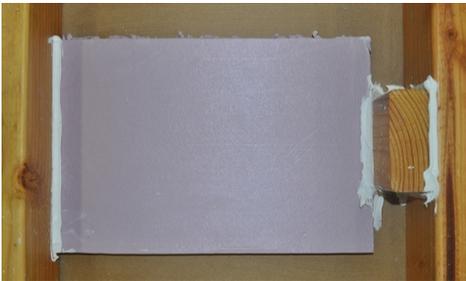
Option 1: Dense pack cavities through wood cap fastened in place



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

3.1001.3e; 3.1003.1b; 3.1003.1d; 3.1003.1e; 3.1003.2d

3.1003.2e; 3.1003.3b; 3.1003.3d; 3.1003.3e; 3.1003.4d; 3.1003.4e

## 3.1003.6d

### Desired Outcome:

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

### Specification(s):

Each stud bay will be spanned with rigid material will be cut to fit and fastened as required

OR

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

OR

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

OR

A sealed rigid barrier will be installed at all transitions

### Objective(s):

Prevent air leakage from wall to soffit

Reduce opening to what can be sealed with sealant

Ensure soffit is outside of the thermal boundary

### Tools:

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

### Materials:

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



**Before**

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



**After**

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

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



Clear work area of insulation and debris



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



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



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

## 3.1201.1d

### Desired Outcome:

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

### Specification(s):

Beveled sill will be flush with interior wall and sloped to the exterior

Seams will be continuously and completely sealed with sealant to the jambs and to the frame

Sill will be water-sealed and primed

### Objective(s):

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

Maintain operability of the window

Allow for drainage to the exterior

### Tools:

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

### Materials:

1. Lumber or metal sill
2. Caulk
3. Fasteners
4. Flashing



**Before**

Rot in and under a window sill is often a sign of a bigger problem



**After**

Once repaired, this window is less leaky and better supported

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## 3.1201.1d - Replacement sills



Remove sill to determine full extent of rot and necessary repairs



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



Cut new materials flush to surrounding surfaces and pitch toward exterior



For exterior repairs, replace flashing



Set new sill, then replace and prime trim

## 3.1201.3b

### Desired Outcome:

Doors operable and weather tight

### Specification(s):

Door will be adjusted to properly fit the jamb and allow for ease of operation (e.g., hinge replacement, re-plane door, door strike adjustment)

### Objective(s):

Ensure proper operation of the door

### Tools:

1. Screwdriver
2. Planer

### Materials:

1. Shims



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



With proper adjustment, doors should hang true and minimize leakage

3.1201.3c; 3.1201.3d; 3.1501.1d

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## 3.1202.1b

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

### Specification(s):

Putty and push points will be removed

Broken or cracked glass will be removed

### Objective(s):

Safely remove old glass

### Tools:

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

### Materials:

1. Tape



Broken glass with failed repairs needs to be replaced



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

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

Protection.

3.1202.2b

## 3.1202.1c

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

### Specification(s):

Opening will be cleaned

### Objective(s):

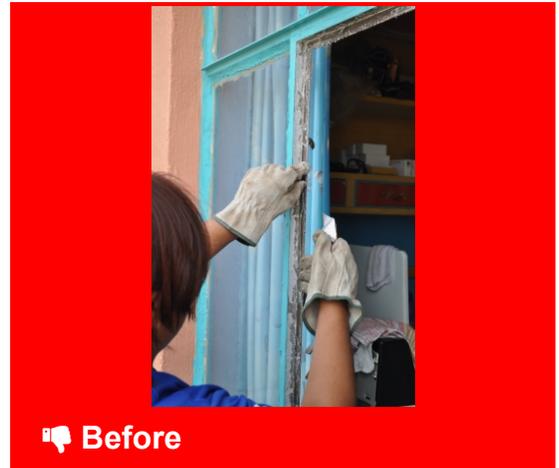
Prepare opening for new glass

### Tools:

1. Chisel
2. Utility knife

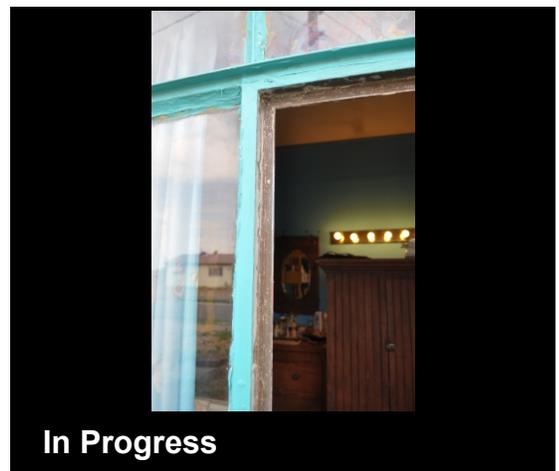
### Materials:

1. Sand paper
2. Cleaning solution
3. Rags



**Before**

Remove all debris from sash either by sand paper, knife, or chisel



**In Progress**

Mount new glass onto a clean surface

3.1202.2c

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## 3.1202.1d

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

### Specification(s):

Glass will be sized 1/8" to 3/16" smaller than opening to allow for movement of frame

Safety glass will be installed in accordance with local codes

Push points will be provided on each side to secure glass in frame

Glazing compound will be added in accordance with manufacturer specifications

### Objective(s):

Ensure glazing compound will adhere to sash

Install, seal, and secure new glass in place

Allow glazing compound to harden to ensure secure installation

### Tools:

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

### Materials:

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

3.1202.2d; 3.1501.1e

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With sash prepared, installation of new pane can begin



Replacement glass should be securely fixed with points and glazing

### 3.1203.1c

**Desired Outcome:**

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

**Specification(s):**

Replacement window will be installed in accordance with manufacturer specifications, ensuring that the exterior stops are caulked

**Objective(s):**

Ensure replacement window operates properly

Ensure replacement window has a weather tight fit



Window opening ready to receive replacement window



Replacement window installed, with stop molding replaced and caulked

**Tools:**

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

**Materials:**

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

3.1203.1b

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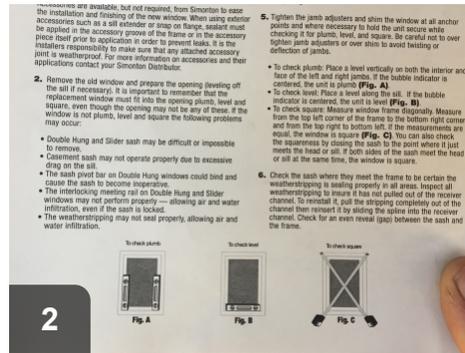


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# 3.1203.1c - Replacement window installation



1 Prepare and clean opening before installing new window



2 Check opening for plumb, level, and square



3 Measure diagonally both ways across opening. If measurements are equal, the opening is square



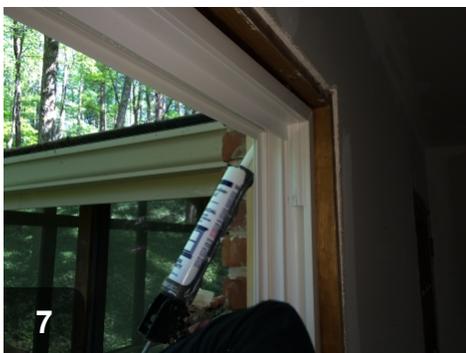
4 Apply caulk to stop molding and install the new window in accordance with manufacturer's instructions.



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



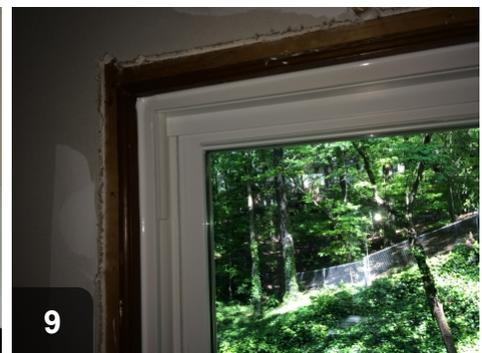
6 Make sure the sashes open, close, and lock properly. Check that the sashes are parallel with the frame as shown



7 Caulk new window to existing stop molding



8 Reinstall and caulk interior stop molding



9 Completed installation

### 3.1203.2b

**Desired Outcome:**

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

**Specification(s):**

Replacement window will be laid out with trim

Exterior trim will be removed or exterior siding will be cut back to fit new window with trim

Existing window will be removed

Window opening will be flashed in accordance with accepted industry standards

**Objective(s):**

Provide a clean and properly flashed opening for replacement window unit

**Tools:**

- 1. Pry bar
- 2. Utility knife
- 3. Drill

**Materials:**

- 1. Window and door flashing



Single pane window in newer home



Window is removed to allow for replacement with double pane unit

3.1203.2c; 3.1203.2d

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## 3.1402.1a

### Desired Outcome:

Air leakage prevented and indoor air quality protected

### Specification(s):

Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration

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

### Objective(s):

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

Ensure sealant does not fall out

### Tools:

1. Headlamp

### Materials:

1. Backer rod
2. Sealant



Gaps around floor penetrations, such as plumbing, HVAC, and electrical



Gaps should be sealed to maintain air barrier

4.1301.1a; 4.1301.2a; 4.1301.3a; 4.1301.4a; 4.1301.6a; 4.1301.7a

4.1301.8a

## 3.1402.1b

### Desired Outcome:

Air leakage prevented and indoor air quality protected

### Specification(s):

Sealants will be used to fill holes no larger than recommended by manufacturer specifications

Sealants will be compatible with their intended surfaces

Sealants will allow for differential expansion and contraction between dissimilar materials

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

### Objective(s):

Create a permanent seal

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

### Tools:

1. Caulk gun
2. Spray foam gun

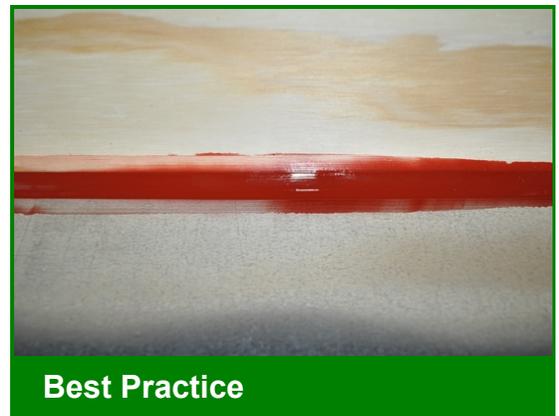
### Materials:

1. Caulk
2. Spray foam



**Bad Practice**

Avoid sealants that do not allow for expansion between dissimilar materials



**Best Practice**

Flexible sealants compensate for differential expansion and maintain a seal

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### 3.1402.3a

**Desired Outcome:**

Well-sealed exterior wall prevents leakage and pests

**Specification(s):**

Penetrations will be sealed with a durable material

A minimum expected service life of 10 years will be ensured

**Objective(s):**

Prevent air and moisture penetration into crawl space

**Tools:**

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

**Materials:**

- 1. Caulk
- 2. Sprayfoam
- 3. Metal mesh
- 4. Fasteners



Light showing through penetration in exterior block wall



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

3.1402.3b

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### 3.1501.1a

**Desired Outcome:**

Openings from garage sealed to prevent leakage

**Specification(s):**

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

**Objective(s):**

Prevent air leakage and pollutant entry

**Materials:**

- 1. Backer Rod
- 2. Caulk
- 3. Spray foam



Penetrations between the garage and house can leak hazardous fumes



Seal penetrations to minimize risks and air leakage

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## 3.1501.1b

### Desired Outcome:

Openings from garage sealed to prevent leakage

### Specification(s):

All joints and connections in ductwork will be fastened and sealed with UL 181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus- embedded-fabric systems

### Objective(s):

Prevent air leakage and pollutant entry

### Materials:

1. Mesh tape
2. Mastic



 **Before**

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



 **After**

Sealed ductwork connections help prevent leakage.

3.1602.1c; 3.1602.5c; 4.1601.2b

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### 3.1501.1c

**Desired Outcome:**

Openings from garage sealed to prevent leakage

**Specification(s):**

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

All cracks in ceiling surfaces will be sealed

**Objective(s):**

Prevent air leakage and pollutant entry

**Materials:**

- 1. Sprayfoam
- 2. Fire-block caulk



**Before**

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



**After**

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

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## 3.1501.1g

### Desired Outcome:

Openings from garage sealed to prevent leakage

### Specification(s):

Occupant will be educated on need to keep door from garage to house closed and not to warm up vehicles or use any gas engine appliances or grills in the garage, even if the main door is left open

### Objective(s):

Reduce risk of CO poisoning inside of garage and adjacent rooms



**Unsafe**

Communicate importance of never running vehicles in a closed garage



**Best Practice**

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

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## 3.1501.1g - Occupant education



Occupants should never run vehicles in a closed garage



Occupants should not light combustibles inside garages



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

### 3.1601.3a

**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 1/2" wide material

Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction

Metal ducts will be supported by 1/2 inch wide eighteen gauge metal straps or 12-gauge galvanized wire at intervals not exceeding 10 feet or other approved means

**Objective(s):**

Eliminate falling and sagging

**Tools:**

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

**Materials:**

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



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



Properly supported ducts minimize heat loss and maximize duct run

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### 3.1601.3a - Support (applies to all duct types)



BAD: Make sure supports DO NOT compress insulation or duct



Flex ducts should have supports no less than every 4 feet



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



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



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



Metal wire should be at least 12 gauge and galvanized

## 3.1602.4a

**Desired Outcome:**

Ducts and plenums sealed to prevent leakage

**Specification(s):**

All gaps between boot and interior surface that defines conditioned space will be air sealed

Gypsum edge will be wetted before applying water-based sealant

Sealants will be continuous and be in accordance with ND State Building Code

**Objective(s):**

Prevent air leakage

Prevent a fire hazard

**Tools:**

- 1. Utility knife
- 2. Spray bottle
- 3. Putty knife

**Materials:**

- 1. Mastic
- 2. Mesh tape



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



Use a mesh in mastic system to seal duct boot to interior surface

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### 3.1602.4a - Duct boot to interior surface



**1**  
Remove grill to expose duct boot and gaps



**2**  
Wet the edges of the drywall to ensure a good bond



**3**  
Cut mesh tape to fit around duct boot and cover gaps



**4**  
Apply mastic over mesh tape to create heat resistant, durable bond



**5**  
Once mastic is set, grill can be replaced and mastic should not show

## 3.1602.4b

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

### Specification(s):

Accessible connections and joints will be made airtight using approved material

### Objective(s):

Ensure ducts and plenums will not leak



Locate unsealed ducts constructed from building cavities



Return plenum lined with fiberglass duct board and sealed with mastic

### Tools:

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

### Materials:

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

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

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

From NFPA 90B 4.3.1.1: "Duct coverings, duct linings, and tapes used in duct systems shall have a maximum flame spread index of 25 without evidence of continued progressive combustion and a

maximum smoke developed index of 50 when tested in accordance with ASTM E 84 or ANSI/UL 723..."

## 3.1602.4c

**Desired Outcome:**

Ducts and plenums sealed to prevent leakage

**Specification(s):**

Joints will be closed and cracks and holes not needed for proper function of unit will be sealed using removable sealant (e.g., foil tape) or in accordance with the original equipment manufacturer directions (if available)

**Objective(s):**

Reduce air leakage while maintaining accessibility

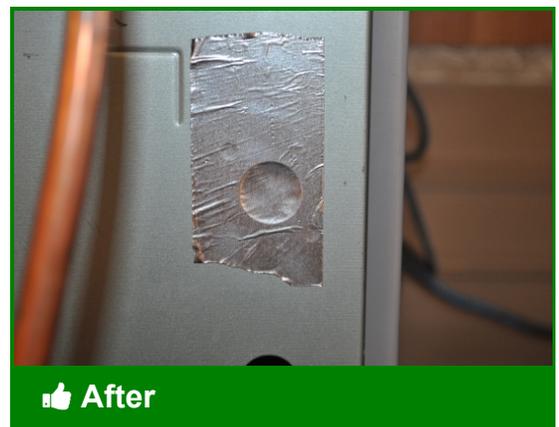
**Materials:**

1. Foil tape



**Before**

Unnecessary holes in the air handler cabinet need to be sealed



**After**

Use removable foil tape to seal holes

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## 3.1602.4d

**Desired Outcome:**

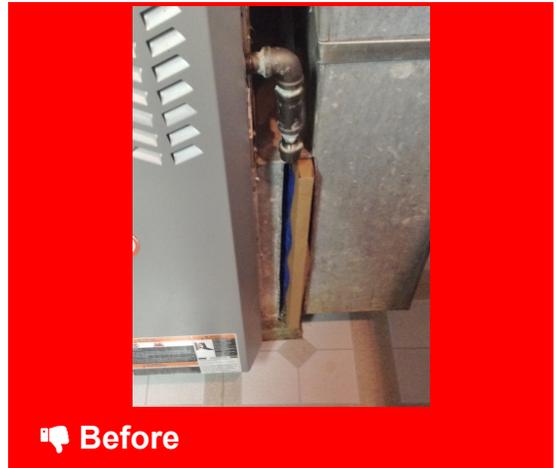
Ducts and plenums sealed to prevent leakage

**Specification(s):**

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

**Objective(s):**

Reduce air leakage while maintaining accessibility



Uncovered filter slots are a point of leakage



Filter slots should be covered

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## 3.1602.5a

### Desired Outcome:

The return duct installed to prevent air leakage

### Specification(s):

Debris and dirt will be cleaned out of the return platform

### Objective(s):

Allow for the application of rigid materials and sealants

### Tools:

1. Shop vacuum



Dirty, unsealed return platform needs to be cleaned out before sealing



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

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### 3.1602.5b

**Desired Outcome:**

The return duct installed to prevent air leakage

**Specification(s):**

Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space

Backing or infill will not bend, sag, or move once installed

Material will be rated for use in return duct systems

**Objective(s):**

Minimize hole size to ensure successful use of sealant

Ensure closure is permanent and supports any load (e.g., return air pressure)

Ensure sealant does not fall out

**Tools:**

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

**Materials:**

- 1. XPS
- 2. Drywall
- 3. Fire-resistant caulk
- 4. Fasteners



Leakage from air return into wall cavities should be eliminated



Only materials rated for use in higher temperature areas should be used

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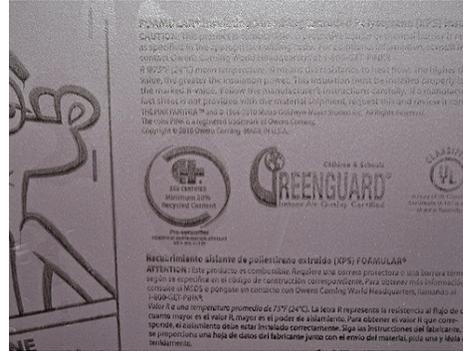


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### 3.1602.5b - Infill and backing



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



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

## 4.1001.1a

### Desired Outcome:

Ensure safety from fire and prevent air leakage

### Specification(s):

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

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

OR

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

OR

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

OR

Air sealing measures as approved by the authority having jurisdiction

### Objective(s):

Prevent a fire hazard

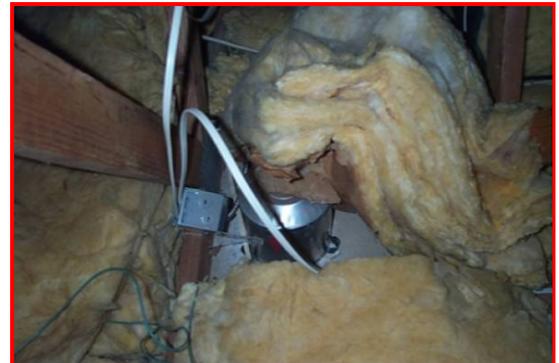
Prevent air leakage through fixture

### Tools:

1. Utility knife
2. Tape measure

### Materials:

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



**Before**

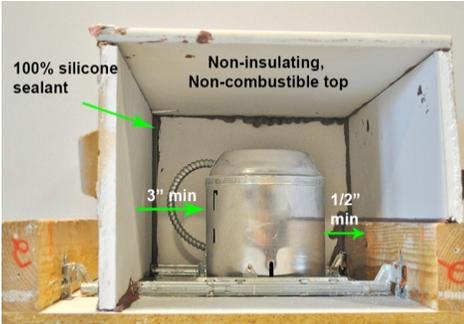
Non-IC rated recessed light fixtures should be dammed from insulation



**After**

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

## 4.1001.1a - Air barrier system



Box should be constructed with clearances in mind



Sealed box should be constructed of fire-rated drywall



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

4.1001.1b; 4.1001.1c; 4.1001.1d

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## 4.1001.3a

### Desired Outcome:

Combustible materials kept away from combustion sources

### Specification(s):

Holes, penetrations, and bypasses will be sealed

Dams will be fixed in places that maintain required clearance

### Objective(s):

Prevent air leakage

Ensure insulation dams maintain clearance

### Tools:

1. Metal snips
2. Caulk gun
3. Fasteners

### Materials:

1. 26-gauge steel sheeting
2. High temperature caulk
3. Caulk
4. Backer rod
5. Spray foam



 Before

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



 After

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

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## 4.1001.3a - Verify attic prep



Gaps around flues and penetrations need to be sealed before insulating



High temperature caulk should be used for flues and chimneys



26-gauge steel should be used to construct seals and dams on flues



Only construct dam after sealing has been completed properly



Dammed chimneys, flues and light fixtures prevent fires

## 4.1001.3b

### Desired Outcome:

Combustible materials kept away from combustion sources

### Specification(s):

A rigid dam having a height greater than the insulation to be installed will be constructed to ensure a 3" clearance between combustion flue vent and dam

Chimney vents will have an airspace clearance to combustibles in accordance with ND State Building Code

### Objective(s):

Ensure dam material does not bend, move, or sag

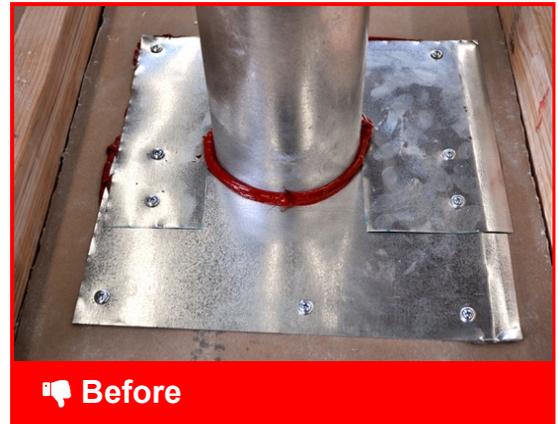
Prevent a fire hazard

### Tools:

1. Metal snips

### Materials:

1. 26-gauge steel sheeting
2. Fasteners



 Before

To prevent fire hazards, flues, chimneys, and light fixtures require dams



 After

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

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## 4.1001.3d

### Desired Outcome:

Combustible materials kept away from combustion sources

### Specification(s):

Documentation of material and R-value will be provided to occupant

### Objective(s):

Provide occupant with documentation of installation



### Best Practice

Provide occupant with documentation of and about insulation installed

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4.1003.3c; 4.1005.1c; 4.1005.3e; 4.1005.3e; 4.1088.3c; 4.1301.2d;

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4.1302.1d; 4.1301.3d; 4.1301.1d; 4.1301.4d; 4.1301.5e; 4.1301.6e

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4.1301.7d; 4.1301.8d; 4.1103.1b

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## 4.1001.4a

### Desired Outcome:

Attic ventilation meets code requirements and insulation is protected from wind washing

### Specification(s):

If soffit venting or eave venting is present, baffles will be mechanically fastened to block wind entry into insulation or to prevent insulation from blowing back into the attic

If soffit venting or eave venting is present, baffles will be installed to maintain clearance between the roof deck and baffle in accordance with manufacturer specifications

Installation will allow for the highest possible R-value above the top plate of the exterior wall

### Objective(s):

Ensure insulation R-value is not reduced

Maintain attic ventilation

### Tools:

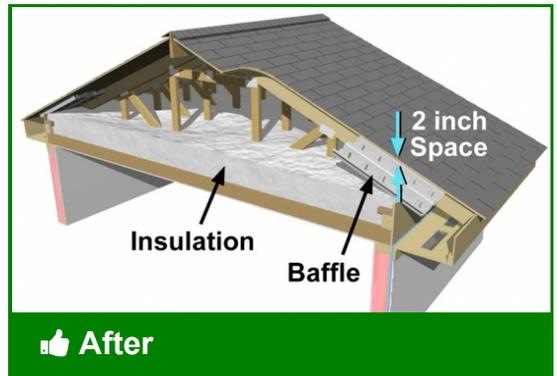
- 1. Stapler

### Materials:

- 1. Baffles
- 2. Staples



Insulation should not block vented eaves



Baffles installed in vented attics to allow air flow past insulation

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## 4.1003.3a

### Desired Outcome:

Insulation reduces heat flow through unvented roof

### Specification(s):

Code compliant ventilation will be installed before insulation

### Objective(s):

Reduce possibility of moisture issues

### Tools:

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

### Materials:

1. Metal lath
2. Stucco



Unvented flat roofs should have venting installed



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

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## 4.1003.3b

### Desired Outcome:

Insulation reduces heat flow through unvented roof

### Specification(s):

Roof cavities will be blown with loose fill insulation (or roof cavities will be dense packed with insulation) without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value

### Tools:

1. Insulation machine

### Materials:

1. Loose fillable or dense packable insulation



**Before**

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



**In Progress**

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

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## 4.1004.1a

### Desired Outcome:

Airtight cavity and insulated knee wall

### Specification(s):

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

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

If fabric is used before dense packing, it will be secured, according to manufacturers specifications or with furring strips every wall stud

If rigid material is used, material will be installed to cover 100% of the surface of the accessible knee wall area

If foam sheathing is used, sheathing will be listed for uncovered use in an attic or covered with a fire barrier

### Objective(s):

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

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

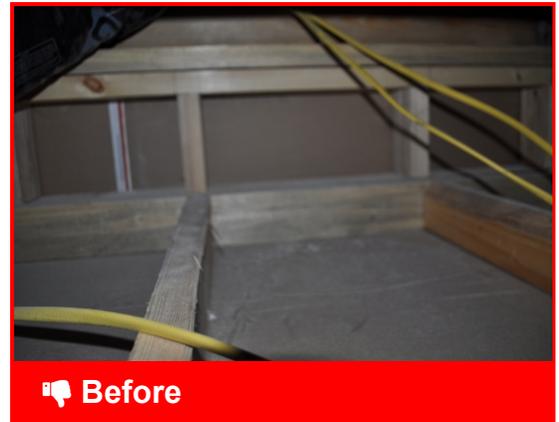
Ensure material will not tear under stress from wind loads or insulation

### Tools:

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

### Materials:

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



**Before**

Knee walls often need sealing and insulation



**After**

Knee wall is prepped for dense pack insulation

## 4.1004.1a - Backing



Knee walls missing top plates need one created from rigid material



Top plate holds dense pack insulation in cavity



New top plate should be sealed to surrounding joists and studs



Bottom plates also need to be installed. Measure for size



Cut to size and attempt to install in line with air barrier above



Seal to surrounding joist



If using house-wrap or fabric, tack in place with furring strips or staples



Drywall is also a good barrier for dense packing knee walls

## 4.1004.1b

### Desired Outcome:

Airtight cavity and insulated knee wall

### Specification(s):

All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates

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

Follow manufacturer's requirements for fiberglass dense pack applications

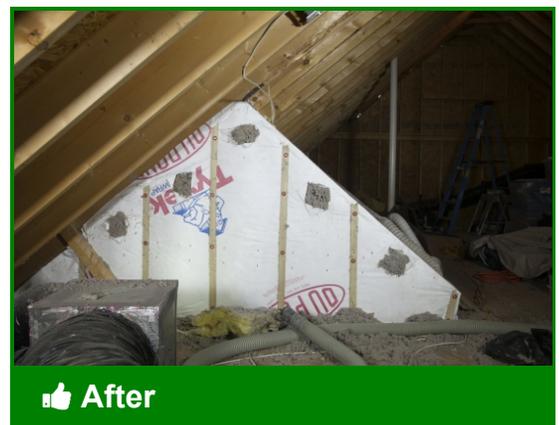
### Objective(s):

Eliminate misalignment of existing insulation

Prevent insulation from settling or moving



Existing batt insulation should be adjusted to fit properly



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

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## 4.1004.1b - Installation



Attach furring strips to create pockets for dense-pack insulation



Insulation should meet manufacturer specifications for density.

## 4.1004.2a

### Desired Outcome:

Airtight cavity and properly insulated knee wall

### Specification(s):

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

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

### Objective(s):

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

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

Create an air barrier

### Tools:

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

### Materials:

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



Top plate is missing from knee wall



New top plate is sealed to adjacent framing

4.1005.2b

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## 4.1004.2b

### Desired Outcome:

Airtight cavity and properly insulated knee wall

### Specification(s):

Insulation will be installed using one of the following methods:

- New batts will be installed in accordance with manufacture specifications
- All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates

### Objective(s):

Eliminate misalignment of existing insulation

### Tools:

1. Utility knife
2. Tape measure

### Materials:

1. Fiberglass batts



**Before**

Knee wall with batts improperly installed and missing from stud bays



**After**

Properly fit insulation filling full volume of stud bay

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## 4.1004.2c

### Desired Outcome:

Airtight cavity and properly insulated knee wall

### Specification(s):

If rigid material is used, material will be installed to cover 100% of the surface of the knee wall

If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier

### Objective(s):

Prevent insulation from settling or moving

### Tools:

1. Utility knife
2. Tape measure
3. Drill

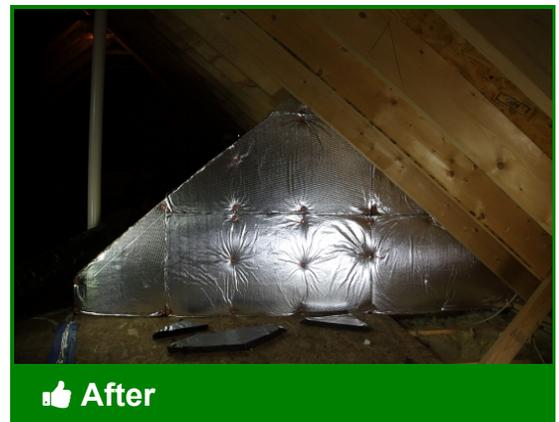
### Materials:

1. Drywall
2. House wrap



 Before

Knee walls with batt insulation require covering



 After

Foam sheathing? Needs to be covered with a fire barrier

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## 4.1004.2c - Backing knee wall



Fiberglass batts in attic knee walls can be held in place by house wrap



If foam sheathing is used, it needs to be covered with a fire barrier

## 4.1005.1a

### Desired Outcome:

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

### Specification(s):

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

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

Open electrical junction boxes will have covers installed

### Objective(s):

Access the workspace

Provide location of electrical junctions for future servicing

Prevent an electrical hazard

### Tools:

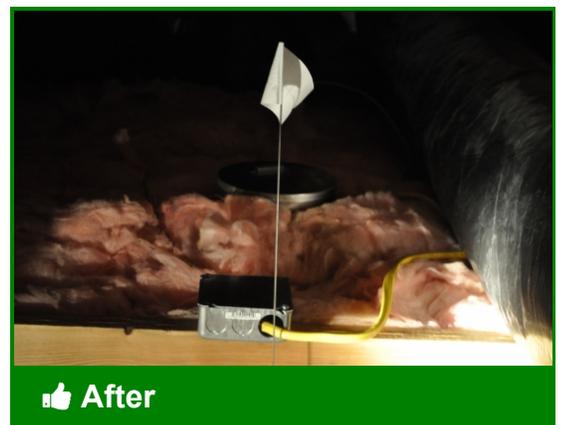
1. Hammer
2. Pry bar

### Materials:

1. Flags



Remove flooring in attic spaces to access floor cavities and insulate



Flag electrical junctions to make future maintenance and repairs easier

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## 4.1005.2a

### Desired Outcome:

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

### Specification(s):

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

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

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

Open electrical junctions will have covers installed

Insulation dams and enclosures will be installed as required

### Objective(s):

Access the workspace

Verify uniformity of insulation material

Provide location of electrical boxes for future servicing

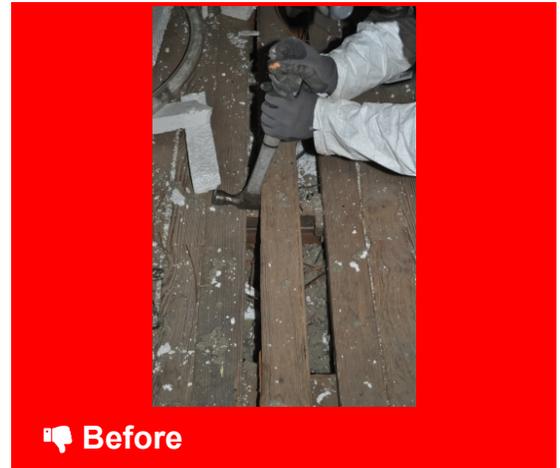
Prevent an electrical hazard

### Tools:

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

### Materials:

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



**Before**

Accessible attic floors should be air sealed and insulated



**After**

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

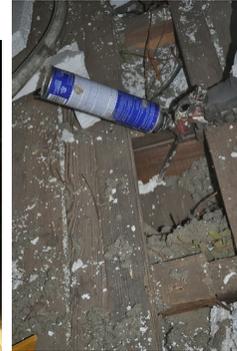
## 4.1005.2a - Preparation



Check cavity for electrical junctions and penetrations



Flag and install covers on electrical junctions



Seal any penetrations



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



Install depth markers and insulation dams above height of insulation

4.1005.1b; 4.1005.1a

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## 4.1005.2b

### Desired Outcome:

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

### Specification(s):

Existence of air barrier material in line with the knee walls will be installed or verified when dense packing

Air barrier material will not bend, sag, or move once dense packed

### Objective(s):

Hold dense pack in place

### Tools:

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

### Materials:

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



When missing, bottom plates must be installed under knee walls



New bottom plates complete air barrier and hold insulation in place

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# 4.1005.2c

## Desired Outcome:

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

## Specification(s):

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

## Objective(s):

Reduce heating and air conditioning costs

Improve comfort

Minimize noise

## Tools:

1. Insulation machine

## Materials:

1. Loose fill insulation



**Before**

Accessible attic floor should be air sealed and insulated



**After**

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

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## 4.1005.2d

### Desired Outcome:

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

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

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

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

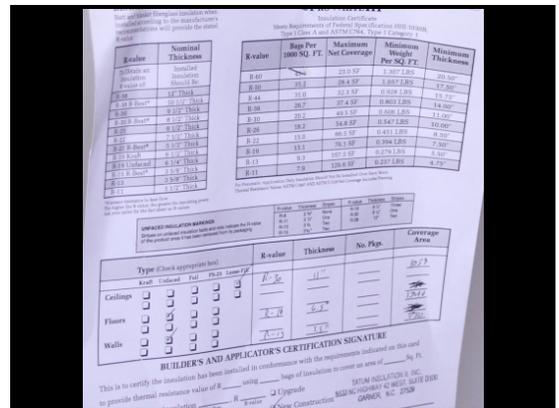
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



**Best Practice**

Information on insulation installed should be posted nearby



**Best Practice**

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

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

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4.1005.4d; 4.1005.5d

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## 4.1005.5a

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

Existence of air barrier material in line with the knee walls will be installed or verified when dense packing

Air barrier material will not bend, sag, or move once dense packed

### Objective(s):

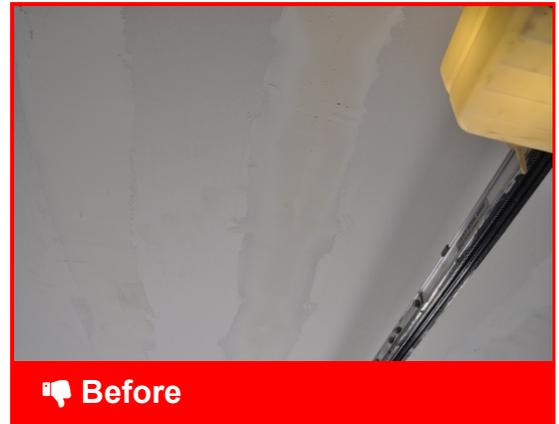
Hold dense pack in place

### Tools:

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

### Materials:

1. XPS or other rigid material



 Before

This finished garage below a bonus room is an unconditioned space



 After

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

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## 4.1005.5b

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

Each cavity will be 100% filled to consistent density:

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

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

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

### Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows

### Tools:

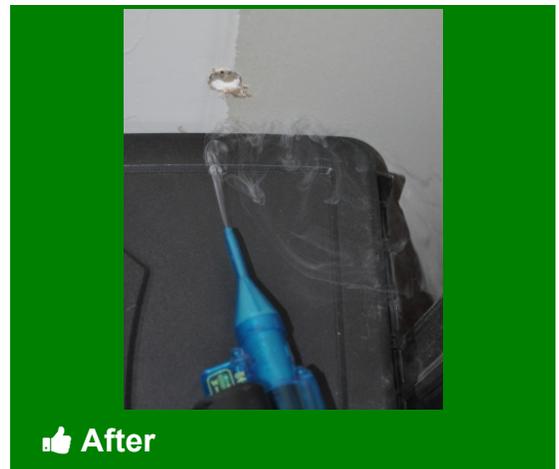
1. Insulation machine
2. Drill
3. Smoke pencil
4. Blower door
5. Small hole saw bit

### Materials:

1. Cellulose insulation
2. Dense packable insulation
3. Spackle
4. Seam tape



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



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

## 4.1005.5c

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

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

### Objective(s):

Prevent a fire hazard



 Before

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



 After

Clear dams of any insulation or debris in order to minimize risk of fire

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## 4.1006.1a

### Desired Outcome:

Pull-down attic stair properly sealed and insulated

### Specification(s):

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

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

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

### Objective(s):

Achieve uniform R-value

Prevent loose insulation from entering the living area

### Tools:

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

### Materials:

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



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



Insulated pull-down stairs cover installed to prevent air leakage

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## 4.1006.1b

### Desired Outcome:

Pull-down attic stair properly sealed and insulated

### Specification(s):

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

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

### Objective(s):

Prevent air leakage

### Tools:

1. Caulk gun

### Materials:

1. Weatherstripping
2. Spray foam
3. Caulk



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



To preserve thermal envelope, an airtight seal needs to be created

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## 4.1006.2a

### Desired Outcome:

Attic access door properly sealed and insulated

### Specification(s):

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

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

### Objective(s):

Achieve uniform R-value on the attic door or hatch

Achieve uniform R-value on the attic floor

Prevent loose attic floor insulation from entering the living area

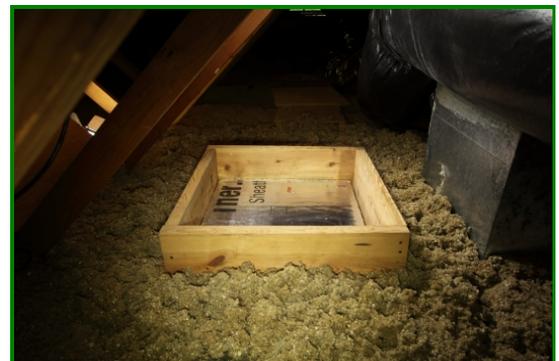
### Materials:

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



 Before

Uninsulated attic hatches and access panels weaken the thermal envelope



 After

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

4.1006.2b

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## 4.1006.2c

### Desired Outcome:

Attic access door properly sealed and insulated

### Specification(s):

Insulation will be permanently attached and in complete contact with the air barrier

### Objective(s):

Insulate to prescribed R-value

### Tools:

1. Caulk gun
2. Utility knife

### Materials:

1. XPS
2. Adhesive



 Before

Unsealed and uninsulated attic hatches and access doors allow leakage



 After

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

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## 4.1088.3b

### Desired Outcome:

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

### Specification(s):

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

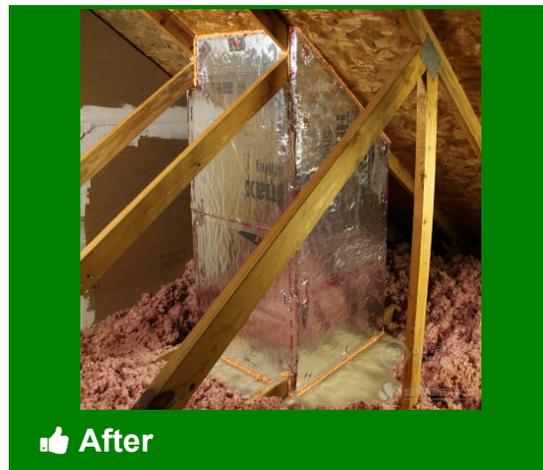
Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value



Uninsulated, unsealed skylight well



Insulated, air sealed skylight well

### Tools:

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

### Materials:

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

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

## 4.1102.1a

### Desired Outcome:

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

### Specification(s):

Holes and penetrations will be sealed

Bypasses will be blocked and sealed

### Objective(s):

Prevent air leakage

### Tools:

1. Caulk gun

### Materials:

1. Backer rod
2. Spray foam
3. Caulk



Penetrations and bypasses create places where blown in insulation can leak



Sealed penetrations offer leakage protection and keep insulation in place

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## 4.1102.1b

### Desired Outcome:

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

### Specification(s):

Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

### Objective(s):

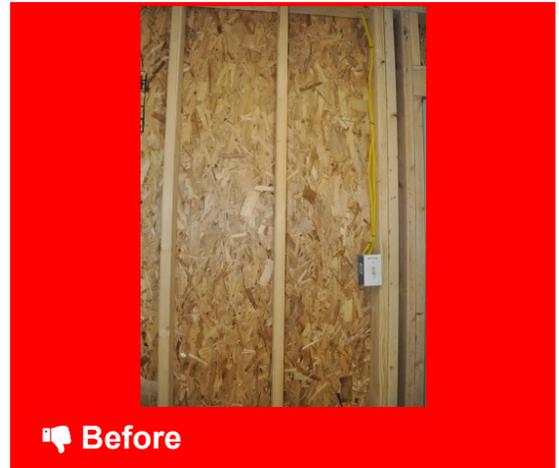
Insulate to prescribed R-value

### Tools:

1. Insulation machine
2. Staple gun

### Materials:

1. Loose fillable insulation
2. Netting
3. Staples
4. Fiberglass batts



 Before

Open walls should be insulated



 After

Well-insulated rooms are significantly more comfortable in all seasons

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## 4.1102.1c

### Desired Outcome:

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

### Specification(s):

Verification of complete installation without gaps, voids, compressions, misalignments, or wind intrusions will be provided

### Objective(s):

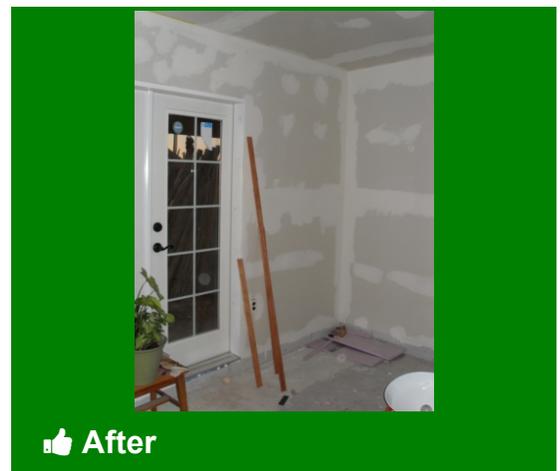
Install insulation correctly

### Tools:

1. Hands
2. Eyes



Verify insulation is properly installed before drywalling



Once proper installation is verified, begin drywalling to finish wall

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## 4.1103.1a

### Desired Outcome:

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

### Specification(s):

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

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

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

### Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows



Make accurate count of insulation bags to be installed



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

4.1103.2c

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## 4.1103.2a

### Desired Outcome:

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

### Specification(s):

Details remaining in or between completed wall sections will be located and accessed

### Objective(s):

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

### Tools:

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



Cavities missing insulation allow greater heat transfer than insulated ones



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

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## 4.1103.2b

### Desired Outcome:

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

### Specification(s):

Backing will be provided and all newly uncovered openings will be sealed with air barriers, foam, or mastic, maintaining all required clearances

### Objective(s):

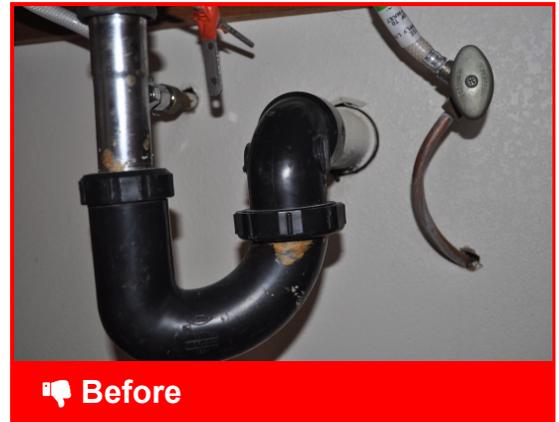
Ensure the air barrier is connected across all accessible house elements

### Tools:

1. Caulk gun

### Materials:

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



Unsealed penetrations should be sealed to ensure insulation stays in place



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

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## 4.1103.2d

**Desired Outcome:**

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

**Specification(s):**

Completed wall sections will be viewed using infrared camera with blower door operating

Any voids or low density areas will be drilled and re-packed

**Objective(s):**

Establish air barrier and thermal boundary

Confirm no voids or hidden air flows remain

**Tools:**

- 1. Infrared camera



Uninsulated exterior wall cavities to be insulated



Reduced temperature difference indicating insulated wall cavities

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## 4.1103.2e

### Desired Outcome:

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

### Specification(s):

Installation holes will be plugged as follows:

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

All construction debris and dust will be collected and removed

### Objective(s):

Ensure house is returned to watertight and clean condition

### Tools:

1. Taping knife
2. Caulk gun
3. Drill
4. Paint brush

### Materials:

1. Spackle
2. House wrap
3. Lath
4. Stucco
5. Fasteners
6. Adhesive
7. Primer
8. Drywall
9. XPS

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**In Progress**

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



**After**

When repair is finished, it shouldn't be obvious any work was done

## 4.1103.2e - Close holes



For interior access, locate access holes at studs for easier patching



Once drywall patches are spackled, prime and paint.



For exterior access, use a drop cloth or gutter to help with clean up



Plug holes with rigid material that will not move or sag over time



For stucco and plaster patches, lath will need to be used to hold weight



If possible, maintain house wrap, or replace it after holes are plugged



Put siding back in place, or return exterior finish to match remaining wall

## 4.1301.1b

### Desired Outcome:

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

### Specification(s):

Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

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

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value

### Tools:

1. Utility knife
2. Tape measure

### Materials:

1. Kraft-faced fiberglass batts to work order specifications



**Before**

Uninsulated floors above unconditioned spaces are an energy drain



**After**

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

4.1301.6b

## 4.1301.1c

### Desired Outcome:

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

### Specification(s):

Batts will be secured with physical fasteners

### Objective(s):

Ensure insulation remains in contact with subfloor

### Tools:

1. Utility knife
2. Drill
3. Staple gun

### Materials:

1. Lightning rods
2. Twine
3. Fasteners



Fiberglass batts should not be hanging away from subfloor



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

4.1301.5c; 4.1301.6c

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## 4.1301.2b

### Desired Outcome:

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

### Specification(s):

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

Netting or fabric will meet local fire codes

### Objective(s):

Secure insulation

### Tools:

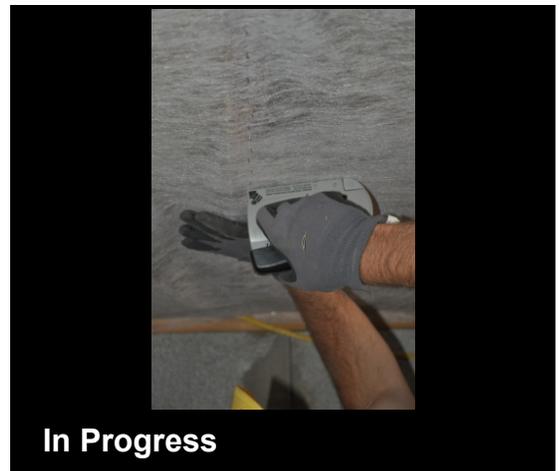
1. Utility knife
2. Scissors
3. Stapler

### Materials:

1. Fabric netting
2. Staples



Uninsulated floors above unconditioned spaces are an energy drain



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

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## 4.1301.2c

### Desired Outcome:

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

### Specification(s):

Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications

Insulation will be installed to prescribed R-value

Insulation will be in continuous contact with air barrier

### Objective(s):

Insulate to prescribed R-value

Ensure a continuous thermal boundary between conditioned and unconditioned space

### Tools:

1. Utility knife
2. Insulation machine

### Materials:

1. Loose fill fiberglass



**In Progress**

With netting in place, insulation can begin



**After**

Cavities filled to manufacturer specs to achieve prescribed r-value

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## 4.1301.3b

### Desired Outcome:

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

### Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

Seams and penetrations will be sealed

### Objective(s):

Relocate air barrier

### Tools:

1. Utility knife
2. Saw
3. Drill
4. Caulk gun

### Materials:

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



 Before

Uninsulated floors over unconditioned spaces are an energy drain



 After

Rigid barriers provide air sealing and create cavities for insulation

4.1301.4b; 4.1301.6d; 4.130.7b; 4.1301.8b

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## 4.1301.3c

### Desired Outcome:

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

### Specification(s):

Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value

### Tools:

1. Insulation machine
2. Caulk gun

### Materials:

1. Loose fill insulation
2. Caulk



Before

Once rigid barrier is sealed, insulation can be blown in



After

4.1301.7c; 4.1301.4c;

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## 4.1301.5a

### Desired Outcome:

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

### Specification(s):

Air barrier will be installed between joists and sealed

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

### Objective(s):

Separate cantilevered floor from conditioned floor space

Allow for insulation



**Before**

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



**After**

Cavity has been blocked, sealed, and insulated. Rigid air barrier is hidden behind insulation in this photo

### Tools:

1. tape measure
2. utility knife
3. flashlight
4. caulking gun
5. foam gun

### Materials:

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

1. Stuff the cavities with fiberglass insulation as a backer, and then apply two-part spray polyurethane foam to seal the openings. 2. Cut and install drywall, plywood, OSB, or rigid foam board in each cavity, then seal around the edges with foam or caulk. 3. Install dense-pack insulation in cantilevered

area, being careful to extend it inward past the supporting wall (this also accomplishes insulating the cantilevered floor area).

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

## 4.1301.5a - Air barrier



Measure cavity to determine size necessary for blocking.



Measure and cut blocking to fit snugly between floor joists.



Ensure the blocking is placed to the most interior edge of the top plate of the wall below.



Air seal blocking around its perimeter edges with foam or caulk.



Cut batt insulation to match the size of the blocking.

## 4.1301.5b

### Desired Outcome:

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

### Specification(s):

Air barrier will be insulated between joist from top plate of the wall below to subfloor above

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

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

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value



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



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

### Tools:

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

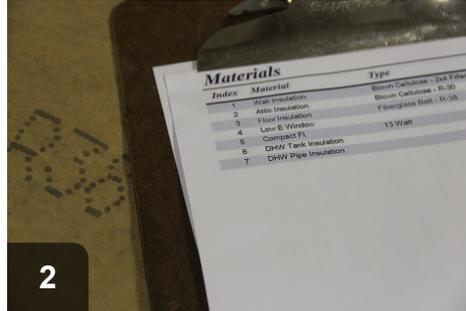
### Materials:

1. batt insulation - kraft-faced or unfaced
2. insulation supports

## 4.1301.5b - Installation



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



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



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



4 Ensure the batt is positioned correctly.



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

## 4.1301.5c

### Desired Outcome:

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

### Specification(s):

Batts will be secured with physical fasteners

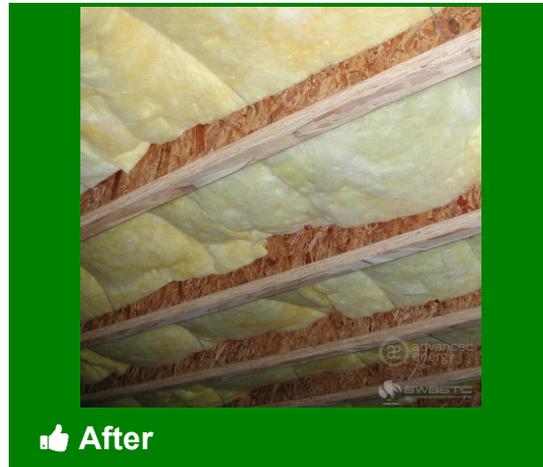
### Objective(s):

Ensure insulation remains in contact with subfloor and air barrier



 Before

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



 After

Fiberglass floor insulation properly installed with wire supports

### Tools:

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

### Materials:

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

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

## 4.1301.5c

### Desired Outcome:

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

### Specification(s):

Batts will be secured with physical fasteners

### Objective(s):

Ensure insulation remains in contact with subfloor and air barrier



 Before

Insulation should be secured to prevent drooping or movement



 After

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

### Tools:

1. Utility knife
2. Drill
3. Staple gun

### Materials:

1. Lightning rods
2. Twine
3. Fasteners

## 4.1301.5d

### Desired Outcome:

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

### Specification(s):

Exterior soffit material will be installed and sealed

### Objective(s):

Cover and protect insulation



Cavities have been insulated but are still exposed.



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

### Tools:

1. claw hammer
2. drill
3. mechanical fasteners

### Materials:

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

## 4.1301.8c

### Desired Outcome:

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

### Specification(s):

Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value

### Tools:

1. Insulation machine
2. Caulk gun

### Materials:

1. Dense packable insulation
2. Caulk



**Before**

Once rigid barrier has been sealed, insulation can be blown in



**After**

Rigid barrier should be sealed after insulating to maintain air barrier

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## 4.1402.2a

### Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

### Specification(s):

Regional IECC will be followed for required R-values

### Objective(s):

Improve thermal performance of the basement and living space

	Continuous Rigid Insulation, Interior or Exterior	Interior Cavity Insulation
Zone 1	0	0
Zone 2	0	0
Zone 3	5	13
Zone 4, except marine	10	13
Zone 5 and marine 4	15	19
Zone 6-8	16	19

### Best Practice

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

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## 4.1402.2b

### Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

### Specification(s):

A continuous air barrier will be installed on the warm side of the insulation

### Objective(s):

Prevent condensation on the basement wall

### Tools:

1. Utility knife
2. Tape measure
3. Drill
4. Taping knife

### Materials:

1. XPS insulation board
2. Kraft-faced fiberglass batts
3. Drywall
4. Spackle
5. Seam tape
6. Fasteners



Basement shows no sign of ground water penetration, but needs insulation



Insulation and drywall create an air barrier

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## 4.1402.2b - Air barrier



XPS insulation board is a non-absorbent insulation option



The drywall still provides an air barrier to keep moisture build up on wall

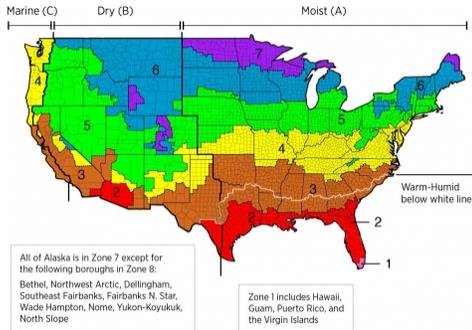


OR Kraft-faced fiberglass batts can be used with paper toward living space



Both kraft-face and drywall create air barrier, but batts are absorbent

## 4.1402.2c - Vapor permeability



Determine in which zone you are working before selecting work materials



Many light-weight drywall brands have higher perm ratings for humid zones



In zones 7&8, vapor permeability is undesirable. Use a vapor retarder

## 4.1601.2a

### Desired Outcome:

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

### Specification(s):

Duct insulation on all ducts located in unconditioned spaces will be a minimum of R-8, in accordance with local code, or buried under attic insulation, whichever is greater, and have an attached vapor retarder

Hot humid and warm coastal regions will not bury ducts

### Objective(s):

Decrease heat loss and condensation problems



Uninsulated ducts in unconditioned spaces are an energy drain



Properly insulated ducts operate at much higher rates of efficiency

4.1601.2d; 6.6002.1b

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## 4.1601.2c

### Desired Outcome:

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

### Specification(s):

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

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

### Objective(s):

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

### Tools:

1. Scissors
2. Metal snips

### Materials:

1. Nylon twine
2. Wire
3. Tie bands



Materials holding insulation in place should not compress or kink duct



Durable materials can be attached without compressing insulation

6.6002.1c

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## 5.3003.2a

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Nozzle size will be correct for design input and within equipment firing rate of the heating system manufacturer

### Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

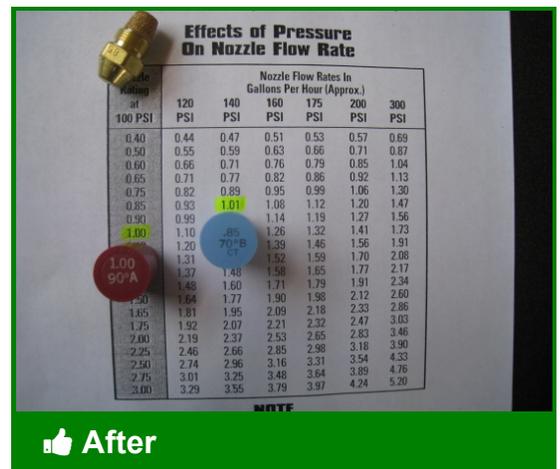
Ensure equipment is durable

### Tools:

1. Calipers



Locate nozzles on oil-fired water heaters and furnaces



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

## 5.3003.2b

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Measurement will be verified in accordance with manufacturer specifications

### Objective(s):

Ensure equipment operates as designed

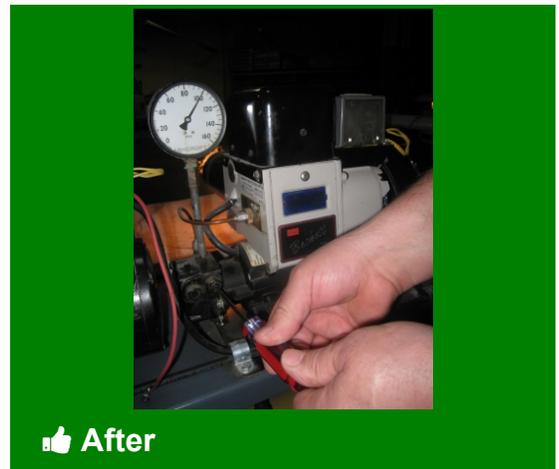
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable



Check oil-fired furnaces and water heaters for proper fuel pressure



👍 After

Verify that fuel pressure matches manufacturer's specifications

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## 5.3003.2c

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Measurement will be verified in accordance with manufacturer specifications

### Objective(s):

Ensure equipment operates as designed

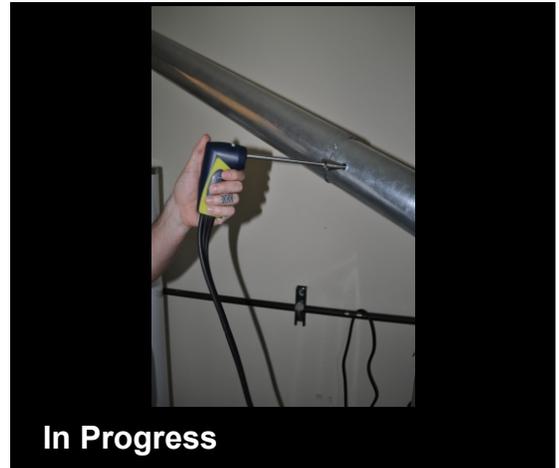
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable

### Tools:

1. Combustion analyzer with probe



Test flue gases to determine steady state efficiency



At steady state, this furnace tests at 83%-- within manufacturer tolerances

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## 5.3003.2d

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Smoke spot reading will be in accordance with burner manufacturer specifications

If smoke test is more than actionable levels, specify a clean and tune

### Objective(s):

Ensure equipment operates as designed

Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable

### Tools:

1. Smoke testing pump

### Materials:

1. Filter paper



Verify oil-fired furnaces and water heaters are operating safely



### Best Practice

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

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## 5.3003.2e

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Net stack temperature will be measured and verified in accordance with manufacturer specifications

### Objective(s):

Ensure equipment operates as designed

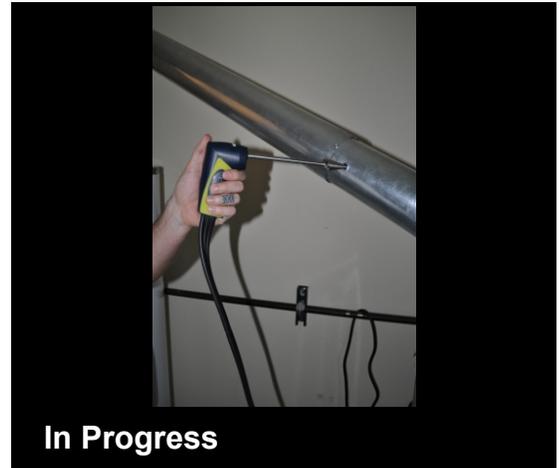
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable

### Tools:

1. Combustion analyzer with probe



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



T-stack minus T-air equals net stack temperature. Check against specs

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

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## 5.3003.2f

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Measurement will be verified in accordance with industry manuals and manufacturer specifications

### Objective(s):

Ensure equipment operates as designed

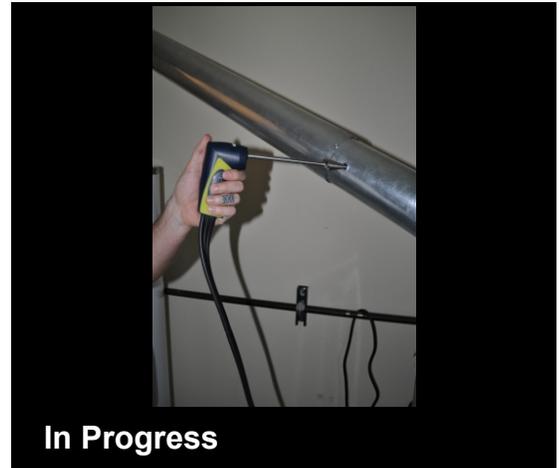
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable

### Tools:

1. Combustion analyzer with probe
2. Drill



**In Progress**

Verify oil-fired appliances are burning safely by testing CO<sub>2</sub> and O<sub>2</sub> levels



**After**

Levels should be within industry standards and match manufacturer specs

15.4% should be the highest allowable level of CO<sub>2</sub> produced by an oil-fired appliance.

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

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## 5.3003.2g

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Excess air will be calculated and shown to be in accordance with manufacturer specifications

### Objective(s):

Ensure equipment operates as designed

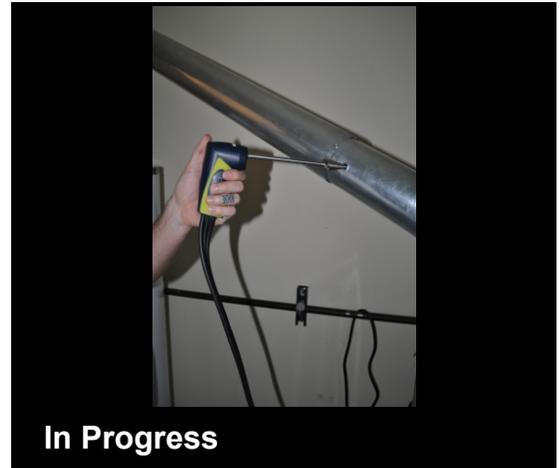
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable

### Tools:

1. Combustion analyzer with probe
2. Drill



**In Progress**

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



**After**

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

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## 5.3003.2h

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Undiluted flue gases will be checked with a calibrated combustion analyzer

If CO levels exceed levels in the chart below, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)

### Objective(s):

Ensure equipment operates as designed

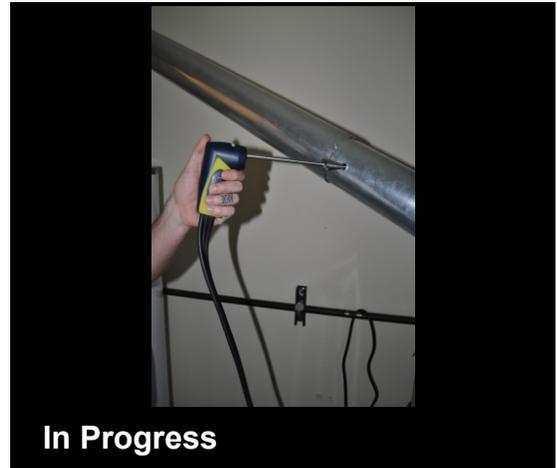
Ensure equipment operates safely

Ensure equipment operates efficiently

Ensure equipment is durable

### Tools:

1. Combustion analyzer with probe
2. Drill



### In Progress

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



### After

CO should measure less than 200ppm

### CO Thresholds for Fossil-Fuel Fired Combustion Appliances Appliance

	Threshold Limit
Central Furnace (all categories)	400 ppm air free
Boiler	400 ppm air free
Floor Furnace	400 ppm air free
Gravity Furnace	400 ppm air free
Wall Furnace (BIV)	200 ppm air free
Wall Furnace (Direct Vent)	400 ppm air free
Vented Room Heater	200 ppm air free
Unvented Room Heater	200 ppm air free
Water Heater	200 ppm air free

## 5.3003.10a

### Desired Outcome:

Equipment and condensate drain operate as designed

### Specification(s):

Connections in condensate drain system will be watertight

### Objective(s):

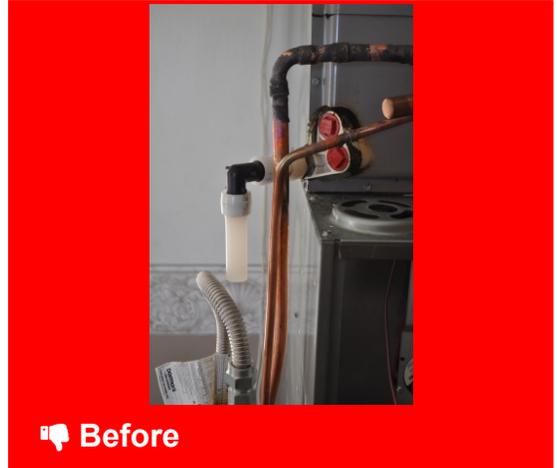
Ensure condensate drain connections do not leak

### Tools:

1. Hacksaw
2. Crimper

### Materials:

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



HVAC equipment needs condensate drainage to prevent water damage



Drainage pipes should be sealed to be water-tight

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## 5.3003.10b

### Desired Outcome:

Equipment and condensate drain operate as designed

### Specification(s):

Condensate drainlines will be insulated with a minimum 1" of insulation with a vapor retarder when there is potential for condensation or freezing on the drainline

### Objective(s):

Ensure condensate drain connections do not leak

### Tools:

1. Tape measure
2. Utility knife

### Materials:

1. 1" thick pipe insulation
2. Zip ties



Once drainage pipes cross into unconditioned space, they can freeze



Pipes in unconditioned spaces should be insulated with 1" pipe insulation

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## 5.3003.10c

**Desired Outcome:**

Equipment and condensate drain operate as designed

**Specification(s):**

Secondary drain pan and float switch will be installed when overflow could damage finished surfaces

OR

Float switch in the primary condensate drain for upflow systems will be installed when overflow could damage finished surfaces

**Objective(s):**

Ensure condensate drain connections do not leak



A float switch should be installed to prevent overflow and damage

5.3003.10g

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## 5.3003.10d

### Desired Outcome:

Equipment and condensate drain operate as designed

### Specification(s):

Condensate drain pumps will be installed when condensate cannot be drained by gravity

Power source for pump will be installed

Operation and drainage of pump will be verified

### Objective(s):

Ensure condensate drain connections do not leak



 **Before**

HVAC equipment that drains upward through a roof cannot drain naturally



 **After**

For non-gravity draining systems, a pump is necessary

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## 6.6002.1a

### Desired Outcome:

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

### Specification(s):

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

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

### Objective(s):

Effectively move the required volume of air

### Tools:

1. Metal snips
2. Drill

### Materials:

1. Metal duct piping
2. Fasteners



👎 Before

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



👍 After

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

See also ASHRAE 62.2-2013.

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## 6.6002.1d

### Desired Outcome:

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

### Specification(s):

Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws

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

Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool

PVC-to-PVC materials will be fastened with approved PVC cement

Other specialized duct fittings will be fastened in accordance with manufacturer specifications

In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

### Objective(s):

Effectively move the required volume of air

Preserve the integrity of the duct system



Fan duct is disconnected and venting into the attic space.



Fan has been vented with sealed, insulated duct material.

**Tools:**

1. drill
2. tie band tensioner
3. brush

**Materials:**

1. tie bands
2. insulated flex duct
3. mastic
4. PVC primer
5. PVC cement

# 6.6002.1d - Duct connections



Apply mastic to the connection fitting.



Snug duct liner onto connection fitting.



Use zip tie and tensioner to secure liner to connection fitting.



Apply mastic to fan connection.



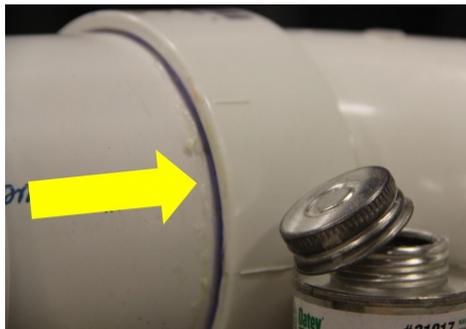
Using mechanical fasteners, secure connection fitting to fan connection.



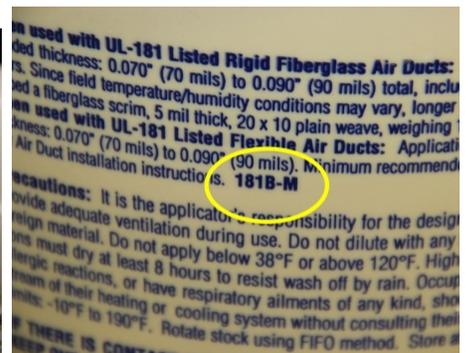
Snug insulation to fan housing and strap into place.



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



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



Sealants should show UL181-M or UL181B-M.

## 6.6002.1e

### Desired Outcome:

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

### Specification(s):

Flexible materials will be UL 181 listed or Air Diffusion Council approved

Rigid, kitchen fans gauges shall meet code requirements or authority having jurisdiction

### Objective(s):

Effectively move the required volume of air

Preserve the integrity of the duct system



**Bad Practice**

Existing duct is installed incorrectly and is not UL listed



**Best Practice**

This flexible duct conforms to UL 181

### Materials:

1. All materials should be UL 181 Listed
2. 30-gauge minimum Rigid Duct

## 6.6002.2a

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

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

### Objective(s):

Allow for ease of weatherproofing

### Tools:

1. Hole saw
2. Drill
3. Tape measure



Exhaust fans need exterior ventilation, often through roofs and walls



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

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## 6.6002.2b

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

A termination fitting with an integrated collar will be used

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

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

### Objective(s):

Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation

### Tools:

- 1. Drill

### Materials:

- 1. Fasteners



Termination fittings with no collar are to be avoided



Properly sized ducts with snug connections to collared fittings last longer

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## 6.6002.2c

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

Duct will be connected and sealed to termination fitting as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Fasteners will not inhibit damper operation

### Objective(s):

Effectively move the required volume of air to the outside

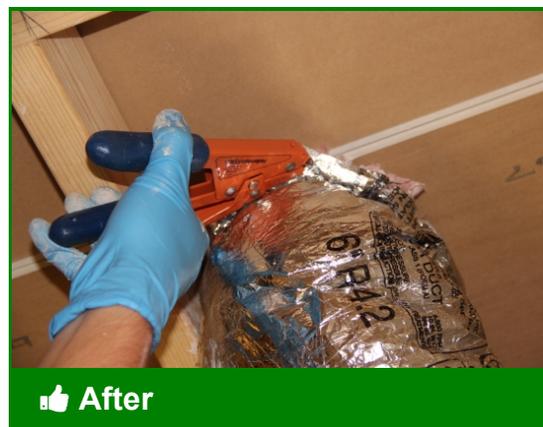
Preserve integrity of the building envelope

Ensure durable installation



 Before

Termination is not mechanically fastened, or sealed appropriately.



 After

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

## 6.6002.2d

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Installation will not inhibit damper operation

Manufacturer specifications will be followed

### Objective(s):

Preserve integrity of the building envelope

Ensure a weather tight and durable termination installation

Ensure unrestricted air flow

### Tools:

1. Hole saw
2. Caulk gun
3. Drill

### Materials:

1. Fasteners
2. Caulk



 Before

Holes for termination fitting need to be sealed to weatherproof



 After

Termination installation should follow shingling to deter water penetration

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## 6.6002.2e

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

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

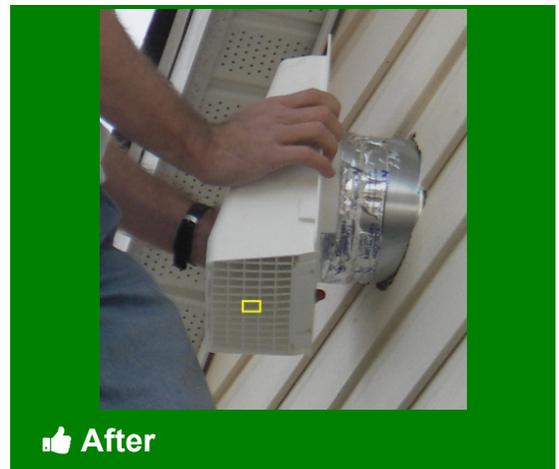
### Objective(s):

Prevent pest entry

Ensure proper air flow



Exhaust terminations without screens are an invitation to pest intrusion



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

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## 6.6002.2f

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

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

Terminations will be installed:

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

### Objective(s):

Prevent exhaust from reentering house

### Tools:

1. Measuring tape
2. Hole saw
3. Drill

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Exhaust vent has been improperly mounted too close to mechanical vent



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

## 6.6002.2g

**Desired Outcome:**

Securely installed termination fittings with unrestricted air flow

**Specification(s):**

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

**Objective(s):**

Prevent a fire hazard



**Before**

Kitchen exhaust vents should not be made from highly combustible materials



**After**

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

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## 6.6003.3a

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

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

### Objective(s):

Allow for ease of weatherproofing



 Before

Determine size to cut hole by measuring fan assembly and ducting



 After

A snug fit should be ensured to minimize weatherproofing required

### Tools:

1. Tape measure
2. Saw

## 6.6003.3b

### Desired Outcome:

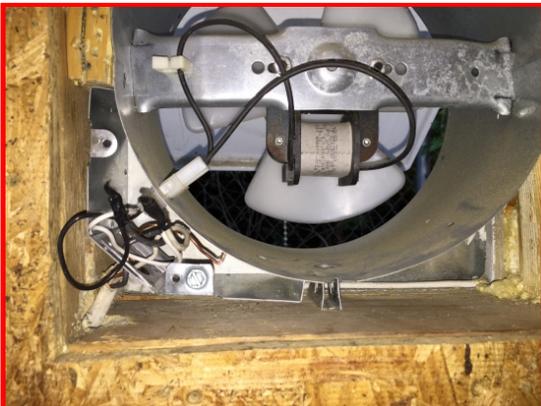
Through the wall fans installed to specification

### Specification(s):

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

### Objective(s):

Prevent an electrical hazard



👎 Before

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



👍 After

Fan junction box with cover installed

### Tools:

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

### Materials:

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

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

## 6.6003.3c

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

Fan outlet will be oriented toward the final termination location

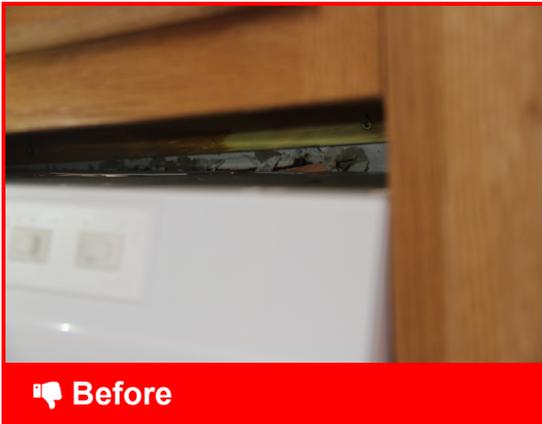
Fan will be oriented so the equivalent length of the duct run is as short as possible

Fan will be mounted securely according to manufacturer specifications

### Objective(s):

Install mounting fan securely

Ensure fan housing does not shake, rattle, or hum when operating



Improperly aligned fan



Fan is mounted securely with the termination outlet lined up.

### Tools:

1. drill
2. drill bits

### Materials:

1. fasteners

## 6.6003.3d

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Termination fitting installation will not inhibit damper operation

Manufacturer specifications will be followed

### Objective(s):

Preserve integrity of the building envelope

Ensure a weather tight and durable installation

Ensure unrestricted air flow



**Best Practice**

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



**Best Practice**

Termination is sealed and securely attached to the wall.

### Tools:

1. caulk gun
2. drill
3. drill bits
4. reciprocating saw
5. drywall saw or utility knife

### Materials:

1. weatherproof termination kit with pest screen
2. caulk or equivalent sealant
3. mechanical fasteners

## 6.6003.3e

### Desired Outcome:

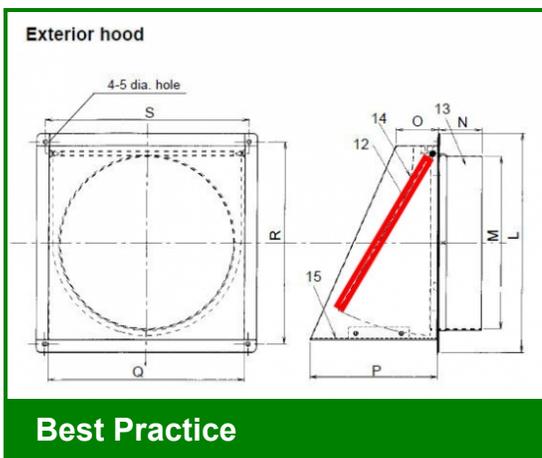
Through the wall fans installed to specification

### Specification(s):

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

### Objective(s):

Prevent reverse air flow when the fan is off



Damper should be installed to maintain exterior air barrier

## 6.6003.3f

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

### Objective(s):

Prevent air leakage through fan housing

Ensure a permanent seal to the building air barrier



**Best Practice**

Sealant should be waterproof and adhere to the desired surfaces.



**Best Practice**

Seal unused holes in the fan housing.

### Tools:

1. caulk gun

### Materials:

1. weatherproof, code approved caulk

## 6.6003.3g

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

### Objective(s):

Prevent air leakage around intake housing

Prevent a fire hazard



**Best Practice**

Sealant should be waterproof and adhere to desired surfaces.



**Best Practice**

Sealant should be applied to the fan housing where it comes in contact with the exterior wall.

### Tools:

1. caulk gun

### Materials:

1. code approved caulk

## 6.6003.3i

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

Air flows in CFM will be measured and adjusted to meet the design requirements

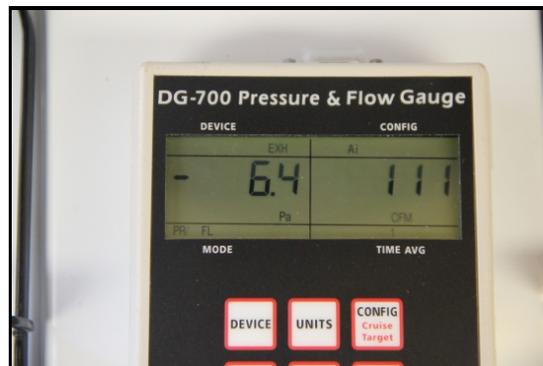
### Objective(s):

Exhaust sufficient air from desired locations to outside



**Best Practice**

Using a digital manometer, exhaust flow meter and fabricated cover, measure the fan flow.



**Best Practice**

Air flow should be within acceptable limits for the location of the fan.

### Tools:

1. exhaust fan flow meter
2. manometer

### Materials:

1. a fabricated cover for fans larger than the flow meter

## 6.6003.3i - Air flow



1 The exhaust fan flow meter won't fit most range hoods. A fabricated cover is needed.



2 A fabricated cover can be used so long as the opening is smaller than the meter itself and larger than the E1 opening.



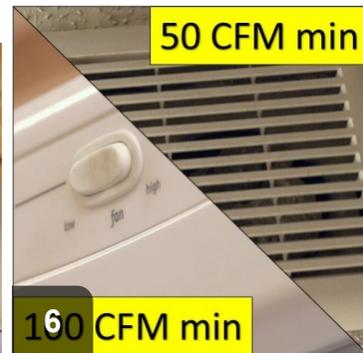
3 Attach a pressure hose to the exhaust fan flow meter.



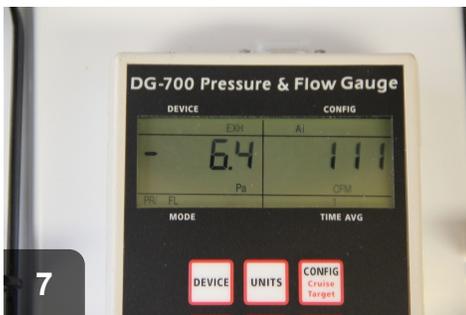
4 Attach a the hose to a T connection on channels A & B with the manometer set to measure exhaust fan flow.



5 With manometer properly set up, prepare to test air flow



Fans must pull the required CFM according to ASHRAE.



7 With the manometer Mode set to PR/FL, Device set to EXH, and Config set to E1, this fan pulls 111 CFM.



## 6.6003.3k

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

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

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

### Objective(s):

Ensure safe operation of combustion appliances

### Tools:

1. Manometer



Installing new ventilation can cause imbalances within the house



Test that depressurization limit is not being exceeded by new ventilation

See SWS 2.0299.1a-i for CAZ depressurization limits

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## 6.6005.1a

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

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

As short a run as practical of rigid sheet metal or semi-rigid sheet metal venting material will be used in accordance with manufacturer specifications

Dryer ducts exceeding 35' in duct equivalent length will have a dryer booster fan installed

Plastic venting material will not be used

Uninsulated clothes dryer duct will not pass through unconditioned spaces such as attics and crawl spaces

Ducts will be connected and sealed as follows:

- UL listed foil type or semi-rigid sheet metal to rigid metal will be fastened with clamp
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

In addition:

- Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used
- Condensing dryers will be plumbed to a drain

### Objective(s):

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



 **Before**

Dryer is vented outside, but with the incorrect material.



 **After**

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

**Tools:**

1. metal trimmers
2. drill

**Materials:**

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

## 6.6005.1b

**Desired Outcome:**

Dryer air exhausted efficiently and safely

**Specification(s):**

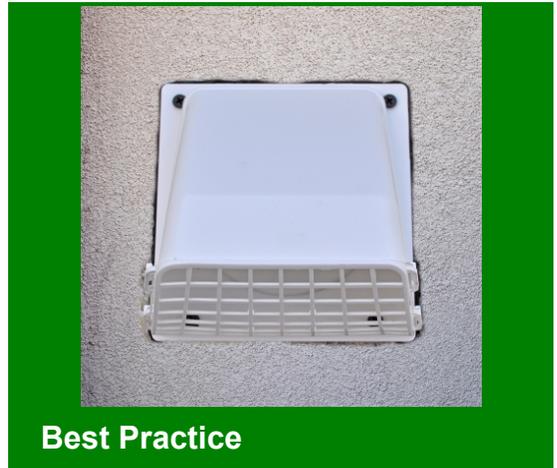
Termination fitting manufactured for use with dryers will be installed

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

**Objective(s):**

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



Termination fittings for dryers should have backdraft dampers

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## 6.6005.1d

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

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

### Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety

### Tools:

1. Manometer



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



Test to verify combustion appliances are within depressurization limits

See SWS 2.0299.1a-i for CAZ depressurization limits

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## 6.6005.1e

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

Occupant will be instructed to keep lint filter and termination fitting clean

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

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

### Objective(s):

Effectively move air from clothes dryer to outside



Neglect of clothes dryer maintenance can cause fire hazards



Occupants should be taught to clean lint filters and termination fittings

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## 6.6005.1e - Occupant education



In homes with booster fans, occupant should know location and how to clean



Occupants should be taught never to put flammable articles in dryer (in this case, oily rags)

## 6.6005.2b

### Desired Outcome:

Kitchen range fan installed to specification

### Specification(s):

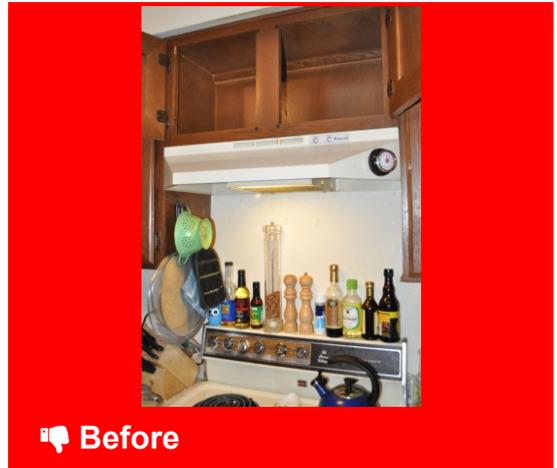
Kitchen range fans will be vented to the outdoors

Recirculating fans will not be used as a ventilating device

### Objective(s):

Remove cooking contaminants from the house

Preserve integrity of building envelope



Recirculating fans over ranges do not actually remove contaminants



Daylight visible through dampered kitchen exhaust proves venting access

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## 6.6005.2c

### Desired Outcome:

Kitchen range fan installed to specification

### Specification(s):

Kitchen range fans will be ducted to the outdoors

As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications

Ducting will be connected and sealed as follows:

- Metal-to-metal will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- For down-draft exhaust systems, PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

### Objective(s):

Preserve integrity of building envelope

Effectively move air from range to outside

### Tools:

1. Drill
2. Putty knife
3. Tape measure
4. Metal snips
5. Saw

### Materials:

1. Round metal ducting
2. Mastic
3. Fiberglass mesh tape
4. Fasteners



**Before**

Exhaust duct should be smooth-walled and in as short a run as possible



**After**

Daylight visible through dampered kitchen exhaust proves outside access

See also 6.6002.1d. Note: Only smooth-wall metal duct will be used, except for down-draft exhaust systems where PVC is acceptable as well. Flex duct is NOT acceptable for kitchen fan exhaust application.

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## 6.6005.2d

### Desired Outcome:

Kitchen range fan installed to specification

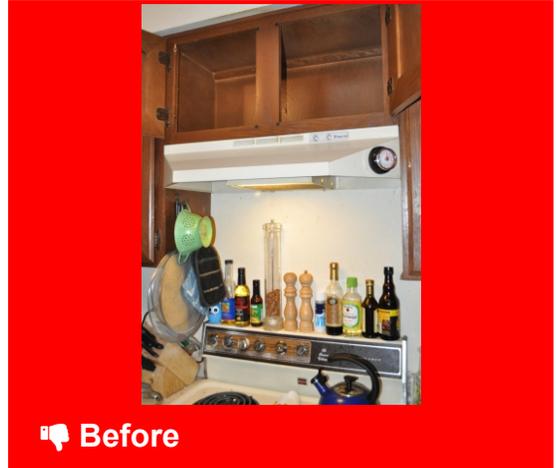
### Specification(s):

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

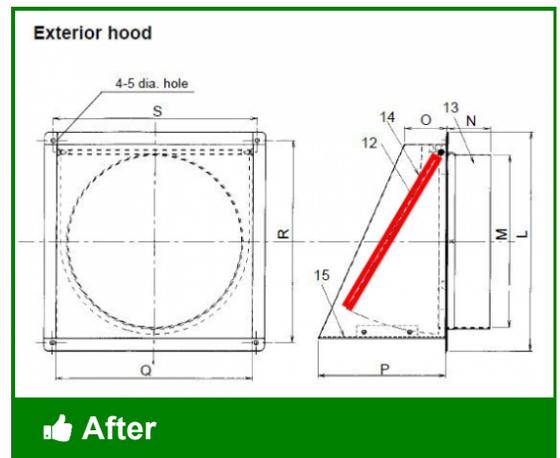
### Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety



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



Exhaust fans should have backdraft dampers

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## 6.6005.2e

### Desired Outcome:

Kitchen range fan installed to specification

### Specification(s):

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

### Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety

### Tools:

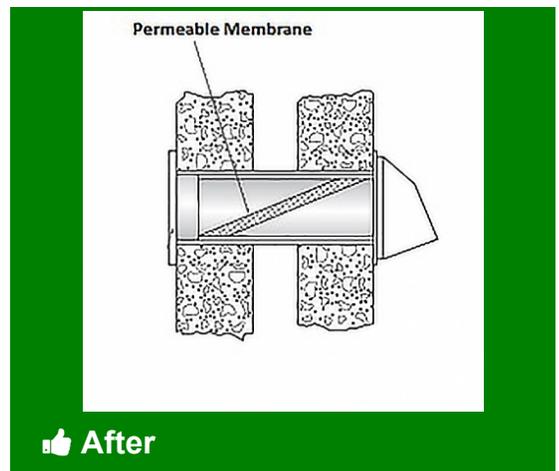
1. Drill
2. Hole saw
3. Caulk gun

### Materials:

1. Caulk sealant
2. Fasteners



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



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

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## 6.6005.2f

### Desired Outcome:

Kitchen range fan installed to specification

### Specification(s):

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

### Objective(s):

Ensure safe operation of combustion appliances

Ensure occupant health and safety

### Tools:

1. Manometer



Kitchen exhaust fans can cause combustion appliances to depressurize



Test that combustion appliances are operating within depressurization limit

See SWS 2.0299.1a-i for CAZ depressurization limits

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## 6.6201.2a

### Desired Outcome:

Air circulates freely between rooms

### Specification(s):

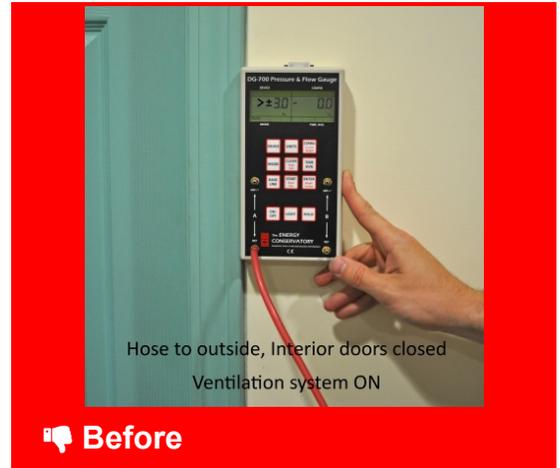
An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)

No room will exceed +/- 3 pascals with reference to the outdoors with all interior doors closed and ventilation systems running

### Objective(s):

Ensure free flow of air between rooms

Preserve integrity of the building envelope



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



Passive door vents and individual room returns are two possibilities

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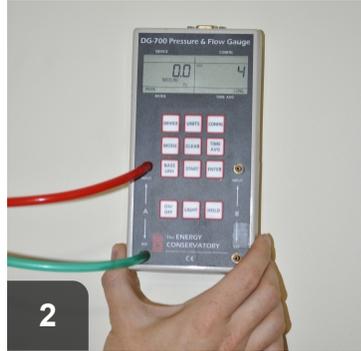
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## 6.6201.2a - Balancing pressure



1

With interior doors open, put reference hose to exterior



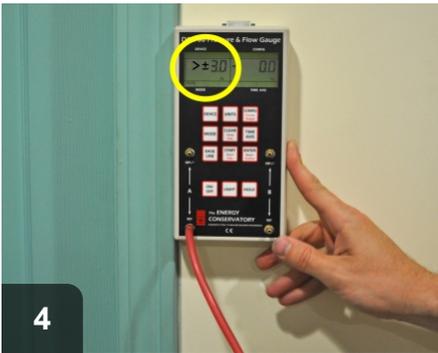
2

Take baseline reading



3

Turn on exhaust fans and close interior doors



4

With hose under door, check pressure again. Readings  $>+/-3pa$  are no good and require interior ventilation

## 7.8102.2e

### Desired Outcome:

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

### Specification(s):

A potable water expansion tank will be installed on the cold water side

A direct connection with no valves between the storage tank and expansion tank will be installed in accordance with the ND State Plumbing Code, authority having jurisdiction, and according to manufacturer specifications

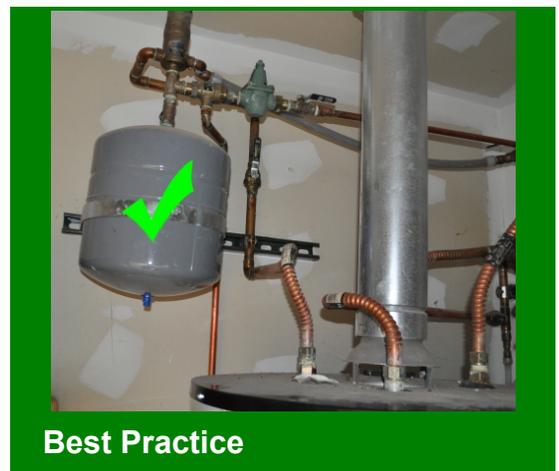
### Objective(s):

Protect the storage tank from expansion



**Bad Practice**

Need to eliminate the valves between the storage tank and expansion tank



**Best Practice**

GOOD: Expansion tank is installed on both cold sides

Appropriate licensing for installer required.

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## 7.8102.2f

### Desired Outcome:

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

### Specification(s):

Correct temperature and pressure relief valve will be installed in compliance with the ND State Building Code and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with the ND State Building Code

### Objective(s):

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

### Tools:

1. Pipe wrench
2. Hacksaw

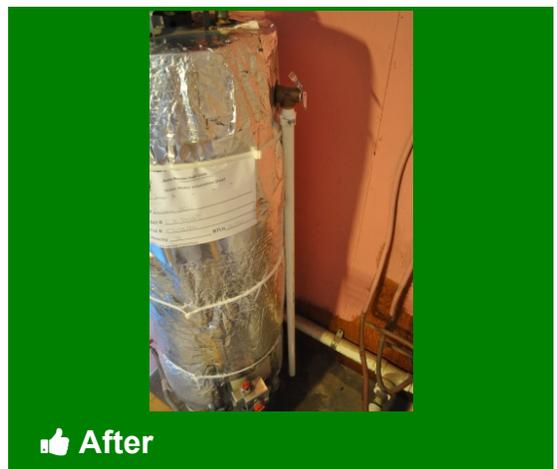
### Materials:

1. PVC
2. Plumber's epoxy



**Before**

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



**After**

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

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Check local jurisdictional codes. Paraphrased from the ND State Building Code: 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.

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## 7.8102.2f - 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

## 7.8102.2k

### Desired Outcome:

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

### Specification(s):

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

### Objective(s):

Ensure safe hot water supply temperature to fixtures

### Tools:

1. Thermometer



**Unsafe**

Water heaters producing water over 120 degrees raise heating costs



**Safe**

Water heaters should produce water under 120 degrees to prevent scalding

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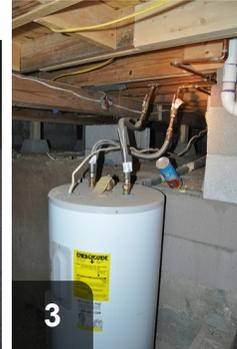
## 7.8102.2k - Discharge temperature



1  
Test temperature of hot water at faucets in house



2  
Hot water temperatures should not exceed 120 degrees Fahrenheit



3  
Adjust water heater settings and insulate as needed



4  
After adjustment and insulation, retest to verify temp is under 120 degrees

## 7.8103.1a

### Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

### Specification(s):

Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice

Electrical components will be verified to comply with the ND State Electrical Code (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)

### Objective(s):

Identify potential health and safety issues

### Tools:

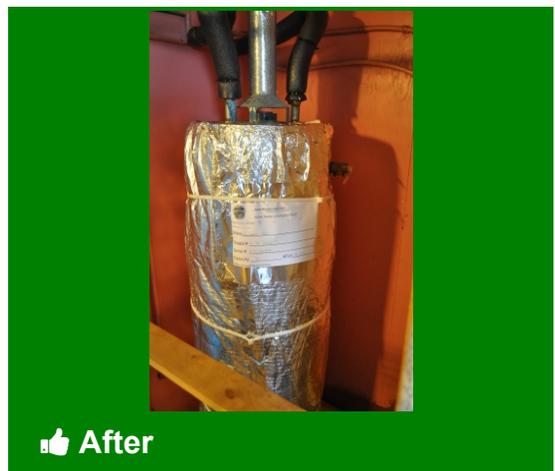
1. Personal CO monitor
2. Combustion analyzer with probe
3. Manometer
4. Smoke pencil

### Materials:

1. CO alarm
2. Fasteners



Complete combustion safety testing to ensure healthy, safe work environment



When completed work, retest to verify home is still healthy and safe

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

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## 7.8103.1c

### Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

### Specification(s):

Water heater storage tanks shall have a minimum R-value of R-24, unless the SIR to add insulation is less than 1.0

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

The first 6' of inlet and outlet piping will be insulated in accordance with the ND State Building Code or local requirements, whichever is greater

### Objective(s):

Reduce standby losses from near tank piping and storage tank

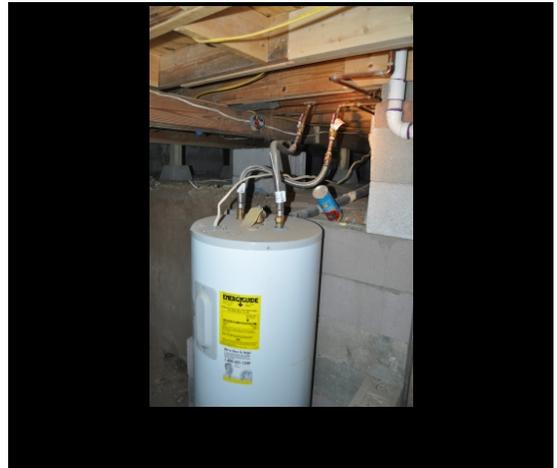
Ensure insulation does not make contact with flue gas venting

### Tools:

1. Utility knife

### Materials:

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



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



### Best Practice

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

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## 7.8103.1c - Thermal efficiency



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



Blanket does not obstruct draft diverter or plumbing pipes and elements



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



Data plate should still be accessible after wrapping



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

## 7.8103.1e

### 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 the ND State Building Code and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with the ND State Building Code

### Objective(s):

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

### Tools:

1. Pipe wrench
2. Hacksaw

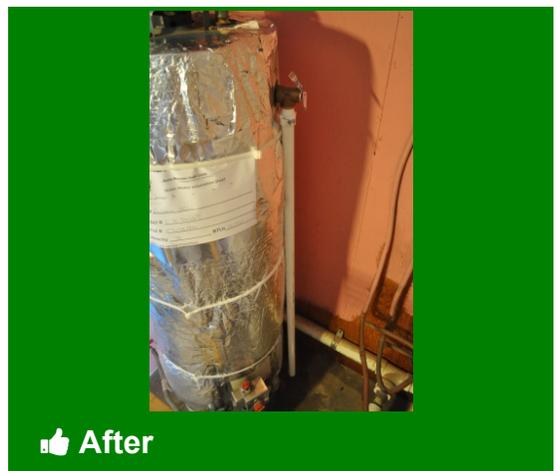
### Materials:

1. PVC
2. Plumber's epoxy



**Before**

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



**After**

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

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

## 7.8103.1e - Temperature and pressure relief valve



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



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



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