Guidelines for Home Energy Professionals: 2016 Standard Work Specifications (SWS) Redline Report

Guidelines for Home Energy Professionals Project

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Introduction

2016 Maintenance Update—Standard Work Specifications (SWS) Redline to address comments received prior to October 31, 2015

A total of 94 comments received on the SWS prior to October 31, 2015, were reviewed and adjudicated by the Health & Safety Committee, the HVAC & Baseload Committee, and the Air Sealing & Infiltration Committee. The resulting updates pertained to the specific details and classification numbers listed in the table on the next page. An accompanying comment spreadsheet, published alongside this redline, details the specific comments and adjudication responses. The reference table also lists all details which were changed during the 2015 Maintenance Update.

The changes represented in this redline version are intended to be integrated into the SWS Online Tool at a future date.

Redline documents can be used as reference by users who are looking for the most up-to-date industry standards. Please note: At this time, WAP grantees are not required to revise their field guides in accordance with the redline documents.

2015 Maintenance Update—SWS Update to Align SWS with the Combustion Appliance Section of ANSI/BPI-1200-S-2015: *Standard Practice for Basic Analysis of Buildings*

The SWS define the minimum requirements to ensure that the work performed during home energy upgrades is effective, durable, and safe. The SWS can be used as an industry guide for workers, training instructors, homeowners, and program administrators involved in the home performance industry.

To ensure that the SWS are accurate and contain the most up-to-date information, comments are accepted on the SWS. These comments are adjudicated by several committees of experts, as detailed in the "2014 SWS Maintenance Report" on the SWS website.

In 2014, several of the comments received were on Section 2.02: Combustion Safety. At the same time, the Building Performance Institute was updating guidance on combustion safety testing. Rather than adjudicate these comments related to combustion safety, members of the SWS Health & Safety SWS Maintenance Committee decided to wait until BPI finalized their guidance, then align the SWS with BPI's guidance.

In 2015, BPI-1200 was updated to reflect industry consensus around, among other things, testing of combustion appliances. The "redline" document in this report details edits to the SWS Section 2.02: Combustion Safety as well as Details 5.3003.14 & 15: Heating & Cooling – Forced Air.

Details and their Classification Number with Redline Changes from the 2015 and 2016 Maintenance Updates

Classification	Detail
2.0100.1	Global Worker Safety
2.0201.1	Combustion Appliance Zone (CAZ) Testing
2.0201.2	Combustion Safety
2.0201.4	Vented Combustion Appliance Safety Testing
2.0202.1	Unvented Space Heaters: Propane, Natural Gas, and Kerosene Heaters
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2.0203.2	Combustion Flue Gas—Orphaned Water Heaters
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2.0204.1	Isolating Combustion Water Heater Closet
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2.0205.1	Gas and Oil-Fired Equipment
2.0401.1	Air Sealing Moisture Precautions
2.0403.1	Vented Crawl Spaces—Ground Moisture Barrier
2.0403.2	Closed Crawl Spaces—Ground Moisture Barriers
2.0601.1	Knob and Tube Wiring
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3.1601.8	Preparation and Mechanical Fastening—Mid and High Rise
3.1802.1	Roof/Exterior Wall Connection, Including Joints at Roof/Parapet/Wall Connections
4.1001.1	Non-Insulation Contact (IC) Recessed Light
4.1001.3	Fireplace Chimney and Combustion Flue Vents
4.1003.1	Pitched/Vaulted/Cathedralized Ceilings—Loose Fill Over
4.1003.2	Pitched/Vaulted/Cathedralized Ceilings—Dense Pack Over
4.1004.2	Preparation for Batt Insulation
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4.1005.3	Accessible Floors—Batt Insulation Over Existing Insulation
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4.1005.7	Attic Floor—Preparation and Installation of Spray Polyurethane Foam (SPF)
4.1006.1	Pull-Down Stairs
4.1006.2	Access Doors and Hatches
4.1088.8	Installation/Correction of Unconditioned Attic Ventilation
4.1102.1	Open-Cavity Wall Insulation—General
4.1103.1	Dense Pack Exterior Walls
4.1103.2	Additional Exterior Wall Cavities
4.1103.4	Dense Packing Blown Insulation
4.1401.1	Band/Rim Joists—Spray Polyurethane Foam (SPF) Installation
4.1401.2	Band/Rim Joists—Insulation other than Spray Polyurethane Foam

4.1402.1	Closed Crawl Spaces—Wall Insulation
4.1402.2	Basement Wall Insulation—No Groundwater Leakage
5.3003.2	Combustion Analysis of Oil-Fired Appliances
5.3003.3	Evaluating Air Flow
5.3003.5	Refrigerant Line Inspection
5.3003.14	Combustion Analysis of Gas-Fired Appliances (LP and Natural Gas)
5.3003.15	Combustion Analysis of Oil-Fired Appliances
5.3104.2	Maintenance: Gas Boiler Service Inspection
6.6004.2	Individual Exhaust Fan Serving Multiple Rooms Within Single Dwelling Unit (All Building Types)
6.6102.3	Intake for Ventilation Air to Forced Air System Used for Heating or Cooling
6.6202.3	Airflow Control Devices (All Building Types)
6.6202.9	Filtration for Fan-Powered (Active) Systems
6.6204.1	Commissioning Existing Exhaust or Supply Ventilation Systems
6.6205.1	Manufactured Housing Exhaust-Only Strategies
6.6288.1	Sound-Rating Limits
7.8003.1	Lighting Upgrade
7.8102.2	Storage-Type Appliance

2.0201.1	Combustion Appliance Zone (CAZ) Testing	
Topic	Combustion Safety	
Subtopic	Combustion Safety Testing-General	
Desired Outcome	Accurate information about appliance safe operation is gathered	
Manufactured Housing, Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
2.0201.1a Assessment	Emergency problems (e.g., gas leak greater than 10% Lower Explosion Limit (LEL), ambient CO levels that exceed 70 ppm) will be communicated clearly and immediately to the customer, the home shall be evacuated, and appropriate emergency services shall be contacted Significant problems (e.g., gas leak less than 10% LEL, ambient CO levels that exceed 35 ppm but less than 70 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance	Ensure system does not have potentially fatal problems
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	
2.0201.1c Venting	For oil systems, the presence and operability of a draft regulator will be verified and tested	Determine if a regulator is present and working
	Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards	Determine whether vent system is in good condition and installed properly

2.0201.1d Base pressure test	Baseline pressure will be measured in Combustion Appliance Zone (CAZ) with reference to outdoors	Measure pressure difference between combustion zone and the outside under natural conditions
2.0201.1e Depressurization test	CAZ depressurization testing will be administered for all equipment equipped with a draft hood. Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof; the test will be done to determine the largest negative pressure per BPI Standard 1200.	Determine worst-case depressurization in combustion zone due to mechanical system fans

2.0201.2	Combustion Safety – Make-up Air	
Topic	Combustion Safety	
Subtopic	Combustion Safety 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, Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
2.0201.2a Outside combustion make-up air	Where applicable, combustion air will be provided from the outside and installed in accordance with the 2012 IRC for the type of appliance installed	Prevent combustion byproducts from entering the house
2.0201.2b New appliances	If replacing appliances, a sealed-combustion, direct-vent appliance will be installed if possible. New appliances will be installed in accordance with manufacturer specifications, the 2012 IRC and additional applicable codes	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
	Installation will be accomplished by a licensed electrician when required by local code	
2.0201.2d Gas ovens	Gas ovens will be tested for CO	Ensure clean burn of gas ovens
	A clean and tune will be conducted if measured CO in the undiluted flue gases of the oven vent at steady state exceeds 225 ppm as measured	
2.0201.2e Gas range burners	Specify clean and tune if the flame has any discoloration, flame impingement, an irregular pattern, or if burners are visibly dirty, corroded, or bent	Ensure clean burn and operation of gas range burners
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

2.0201.4	Vented Combustion Appliance Safety Testing	
Topic	Combustion Safety	
Subtopic	Combustion Safety Testing-General	
Desired Outcome	Buildup of dangerous combustion byproducts in the living space prevented	
Manufactured Housing, Single-family		
Title	**Specification(s)**	**Objective(s)**
2.0201.4a Spillage test	In conditions with largest negative pressure as determined from Detail 2.0201.1e: If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate. If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate.	Detect excessive spillage of combustion gases
2.0201.4b Carbon monoxide (CO) test in appliance vent	CO will be tested for in undiluted flue gases of combustion appliances In conditions with largest negative pressure as determined from Detail 2.0201.1e: If CO levels exceed 400 ppm air-free measurement in furnaces, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications) If CO levels exceed 200 ppm air-free measurement in water heaters or room heaters, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)	Measure CO and report excessive levels
2.0201.4c Final test out	Final combustion testing will be conducted at project completion to ensure compliance with the above specifications	Ensure safe operation of combustion appliance within the whole house system after any repair project

2.0202.1	Unvented Space Heaters: Propane, Natural Gas, and Kerosene Heaters

Topic	Combustion Safety
Subtopic	Unvented Space Heaters
Desired Outcome	Elimination of combustion byproducts

Single-Family Homes

Title	Specification(s)	Objective(s)
2.0202.1a Removal	With the occupant's permission, unvented heaters will be removed except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2 Units that are not being operated in compliance with ANSI Z21.11.2 should be removed before the retrofit but may remain until a replacement heating system is in place Failure to remove unvented space heaters serving as primary heat sources has the potential to create hazardous conditions and thus any further weatherization services will be re-evaluated in the context of potential indoor air quality risks	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

Manufactured Housing

Title	Specification(s)	Objective(s)
2.0202.1a Removal	With the occupant's permission, unvented heaters will be removed except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2 Units that are not being operated in compliance with ANSI Z21.11.2 should be removed before the retrofit but may remain until a replacement heating system is in place Failure to remove unvented space heaters serving as primary heat sources has the potential to create hazardous conditions, and thus any further weatherization services will be reevaluated in the context of potential indoor air quality risks	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

2.0203.1	Combustion Air for Natural Draft Appliances
Topic	Combustion Safety
Subtopic	Vented Gas Appliances
Desired Outcome	Sufficient air provided in the Combustion Appliance Zone (CAZ)

Single-Family Homes

Title	Specification(s)	Objective(s)
2.0203.1a Required combustion air	The required volume of indoor air will be determined in accordance with 2012 IRC Section G2407.5.1 or G2407.5.2 and authority having jurisdiction, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), 2012 IRC Section G2407.5.2 will be used	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 2012 IRC G2407 and authority having jurisdiction when necessary to solve spillage problems	Ensure adequate combustion air for operation of the appliance
2.0203.1c Spillage testing	If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate. If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate.	Detect excessive spillage of combustion gases.

2.0203.2	Combustion Flue Gas—Orphaned Water Heaters	
Topic	Combustion Safety	
Subtopic	Vented Gas Appliances	
Desired Outcome	Flue gases successfully removed from the house	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
2.0203.2a Spillage testing	If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate	Detect excessive spillage of combustion gases
2.0203.2b Flue gas removal (chimney liner or approved methods)	A chimney liner will be installed in accordance with the 2012 IRC 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 with a warm vent
2.0203.2d Required combustion air	The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with 2012 IRC G2407.5.1 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 2012 IRC G2407 or other authority having jurisdiction	Ensure adequate combustion air for operation of the appliance

2.0203.7	Combustion Air—Boilers	
Topic	Combustion Safety	
Subtopic	Vented Gas Appliances	
Desired Outcome	Amount and quality of combustion air allows for safe and efficient operation of equipment	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
2.0203.7a Combustion air	Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer requirements. In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply (i.e., more air rather than less) In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31	Meet burner combustion air requirements
2.0203.7b Education	Property manager/occupant will be educated on proper operation of combustion air systems	Ensure occupant safety Ensure optimal operation of equipment

2.0203.8	Occupant Education	
Topic	Combustion Safety	
Subtopic	Occupant Education	
Desired Outcome	Ensure persistence of resident safety	
Single-Family Homes, Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
2.0203.8a Occupant health and safety	All homes will have a functioning CO alarm	Ensure occupant health and safety
	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 indoor CO levels do not exceed outdoor CO levels
2.0203.8b Occupant education	Occupants will be educated on the operation and maintenance of the CO alarm	Ensure occupant can operate and maintain installations
	Completed work on combustion appliances and recommended maintenance will be reviewed with occupant	Inform occupant regarding possible CO hazards
	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	

2.0204.1	Isolating Combustion Water Heater Closet	
Topic	Combustion Safety	
Subtopic	Isolation	
Desired Outcome	Isolate combustion water heater closet from conditioned space	
Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
2.0204.1a Work assessment	Installer prework assessment will be conducted to determine: Combustion safety Proper venting Structural integrity Roof leaks Insect infestation Accessibility Number, type, size, and location of penetrations	Ensure combustion appliance is functioning safely Ensure work space is safe and ready for air sealing Verify scope of work
2.0204.1b Air seal closet	When the water heater closet contains a heater that is not sealed combustion or power vented, the closet will be isolated/separated from the rest of the home through air sealing with fire-rated materials, if feasible Avoiding frozen pipes must be considered without creating an additional utility burden (e.g., heat tape)	Prevent combustion gases from entering living area and minimize extension of interior pressures caused by exhaust fan, dryers, and interior door closure into the water heater closet
2.0204.1c Materials	Only noncombustible materials will be used in contact with chimneys, vents, and flues	Prevent a fire hazard
2.0204.1d Post-work testing/verification	Blower door assisted zonal pressure diagnostics will be used to verify isolation has been achieved	Prevent combustion gases from entering living area

2.0204.2	Isolating Combustion Appliance Rooms (e.g., Boiler Room, Furnace Room, and Generator Room)	
Topic	Combustion Safety	
Subtopic	Isolation	
Desired Outcome	Effective air barrier between the combustion appliance room and all other spaces of the building	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
2.0204.2a Pre-inspection	Hazardous materials stored in mechanical rooms with air handlers or combustion appliances (e.g., boilers, furnaces) will be identified and removed; operators will be educated on the dangers of storing hazardous materials in these areas	Eliminate existing storage hazards and prevent future dangerous storage occurrences
	Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins	Repair or address moisture, pest, and structure-related issues
	Mechanical room doors in a fire-rated wall will be closed; problems that cause doors to be blocked open will be determined and resolved	Provide a safe and stable work environment
2.0204.2b Identification of penetrations	Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests [ASTM E1186-03 (2009)]	Locate air leakage pathways to repair
2.0204.2c Preparation	Health and safety concerns will be addressed for occupants, workers, and repair materials in accordance with OSHA standards (OSHA 1926, 1910)	Provide a safe work environment
	The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide)	Provide a safe indoor environmental quality (IEQ) work environment
	Work lighting, work platform, and adequate ventilation will be provided	Provide effective repair access
2.0204.2d Sealant and materials selection	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications	Ensure sealants and materials meet or exceed the performance characteristics required of the assembly (e.g., fire rating)
	Selection will be durable, pest resistant, and have a weather-appropriate seal	Prevent intrusion of moisture and pests into the sealed assembly
	Indoor sealants will be low VOC products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications	Prevent exposing workers or occupants to excessive VOC levels
	Fire-rated assemblies will be sealed by qualified workers, using materials and sealants permitted by the authority having jurisdiction, and in accordance with adopted building codes	Provide a durable and effective isolation of the identified compartmentalized space

	Mechanical and boiler room enclosures may need to be fire-rated assemblies. Materials will be rated for application in approved details; for example, the annular space around a pipe penetration through a fire-rated wall can usually be sealed using mineral wool fire safing sealed with a coating of flexible fire dam material Sealants and materials will be continuous and meet fire resistance rated assembly specifications	
2.0204.2e Verification	Repairs will be verified using visual inspections, infrared thermography, smoke, and/or pressure tests [ASTM E1186-03 (2009)]	Ensure quality and effectiveness of air sealing

2.0205.1	Gas and Oil-Fired Equipment	
Topic	Combustion Safety	
Subtopic	Gas and Oil-Fired Equipment	
Desired Outcome	Combustion products are properly vented to the outdoors	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
2.0205.1a Combustion air	Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction, and manufacturer installation requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31	Do not damage building Protect workers and occupants from injury
2.0205.1b Installation	Venting systems will be installed considering proper material, pitch, common venting, chimney liner, clearance, total equivalent length, and termination in accordance with the applicable code adopted by the jurisdiction and manufacturer installation requirements In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply In absence of local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31	Exhaust combustion products to the outdoors Protect building from damage Protect workers and occupants from injury
2.0205.1c Orphaned equipment	Existing vent system or chimney will be resized or relined in accordance with the applicable code adopted by the jurisdiction when one or more common vented appliances are removed In absence of local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31	Exhaust combustion products to the outdoors Protect building from damage Protect workers and occupants from injury

2.0100.1	Global Worker Safety	
Topic	Safe Work Practices	
Subtopic	Safe Work Practices	
Desired Outcome	Work completed safely without injury or hazardous exposure	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
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 hazards
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 MSDSs for respiratory protection requirements	
2.0100.1d Electrical safety	An electrical safety assessment will be performed	Avoid electrical shock and arc flash hazards
	All electric tools will be protected by ground-fault circuit interrupters (GFCI)	
	Three-wire type extension cords will be used with portable electric tools	
	Worn or frayed electrical cords will not be used	
	Water sources (e.g., condensate pans) and electrical sources will be kept separate	

	Metal ladders will be avoided	
	Special precautions will be taken if knob and tube wiring is present	
	Aluminum foil products will be kept away from live wires	
	For arc flash hazards, NFPA 70E will be consulted	
2.0100.1e Carbon monoxide (CO)	All homes will have a carbon monoxide alarm	Protect worker and occupant health
	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)	
2.0100.1f Protective clothing	MSDSs and OSHA regulations will be consulted for protective clothing and equipment	Protect worker from skin contact with contaminants
	Eye protection will always be worn (e.g., safety glasses, goggles if not using full-face respirator)	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	Provide adequate access and egress points
	Adequate ventilation will be provided	Prevent electrical shock
	Use of toxic material will be reduced	
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, noise, and improper or defective cords or extension cords	Prevent power tool injuries
	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	

2.0100.1i Chemical safety	Hazardous materials will be handled in accordance with manufacturer specifications or MSDS standards to eliminate hazards associated with volatile organic compounds (VOCs), sealants, insulation, contaminated drywall, dust, foams, asbestos, lead, mercury, and fibers	Prevent worker exposure to toxic substances
	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	
2.0100.1j Ergonomic safety	Appropriate PPE will be used (e.g., knee pads, bump caps, additional padding)	Prevent injuries from awkward postures, repetitive motions, and improper lifting
	Proper equipment will be used for work	
	Proper lifting techniques will be used	
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	Prevent injuries due to slips, trips, and falls
	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	
2.0100.1m Heat and thermal stress	Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided	Prevent heat stroke, heat stress, and cold stress related injuries
	911 will be dialed when necessary	
2.0100.1n Fire safety	Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply)	Prevent a fire hazard
	Use of flammable material will be reduced and fire-rated materials will be used	
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	Protect workers and occupants from potential asbestos hazards
	If suspected ACM is in good condition, do not disturb	

	If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s)	
	For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair in accordance with federal, state, and local requirements; only a licensed or trained professional may abate, repair, or remove ACM	
	When working around ACM, do not:	
	Dust, sweep, or vacuum ACM debris	
	Saw, sand, scrape, or drill holes in the material	
	Use abrasive pads or brushes to strip materials	
	Asbestos abatement or repair work should be completed prior to blower door testing; exercise appropriate caution when conducting blower door testing where friable asbestos or vermiculite attic insulation is present to avoid drawing asbestos fibers into the living space (i.e., use positively pressurized blower door testing) unless the material has been tested and found not to contain asbestos	
2.0100.1p Lead paint assessment	Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise	Protect workers and occupants from potential lead hazards
	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	

2.0401.1	Air Sealing Moisture Precautions	
Topic	Moisture	
Subtopic	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 Comment	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 Comment	Exposed earth will be covered with a continuous, durable, sealed Class 1 vapor retarder a minimum of 6 mils in thickness	Ensure durability of repairs
		Reduce potential for occupant exposure to mold and other moisture-related hazards
	Any vapor retarder shall not encapsulate wood building materials or spray foam	
	Holes between the crawl space and the living space will be sealed	
2.0401.1c Moisture precautions for the living space Comment	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 62.2-2010	Reduce potential for occupant exposure to mold and other moisture-related hazards
	Unvented combustion appliances that are not listed to ANSI Z21.11.2 will be removed	

2.0401.1d Moisture precautions for exterior water Comment	Before air sealing basement or crawl space walls near wet areas, surface water pooling near the foundation will be addressed by:	Reduce potential for occupant exposure to mold and other moisture-related hazards
	Repairing, modifying or replacing gutters and downspouts	
	Grading and subsurface drainage at critical locations (e.g., localized drain and grading beneath valleys) in accordance with Environmental Protection Agency (EPA) Indoor airPLUS Construction Specifications Section 1.1	
	Possible mitigation by waterproofing or installing draining plane with construction adhesive	
Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
2.0401.1a Moisture precautions for attics Comment	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
	Water-resistant sealants and/or closed cell foams (use a minimum of 2" to reach water barrier requirement) will be used in all attic sealing details in cold climates	Prevent moisture from communicating from within the conditioned space into unconditioned attic space when economically feasible
	Plastic, foil, or any other Class 1 vapor barrier will not be used in hot humid climates	Increase durability of seal
	In marine climates, vapor permeable materials will be used to block and seal penetrations in attic	Avoid moisture-related damage to the home

2.0401.1b Moisture precautions for crawl spaces Comment	Exposed earth will be covered with a continuous, durable, sealed Class 1 vapor retarder a minimum of 6 mils in thickness	Ensure durability of repairs
	Any vapor retarder shall not encapsulate wood building materials or spray foam	Reduce potential for occupant exposure to mold and other moisture-related hazards
	Holes between the crawl space and the living space will be sealed	
2.0401.1c Moisture precautions for the living space Comment	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 62.2-2010	Reduce potential for occupant exposure to mold and other moisture-related hazards
	Unvented combustion appliances that are not listed to ANSI Z21.11.2 will be removed	
2.0401.1d Moisture precautions for exterior water Comment	Before air sealing basement or crawl space walls near wet areas, surface water pooling near the foundation will be addressed by:	Reduce potential for occupant exposure to mold and other moisture-related hazards
	Repairing, modifying, or replacing gutters and downspouts	
	Grading and subsurface drainage at critical locations (e.g., localized drain and grading beneath valleys) in accordance with EPA) Indoor airPLUS Construction Specifications Section 1.1	
	Possible mitigation by waterproofing or installing draining plane with construction adhesive	

2.0403.1	Vented Crawl Spaces—Ground Moisture Barrier	
Topic	Moisture	
Subtopic	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 floor will be installed	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 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	
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	When ground moisture barrier is installed on sloping ground, may be exposed to wind, or accessed for routine maintenance or storage it will be fastened to ground with durable fasteners or ballast(s)	Prevent movement of the ground moisture barrier

2.0403.2	Closed Crawl Spaces—Ground Moisture Barriers	
Topic	Moisture	
Subtopic	Vapor Barriers	
Desired Outcome	Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
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, will be installed and sealed to the wall's air and moisture barrier in accordance with ASTM E1643 and manufacturer's recommendations	Reduce ground moisture entering the crawl space
	Ground moisture barrier will be fastened to ground in accordance with manufacturer's recommendations and extend a minimum of 6 inches up the foundation wall	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	Reduce ground vapor entering the crawl space
	A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745	Ensure crawl space is accessible for service and maintenance without destroying the integrity of the moisture barrier
	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	
2.0403.2d Overlap seams	When seams exist, they will be overlapped a minimum of 12" with reverse or upslope lapping technique	Keep water under the liner
	For wall to floor connection, the wall moisture barrier will be installed under the ground moisture barrier	

2.0403.2e Fastening	When ground moisture barrier is installed on sloping ground, or accessed for routine maintenance or storage it will be fastened to the ground with durable fasteners or ballast(s)	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	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	Maintain continuous air barrier and ground moisture barrier
	Physical attachments will be provided where practical (e.g., masonry columns, footings)	
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

2.0601.1	Knob and Tube Wiring	
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		
Title	**Specification(s)**	**Objective(s)**
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
		Preserve the integrity and safety of the house
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	Proper clearance will be maintained around live knob and tube as required by the National Electrical Code (NEC) or authority having jurisdiction	Ensure occupant safety
		Preserve the integrity and safety of the house
	When required, a dam that does not cover the top will be created to separate insulation from the wire path	
2.0601.1d Replacement	Exposed wiring will be replaced with new appropriate wiring in accordance with the NEC and local codes	Ensure occupant safety
	Old wiring will be rendered inoperable by licensed electrician in accordance with the NEC and local codes	Preserve the integrity and safety of the house

2.0702.1	Warranty and Service Agreement	
Topic	Occupant Education and Access	
Subtopic	Installed Equipment	
Desired Outcome	Occupants provided recourse for failures in materials, workmanship, and serviceability and informed of potential hazards	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
2.0702.1a Warranty	A minimum 1-year warranty for materials, workmanship, and serviceability will be provided to occupants upon completion of work	Provide recourse to occupants for failures in materials, workmanship, and serviceability
2.0702.1b Warranty and Maintenance Agreement – Client Education	Provide occupants with manufacturers' warranties on installed equipment and inform of installer maintenance agreement options Share information on company related annual inspections and maintenance agreements as well as manufacturer related warranty details	Ensure occupants are aware of warranty and maintenance agreement options
2.0702.1c General conditions	At a minimum, the following concerns and warnings will be addressed within the warranty:	Educate occupants on potential hazards
	Possible drying and shrinking effects	
	Storage of hazardous and flammable materials	
	Mold	

3.1201.1	Double-Hung Wood Windows	
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		
Title	**Specification(s)**	**Objective(s)**
3.1201.1a Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise	Protect worker and occupant from potential lead hazards
	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	
3.1201.1b Weather stripping	Existing weather stripping and sash sealant will be removed	Form a complete seal from the outer edge of the sash to the jamb
	Surface where the sill meets the sash will be cleaned	Maintain operability of the window
	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	
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	Form a secure connection between the two sashes
	No gaps will be visible between the two sashes	
	Locks will be installed to achieve compression of the two sashes	
3.1201.1d Replacement sills	Beveled sill will be flush with interior wall and sloped to the exterior	Form a complete seal from the bottom of the lower sash to the sill

	Seams will be continuously and completely sealed with sealant to the jambs and to the frame	Maintain operability of the window
	Sill will be water-sealed and primed	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	Ensure sash remains in a fixed position when open or partially open
	Sash will be water-sealed and primed	Maintain operability of the window
		Form a complete seal from the bottom of the lower sash to the sill
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	Form a complete seal between the jamb, sash, and stop
	Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window	Maintain operability of the window

3.1601.8	Preparation and Mechanical Fastening—Mid and High Rise	
Topic	Ducts	
Subtopic	Duct Preparation	
Desired Outcome	Ducts and plenums properly fastened to prevent leakage	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
3.1601.8a Preparation	Surrounding insulation will be cleared to expose the joints being sealed	Gain access
	Duct surface that accepts sealant will be cleaned	Achieve proper adhesion for airtight seal
3.1601.8b Metal to metal	Ducts will be fastened with a minimum of three equally spaced screws or acceptable mechanical connections	Ensure joints are durable
		Reduce air leakage
3.1601.8c Flex to metal (150)	Joints will be fastened with tie bands using a tie band tensioning tool or mechanical band, and sealed with approved mastic and UL181B tape. Must have a minimum performance temperature rating of 165° (per UL 181A-type test) and a minimum tensile strength rating of 50 pounds tensioning tool or mechanical band, and sealed with approved mastic and UL181B tape	Ensure joints are durable
		Reduce air leakage
3.1601.8d Duct board to duct board	In a repair or replacement, joints will be fastened with clinch stapler, rated tape, and mastic	Ensure joints are durable
		Reduce air leakage
3.1601.8e Duct board to flexible duct (152)	An approved take-off collar in accordance with NAIMA standards will be used and sealed with approved mastic	Ensure joints are durable
		Reduce air leakage
3.1601.8f Phenolic board to phenolic board	Joints will be a metal connection fastened together in accordance with manufacturer specifications	Ensure joints are durable
3.1601.8g Phenolic board to flexible duct	Metal take-off collar will be used and mastic will be used on the outside in accordance with manufacturer specifications	Ensure joints are durable
		Reduce air leakage
3.1601.8h Phenolic board to air handler cabinet	Plenum will be fastened with a minimum of three equally spaced screws on each side and sealed with mastic	Ensure joints are durable
	Canvas connection between plenum and unit will be installed so that it does not reduce the inside diameter of the duct	Optimize air flow
		Reduce air leakage

3.1601.8i Metal plenum to air handler cabinet	Plenum will be fastened with a minimum of three equally spaced screws on each side and sealed with mastic	Ensure joints are durable
	Canvas connection between plenum and unit will be installed so that it does not reduce the inside dimensions of the duct	Optimize air flow
		Reduce air leakage
3.1601.8j Duct board plenum to air handler cabinet	Termination bar or metal strip will be fastened with screws and sealed with mastic	Ensure joints are durable
	Duct board will be installed between the screw and the termination bar	Reduce air leakage
3.1601.8k Terminal boot to wood	Screws or nails will be used to fasten boot to wood	Ensure joints are durable
	Seams and boot to subfloor will be sealed with mastic	Reduce air leakage
3.1601.8l Terminal boot to gypsum	Boot hanger will be fastened to adjacent framing with screws or nails	Ensure joints are durable
	Boot will be connected to boot hanger with screws	Reduce air leakage
	Integral snap boots will be installed	
	Seams of the boot will be sealed with mastic	
	Boot to gypsum will be sealed with caulk in accordance with local code and standards	
3.1601.8m Replacement of insulation	Insulation will be returned or replaced with current insulation standards	Insulation values will be maintained

3.1802.1	Roof/Exterior Wall Connection, Including Joints at Roof/Parapet/Wall Connections	
Topic	Roofs	
Subtopic	Roof/Wall Connections	
Desired Outcome	Continuous air barrier between roof and exterior walls where connection is within conditioned space	
Single-Family Homes, Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
3.1802.1a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization	Provide a safe and stable work environment
	Existing water control measures will be identified	Avoid compromising existing water control system
	Air sealing locations will be identified between the roof and the exterior wall	Ensure a continuous air barrier will be appropriately located at the roof/exterior wall junction
3.1802.1b Backing and infill	Where gaps, cracks, or holes are larger than 1/4" across and/or where the air sealing materials will be subject to temperature variations in excess of 50° F, the need for backing or infill will be evaluated	Minimize gap or hole size to ensure successful use of sealant
	If used, backing or infill will meet specific characteristics of the fire-resistance-rated assembly, and be compatible with the characteristics of the gap, crack, or hole, including preservation of any expansion/contraction characteristics for assembly (e.g., expansion joints, steam pipes, or dissimilar material interfaces with differing coefficients of expansion)	Ensure closure is permanent and supports appropriate load (e.g., wind, snow, insulation)
	Backing or infill will be selected that maintains sealant placement and durability while allowing for the expected movement from expansion, contraction, load deflection, settling at the location, or if existing water control measures are compromised (e.g., rain screen, drip edge, weep holes, gutter and roof drains, scuppers, or other exterior water management elements)	Ensure sealant does not fall out
		Ensure integrity of the existing water control system

3.1802.1c Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications	Prevent intrusion of moisture and pests into the sealed assembly
	Selection will be durable, pest resistant, and have a weather-appropriate seal	Prevent exposing workers or occupants to excessive VOC levels
	Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications	Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements
	Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	
3.1802.1d Joint seal	Continuous seal will be installed at roof/exterior wall junctions or roof/exterior and wall/parapet junctions, including, but not limited to, beams, cracks, joints, edges, penetrations, and connections	Provide airtight, durable seal that does not move, bend, or sag
	For metal roof decks, flutes will be accessed to install sealant between top side of roof deck and roof assembly	Ensure hidden flutes are properly sealed
3.1802.1e Cavity seal	For framed parapets that are open between conditioned and unconditioned space, the parapet/wall cavity will be accessed, and an internal air barrier will be created within the parapet wall cavity at the roof plane	Stop air movement within the parapet/wall cavity to create a continuous air barrier at the roof plane
	For parapet walls constructed with hollow core concrete masonry units, the hollow cores will be accessed at the roof plane, and an internal air barrier will be created within the parapet wall cavity at the roof plane	Provide airtight, durable seal that does not move, bend, or sag
	For exterior insulated finishing system (EIFS) parapet, air sealing measures will preserve designed moisture control gaps between EIFS and wall sheathing	

4.1001.1	Non-Insulation Contact (IC) Recessed Light	
Topic	Attics	
Subtopic	General Preparation	
Desired Outcome	Ensure safety from fire and prevent air leakage	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
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:	Prevent a fire hazard
	A fire-rated airtight closure taller than surrounding attic insulation will be placed over non-IC rated recessed lights	Prevent air leakage through fixture
	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	
4.1001.1b Enclosure top	The top-fire rated enclosure material will have an R-value of 0.56 or less	Prevent heat build up
	The top of the enclosure will be left free of insulation	
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

4.1001.3	Fireplace Chimney and Combustion Flue Vents	
Topic	Attics	
Subtopic	General Preparation	
Desired Outcome	Combustible materials kept away from combustion sources	
Single-Family Homes, Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
4.1001.3a Verify attic prep	Holes, penetrations, and bypasses will be sealed	Prevent air leakage
	Dams will be fixed in places that maintain required clearance	Ensure insulation dams maintain clearance
4.1001.3b Required clearance	A rigid dam having a height to ensure a 3" clearance area free of insulation or combustibles between combustion flue vent and dam, unless the flue vent is listed for a lesser clearance	Ensure dam material does not bend, move, or sag
		Prevent a fire hazard
4.1001.3c Safety	Insulation will not be allowed between a heat-generating appliance and a dam unless material is rated for contact with heat generating sources	Prevent a fire hazard
4.1001.3d Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1003.1	Pitched/Vaulted/Cathedralized Ceilings—Loose Fill Over	
Topic	Attics	
Subtopic	Attic Ceilings	
Desired Outcome	Reduce the rate of heat transfer through cathedral or vaulted ceiling	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
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
	Non-insulation contact rated can lights will not be insulated	
4.1003.1c Installation	When using cellulose, stabilized product is preferred when available	Ensure appropriate material and application
	On roof pitches less than 6/12, loose fill cellulose can be used; on roof pitches greater than 6/12, install non-woven polypropylene netting (webbing) 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 webbing stapled to the bottom (underside) of the rafters	Insulate to prescribed R-value
	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	
4.1003.1d Occupant education	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications

	Insulation type	Confirm amount of insulation installed
	Coverage area	Ensure ability to match bags required for total area completed
	R-value	Comply with 16 CFR 460.17
	Installed thickness and minimum settled thickness	
	Number of bags installed in accordance with manufacturer specifications	

4.1003.2	Pitched/Vaulted/Cathedralized Ceilings—Dense Pack Over	
Topic	Attics	
Subtopic	Attic Ceilings	
Desired Outcome	Insulation reduces heat transfer through ceiling and closed attic sections as well as framing cavities inaccessible to other treatments	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1003.2a Fill slant ceilings	Using fill tube, 100% of each cavity will be filled to a consistent density:	Ensure complete and consistent coverage throughout ceiling plane
	Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot	Eliminate voids and settling
	Loose fiberglass material will be installed and will be specifically approved for air flow resistance per manufacturer's recommendations	
		Minimize framing cavity air flows
	The number of bags installed will be confirmed and will match the number required on the coverage chart	
	Insulation will be verified to prevent visible air movement at 50 pascals of pressure difference using chemical smoke, IR scans, or other approved verification method.	
4.1003.2b Onsite documentation	A dated receipt signed by the installer will be provided that includes:• Coverage area• Thickness• R-value	Document job completion to contract specifications
		Confirm amount of insulation installed
		Comply with 16 CFR 460.17

4.1004.2	Preparation for Batt Insulation	
Topic	Attics	
Subtopic	Knee Walls	
Desired Outcome	Airtight cavity and properly insulated knee wall	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
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	Eliminate bending, sagging, or movement that may result in air leakage
	All joints, cracks, and penetrations will be sealed in finished material, including interior surface to framing connections	Prevent air leakage through the top or bottom of the knee wall
	When knee wall floor and walls are being insulated, the floor joist running under the knee wall will be air sealed.	Create an air barrier
4.1004.2b Installation	Insulation will be installed using one of the following methods:	Eliminate misalignment of existing insulation
	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	
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	Prevent insulation from settling or moving
	If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier	

4.1005.2	Accessible Floors—Loose Fill Installation	
Topic	Attics	
Subtopic	Attic Floors	
Desired Outcome	Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1005.2a Preparation	Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces	Access the workspace
	Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier	Verify uniformity of insulation material
	All electrical boxes will be flagged to be seen above the level of the insulation	Provide location of electrical boxes for future servicing
	Open electrical junctions will have covers installed	Prevent an electrical hazard
	Insulation dams and enclosures will be installed as required	
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
	Air barrier material will not bend, sag, or move once dense packed	
4.1005.2c Installation	All insulation will be installed to the minimum unsettled depth and the maximum coverage per bag to reach a consistent depth for desired R-value indicated on the manufacturer's coverage chart.	Reduce heating and air conditioning costs
		Improve comfort
		Minimize noise
4.1005.2d Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Insulation type	Confirm amount of insulation installed
	Coverage area	
	R-value	Ensure ability to match bags required for total area completed
	Installed thickness and settled thickness	

	Number of bags installed in accordance with manufacturer specifications	Comply with 16 CFR 460.17
4.1005.3	**Accessible Floors—Batt Insulation Over Existing Insulation**	
Topic	Attics	
Subtopic	Attic Floors	
Desired Outcome	Insulation controls heat transfer through ceiling	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
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	Ensure uniform depth of insulation in continuous contact with existing insulation
	If the top of the existing insulation is above the top of the framing, new batts will be installed perpendicular to framing members	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	Insulate to prescribed R-value
	Insulation will be installed 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 Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	Ensure ability to match bags required for total area completed
	R-value	Comply with 16 CFR 460.17

4.1005.6	Enclosed Attic Storage Platform Floor—Dense Pack Installation	
Topic	Attics	
Subtopic	Attic Floors	
Desired Outcome	Insulation reduces heat flow through floor and framing cavities inaccessible to other treatments	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1005.6a Fill floors	Each cavity will be 100% filled to consistent density:	Eliminate voids and settling
	Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot or to a maximum density structurally allowable	Minimize framing cavity air flows
	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	
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	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	Comply with 16 CFR 460.17
	R-value	

4.1005.7	Attic Floor—Preparation and Installation of Spray Polyurethane Foam (SPF)	
Topic	Attics	
Subtopic	Attic Floors	
Desired Outcome	Consistent, thermal boundary and air barrier between conditioned and unconditioned space controls the heat flow and air leakage	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1005.7a Preparation	Subfloor or drywall will be removed to access cavities as necessary (e.g., beneath attic knee walls)	Access the workspace
	All electrical junctions will be flagged to be seen above the level of the insulation	Provide location of electrical junctions for future servicing
	Open electrical junction boxes will have covers installed	Prevent an electrical hazard
4.1005.7b Installation	Insulation will be installed to prescribed R-value	Insulate 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	
4.1005.7c Safety	Spray foam should never be installed over light fixtures regardless of if fixture is rated for IC or not. Nor 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	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	Comply with 16 CFR 460.17
	R-value	
4.1005.7e Occupant education	Documentation of material and R-value will be provided to occupant	Provide occupant with documentation of installation

4.1006.1	Pull-Down Stairs	
Topic	Attics	
Subtopic	Attic Openings	
Desired Outcome	Pull-down attic stair properly sealed and insulated	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
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	Achieve uniform R-value
	Pull-down stair rough opening will be surrounded with a durable dam that is higher than the level of the attic floor insulation	Prevent loose insulation from entering the living area
	Counter-weights should be considered to ease accessibility for excessively heavy hatches	
4.1006.1b Sealing	Entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space	Prevent air leakage
	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	
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 Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	Comply with 16 CFR 460.17
	R-value	

4.1006.2	Access Doors and Hatches	
Topic	Attics	
Subtopic	Attic Openings	
Desired Outcome	Attic access door properly sealed and insulated	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1006.2a Installation	Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly	Achieve uniform R-value on the attic door or hatch
	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 floor
		Prevent loose attic floor insulation from entering the living area
4.1006.2b Sealing	Access hatch frames will be sealed using caulk, gasket, weather-strip, or otherwise sealed with an air barrier material, suitable film, or solid material	Prevent air leakage
	Options will include installing a latch or lock or frictionally engaged components that do not require a latch	
	The measure must include a protective baffle or insulation barrier	
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 Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	Comply with 16 CFR 460.17
	R-value	

4.1088.8	Installation/Correction of Unconditioned Attic Ventilation	
Topic	Attics	
Subtopic	Special Considerations	
Desired Outcome	Properly restored vents minimize moisture and ice dams	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
4.1088.8a Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Work Area Inspection and Stabilization	Ensure safety, effectiveness, and durability of improvements
4.1088.8b Air barrier and thermal boundary	Attic ventilation will be recommended or installed only if:	Ensure presence of continuous air barrier and thermal boundary
	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 work scope	
	Ignition barrier and thermal boundaries are provided when foam plastic materials are used	
4.1088.8c Vent type	Attic vent types will be consistent with requirements for their specific location (e.g., exterior soffit, gable end, roof) and material and intended use (e.g., metal vent on metal roof)	Ensure vent meets proper performance characteristics for location and roofing type
	Ventilation opening area and configuration will comply with applicable building code	
4.1088.8d 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
4.1088.8e Ventilation baffling	Baffling for attic soffit vents will be installed to:	Ensure vent allows proper air flow without compromising insulation performance
	Ensure proper air flow	
	Prevent wind washing of insulation	
	Allow maximum insulation coverage	
	Ensure baffle terminates above insulation	
	Minimum clearance between insulation and roof deck will be 1"	
4.1088.8f Ventilation screens	All attic ventilation will have screens with noncorroding wire mesh with openings of 1/8" to prevent pest entry (e.g., birds, bats, bees)	Prevent pest entry

	Existing vents that are not screened will be covered with noncorroding wire mesh with openings of 1/8"	

4.1102.1	Open-Cavity Wall Insulation—General	
Topic	Walls	
Subtopic	Accessible Walls	
Desired Outcome	Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1102.1a Sealing	Holes and penetrations will be sealed	Prevent air leakage
	Bypasses will be blocked and sealed	
4.1102.1b Installation	Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions	Insulate to prescribed R-value
	Insulation will be installed 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 Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Insulation type	Confirm amount of insulation installed
	Coverage area	Comply with 16 CFR 460.17
	R-value	
	Installed thickness and settled thickness (settled thickness required for loose-fill only)	
	Number of bags installed in accordance with manufacturer specifications (for loose-fill only)	

4.1103.1	Dense Pack Exterior Walls	
Topic	Walls	
Subtopic	Enclosed Walls	
Desired Outcome	Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1103.1a Exterior dense pack	Using fill tube, 100% of each cavity will be filled to a consistent density:	Eliminate voids and settling
	Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density	Minimize framing cavity air flows
	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	
	All holes and penetrations will be plugged and/or sealed	
	Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	
4.1103.1b Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
		Confirm amount of insulation installed Comply with 16 CFR 460.17
	Coverage area	
	Thickness	
	R-value	

4.1103.2	Additional Exterior Wall Cavities	
Topic	Walls	
Subtopic	Enclosed Walls	
Desired Outcome	Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1103.2a Location of cavities	Details remaining in or between completed wall sections will be located and accessed	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:	Eliminate voids and settling
	Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density	Minimize framing cavity air flows
	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	
4.1103.2d Quality assurance	Completed wall sections will be viewed using infrared camera with blower door operating	Establish air barrier and thermal boundary
	Any voids or low density areas will be drilled and re-packed	Confirm no voids or hidden air flows remain

	Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference	
4.1103.2e Close holes	Installation holes will be plugged as follows:	Ensure house is returned to watertight and clean condition
	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	
4.1103.2f Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	
	R-value	Comply with 16 CFR 460.17

4.1103.4	Dense Packing Blown Insulation	
Topic	Walls	
Subtopic	Enclosed Walls	
Desired Outcome	Maintain a consistent, uniform thermal and weather-resistant boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
4.1103.4a Worker safety	All worker safety specifications will be in accordance with SWS 2.0100.3 Worker Safety	Ensure worker safety, especially in regard to fall protection considerations and contaminants found in demolition, such as asbestos, lead, polychlorinated biphenyls, etc.
	Lead safety procedures in buildings built before 1978 will be followed, unless approved testing method proves absence of lead based paint in surfaces that will be disturbed	
4.1103.4b Occupant safety	Occupant will be notified of changes or repairs to be made	Ensure occupant safety
	An occupant safety plan will be prepared and implemented	
4.1103.4c Pre-inspection	Conduct pre-inspection in accordance with SWS 2.0100.4 Worker Safety	Identify and remediate pest, moisture, air leakage, and electrical problems before insulation installation
	Gaps, cracks, and holes in fire separations located within the work area will be visually identified and incorporated into air sealing work scope, including those that span two conditioned or unconditioned spaces	Ensure a durable, continuous thermal boundary
	Where drawings are available that identify specific fire-resistance ratings (i.e., 1 hour, 2 hour), materials and methods will be employed to preserve or restore such rating	Avoid compromising existing water control system
	Where drawings are unavailable or do not identify specific fire-resistance ratings, the fire-resistance rating of the assembly may be inferred from the current construction (i.e., single 5/8 sheetrock, concrete masonry unit), and materials and methods employed will be consistent with restoring or preserving such inferred fire-resistance rating	

	Repairs necessary to stabilize work areas and protect or preserve the integrity of energy improvement will be completed before work begins	
	Insulation will not be installed if moisture-related issues are not resolved	
	Existing water control measures will be identified	
	Air sealing locations on the exterior walls will be identified	
	Air sealing will be completed before installing insulation	
4.1103.4d Wall access	When feasible, insulation will be installed into cavities from the exterior side of the wall	Ensure occupant health and safety
	When feasible, exterior cladding at the insulation access point will be removed before creating an access hole through the sheathing	Minimize disruption within the units
	Insulation access point will be created to minimize air barrier and drainage plane disruption	Avoid compromising existing water control system
	Access point will be sealed to be airtight and watertight after insulation installation before reinstalling the exterior cladding	Minimize air and moisture flow through the wall system
	Water management system will be repaired to function as originally intended (e.g., lapping new felt paper underneath the upper and over the lower joint of the existing felt paper)	
4.1103.4e Sealant selection	Sealants will be compatible with their intended surfaces and applied in accordance with manufacturer specifications	Prevent intrusion of moisture and pests into the sealed assembly
	Selection will be durable, pest resistant, and have a weather-appropriate seal	Prevent exposing workers or occupants to excessive VOC levels

	Indoor sealants will be low volatile organic compound (VOC) products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications	Ensure sealant meets or exceeds the performance characteristics of the assembly and is compliant with local fire code requirements
	Fire-resistance-rated assemblies will be provided with sealants permitted by the authority having jurisdiction and adopted building code	
4.1103.4f Exterior dense pack	Using fill tube, 100% of each cavity will be completely filled to a consistent density:	Eliminate voids and settling
	Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density	Minimize framing cavity air flow
	Blown fiberglass, mineral fiber, rock and slag wool, or spray foam used in an enclosed cavity will be installed in accordance at or above manufacturer recommended density to limit air flow that corresponds to an air permeance value of 3.5 cubic feet per minute/square feet at 50 pascals, as measured using the following applicable methods:	
	BPI-102 Standard for Air Resistance of Thermal Insulation Used in Retrofit Cavity Applications, or	
	Material Specification, or	
	ASTM C 522, or	
	ASTM E 283, or	
	ASTM E 2178	
	All insulation materials used will meet ASTM E84 flame spread/smoke development rating of 25/50	
	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	
4.1103.4g Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	
	R-value	Comply with 16 CFR 460.17

4.1401.1	Band/Rim Joists—Spray Polyurethane Foam (SPF) Installation	
Topic	Basements and Crawl Spaces	
Subtopic	Band/Rim Joists	
Desired Outcome	Insulate and seal all band/rim joist areas between subfloor and foundation or top plate of wall below	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1401.1a Preparation	All band/rim joist areas will be open and accessible for SPF application	Prepare all substrate surfaces for the application of SPF
	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%	
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	Insulate and seal floors
	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, except as stipulated by classification 4.1402.1c	
	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	
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)	Provide necessary fire protection for combustible SPF insulation
	Application to rim/band joist up to 3" can be left exposed if the foam is Class I, unless the space is a habitable space and then cover it with drywall or another thermal barrier	
	Local codes will be confirmed and followed for fire protection requirements	

4.1401.1d Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	
	R-value	Comply with 16 CFR 460.17

4.1401.2	**Band/Rim Joists – Insulation other than Spray Polyurethane Foam**	
Topic	Basements and Crawl Spaces	
Subtopic	Band/Rim Joists	
Desired Outcome	Closed crawl spaces insulated to achieve best thermal performance possible	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1401.2a Preparation	The rim joist, sill plate and adjacent surfaces will be sufficiently clean and free of debris to allow for the proper adhesion of any caulks, adhesives or spray foam used during installation.	Prepare all surfaces for the installation of insulation
4.1401.2b Insulation installation	A foam-based insulation will be installed so as to create a continuous thermal and pressure boundary or vinyl faced fiberglass batt insulation, installed tightly to the wood and sealed at all edges. If rigid insulation is used, all edges will be sealed and the insulation will be installed tightly to the wood to prevent the movement of moisture throughout the assembly. Insulation will be installed in accordance with local/national code requirements and/or manufacturer's instructions regarding flame spread	Improve thermal performance Prevent moisture condensation on the inside of the band joist
4.1401.2c Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17
	Coverage area	
	Thickness	
	R-value	

4.1402.1	Closed Crawl Spaces—Wall Insulation	
Topic	Basements and Crawl Spaces	
Subtopic	Basements and Crawl Space Walls	
Desired Outcome	Closed crawl spaces insulated to achieve best thermal performance possible	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1402.1a Insulation selection	A fire-rated insulation (25 or less flame spread or Class I or Class A) will be used with a minimum life expectancy of 10 years	Provide fire-safe durable insulation that will not exacerbate moisture issues in the crawl space
4.1402.1b R-value	Regional International Energy Conservation Code (IECC) 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 better than or equal to manufacturer specifications	Prevent insulation from detaching from the foundation wall
4.1402.1g Onsite documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications
	Coverage area	Confirm amount of insulation installed
	Thickness	
	R-value	Comply with 16 CFR 460.17

4.1402.2	Basement Wall Insulation—No Groundwater Leakage	
Topic	Basements and Crawl Spaces	
Subtopic	Basements and Crawl Space Walls	
Desired Outcome	Basement insulation improves thermal performance and ensures sufficient drying potential	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
4.1402.2a R-value	Regional IECC will be followed for required R-values	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 semi-impermeable to the interior in all climate zones except Zone 7	Provide drying potential to the basement

5.3003.2	Combustion Analysis of Oil-Fired Appliances	
Topic	Forced Air	
Subtopic	System Assessment and Maintenance	
Desired Outcome	Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail. If new installation or replacement is necessary, *ANSI* / *ACCA* 5 QI *HVAC* Quality Installation Specification will be followed.	
Manufactured Housing, Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
5.3003.2a Oil System: filter	Filter will be present, clean, and leak free	Ensure oil filter is present and functional.
5.3003.2b Nozzle	Nozzle size, angle, and spray pattern will be correct for design input and within equipment firing rate of the heating system manufacturer. Position of nozzle and electrodes will be in accordance with manufacturer specifications	Ensure equipment is outfitted with the correct nozzle per manufacturer guidelines.
5.3003.2c Fuel pressure	Measurement will be verified in accordance with manufacturer specifications	Ensure correct oil pump pressure for nozzle installed and at OEM's specified values per ACCA.
5.3003.2d Place appliance in operation	Heating equipment will be placed in operation in accordance with applicable standards and manufacturer specifications when available	Prepare equipment for combustion analysis tests.
5.3003.2f Steady state efficiency (SSE)	Measurement will be verified in accordance with manufacturer specifications	Determine whether steady state efficiency is within manufacturer range.
5.3003.2e Smoke test	Smoke test will be conducted before any combustion testing is completed Smoke spot reading will be in accordance with burner manufacturer specifications	Determine whether equipment is operating within acceptable range according to smoke test and call for action

		if needed.
	If smoke test is more than actionable levels, specify a clean and tune	
5.3003.2g Net stack temperature	Net stack temperature will be measured and verified in accordance with manufacturer specifications	Determine whether net stack temperature is within manufacturer's recommended range.
5.3003.2h Carbon dioxide (CO2) and oxygen (O2)	Measurement will be verified in accordance with manufacturer specifications	Verify combustion performance of equipment is within manufacturer recommended range based on CO2 and O2 readings.
5.3003.2i Excess combustion air	Excess combustion air will be calculated and shown to be in accordance with manufacturer specifications	Verify combustion performance of equipment is within manufacturer recommended range based on excess combustion air readings.
5.3003.2j CO in flue gas	Measure CO and recommend actions to ensure that *CO* in the undiluted flue gas will be less than 400 ppm air-free	Ensure CO in undiluted flue gas is less than 400 ppm air-free.
5.3003.2k Testing/inspection holes	All testing and inspection holes will be sealed with approved materials	Ensure equipment: - Operates as designed - Operates safely - Operates efficiently - Is durable

5.3003.3	Evaluating Air Flow	
Topic	Forced Air	
Subtopic	System Assessment and Maintenance	
Desired Outcome	Air flow is properly tested	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes, Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
5.3003.3a Total air flow	Total system air flow will be measured by one of the following methods:	Ensure equipment operates as designed
	Temperature rise	Ensure equipment operates efficiently
	Flow plate	
	Fan depressurization device (e.g., Duct Blaster®, DucTester®)	Ensure equipment provides comfort
		Ensure equipment operates safely
		Ensure equipment is durable
5.3003.3b External static pressure	External static pressure will be in accordance with manufacturer specifications	Ensure equipment operates as designed
		Ensure equipment operates efficiently
		Ensure equipment provides comfort
		Ensure equipment operates safely
		Ensure equipment is durable
5.3003.3c Pressure	Pressure drop across cooling coils will be in accordance with manufacturer specifications	Ensure equipment operates as designed
		Ensure equipment operates efficiently
		Ensure equipment provides comfort
		Ensure equipment operates safely

		Ensure equipment is durable
5.3003.3d Pressure drop: filter	Pressure drop across filter will be in accordance with manufacturer specifications	Ensure equipment operates as designed
		Ensure equipment operates efficiently
		Ensure equipment provides comfort
		Ensure equipment operates safely
		Ensure equipment is durable
5.3003.3e Balancing room flow: new ductwork	Air flow will be measured at each register to ensure proper air flow delivery	Ensure equipment operates as designed
		Ensure equipment operates efficiently
		Ensure equipment provides comfort
		Ensure equipment operates safely
		Ensure equipment is durable
5.3003.3f Supply wet bulb and dry bulb	Supply wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed
		Ensure equipment operates efficiently
		Ensure equipment provides comfort
		Ensure equipment operates safely
		Ensure equipment is durable
5.3003.3g Return wet bulb and dry bulb	Return wet bulb and dry bulb air temperatures will be recorded	Ensure equipment operates as designed
		Ensure equipment operates efficiently

		Ensure equipment provides comfort
		Ensure equipment operates safely
		Ensure equipment is durable
5.3003.3h Temperature rise: gas and oil furnaces only	Temperature rise between the supply and return will be in accordance with manufacturer specifications	Ensure equipment operates as designed
		Ensure equipment operates efficiently
		Ensure equipment provides comfort
		Ensure equipment operates safely
		Ensure equipment is durable

5.3003.5	Refrigerant Line Inspection	
Topic	Forced Air	
Subtopic	System Assessment and Maintenance	
Desired Outcome	Refrigerant lines properly installed	
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)**
5.3003.5a Insulation	All suction or vapor refrigerant lines will be insulated to a minimum of R-4	Ensure refrigerant lines do not gain excessive heat, or cause condensation to occur inside the building envelope
	High-side or liquid refrigerant lines will not be insulated unless specified by the equipment's manufacturer	
5.3003.5b Ultraviolet (UV) protection of insulation	If exposed to sunlight, refrigerant line insulation will be protected from UV degradation in accordance with manufacturer specifications, 2012 IRC N1103.3.1, or local code	Install insulation so it does not degrade
5.3003.5c Sizing	Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment	Ensure system moves appropriate volume of refrigerant
5.3003.5d Installation quality	Refrigerant lines will be installed without kinks, crimps, or excessive bends	Ensure system moves appropriate volume of refrigerant
5.3003.5e Support	Refrigerant lines will be routed, supported, and secured to house in a manner that protects the line from damage by workers or occupants	Ensure refrigerant lines do not move, vibrate, or sag
		Protect lines from damage
Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
5.3003.5a Insulation	All suction or vapor refrigerant lines will be insulated to a minimum of R-4	Ensure refrigerant lines do not gain excessive heat, or cause condensation to occur inside the building envelope
	High-side or liquid refrigerant lines will not be insulated unless specified by the equipment's manufacturer	Prevent energy loss and condensation

5.3003.5b Ultraviolet (UV) protection of insulation	If exposed to sunlight, refrigerant line insulation will be protected from UV degradation in accordance with manufacturer specifications, 2012 IRC N1103.3.1, or local code	Install insulation so it does not degrade
5.3003.5c Sizing	Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment	Ensure system moves appropriate volume of refrigerant
5.3003.5d Installation quality	Refrigerant lines will be installed without kinks, crimps, or excessive bends	Ensure system moves appropriate volume of refrigerant
5.3003.5e Support	Refrigerant lines will be routed, supported, and secured to house in a manner that protects the line from damage by workers or occupants	Ensure refrigerant lines do not move, vibrate, or sag
		Protect lines from damage

5.3003.14	**Combustion Analysis of Gas-Fired Appliances (LP and Natural Gas)**	
Topic	Forced Air	
Subtopic	System Assessment and Maintenance	
Desired Outcome	Analysis of critical components and operations completed in accordance with industry and manufacturer specifications	
Single-Family Homes, Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
5.3003.14a Place appliance in operation	Heating equipment will be placed in operation in accordance with applicable NFPA standards and manufacturer specifications when available	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.14c Carbon dioxide (CO2)and oxygen (O2)	Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.14d Excess combustion air	Excess combustion air will be calculated and verified in accordance with industry manuals (e.g., Testo, Bacharach)	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable

5.3003.14e Carbon monoxide (CO) in flue gas	CO in the undiluted flue gas will be less than 400 ppm air-free	Ensure equipment: Operates as designed Operates safely Operates efficiently Is durable
5.3003.14f Gas pressure	If fault has been determined in the preceding steps, then measurement will be verified by a certified professional in accordance with fuel type and manufacturer specifications	Ensure equipment: Operates as designed Operates safely Operates efficiently Is durable
5.3003.14g Testing/inspection holes	All testing and inspection holes will be sealed with manufacturer approved materials	Ensure equipment: Operates as designed Operates safely Operates efficiently Is durable

5.3003.15	Combustion Analysis of Oil-Fired Appliances	
Topic	Forced Air	
Subtopic	System Assessment and Maintenance	
Desired Outcome	Analysis of critical components and operations completed to industry and manufacturer specifications	
Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
5.3003.15a Oil system: smoke test	Smoke test will be conducted before any combustion testing is completed	Ensure equipment:
	Smoke spot reading will be in accordance with burner manufacturer specifications	Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15b Oil system: nozzle	Nozzle size, angle, and spray pattern will be correct for design input and within equipment firing rate of the heating system manufacturer	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15c Oil filter	Filter will be present, clean, and leak free	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15d Fuel pressure	Measurement will be verified in accordance with manufacturer specifications	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15e Oil system: steady state efficiency (SSE)	Measurement will be verified in accordance with manufacturer specifications	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15f Net stack temperature	Net stack temperature will be measured and	Ensure equipment:

	verified in accordance with manufacturer specifications	
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15g Carbon dioxide (CO2)and oxygen (O2)	Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15h Excess combustion air	Excess air will be minimized in accordance with industry best practices	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15i CO in flue gas	CO in the undiluted flue gas will be less than 400 ppm air-free	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable
5.3003.15j Testing/inspection holes	All testing and inspection holes will be sealed with approved materials	Ensure equipment:
		Operates as designed
		Operates safely
		Operates efficiently
		Is durable

5.3104.2	Maintenance: Gas Boiler Service Inspection	
Topic	Hydronic Heating (Hot Water and Steam)	
Subtopic	Equipment Maintenance, Testing, and Repair	
Desired Outcome	Boiler service improves safety, efficiency, and performance	
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)**
5.3104.2a Visual inspection	The following conditions will be assessed by a licensed contractor:	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 2012 IRC G2427 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 1200 or other approved standard	Confirm that combustion occurs safely with maximum efficiency
	If combustion is not in compliance with the referenced standard, diagnostics and adjustments will be referred to a qualified technician to meet manufacturer specifications or local codes	

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	Increase the operational efficiency of the system
	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	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	Ensure occupant is informed of the safe and efficient operation and maintenance of the work performed
	Completed work and recommended maintenance will be reviewed	

6.6004.2	Individual Exhaust Fan Serving Multiple Rooms Within Single Dwelling Unit (All Building Types)	
Topic	Exhaust	
Subtopic	Exhaust Ventilation Systems	
Desired Outcome	Multiport fan system installed to provide required ventilation	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
6.6004.2a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation
6.6004.2b Air flow	ASHRAE 62.2 and local code requirements should be followed for identifying design airflow rates within apartment dwelling units.	Exhaust sufficient air from desired locations to the outdoors
	All other areas will follow local code requirements and/or ASHRAE 62.1-2010 requirements	
	Air flows will be measured in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111 and adjusted to meet design requirements	
6.6004.2c Outlet termination	Outlet will be terminated outside of the building shell and will have a louvered cover and bird screen	Direct exhaust to the outdoors and prevent re-entry
	Minimum distance of exhaust outlet from any doors, windows, or outside air intakes shall be in conformance with the applicable building code	Prevent entry of weather and pests into building shell
	Outlet will be sealed to prevent water intrusion and exhaust air leakage into building cavities	Ensure occupant health and safety
6.6004.2d Wiring	Wiring will be installed by a properly licensed contractor	Prevent an electrical hazard
	Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	
	Refer to NFPA 70: National Electrical Code for installation requirements	
6.6004.2e Access	Fan and service switch will be accessible for maintenance	Ensure unit and service switch are accessible for maintenance or

		replacement
6.6004.2f Fan mounting	Fan will be oriented so the equivalent length of the duct run is as short as possible	Ensure short duct runs to achieve optimum air flows
	Fan will be mounted securely in accordance with manufacturer specifications and local code requirements (in terms of seismic restraints, vibration, and noise control)	Ensure mounting is installed securely
	Fan will be isolated from the building framing unless specifically designed to be directly attached	Ensure fan housing or building framing does not shake, rattle, or hum when operating
	Fan will be installed remotely by ducting from intake grilles	Minimize noise
6.6004.2g Backdraft dampers (required in intermittent systems)	A backdraft damper will be installed between the fan and the exterior	Prevent reverse air flow when the system is off
	A backdraft damper will be installed in any duct serving any room with a separate exhaust (e.g., dryer)	Prevent spread of contaminants between rooms
6.6004.2h Combining intake ducts	All individual intake ducts will be combined on the intake side of fan (e.g., Y-fitting, T-fitting, collector box)	Exhaust air from desired locations to the outdoors
6.6004.2i Duct connections	Ducts will be connected and sealed to applicable intakes, collector box, fan, and termination fitting	Exhaust air from desired locations to the outdoors
	Ducts will be connected and sealed in accordance with the applicable code adopted by the jurisdiction	Preserve integrity of the duct system and building envelope
6.6004.2j Insulation	All components 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
		Prevent condensation in ductwork
		Prevent heat loss
6.6004.2k Boot to interior surface seal	Register boot will be sealed to interior surfaces with sealants compatible to their intended surfaces	Prevent air leakage around boot
	Sealants will be continuous and meet fire barrier specifications	Ensure a permanent seal to the building air barrier

	Boots will be connected and sealed in accordance with the applicable code adopted by the jurisdiction	Prevent a fire hazard
6.6004.2l Preventing air leakage caused by exhaust fans	Walls, ceilings, and floors will be sealed to separate any occupied space from any unconditioned spaces and adjacent dwelling units	Ensure occupant health and safety
	Refer to ASHRAE 62.2-2010 Section 6.1	Prevent air leakage into the building from other spaces (e.g., adjacent dwelling units, garages, unconditioned crawl spaces, unconditioned attics)
6.6004.2m Balance and flow	Air flows will be measured and adjusted to match to the design specification	Achieve the desired air flows to and from the desired locations
6.6004.2n Combustion zone testing	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances
6.6004.2o Fire dampers	Fire dampers must be accessible for inspection and/or testing by the local authorities; if fire dampers are not accessible from a grill or register, an access door in the ductwork is required	Ensure access to fire dampers for safe operation
	Sealing activities will not interfere with the operation of fire dampers, balancing dampers, or backdraft dampers	Minimize static pressure
	Type B fire dampers will be used as required by fire code	Maximize air flow
6.6004.2p Occupant/property manager education	Occupant/property manager will be educated on purpose and value of system	Ensure occupant health and safety
	Property manager will be instructed on all maintenance procedures	Preserve integrity of system

6.6102.3	Intake for Ventilation Air to Forced Air System Used for Heating or Cooling	
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		
Title	**Specification(s)**	**Objective(s)**
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	Reduce migration of pollutants
	Any portion of the return located inside the combustion appliance zone will be air sealed	
6.6102.3b Wiring	Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes	Prevent an electrical hazard
6.6102.3c 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	Ensure short duct run to achieve optimum air flow
	Filtration of ventilation air will be provided before passing through the thermal conditioning components	Preserve integrity of the duct system and building envelope
	Duct will be connected to intake fitting	
	Connection and seal will be performed according to supply duct detail	
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	Prevent air flow when none is desired
	Air flow will be provided by sequenced operation of the damper or equivalent technology	

6.6102.3f Intake filter	An accessible filter will be installed	Ensure occupant health and safety
	Filter will be able to remove contaminants consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 52.2-2007	Preserve integrity of the building envelope
	Filter or air cleaning systems that intentionally produce ozone will not be allowed	
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

6.6202.3	Airflow Control Devices (All Building Types)	
Topic	Whole Building Ventilation	
Subtopic	Components	
Desired Outcome	Efficient and balanced distribution system	
Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
6.6202.3a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer (e.g., duct size, type, shape, register type, duct static pressure)	Ensure appropriate design for installation
	Access to all dwelling units and elements of distribution system will be ensured by installer	
6.6202.3b Preparation	Duct cleaning, when performed, will be performed in compliance with ANSI/ACCA 6 HVAC System Cleanliness-2007	Establish preconditions for installing flow control device
	Register cleaning or replacement will be performed as specified	Ensure health and safety of occupant
	Duct sealing will be performed as specified	
	Stack pressures will be verified for proper operation of flow control device	
	Presence and type of dampers and smoke control devices will be identified, and installer will ensure the installation of the air flow device will not interfere with proper operation	
6.6202.3c Material selection	Appropriate selection of air flow regulator or orifice will be confirmed by installer; if custom design is required, it will be determined by installer	Ensure sealants and materials meet or exceed the performance characteristics required of the assembly (e.g., fire rating)
	Registers will be compatible with selected flow control device	Ensure conditions exist for effective installation of flow control device

	Gasketing or transition system will be compatible with selected flow control device and existing duct components	Ensure conditions exist for the flow control device to meet the design specifications
	Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications	
	Duct sealants will be UL 181 compliant	
	Sealants and materials will be continuous and in accordance with fire barrier specifications	
6.6202.3d Installation	Transition or adapter will be securely fastened and sealed in accordance with manufacturer specifications	Achieve specified design flows
	Flow control device will be installed with proper orientation and in accordance with manufacturer specifications	Provide a durable and secure installation
	Adjustable devices will be set to preliminary balancing position	
6.6202.3e Balance and flow	Air flows will be measured and adjusted to match to the design specification in accordance with ANSI/ACCA Standard 5 or ANSI/ASHRAE Standard 111	Achieve the desired air flows to and from the desired locations
6.6202.3f Verification	Final visual inspection of flow control installation and installer documentation will be completed	Ensure the performance of the ventilation system
	Continued operation of dampers and smoke control devices will be verified	Ensure occupant health and safety
6.6202.3g Occupant/property manager education	Occupant/property manager will be educated on how the system works and its purpose	Ensure the durability of the ventilation system
	Occupant/property manager will be educated on how to inspect flow control device upon unit turnover	

6.6202.9	Filtration for Fan-Powered (Active) Systems	
Topic	Whole Building Ventilation	
Subtopic	Components	
Desired Outcome	Indoor air quality (IAQ) improved and equipment efficiency maintained	
Single-Family Homes, Multifamily Homes		
Title	**Specification(s)**	**Objective(s)**
6.6202.9a Pre-inspection	Specifications will be field verified as appropriate to site conditions by installer	Ensure appropriate design for installation
6.6202.9b Selection	All mechanically supplied outdoor air will pass through filter before conditioning	Ensure outdoor air is filtered before entering occupied space
	Filters and filter racks/holders will have a rating of minimum efficiency rating value 6 or higher when tested in accordance with ASHRAE 52.2	Ensure occupant health and safety
	Pressure drop across filter will match equipment capabilities	
	Filter systems that produce ozone will not be allowed	
6.6202.9c Installation	Filter will be located and installed to facilitate access and regular service by occupant/maintenance staff	Prevent air bypass of filter
	Filter will be located on the inlet side of the equipment fan	Allow for proper maintenance and replacement
	Filter access panel will include gasket or comparable sealing mechanism and fit snugly against exposed edge of filter when closed to prevent air bypass	
	Filter plenum construction will be airtight and sealed to adjoining ductwork	
6.6202.9d Occupant/property manager education	Occupant/property manager will be instructed on proper maintenance procedures and replacement schedule	Ensure continued performance of equipment efficiency and IAQ

6.6204.1	Commissioning Ventilation Systems	
Topic	Whole Building Ventilation	
Subtopic	System Evaluation	
Desired Outcome	Verify proper operation of existing system, installed system air flow meets required standard and provides continuous ventilation for background pollutant sources	
Manufactured Housing, Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
6.6204.1a Identification	Identify whole building ventilation strategy that was installed in the home, based on options described in current version of ASHRAE 62.2, e.g., exhaust only, supply only, balanced, combining local and whole home ventilation delivery, incorporating infiltration credit, etc.	Ensure suitable whole building ventilation strategy is installed. Identify testing requirements to determine installed system air flow.
6.6204.1b Equipment inspection	Visually inspect and document status of:	Evaluate equipment
	Electrical connections	
	Name plate (rated sone and flow)	
	Motor cleanliness	
6.6204.1c Pathway inspection	Visually inspect and document status of ducting or other airflow pathways to ensure proper: • Connections (proper materials, sealed and connected) • Insulation • Support • Sizing, and • Termination locations and fittings. Verify proper damper operation	Preserve integrity of building envelope. Effectively move air along selected pathways.
6.6204.1d Measurement and Adjustment	Using a calibrated device, measure air flow of all necessary components, including building air leakage when relevant. Adjust ventilation equipment air flows as necessary to meet the ventilation rates required by the current version of ASHRAE 62.2	Provide sufficient air flows per current ventilation standards. Verify suitable performance of installed ventilation strategy.
6.6204.1e Work order	Develop work order as necessary to correct deficiencies identified during inspections and measurement	Correct deficiencies

		Ensure proper operation
6.6204.1f Occupant education	Instruct occupant on purpose, use and maintenance of ventilation, and typical signs that ventilation is needed, e.g., condensation on windows	Occupant understands benefits of good indoor air quality and can operate ventilation equipment as needed.

6.6205.1	Manufactured Housing Exhaust-Only Strategies	
Topic	Whole Building Ventilation	
Subtopic	Exhaust-Only System	
Desired Outcome	Provide primary ventilation for common spaces	
Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
6.6205.1a Assessment	Assessment will be done using ASHRAE 62.2 standard:	Determine the ventilation needs of the whole house
	Blower door test	
	Fan flow measurements	
	Calculations	
6.6205.1b Selection	Fan type will be capable of continuous operation and selected in accordance with ASHRAE 62.2 for:	Determine proper fan selection
	Sizing	Minimize energy consumption during fan operation
	Climate considerations	
	Control strategy	
	Sone rating	
	Durability	
	Fan will be ENERGY STAR qualified	
6.6205.1c Location	No resistance greater than 3 pascals will exist between fan intake location with reference to the common area	Ensure fresh air distribution to common areas
6.6205.1d Climate considerations	ASHRAE 62.2 will be referenced for climate considerations	Maintain building durability
	Whole house mechanical net exhaust flow for hot-humid climate will not exceed 7.5 cubic feet per minute/100 square feet	Protect occupant health
6.6205.1e Combustion Appliance Zone (CAZ) testing	CAZ test will be performed where combustion appliances are utilized, where applicable	Identify possible conditions that can cause unsafe equipment operating conditions

6.6205.1f Occupant education	Occupant will be educated on:	Ensure occupant is educated on the safe and efficient operation of the system
	Purpose of the ventilation system	Deliver intended air exchange
	Proper operation and use of controls	
	Cost and benefit of system	
	Manual shut off	
	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	
	Operation guide or label will be permanently attached and in full sight	
6.6205.1g Total exhaust airflow	Total exhaust system airflow will be measured	Ensure exhaust airflow is as designed

6.6288.1	**Sound-Rating Limits**	
Topic	Whole Building Ventilation	
Subtopic	Special Considerations	
Desired Outcome	Systems operate as quietly as possible	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
6.6288.1a Primary ventilation system or any continuously operating fan	System shall be rated for sound in accordance with current ASHRAE 62.2 standard	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

7.8003.1	Lighting Upgrade	
Topic	Plug Load	
Subtopic	Lighting	
Desired Outcome	Energy used for lighting reduced while maintaining adequate and safe lighting levels	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
7.8003.1a Day lighting	Window coverings (e.g., blinds, shades, movable insulation) will be replaced or maneuvered to maximize useful daylight where appropriate	Reduce energy use without negative consequences (e.g., glare, unintentional heating)
	Active and passive day lighting will be properly oriented, designed, and installed where appropriate	
7.8003.1b Selection	All bulbs, fixtures, and controls will be appropriate for the intended application (e.g., enclosed, orientation, dimmable, potential for breakage, indoor, and outdoor)	Provide improved lighting quality at lower energy use
	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)	Select equipment that will not be an unnecessary barrier to future technologies
	Selected equipment should have the highest level of efficiency within a technology [e.g., compact fluorescent lamp (CFL), LED]	Avoid inferior products and unsatisfied occupants
	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)	
	When incandescent bulbs cannot be replaced or when occupant chooses not to replace, a dimmer will be selected	
	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	
	Controls to turn off lights when not needed (e.g., no one in room) will be provided	

	All bulbs, fixtures, and controls will be UL-approved and installed in accordance with local code(s) and NFPA 70 National Electric Code	
	Fluorescent light ballasts containing polychlorinated biphenyls (PCBs) will be replaced in accordance with the EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades	
Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
7.8003.1a Daylighting	Window coverings (e.g., blinds, shades, movable insulation) will be replaced or maneuvered to maximize useful daylight where appropriate	Reduce energy use without negative consequences (e.g., glare, unintentional heating)
	Active and passive daylighting will be properly oriented, designed, and installed where appropriate	
7.8003.1b Selection	All bulbs, fixtures, and controls will be appropriate for the intended application (e.g., enclosed, orientation, dimmable, potential for breakage, indoor and outdoor)	Provide improved lighting quality at lower energy use
	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)	Select equipment that will not be an unnecessary barrier to future technologies
	Selected equipment should have the highest level of efficiency within a technology [e.g., compact fluorescent lamp (CFL), LED]	Avoid inferior products and unsatisfied occupants
	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)	
	When incandescent bulbs cannot be replaced or when occupant chooses not to replace, a dimmer will be selected	
	Power quality will be evaluated before new lighting is selected	
	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	
	Controls to turn off lights when not needed (e.g., no one in room) will be provided	
	All bulbs, fixtures, and controls will be UL-approved and installed in accordance with local code(s) and NFPA 70 National Electric Code	
	Fluorescent light ballasts containing polychlorinated biphenyls (PCBs) will be replaced in accordance with the EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades	

7.8102.2	**Storage-Type Appliance**	
Topic	Water Heating	
Subtopic	Installation and Replacement	
Desired Outcome	Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes		
Title	**Specification(s)**	**Objective(s)**
7.8102.2a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified	Remediate health hazards using EPA-certified contractors
	Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator	
	Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)	
7.8102.2b Equipment removal	Accepted industry procedures and practices will be followed to:	Ensure the safety of the workers and occupants

	Remove old water heater and associated components in accordance with 2012 IRC R105.1 or authority having jurisdiction	Preserve integrity of the building
	Seal any unused chimney openings and penetrations in accordance with 2012 IRC N1102.4.1.1 or authority having jurisdiction	
	Remove unused oil tank, lines, valves, and associated equipment in accordance with 2012 IRC M2201.7 or authority having jurisdiction	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	New water heater and associated components will be installed to accepted industry standards, in accordance with the 2012 IRC and manufacturer specifications	Ensure the safety of the workers and occupants
	The system will be installed to be freeze resistant	Preserve integrity of the building
	Any existing water leaks will be repaired before installation begins	Remove old equipment in a timely and efficient manner
	Any penetrations to the exterior of the home created by the installation of the equipment will be sealed	
7.8102.2d 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	Collect and safely dispose of water escaping from the storage tank
	A ¾" drainline or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 IRC	
7.8102.2e Expansion tank	A potable water expansion tank will be installed on the cold water side	Protect the storage tank from expansion
	A direct connection with no valves between the storage tank and expansion tank will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications	
7.8102.2f Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC and according to manufacturer specifications	Discharge excessive energy (pressure or temperature) from storage tank to safe

	Temperature and pressure relief valve discharge tube will be installed in accordance with P2803.6.1 of the 2012 IRC	location
7.8102.2g Dielectric unions	Dielectric unions will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank
7.8102.2h Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes	Protect water supply from contamination
7.8102.2i Thermal efficiency	If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications	Reduce standby loss from near tank piping and storage tank
	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	Ensure insulation does not make contact with flue gas venting
	The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications	
	Combustible pipe insulation must maintain a minimum clearance of 6'' from gas water heater draft hood and/or single wall metal pipe. Clearance from vent such as "B" vent should be maintained per vent manufacturer's specifications.	
	Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer	
7.8102.2j Fuel supply	Electric or fossil fuel supply components will be installed to accepted industry standards as per NFPA 31 and 54, or NFPA 70 National Electric Code (NEC) for electric components, or authority having jurisdiction	Provide sufficient fuel to the water heater, burner, or element
7.8102.2k Discharge temperature	Discharge temperature will be set not to exceed 120° or as prescribed by local code	Ensure safe hot water supply temperature to fixtures
7.8102.2l Commissioning of system	The following will be checked once the system has been filled and purged:	Ensure safe system function

	Safety controls	Keep cost of ownership as low as possible
	Combustion safety and efficiency	
	Operational controls	
	Fuel and water leaks	
	Local code requirements	
	Commissioning will be in compliance with manufacturer specifications and relevant industry standards	
7.8102.2m Occupant safety	Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction	Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate
	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	
7.8102.2n Occupant education	Completed work will be reviewed	Ensure occupant is informed of the safe, efficient operation and maintenance of the system
	Occupants will be educated on the safe and efficient operation and maintenance of the system, including:	
	Adjustment of water temperature and target temperature in accordance with local code	
	Periodic drain and flush	
	Expansion tank and backflow preventer (no occupant maintenance required)	
	Periodic inspection, maintenance, or replacement	
Manufactured Housing		
Title	**Specification(s)**	**Objective(s)**
7.8102.2a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified	Remediate health hazards using EPA-certified contractors
	Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator	
	Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)	

7.8102.2b Equipment removal	Accepted industry procedures and practices will be followed to:	Ensure the safety of the workers and occupants
	Remove old water heater and associated components in accordance with 2012 IRC R105.1 or authority having jurisdiction	Preserve integrity of the building
	Seal any unused chimney openings and penetrations in accordance with 2012 IRC N1102.4.1.1 or authority having jurisdiction	
	Remove unused oil tank, lines, valves, and associated equipment in accordance with 2012 IRC M2201.7 or authority having jurisdiction	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	New water heater and associated components will be installed by a licensed contractor to accepted industry standards, in accordance with the 2012 IRC and manufacturer specifications	Ensure the safety of the workers and occupants
	The system will be installed to be freeze resistant	Preserve integrity of the building
	Any existing water leaks will be repaired before installation begins	Remove old equipment in a timely and efficient manner
	Any penetrations to the exterior of the home created by the installation of the equipment will be sealed	
7.8102.2d 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	Collect and safely dispose of water escaping from the storage tank
	A ¾" drain line or larger will be connected to tapping on pan and terminated in accordance with P2801.5.2 of the 2012 IRC	
7.8102.2e Expansion tank	A potable water expansion tank will be installed on the cold water side	Protect the storage tank from expansion
	A direct connection with no valves between the storage tank and expansion tank will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications	

7.8102.2f Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with P2803 of the 2012 IRC 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 P2803.6.1 of the 2012 IRC	
7.8102.2g Dielectric unions	Dielectric unions will be installed in accordance with the 2012 IRC, authority having jurisdiction, and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank
7.8102.2h Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes	Protect water supply from contamination
7.8102.2i Thermal efficiency	If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications	Reduce standby loss from near tank piping and storage tank
	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	Ensure insulation does not make contact with flue gas venting
	The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications	
	Combustible pipe insulation must maintain a minimum clearance of 6” from gas water heater draft hood and/or single wall metal pipe. Clearance from vent such as "B" vent should be maintained per vent manufacturer's specifications	
	Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer	
7.8102.2j Fuel supply	Electric or fossil fuel supply components will be installed to accepted industry standards as per NFPA 31 and 54, or NFPA 70 National Electric Code (NEC) for electric components, or authority having jurisdiction	Provide sufficient fuel to the water heater, burner, or element
7.8102.2k Discharge temperature	Discharge temperature will be set not to exceed 120° or as prescribed by local code	Ensure safe hot water supply temperature to fixtures
7.8102.2l Commissioning of system	The following will be checked once the system has been filled and purged:	Ensure safe system function
	Safety controls	Keep cost of ownership as low as possible

	Combustion safety and efficiency	
	Operational controls	
	Fuel and water leaks	
	Local code requirements	
	Commissioning will be in compliance with manufacturer specifications and relevant industry standards	
7.8102.2m Occupant safety	Carbon monoxide alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction	Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate
	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	
	Ambient CO to be maintained at or under 10 ppm or within acceptable limits as comparable to outside concentrations	
7.8102.2n Occupant education	Completed work will be reviewed	Ensure occupant is informed of the safe, efficient operation and maintenance of the system
	Occupants will be educated on the safe and efficient operation and maintenance of the system, including:	
	Adjustment of water temperature and target temperature in accordance with local code	
	Periodic drain and flush	
	Expansion tank and backflow preventer (no occupant maintenance required)	
	Periodic inspection, maintenance, or replacement	