Standard Work Specifications 2017 – Manufactured Housing

Disclaimer

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Note: In the specification tables below, the farthest right column (no header) containing a numerical reference should be ignored.

Table of Contents

Glossary

AAMA	American Architectural Manufacturers Association, www.aamanet.org
AARST	American Association of Radon Scientists and Technologists, www.aarst.org
AB	Air barrier
ACCA	Air Conditioning Contractors of America, www.acca.org
ACM	Asbestos-containing material
ADA	Americans with Disabilities Act
ADC	Air Diffusion Council, www.flexibleduct.org
AFUE	Annual fuel utilization efficiency
AGA	American Gas Association, www.aga.org
AHJ	Authority having jurisdiction
AHRI	Air Conditioning, Heating, and Refrigeration Institute, www.ahrinet.org
Air barrier	The separation between the interior and exterior environments of a building that slows air flow to the point that no smoke movement is visible at 50 pascals of pressure difference across the boundary
AL	Action level
ANSI	American National Standards Institute, www.ansi.org
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, www.ashrae.org
ASTM	ASTM International, www.astm.org
Backdraft damper	A damper that allows air to flow in only one direction
Beaded collar	A round fitting with a ridge or lip part way down its length that prevents a flexible duct mechanically attached with a draw band from sliding off
Bonus room	A livable room that is often over a garage or in an attic area; the room commonly contains slanted ceilings and knee walls
BPI	Building Performance Institute, www.bpi.org

BTU	British thermal unit
Can light	A light fixture (or can) that is recessed into the ceiling
Cathedral ceiling	A condition in which the ceiling has the same slope as the roof
Cathedralized attic	An attic that contains insulation located at the roof deck rather than the attic floor, bringing the attic space into the thermal boundary of the house
CAZ	Combustion appliance zone
CFL	Compact fluorescent lamp
CFM	Cubic feet per minute
CGSB	Canadian General Standard Board
Closed crawl space	A foundation without wall vents that uses air-sealed walls, ground and foundation moisture control, and mechanical drying methods to control crawl space moisture. Insulation may be located at the conditioned floor level or on the exterior walls. Return pathways are not allowed from the crawl space to the living space
CO	Carbon monoxide
Conditioned basement	A below- or partially below-grade livable space with concrete or finished floor that is intentionally heated or cooled
Conditioned crawl space	A foundation without wall vents that encloses an intentionally heated and/or cooled space. Insulation is located on the exterior walls
CPSC	Consumer Product Safety Commission
CSA	Canadian Standards Association
DACUM	Developing a curriculum
dBA	A-weighted decibels
Dense pack	The process of installing loose-fill insulation to reduce air flow and perform to a stated R-value
DHW	Domestic hot water
Dielectric union	A plumbing connection that separates two different materials and does not allow them to chemically react and break down

Draft regulator	A device that functions to maintain a desired draft in the appliance by automatically reducing the draft to the desired value. Source: National Fire Protection Association 54, 2012
Dual-Cooling Up-Duct	Piece of duct located between the living space and attic to allow air flow in pressurized homes having evaporative coolers
Efflorescence	Deposits of crystals or salts left attached to masonry materials after moisture has evaporated off of the surface
Egress window	A window that people can escape through in an emergency
EIFS	Exterior insulation and finish systems
EIMA	EIFS Industry Members Association
Energy factor	Measure of overall efficiency for a variety of appliances. For water heaters, the energy factor is based on three factors: 1) the recovery efficiency, or how efficiently the heat from the energy source is transferred to the water; 2) stand-by losses, or the percentage of heat lost per hour from the stored water compared to the content of the water: and 3) cycling losses. For dishwashers, the energy factor is defined as the number of cycles per kWh of input power. For clothes washers, the energy factor is defined as the cubic foot capacity per kWh of input power per cycle. For clothes dryers, the energy factor is defined as the number of pounds of clothes dried per kWh of power consumed.
Envelope	The separation between the interior and exterior environments of a building that includes a combination of air and thermal barrier
EPA	U.S. Environmental Protection Agency, www.epa.gov
ERV	Energy recovery ventilator
ESP	External static pressure
Exfiltration	The uncontrolled passage of inside air out of a building through unintended leaks in the building envelope
Exterior storm window	An additional window assembly installed on the exterior of the main window
Finished attic	An attic space that has been converted into an additional living space of the house
GFCI	Ground-fault circuit interrupter
GPM	Gallons per minute

Hi-limit switch	A protective electronic switch that keeps a burner from continuing to operate and damage the appliance
HRV	Heat recovery ventilator
HVAC	Heating, ventilation, and air conditioning
HVI	Home Ventilation Institute
Hydrophobic	Lacking affinity for water; tending to repel and not absorb water; tending not to dissolve in, mix with, or be wetted by water
I-P	Inch-pound
IAQ	Indoor air quality
IBC	International Building Code
IBR	Institute of Boiler and Radiator Manufacturers
IC	Insulation contact
ICC	International Code Council
IECC	International Energy Conservation Code
IFGC	International Fuel Gas Code
Ignition barrier	Any layer of material that protects another from catching fire due to heat or spark
IMC	International Mechanical Code
Infiltration	The uncontrolled passage of outside air into a building through unintended leaks in the building envelope
Interior storm window	An additional window assembly installed on the interior of the main window
IPM	Integrated Pest Management
IRC	International Residential Code
IWC	Inches of water column
JTA	Job task analysis

Knee wall	Any wall between the conditioned space and the attic
KSA	Knowledge, skills, and abilities
LED	Light-emitting diode
MERV	Minimum efficiency reporting value
Modulating systems	Heating systems with the ability to adjust the heating capacity and output based on the heating demand
MSDS	Material Safety Data Sheet
NAHB	National Association of Home Builders, www.nahb.com
NAIMA	North American Insulation Manufacturers Association, www.naima.org
NATE	North American Technician Excellence, www.natex.org
NEBB	National Environmental Balancing Bureau, www.nebb.org
NEC	National Electrical Code
NFPA	National Fire Protection Association, www.nfpa.org
NIOSH	National Institute for Occupational Safety and Health, www.cdc.gov/niosh
Orphaned equipment	Condition when one smaller combustion appliance exists after being commonly vented with a larger appliance. What remains is a larger exhaust flue or chimney than is necessary for the remaining smaller appliance
Orphaned water heater	Condition when one smaller combustion appliance (e.g., water heater) exists after being commonly vented with a larger appliance. What remains is a larger exhaust flue or chimney than is necessary for the water heater
OSHA	U.S. Occupational Safety and Health Administration, www.osha.gov
PEL	Permissible exposure limit
Perm rating	The measurement of a material's ability to allow the transfer of water vapor through the material
PPE	Personal protective equipment
Programmable thermostat	A thermostat designed to adjust the temperature according to a series of programmed settings that take effect at different times of the day

Psi	Pounds per square inch
Psig	Pound per square inch gauge
Reverse or upslope lapping technique	Upper course laps under a lower course to keep the moisture under the barrier
Rigid material	Drywall, oriented strand board, duct board, cardboard, or any other stiff product that may support the load of insulation while serving as a durable air barrier
RPA	Radiant Professional Alliance
RRP	Renovation, repair, and painting
SDS	Safety Data Sheet
Sealant foam	One- or two-component polyurethane foam typically applied as a bead and used to control air leakage as part of an air barrier system within the building envelope
Service switch	An electrical switch that controls the complete flow of electricity to a mechanical device
SHGC	Solar heat gain coefficient
SI	Système International
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, www.smacna.org
SPF	Spray polyurethane foam
SPFA	Spray Polyurethane Foam Alliance
SSE	Steady state efficiency
Standby loss	Heat loss through the outer part of a water heater. Energy that is used even when a device is turned off
Storm door	An additional door assembly that is installed on the exterior of the main door
Strip heat	A function of a heat pump that uses energy-intensive resistance heat to warm conditioned space when the heat pump is unable to satisfy the heating demand; also provides emergency heat backup for heat pumps
Support material	Typically, wooden strips that provide support over holes greater than 24" in size for less rigid air barrier materials

T&TA	Training and Technical Assistance
TABB	Testing and Balancing Bureau, www.tabbcertified.org
TDC	Transverse duct connector
TDF	Transverse duct flange
Thermal boundary	The separation between the interior and exterior environments of a building that slows heat flow
Thermal resistance	The insulation or other building material that offers the primary barrier to thermal transmittance. R-value is a measurement of thermal resistance
Tie band	A strap, often made of nylon, that mechanically squeezes a flexible duct to a fitting. Must have a minimum performance temperature rating of 165° (per UL 181A-type test) and a minimum tensile strength rating of 50 pounds
UL	Underwriters Laboratories
Unconditioned basement	A below- or partially below-grade livable space with concrete or finished floor without intentional heating or cooling
UV	Ultraviolet
Vapor barrier	A material that retards the passage of water vapor and contains a perm rating of less than 1
Vapor retarder	A material that slows the passage of water vapor and contains a perm rating above 1
Vaulted ceiling	A condition where a non-horizontal ceiling has a different slope than the roof
Vented crawl space	A foundation that uses wall vents as a primary means to control moisture. Insulation is located at the conditioned floor level above the crawl space
VOC	Volatile organic compound
WAP	DOE Weatherization Assistance Program
WDMA	Window and Door Manufacturers Association, www.wdma.com
Wg	Water gauge
Wind intrusion	A condition where air from outside of a structure can pass through insulation and reduce its performance

Wood/materials shrinkage	A loss of dimension and weight as a result of drying the structure and operating the building at lower relative humidity

Section 2: Health and Safety

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.

For supporting material, see Calculation of the Infiltration Credit and Building America Solution Center.

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		1691
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		1692
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) 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 SDS for respiratory protection requirements	Minimize exposure to airborne contaminants (e.g., insulation materials, mold spores, feces, bacteria, chemicals)		1693

	OSHA 1910.134 shall be followed for the implementation of a respiratory protection program			
2.0100.1d Electrical safety	An electrical safety assessment will be performed All electric tools will be protected by ground-fault circuit interrupters (GFCI) Three-wire type extension cords will be used with portable electric tools Worn or frayed electrical cords will not be used Water sources (e.g., condensate pans) and electrical sources will be kept separate Metal ladders will be avoided Special precautions will be taken if knob and tube wiring is present Aluminum foil products will be kept away from live wires For arc flash hazards, NFPA 70E will be consulted	Avoid electrical shock and arc flash hazards		1694
2.0100.1e Carbon monoxide (CO)	All homes will have a carbon monoxide alarm Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)	Protect worker and occupant health		1695
2.0100.1f Personal Protective Equipment	SDS and OSHA regulations will be consulted for equipment and protective clothing would be worn if contaminants are present(e.g., insulation materials) Eye protection will always be worn (e.g., safety glasses, goggles if not using full-face respirator)	Protect worker from skin contact with contaminants Minimize spread of contaminants Provide eye protection		1696

2.0100.1g Confined space safety	Spaces with limited ingress and egress and restricted work area will be considered confined space Access and egress points will be located before beginning work Inspection will be conducted for hazards, such as damaged or exposed electrical conductors, mold, sewage effluent, friable asbestos or fiberglass, pests, and other potential hazards Adequate ventilation will be provided Use of toxic material will be reduced	Prevent build-up of toxic or flammable contaminants Reduce risk to the workers in the confined space Provide adequate access and egress points Prevent electrical shock		1697
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. All tools must be maintained in proper operating condition with all guards securely in place All devices used will be verified as GFCI protected or double insulated Exhaust gases from compressors and generators will be prevented from entering interior space	Prevent power tool injuries Prevent buildup of toxic or flammable contaminants		1698
2.0100.1i Chemical safety	Hazardous materials will be handled in accordance with manufacturer specifications, SDS and OSHA standards to eliminate hazards associated with volatile organic compounds (VOCs), sealants, insulation, contaminated drywall, dust, foams, asbestos, lead, mercury, and fibers Appropriate personal protective equipment (PPE) will be provided	Prevent worker exposure to toxic substances		1699

	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) Proper equipment will be used for work Proper lifting techniques will be used	Prevent injuries from awkward postures, repetitive motions, and improper lifting		1700
2.0100.1k Hand tool safety	Hand tools will be maintained in safe working order and used for intended purpose	Prevent injuries		1701
2.0100.1l Slips, trips, and falls	Caution will be used around power cords, hoses, tarps, and plastic sheeting Precautions will be taken when ladders are used, when working at heights, or when balancing on joists Walk boards will be used when practical When scaffolding is used, manufacturer set-up procedures will be followed Appropriate footwear and clothing will be worn	Prevent injuries due to slips, trips, and falls		1702
2.0100.1m Thermal stress	Ensure staff is aware of risks during extreme weather including the symptoms of heat stroke, heat exhaustion, and hypothermia Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided 911 will be dialed when necessary	Prevent heat stroke, heat stress, and cold stress related injuries		1703
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		1704

	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 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	Protect workers and occupants from potential asbestos hazards		1705

2.0100.1p Lead paint assessment	Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect workers and occupants from potential lead hazards		1706
2.0100.1q Site security	Work site will be secured to prevent unauthorized entry Temporarily disconnected equipment will be locked up and tagged out All loose or unbagged trash and unused materials will be removed from work site daily	Protect the occupant from exposure to potential hazards		6906
2.0100.1r Crawl space safety	The source of all contaminants (e.g., sewage, dead animals, needles) will be corrected, repaired, or removed before performing inspections that require complete access to the crawl space If appropriate, the contaminant will be neutralized and/or a protective barrier will be installed in the area	Ensure work safety Prevent worker exposure to hazards		6907

2.0101.1 Air Sealing Worker Safety

Topic: Safe Work Practices

Subtopic: Air Sealing

Desired Outcome: Work completed safely without injury or hazardous exposure

For supporting material, see Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

2.0101.1a Worker safety	Worker safety specifications will be in accordance with SWS Global Worker Safety Complete safety action plan based on hazard; plan will be in place for each job site	Prevent injury Minimize exposure to health and safety hazards		4312
2.0101.1b Moisture precautions for crawl spaces and basements	Exposed earth will be covered with a continuous, durable, and sealed class I vapor retarder that is suitable for ground contact exposure to normal service traffic Causes of air dew points greater than 55°F will be identified and eliminated in crawl spaces connected to conditioned spaces Seasonal dehumidification (e.g., dehumidified or conditioned with air conditioner supply) will be recommended where humidity sources, including outdoor air incursion, cannot be eliminated Undesigned penetrations between the crawl space or basement and the outdoors will be sealed Holes between the crawl space or basement and the living space will be sealed Open sumps and intentional slab or vapor barrier penetrations will be sealed or capped to control moisture and radon levels	Ensure durability of repairs Reduce potential for occupant exposure to mold and other moisture-related hazards Reduce potential for occupant exposure to radon and other soil gases		4313
2.0101.1c Moisture precautions: living space	Moisture sources in the building will be identified and reduced or removed Where local ventilation will be installed, (e.g., baths, kitchens), exhaust units will be vented to the outdoors in accordance with ASHRAE 62.2 Unvented heaters will be removed except when used as a secondary heat source and when it can be confirmed	Ensure durability of building components and repairs Reduce potential for occupant exposure to mold and other moisture-related hazards Reduce potential occupant exposure to CO		4314

	that the unit is listed to ANSI Z21.11.2 Unvented gas or propane cooking stoves will be tested for carbon monoxide (CO) per BPI Standard and corrected as required before air sealing work begins If replacing air conditioning system, new system will be sized to optimize dehumidification Properly sized dehumidifier will be installed to satisfy latent and sensible loads, when necessary ANSI/ACCA 2 Manual J-2011 (Residential Load Calculation) will be used to size replacement AC and heat pumps Enhanced dehumidification will be installed in the Gulf Coast region areas on the Gulf side of the warm humid line on the International Energy Conservation Code map			
2.0101.1d Moisture precautions for exterior water	Before air sealing and insulating building components, exterior water management will be addressed Before insulating basement or crawl space walls near wet areas, surface water pooling near the foundation will be addressed by repairing, modifying, or replacing gutters and downspouts Grading and subsurface drainage at critical locations (e.g., localized drain and grading beneath valleys) will be in accordance with EPA Indoor airPLUS Construction Specifications Section 1.1	Reduce potential for occupant exposure to mold and other moisture-related hazards		4315

2.0102.1 Insulation Worker Safety

Topic: Safe Work Practices

Subtopic: Insulation

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

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
2.0102.1a Worker safety	Worker safety specifications will be followed in accordance with SWS 2.0100 Global Worker Safety	Prevent injury Minimize exposure to health and safety hazards	6913
2.0102.1b Asbestos containing materials (ACM)	OSHA asbestos abatement protocol 29 CFR 1926.1101 will be followed if vermiculite insulation is present Assess potential asbestos hazard; if unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material, and to sample and test as needed If suspected ACM is in good condition, do not disturb If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s) For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair, in accordance with federal, state, and local requirements; only a licensed or 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	Protect workers and occupants from potential asbestos hazards	6914

	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			
2.0102.1c Materials	All materials will be handled in accordance with manufacturer specifications or safety data sheets (SDS) standards	Eliminate hazards associated with incorrect, defective, or improperly used or installed materials		6916
2.0102.1d Lead paint assessment	Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rule making or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards		6917

2.0103.2 Heating and Cooling Worker Safety

Topic: Safe Work Practices

Subtopic: Heating and Cooling Equipment

Desired Outcome: Work completed safely without injury or hazardous exposure

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0103.2a Worker safety	Follow all worker safety specifications in SWS 2.0100 Global Worker Safety section	Prevent injury Minimize exposure to health and safety hazards		3928
2.0103.2b Mercury	When replacing existing thermostats, identify and dispose of any mercury containing thermostats in accordance with Environmental Protection Agency (EPA) guidance	Protect worker and occupant from mercury exposure		3930

2.0103.2c Asbestos	Suspected asbestos hazards will be identified in furnaces (e.g., gaskets), wood stoves, zonal heating devices, electrical wiring insulation, boilers, and pipe insulation and corrected in accordance with EPA guidance Workers will take precautionary measures to avoid exposure	Protect worker and occupant from asbestos exposure		3932
2.0103.2d Personal protective equipment (PPE)	Workers will wear personal protective equipment (PPE) as needed to protect themselves against exposure to hazards (e.g., pests, sewage, flooded duct work, mold, chemicals, scat, viruses) Long sleeves and long pants should be worn as additional protection from liquid nitrogen and other hazardous materials	Protect worker from exposure to hazards Protect worker from skin contact with liquid nitrogen		3934
2.0103.2e Combustible gas detection	Worker will check for presence of combustible gas leaks before work begins Leaks will be repaired before work is performed	Protect worker and occupant from exposure to hazards		3936
2.0103.2f Carbon monoxide (CO)	Workers will check for presence of ambient CO before and during work CO issues will be addressed before work is performed or continued	Protect worker and occupant from exposure to hazards		3938
2.0103.2g Sealant	Pipes will be sealed by a certified professional with an approved fastening process and sealant in accordance with manufacturer specifications (International Fuel Gas Code) Gas lines will be leak free when tested with an electronic combustible gas leak detector and verified with bubble solution OR	Install gas lines with no leaks		3940

	Gas lines will be leak free when tested by a standing pressure test that meets the approval of the local code			
2.0103.2h Safety devices	A secondary LP safety detector system (valve, exhaust fan, alarm light) will be installed by a certified professional for propane piping installed below grade When installing new equipment, a shut off valves will be installed by a certified professional at each gas appliance (ANSI Z21.15)	Detect accumulation of dangerous levels of propane in below-grade areas Isolate appliances from the rest of the system for emergencies, removal, or repairs		3942

2.0105.1 Baseload Worker Safety

Topic: Safe Work Practices

Subtopic: Baseload

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0105.1a Worker safety	All worker safety specifications in SWS 2.0100 Global Worker Safety section will be followed	Prevent injury Minimize exposure to health and safety hazards		1720

2.0105.2 Licensed Electrical Professional

Topic: Safe Work Practices

Subtopic: Baseload

Desired Outcome: Work completed safely without injury from shock or arc flash

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0105.2a Worker safety	Any fixture, ballast, line voltage control, receptacle, or circuit modification will be performed by a licensed electrical professional in accordance with ANSI/NFPA 70 or as required by the authority having jurisdiction	Prevent property damage Ensure worker safety		4320

	All workers will comply with ANSI/NFPA 70E All OSHA standard practices will be followed			

2.0106.1 Material Selection, Labeling, and Material Safety Data Sheets (MSDSs)

Topic: Safe Work Practices

Subtopic: Material Safety

For supporting material, see Building America Solution Center.

Desired Outcome: Occupant and worker risk from hazardous materials minimized

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0106.1a Material selection	Materials that do not create long-term health risks for occupants and workers will be used	Improve indoor air quality in the living space		1721
2.0106.1b Material labels	Manufacturer specifications will be followed	Reduce risk of exposure to harmful substances Follow safety procedures		1722
2.0106.1c Material Safety Data Sheets (MSDSs)	MSDSs will be provided onsite and available during all work	Assess exposure risk Prepare a response in case of emergency		1723

2.0107.5 Prework Qualifications (Home Installation)

Topic: Safe Work Practices

Subtopic: Basements and Crawl Spaces

Desired Outcome: Manufactured home is properly installed

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0107.5a Installation deficiencies	Any installation deficiencies that may affect worker safety or integrity or installed measures will be repaired before starting work	Ensure site is safe and ready for upgrade		3956

2.0107.5b Stabilization	Home must be stabilized in accordance with manufacturer specifications or local authority having jurisdiction	Ensure the home is secured properly Prevent injury Minimize exposure to health and safety hazards		3957

2.0201.1 Combustion Appliance Zone (CAZ) Testing

Topic: Combustion Safety

Subtopic: Combustion Safety General

Desired Outcome: Accurate information about appliance safe operation is gathered

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0201.1a Assessment	Emergency problems (e.g., ambient gas levels greater than 10% Lower Explosion Limit (LEL), ambient CO levels that exceed 70 ppm) will be communicated clearly and immediately to the customer, the home shall be evacuated, and appropriate personnel (e.g.: HVAC technician, utility, emergency services) shall be contacted. ; Significant problems (e.g., gas leak less than 10% LEL, ambient CO levels that exceed 35 ppm but less than 70 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance	Ensure system does not have potentially fatal problems		1739
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 Determine and report need for repair		1740

	If leaks are found, immediate action will be taken to notify occupant to help ensure leaks are repaired The report will specify repair for leaks and replacement for hazardous or damaged gas or oil connectors and pipes			
2.0201.1c Venting	For oil systems that require a draft regulator, the presence and operability of it (that draft regulator) will be verified and tested Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards	Determine if a regulator is present and working Determine whether vent system is in good condition and installed properly		1741
2.0201.1d Base pressure test	Baseline pressure for naturally drafting vented appliances will be measured in Combustion Appliance Zone with reference to outdoors	Measure pressure difference between combustion zone and the outside under natural conditions		1742
2.0201.1e Depressurization test	CAZ depressurization testing will be administered for all atmospherically vented appliances located inside the pressure boundary. Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof; the test will be done to determine the largest negative pressure per BPI Standard 1200.	Determine worst-case depressurization in combustion zone due mechanical system fans		1743

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.

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

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 IRC for the type of appliance installed	Prevent combustion byproducts from entering the house	1747
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 IRC and additional applicable codes	Prevent combustion byproducts from entering the house	1748
2.0201.2d Gas ovens	Gas ovens will be tested for CO A clean and tune will be conducted if measured CO in the undiluted flue gases of the oven vent at steady state exceeds 225 ppm as measured	Ensure clean burn of gas ovens	1750
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	1751
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	1752

2.0201.3 Vented Combustion Appliance Safety Testing

Topic: Combustion Safety

Subtopic: Combustion Safety General

Desired Outcome: Accurate information about appliance safe operation is gathered

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0201.3a 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		3974
2.0201.3b 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		3975
2.0201.3c 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		3976

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

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

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		3982
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		3983

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*)

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0203.1a Required combustion air	The required volume of indoor air will be determined in accordance with IRC and authority having jurisdiction, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), IRC will be used	Determine if existing conditions meet the combustion air calculation		1755

	Exception: Existing appliances that have passed combustion safety testing per BPI 1200 are deemed to have sufficient combustion air			
2.0203.1b Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with IRC and authority having jurisdiction when necessary to solve spillage problems	Ensure adequate combustion air for operation of the appliance		1756
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		6968

2.0203.2 Combustion Flue Gas—Orphaned Water Heaters

Topic: Combustion Safety

Subtopic: Vented Gas Appliances

Desired Outcome: Flue gasses successfully removed from the house

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

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		1757
2.0203.2b Flue gas removal (chimney liner or	A chimney liner will be installed in accordance with the IRC or applicable NFPA standard	Allow water heater to vent properly Prevent damage to the chimney		1758

approved methods)				
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		1759
2.0203.2d Required combustion air	The minimum required volume will be 50 cubic feet per 1,000 Btu /h in accordance with IRC and authority having jurisdiction. Exception: Existing appliances that have passed combustion safety testing per BPI 1200 are deemed to have sufficient combustion air.	Determine if existing conditions meet the combustion air calculation		1760
2.0203.2e Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with IRC or other authority having jurisdiction	Ensure adequate combustion air for operation of the appliance		1761

2.0203.4 Occupant Education

Topic: Combustion Safety

Subtopic: Vented Gas Appliances

Desired Outcome: Ensure persistence of resident safety

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0203.4a Occupant health and safety	All homes will have a functioning CO alarm If CO levels in interior living spaces exceed outdoor levels, potential sources will be investigated and appropriate action taken to reduce them (e.g., have a qualified professional tune, repair, or replace improperly operating combustion appliances; apply weather stripping or conduct air sealing between the garage or crawl space and the home)	Ensure occupant health and safety Ensure indoor CO levels do not exceed outdoor CO levels		3989

2.0203.4b Occupant education	Occupants will be educated on the operation and maintenance of the CO alarm Completed work on combustion appliances and recommended maintenance will be reviewed with occupant Occupant will be provided information regarding the health effects and risk of high CO concentrations; EPA provides possible expanded actions and offers client education information in an appendix to the protocols	Ensure occupant can operate and maintain installations Inform occupant regarding possible CO hazards		3990

2.0204.1 Isolating Combustion Water Heater Closet

Topic: Combustion Safety

Subtopic: Isolation

Desired Outcome: Isolate combustion water heater closet from conditioned space

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		4000
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	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		4001

	Avoiding frozen pipes must be considered without creating an additional utility burden (e.g., heat tape)			
2.0204.1c Materials	Only noncombustible materials will be used in contact with chimneys, vents, and flues	Prevent a fire hazard		4002
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		4003

2.0301.1 Smoke Alarm

Topic: Safety Devices

Subtopic: Combustion Safety Devices

Desired Outcome: Properly installed smoke alarms

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

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0301.1a Smoke alarm (hardwired)	When installing hardwired smoke alarms, it will be listed and labeled in accordance with UL 217 and installed in accordance with the IRC or as required by the authority having jurisdiction	Ensure proper installation		4013
2.0301.1b Smoke alarm (battery operated)	When installing battery operated smoke alarms, it will be installed in accordance with manufacturer specifications	Ensure proper installation		4014

2.0301.2 Carbon Monoxide Alarm or Monitor

Topic: Safety Devices

Subtopic: Combustion Safety Devices

Desired Outcome: Properly installed *CO* alarms or monitors

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

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
2.0301.2a CO detection and warning equipment (hardwired)	Hardwired CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 or as required by the authority having jurisdiction Installation will be accomplished by a licensed electrician when required by the authority having jurisdiction	Ensure proper installation	4015
2.0301.2b CO detection and warning equipment (battery operated)	Battery-operated CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction	Ensure proper installation	4016

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

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
2.0401.1a Moisture precautions for attics	Roof leaks will be repaired before performing attic air sealing or insulation Moisture sources in the house that can generate moisture into the attic will be identified and removed or reduced	Ensure durability of repairs 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.	1782

	Where possible, water resistant sealants and/or closed cell foams will be used in cold climates. Plastic, foil, or any other Class 1 vapor barrier will not be used in hot humid climates In marine climates, vapor permeable materials will be used to block and seal penetrations in attic	Increase durability of seal Avoid moisture-related damage to the home		
2.0401.1b Moisture precautions for crawl spaces	Exposed earth will be covered with a continuous, durable, sealed Class 1 vapor retarder a minimum of 6 mils in thickness Any vapor retarder shall not encapsulate wood building materials or spray foam Holes between the crawl space and the living space will be sealed	Ensure durability of repairs Reduce potential for occupant exposure to mold and other moisture-related hazards		1783
2.0401.1c Moisture precautions for the living space	Moisture sources in the home will be identified and removed or reduced Local ventilation will be installed where appropriate (e.g., baths, kitchens) and vented to outside according to ASHRAE 62.2 Unvented combustion appliances that are not listed to ANSI Z21.11.2 will be removed	Ensure durability of repairs Reduce potential for occupant exposure to mold and other moisture-related hazards		1784
2.0401.1d Moisture precautions for exterior water	Before air sealing basement or crawl space walls near wet areas, surface water pooling near the foundation will be addressed by: • Repairing, modifying or replacing gutters and downspouts • Grading and subsurface drainage at critical locations (e.g., localized drain and grading beneath valleys) in accordance with	Reduce potential for occupant exposure to mold and other moisture-related hazards		1785

	Environmental Protection Agency (EPA) Indoor airPLUS Construction Specifications Section 1.1 • Possible mitigation by waterproofing or installing draining plane with construction adhesive			

2.0402.1 Drainage

Topic: Moisture

Subtopic: Drainage

For supporting material, see Building America Solution Center.

Desired Outcome: Move water away from home

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0402.1a Work assessment	Installer prework assessment will be conducted to determine: • Standing water • Positive grade/drainage • Conditions of gutter system • Vegetation/shrubbery • Settling of home • Leveling of home Ensure no organic material is under the supports, including topsoil and roots	Verify scope of work Ensure that work space is ready for work		4021
2.0402.1b Corrective action	Ground will be properly graded to provide positive slope (1" per foot)away from home Gutter and downspouts will be installed or repaired Vegetation within 36" and encroaching on home will be cleared or trimmed if occupant approves	Ensure positive drainage Maintain ventilation around home		4022

	Home will be leveled to compensate for settling or improper installation			
2.0402.1c Occupant education	Occupant will be educated on the benefit of trees and shrubs to reduce heat gain and provide wind breaks in high wind locations Occupant will be educated on the need to maintain positive drainage (e.g., gutters, down spouts, grading) and maintain ventilation	Maintain durability Ensure water is moved down and away from home		4023

2.0403.4 Pier and Skirting Foundations—Ground Moisture Barriers

Topic: Moisture

Subtopic: Vapor Barriers

Desired Outcome: Durable, effective ground moisture barrier that provides ongoing access and minimizes ground vapor

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0403.4a Coverage	If existing conditions of the ground and skirting mandates, a moisture barrier that covers the crawl space ground will be installed with allowances for structural supports (piers) and accessibility	Reduce ground moisture entering crawl space		4024
2.0403.4b Material specification	A ground moisture barrier with a rating of no more than 0.1 perm will be used A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745 Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home (5 years), and it will need replacing to remain effective	Ensure crawl space is accessible for service and maintenance without damaging the integrity of the ground moisture barrier		4025
2.0403.4c 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 likelihood of damage at seams		4026

2.0403.4d Fastening	Ground moisture barrier may be fastened to ground with durable fasteners	Prevent movement of the ground moisture barrier		4027

2.0404.1 Stand-Alone Dehumidifiers

Topic: Moisture

Subtopic: Space Conditioning

Desired Outcome: Energy used to control humidity in conditioned spaces reduced

For supporting material, see Referenced Standards and Calculation of the Infiltration Credit.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0404.1a Selection	Equipment will have a minimum efficiency level of ENERGY STAR® or better Equipment will have a fan-off option Equipment will retain settings after power-off Equipment will have features that reduce both peak electric use (e.g., internal and external timers) and absolute energy use Equipment will have standby losses of 1 watt or less Controls will be labeled so they are understandable, readable, and accurate for occupant needs Systems located in a basement or crawl space will be rated for cold temperature operation Operating environment will be determined and appropriate equipment will be selected for that environment (e.g., low temperature and high relative humidity)	Reduce energy use Provide durable equipment Control moisture Provide equipment appropriate for occupant use		4028

2.0404.1b Installation	Installation will proceed only when the following applicable steps have been taken to control moisture: • Downspouts are redirected away from foundation • Moisture from drying clothes is vented to the outside • Sump pit is covered and sealed • Dirt in crawl space is covered with a vapor barrier • Plumbing leaks are eliminated Equipment will be installed according to manufacturer specifications and meet all applicable codes Equipment will be installed to permit adequate air flow Equipment will have a timer for off-peak operation if time-of-use program is available and if the equipment can handle power interruptions Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Initial relative humidity and temperature settings will be set by the installer to ensure the space does not reach dew point Operation of controls and needed maintenance will be reviewed with occupant A user guide for dehumidifier settings in different climate conditions will be created by the	Reduce or retire dehumidifiers Reduce allergens and asthma triggers Improve health and reduce irritants Improve building durability Improve comfort Reduce pest populations Reduce risk of mold issues Educate occupant on how to operate and maintain equipment		4029

	installer and provided to the occupant Installer will commission the equipment to ensure it is functioning properly An independent measurement will be made to verify relative humidity System will be connected directly to condensate line that drains to a plumbing drain or the exterior, away from the home's foundation and in compliance with the plumbing code or the authority having jurisdiction Specific information on the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant			
2.0404.1c Decommissioning	Removed equipment will be recycled or disposed of properly in accordance with local regulations	Prevent the reuse of inefficient equipment and its components Reduce waste Protect the environment		4030

2.0404.2 Crawl Spaces—Preliminary Dehumidification

Topic: Moisture

Subtopic: Space Conditioning

Desired Outcome: A dry and moisture controlled space ensured

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0404.2a Close vents	Vents and other openings will be closed after ensuring sufficient combustion air for fuel burning appliances in accordance with IRC	Reduce moisture load coming from outside of the crawl space		4031

2.0404.2b Drying	If liquid moisture is present, the area will be dried until any liquid moisture is eliminated	Reduce moisture in the crawl space Improve work environment		4032
2.0404.2c Drying time	Space will be dehumidified until wood moisture content in solid, untreated lumber is less than 20%	Reduce moisture content of wood		4033

2.0404.4 Basements—Dehumidification

Topic: Moisture

Subtopic: Space Conditioning

Desired Outcome: Basement humidity controlled with supplemental dehumidification

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0404.4a Dehumidifier	A permanent, low-temperature, auto-restart, minimum ENERGY STAR® rated dehumidifier will be installed Manufacturer specifications will be followed for size and use Condensate will be drained to daylight or a condensation pump	Maintain a dry basement Reduce conditions conducive to mold growth, wood rot, and pests		1823
2.0404.4b Dehumidification for divided spaces	Drying will be provided to all basement areas	Maintain a dry basement Reduce conditions conducive to mold growth, wood rot, and pests		1824
2.0404.4c Relative humidity	All basement spaces will be maintained at a relative humidity that ensures condensation will not occur on cool surfaces	Maintain a dry basement Reduce conditions conducive to mold growth, wood rot, and pests		1825
2.0404.4d Condensing surfaces(e.g., cold water pipes)	Condensing surfaces in basement will be insulated and sealed	Maintain a dry basement Reduce conditions conducive to mold growth, wood rot, and pests		1826
2.0404.4e Dehumidification (option for dry climates and heating-	Ventilation in the basement will be controlled to maintain relative humidity that ensures condensation will not occur on cool surfaces	Maintain a dry basement Reduce conditions conducive to mold growth, wood rot, and pests		1827

dominated climates seasonally)				
2.0404.4f Occupant education	Occupant will be educated on how and when to change filter and clean condensate drain of the dehumidifier in accordance with manufacturer specifications	Ensure occupant health Preserve integrity of system		1828

2.0501.2 Pier and Skirting Foundation—Venting

Topic: Radon

Subtopic: Air Sealing

Desired Outcome: Pollutants are effectively vented

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0501.2a Venting	Pier and skirting foundations will be vented in accordance with local climate conditions or code as required	Provide ventilation for pollutant sources (e.g., moisture, radon, soil gases)		4040
2.0501.2b Occupant education	Occupants will be educated on purpose, operation, and maintenance of vents	Ensure vents function as intended		4041

2.0602.1 Static Electric Shock

Topic: Electrical

Subtopic: Electric Hazards

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0602.1a Rigid fill tube	Rigid fill tubes will be made of a material that will not hold an electric charge, such as Schedule 40 PVC Electrical Conduit, or be grounded	Prevent injury to the installer		4042
2.0602.1b Metal coupler grounding	For an additional level of protection, the metal coupler on the hose will be connected to the grounding wire Grounding wire will be connected to the grounding rod	Divert static discharge of electricity to ground instead of installer		4043

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

2.0602.2 House Current Electric Hazard

Topic: Electrical

Subtopic: Electric Hazards

Desired Outcome: Prevention of injury to the installer and occupant, and prevent damage to the structure, if required by authority having jurisdiction

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
2.0602.2a Metal skin and frame grounding	Metal skin and frame will be grounded through the panel box to avoid electrical shock	Prevent injury to the installer		4044
2.0602.2b Metal fill tube grounding	For an additional level of protection, metal fill tube will be connected to the grounding wire Grounding wire will be connected to the copper grounding rod that is driven into the ground a minimum of 8' when possible and required by code or authority having jurisdiction	Divert house electric current to ground instead of installer in the event of contact with a live wire		4045
2.0602.2c Electrical tool safety	An electrical safety assessment will be performed All electric tools will be protected by ground-fault circuit interrupters (GFCI) Three-wire type extension cords will be used with portable electric tools Worn or frayed electric cords will not be used	Avoid electrical shock and arc flash hazards		4046

	Water sources (e.g., condensate pans) and electrical sources will be kept separate Metal ladders will be avoided Aluminum foil products will be kept away from live wires For arc flash hazards, NFPA 70E will be consulted			
2.0602.2d Aluminum wiring	If aluminum wiring is present, work on the home will be stopped until the suspect wiring is inspected and determined to be safe by a licensed electrician After energy retrofit is completed, wiring will be reinspected by a licensed electrician	Prevent injury to installer and occupant Prevent damage to structure		4047

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

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		1843
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		1844

2.0702.1c General conditions	At a minimum, the following concerns and warnings will be addressed within the warranty, as applicable to the work being warrantied: • Possible drying and shrinking effects • Storage of hazardous and flammable materials • Mold	Educate occupants on potential hazards		1845

Section 3: Air Sealing

3.1001.4 General Penetrations (Electrical, HVAC, Plumbing, Vent Termination, Recessed Lighting)

Topic: Attics

Subtopic: Penetrations and Chases

Desired Outcome: Penetrations sealed to prevent air leakage and moisture movement between unconditioned and conditioned space

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1001.4a Work assessment	Installer prework assessment will be conducted to determine: • Structural integrity • Roof leaks • Insect infestation • Accessibility • Number, type, size, and location of penetrations	Ensure work space is safe and ready for air sealing Verify scope of work		4048
3.1001.4b Air sealing penetrations	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the penetration or hole The infill or backing will not bend, sag, or move once installed	Ensure closure is permanent and supports any load (e.g., wind, insulation, mechanical pressures) Ensure sealant is effective and durable		4049

	All accessible damaged vapor barrier will be repaired Penetration through the air barrier will be repaired			
3.1001.4c Sealant selection	Sealants will be used to fill holes no larger than recommended by manufacturer specifications Sealants will be compatible with all adjoining surfaces Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction	Create a permanent seal Ensure sealant meets or exceeds the performance characteristics of the surrounding materials Create a continuous seal		4050
3.1001.4d Ceiling hole repair	Ceiling repair material must meet or exceed strength of existing ceiling material Ceiling repair must span from truss to truss or add blocking as needed for support The backing or infill will not bend, sag, or move once installed All accessible damaged vapor barriers will be repaired Penetrations through the air barrier must be repaired	Ensure ceiling is structurally sound Minimize air leakage Ensure closure is permanent and supports expected wind and mechanical pressure loads Ensure sealant does not fall out		4051
3.1001.4e Materials	Materials will be used or installed in accordance with product manufacturer specifications	Select materials to ensure durable and permanent repair		4052
3.1001.4f High temperature application	Only noncombustible materials will be used in contact with chimneys, vents, and flues Local codes will be referenced	Prevent a fire hazard		4053

3.1101.1 Exterior Holes and Penetrations

Topic: Walls

Subtopic: Manufactured Housing Walls

Desired Outcome: Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs will maintain structural integrity

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1101.1a Work assessment	Installer prework assessment will be conducted to determine: • Structural integrity • Size of wall stud • Insect infestation • Accessibility • Number, type, size, and location of penetrations	Ensure work space is safe and ready for air sealing Verify scope of work		4054
3.1101.1b Materials	Like material and/or compatible materials will be used for repairs Materials will be selected to comply with manufactured housing rules and regulations (e.g., Manufactured Housing Institute)	Select materials to ensure durable and permanent repair		4055
3.1101.1c Exterior wall air sealing	All holes and penetrations on exterior surface of exterior walls will be sealed to ensure resistance to outdoor elements Intentionally ventilated walls will not be sealed at vent locations (e.g., weep holes) All holes and penetrations on the interior surface of exterior walls will be repaired Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration	Minimize air leakage Maintain durability Ensure resulting closure is permanent and supports expected load Ensure sealant is effective and durable		4056

3.1101.2 Interior Holes and Penetrations

Topic: Walls

Subtopic: Manufactured Housing Walls

Desired Outcome: Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs will maintain structural integrity

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1101.2a Work assessment	Installer prework assessment will be conducted to determine: • Structural integrity • Size of wall stud • Insect infestation • Accessibility • Number, type, size, and location of penetrations	Ensure work space is safe and ready for air sealing Verify scope of work		4057
3.1101.2b Interior wall air sealing	All accessible holes and penetrations in top and bottom plates will be sealed Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration	Minimize air leakage Maintain durability Ensure resulting closure is permanent and supports expected wind and mechanical pressure loads Ensure sealant is effective and durable		4058
3.1101.2c Materials	Like material and/or compatible materials will be used for repairs Materials will be selected to comply with manufactured housing rules and regulations (e.g., Manufactured Housing Institute)	Select materials to ensure durable and permanent repair		4059

3.1101.3 Holes, Penetrations, and Marriage Line

Topic: Walls

Subtopic: Manufactured Housing Walls

Desired Outcome: Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs to maintain structural integrity

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1101.3a Work assessment	Installer prework assessment will be conducted to determine: • Structural integrity • Insect infestation • Accessibility	Ensure work space is safe and ready for air sealing Verify scope of work		4060

	• Number, type, size, and location of penetrations • Identify marriage walls and lines			
3.1101.3b Marriage wall air sealing of holes and penetrations	All accessible holes and penetrations in top and bottom plates will be sealed Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration	Minimize air leakage Maintain durability Ensure resulting closure is permanent and supports expected wind and mechanical pressure loads Ensure sealant is effective and durable		4061
3.1101.3c Marriage line air sealing	All accessible holes and penetrations at marriage lines will be sealed continuously at end walls, floors, and ceiling Backing or infill will be provided at the marriage line as needed All remaining gaps will be sealed with an approved material	Minimize air leakage Maintain durability Ensure sealant is effective and durable		4062
3.1101.3d Materials	Materials will be used or installed in accordance with product manufacturer specifications	Select materials to ensure durable and permanent repair		4063

3.1201.5 Manufactured Housing Windows and Doors

Topic: Windows and Doors

Subtopic: Maintenance, Repair, and Sealing

For supporting material, see Building America Solution Center.

Desired Outcome: Windows and doors are operable, sealed, and weathertight

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1201.5a Work assessment	Installer prework assessment will be conducted to determine: • Number • Type • Operating condition	Ensure work space is safe and ready for air sealing Verify scope of work		4064

	• Wall construction			
3.1201.5b Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise; documentation of testing results will be kept on file EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards		4065
3.1201.5c Operable windows and doors	All egress windows will be operable as required by local codes All egress doors will be operable as required by local codes	Maintain operability of egress windows and doors		4066
3.1201.5d Air infiltration	Details that reduce air infiltration will be repaired, replaced, sealed, or installed (e.g., plastic gliders, weatherstripping, cranks, latches, locks, knobs, thresholds)	Reduce air infiltration		4067
3.1201.5e Water infiltration	Details that reduce water infiltration will be repaired, replaced, or installed (e.g., replace missing glazing on sash, exterior caulking, exterior storm windows, storm doors, drip cap, J-channel, flashing)	Reduce water infiltration		4068
3.1201.5f Materials	Materials will be used or installed in accordance with product manufacturer specifications	Select materials to ensure durable and permanent repair		4069
3.1201.5g Quality assurance	Windows and doors will be adjusted to properly fit the jamb and allow for ease of operation and security	Ensure proper operation of the window, door, and hardware Ensure air and watertight installation		4070
3.1201.5h Occupant education	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain windows and doors	Ensure long-term weathertightness		4071

and maintenance				

3.1201.6 Interior Storm Windows

Topic: Windows and Doors

Subtopic: Maintenance, Repair, and Sealing

For supporting material, see Building America Solution Center.

Desired Outcome: Minimize air *infiltration* through existing leaky windows while maintaining safe egress for occupants

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1201.6a Work assessment	Installer prework assessment will be conducted to determine: • Number • Type • Size • Condition of opening	Verify scope of work		4072
3.1201.6b Fixed storm window	Fixed interior storm windows will not be installed in egress locations	Safety		4073
3.1201.6c Installing operable storm window	Operable interior storm windows will be installed in accordance with manufacturer specifications	Minimize air leakage Provide safe egress for occupants		4074
3.1201.6d Health and safety	Interior storm windows will be operable and egress rated in egress locations	Provide safe egress for occupants		4075
3.1201.6e Occupant education	Occupants will be educated on the proper use and maintenance of storm windows	Ensure weathertightness and safety		4076

3.1202.3 Replacing Damaged Window Glass in Manufactured Housing

Topic: Windows and Doors

Subtopic: Repairing/Replacing Cracked and Broken Glass

Desired Outcome: Glass complete and intact

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1202.3a Work assessment	Installer prework assessment will be conducted to determine: • Number • Type • Location • Operating condition • Wall construction • Size	Ensure that work space is safe and ready for glass replacement Verify scope of work		4077
3.1202.3b Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise; documentation of testing results will be kept on file EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards		4078
3.1202.3c Broken glass removal	Damaged glass will be removed	Safely remove old glass		4079
3.1202.3d Opening preparation	Opening will be cleaned Original sealant/material will be removed	Prepare opening for new glass		4080
3.1202.3e New glass installation	Replacement glass will be sized to original width, height, and depth Stops will be replaced or installed	Install, seal, and secure new glass in place		4081

	Glass will be sealed in accordance with original installation design Glass will be selected with comparable tint and coating (color and look) Tempered or safety glass will be used as required by local code			

3.1203.3 Replacement of Manufactured Housing Windows and Doors

Topic: Windows and Doors

Subtopic: Replacement

Desired Outcome: Smooth operation and an airtight and weathertight fit of replacement windows and doors

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1203.3a Work assessment	Installer prework assessment will be conducted to determine: • Number • Type • Operating condition • Wall construction	Ensure work space is safe and ready for air sealing Verify scope of work		4082
3.1203.3b Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise; documentation of testing results will be kept on file EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards		4083

3.1203.3c Window or door selection	Window or door units will be designed for manufactured home use and will be ENERGY STAR qualified Rough opening will be measured before ordering replacements Access to emergency egress points, such as primary windows or exit doors, will be considered during the selection of retrofit window or door units	Ensure proper size, type, and operation of window or door		4084
3.1203.3d Rough opening preparation	Existing units will be removed Opening will be cleaned Any damaged framing will be replaced Opening for installation will be prepared in accordance with manufacturer specifications	Provide a clean opening for replacement unit		4085
3.1203.3e Window and door installation	Window or door units will be installed in accordance with manufacturer specifications	Ensure replacement window or door operates properly Ensure replacement window or door has a weathertight fit		4086
3.1203.3f Safety	Egress windows will only be replaced with egress windows	Provide safe egress for occupants		4087
3.1203.3g Maintenance and occupant education	Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain window or door	Ensure long-term weathertightness		4088

3.1301.1 Electrical, HVAC, Plumbing, Gas, Dryer Vent, and General Penetrations Through Bottom Board

Topic: Floors

Subtopic: Penetrations

Desired Outcome: Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1301.1a Work assessment	Installer prework assessment will be conducted to determine: • Structural integrity • Standing water • Raw sewage • Insect infestation • Pests • Accessibility • Number, type, size, and location of penetrations	Ensure work space is safe and ready for air sealing Verify scope of work		4089
3.1301.1b Soft bottom board repair	Patching material will be provided as needed to meet the specific characteristics of the bottom board material and the characteristics of the hole Patch will have a service life of a minimum of 20 years	Minimize air leakage Keep insulation in place Ensure repair materials are compatible Ensure patch will support insulation		4090
3.1301.1c Hard bottom board repair	Patching will be provided as needed to meet both the specific characteristics of the bottom board material and the characteristics of the hole Patch will not bend, sag, or move once installed Patch will be permanent	Minimize air leakage Ensure repair materials are compatible Minimize hole size to ensure successful use of sealant Ensure closure is permanent and supports insulation Ensure sealant does not fall out		4091
3.1301.1d Bottom board penetrations	Combustion air supplies will be labeled for identification and will not be blocked or sealed Penetrations will be sealed to meet both the specific characteristics of the bottom board material and the characteristics (hole size and type) of the penetrations (e.g., electrical, PVC, gas line, dryer vent)	Ensure combustion equipment is not compromised Minimize air leakage around penetrations		4092

	The patch will not bend, sag, or move once installed			
3.1301.1e Materials	Materials will be selected to comply with manufactured housing rules and regulations (e.g., Manufactured Housing Institute) Surface preparation and material selected will be used or installed in accordance with product manufacturer specifications	Select materials to ensure durable and permanent repair		4093

3.1301.2 Electrical, HVAC, Plumbing, Gas, Dryer Vent, and General Penetrations Through Flooring

Topic: Floors

Subtopic: Penetrations

Desired Outcome: Penetrations sealed to minimize air leakage and moisture movement between unconditioned and conditioned space; all repairs will maintain structural integrity

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1301.2a Work assessment	Installer prework assessment will be conducted to determine: • Structural integrity • Insect infestation • Pests • Accessibility • Plumbing leaks • Number, type, size, and location of penetrations	Ensure work space is safe and ready for air sealing Verify scope of work		4094
3.1301.2b Floor air sealing (decking, subfloor, floor decking)	Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration The backing or infill will not bend, sag, or move once installed	Ensure resulting closure is permanent and supports expected load Ensure sealant is effective and durable		4095

3.1301.2c Sealant selection	Sealants will be used to fill holes no larger than recommended by manufacturer specifications Sealants will be compatible with all adjoining surfaces Sealants will be continuous and meet fire barrier specifications, if required	Ensure sealant meets or exceeds the performance characteristics of the surrounding materials		4096
3.1301.2d Floor repair	Floor repair material will meet or exceed strength of existing floor material Repair will span from joist to joist and blocking added as needed to support floor Patches smaller than 144 square inches will not require repairs from joist to joist Floor repair material will be glued, fastened, and air sealed	Ensure floor is structurally sound Minimize air leakage		4097
3.1301.2e Structural materials	Materials will be selected to comply with manufactured housing rules and regulations (e.g., Manufactured Housing Institute) Materials will be used or installed in accordance with manufacturer specifications	Select materials to ensure durable and permanent repair		4098
3.1301.2f High temperature application	Only noncombustible materials will be used in contact with chimneys, combustion exhaust vents, and flues	Prevent a fire hazard		4099

3.1302.1 Floor Framing—Bay Window

Topic: Floors

Subtopic: Floor Framing

Desired Outcome: Floor/framing around bay windows sealed and weathertight

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

3.1302.1a Work assessment	Installer prework assessment will be conducted to determine: • Accessibility • Number • Type • Size • Operating condition • Condition of opening • Wall construction type	Ensure work space is safe and ready for air sealing Verify scope of work		4100
3.1302.1b Lead paint assessment	Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise; documentation of testing results will be kept on file EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards	Protect worker and occupant from potential lead hazards		4101
3.1302.1c Air infiltration	Details that reduce air infiltration will be repaired, replaced, sealed, or installed Bay window floor framing that connects interior to exterior underpinning and insulation must be removed to seal gaps, cracks, and joints Blocking must be installed on perimeter rail (rim joist) if missing Seal all gaps, cracks, and joints of all framing in bay window assembly Insulation must be replaced or installed in full contact with subfloor	Reduce air infiltration		4102

	Underpinning will be replaced and sealed			
3.1302.1d Water infiltration	Details that reduce water infiltration will be repaired, replaced, or installed	Reduce water infiltration		4103
3.1302.1e Materials	Materials will be used or installed in accordance with product manufacturer specifications	Ensure proper use and installation of materials		4104

3.1488.2 Skirting Manufactured Homes

Topic: Basements and Crawl Spaces

Subtopic: Special Considerations

Desired Outcome: Wind, weather, debris, and pests are excluded from the underside of the home

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1488.2a Work assessment	Installer prework assessment will be conducted to determine: • Type (ventilated or unventilated, insulated or noninsulated) • Extent of repair/replacement • Accessibility • Moisture and drainage • Structural integrity of foundation (e.g., piers and supports) • Structural integrity of perimeter rail/rim joist • Integrity of existing skirting support material • Presence of infestation or pests Problems will be corrected before skirting work begins	Ensure work space is safe and ready for repair or installation Verify scope of work		4105

3.1488.2b Repair and installation	Manufacturer specifications will be followed when applicable No exposed wood will be left unfinished (e.g., wood to be painted, sealed, treated) If framing is required for skirting, framing will be structurally sound Skirting will be installed to allow for movement (e.g., no screws or nails directly through panels) Skirting installation will allow for expansion, contraction, and frost heaving	Match existing skirting Provide resistance from outdoor elements Limit pest access		4106
3.1488.2c Venting	Venting will be in accordance with local climate conditions or code as required	Achieve and maintain building durability		4107
3.1488.2d Insulated skirting	Insulated skirting may be installed where belly is inaccessible and not repairable	Reduce conductive heat loss through floor assembly		4108
3.1488.2e Flashing	Flashing or proper caulking will be installed between skirting and manufactured home, if required by authority having jurisdiction	Prevent water penetration		4109
3.1488.2f Materials	Like material and/or compatible materials will be used for repairs (e.g., galvanized metal, aluminum, alkaline copper quaternary treated lumber) Selected materials will be corrosion resistant	Achieve/increase durability		4110
3.1488.2g Fasteners	Like material and/or compatible materials will be used for repairs (e.g., galvanized metal, aluminum, alkaline copper quaternary treated lumber) Fasteners will be corrosion resistant	Achieve/increase durability		4111
3.1488.2h Structural	Existing skirting support material will be structurally sound and completely	Provide adequate support		4112

	intact; any damaged framing will be replaced			
3.1488.2i Skirting stiffener/high wind support	Skirting support (e.g., vinyl blowout rods, horizontal bracing for other types) will be placed in high-wind locations	Increase strength to resist wind loading		4113
3.1488.2j Occupant education	Occupants will be educated on maintenance of skirting (e.g., floating panels are not tightly screwed to framing, string trimmers may damage skirting)	Increase durability		4114

3.1601.2 Duct Preparation for SPF Application

Topic: Ducts

Subtopic: Duct Preparation

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

For supporting material, see Referenced Standards, General Information on Spray Polyurethane Foam (SPF), Calculation of the Infiltration Credit and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1601.2a Inspection	All exposed ductwork in unconditioned spaces (e.g., attics, basements, crawl spaces) will be inspected Broken joints or large cracks, gaps, or holes will be identified Type of ductwork (e.g., metal, duct board, flex duct) will be identified Type and R-value of existing duct insulation (e.g., fiberglass, stone wool, asbestos) will be identified as will the location of vapor retarders, if any If asbestos insulation was used, it will not be disturbed; consult with an asbestos abatement expert for removal	Identify damaged ductwork in need of repair Identify type and R-value of existing insulation		4115

	Loose fitting or damaged fiberglass or stone wool insulation will be removed using proper safety equipment Necessary clearances for installation of SPF will be ensured			
3.1601.2b Repair	Broken or missing ductwork will be repaired or replaced All cracks, gaps, or holes greater than ¼" will be taped or sealed as feasible Dust, dirt, and grease will be removed from exterior surfaces of ducts	Cover openings in ducts to prevent SPF from entering the interior of the duct Ensure surfaces of duct are clean to promote proper adhesion of SPF		4116

3.1601.4 Support for Horizontal, Suspended Ducts

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums properly supported

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1601.4a Support (applies to all duct types)	Flexible and duct board ducts and plenums will be supported where feasible in accordance with flex duct manufacturer specifications and local codes Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping) Metal ducts will be supported by metal strapping, rods, or other materials, where feasible	Eliminate falling and sagging		4117

3.1601.5 Preparation and Mechanical Fastening

Topic: Ducts

Subtopic: Duct Preparation

Desired Outcome: Ducts and plenums properly fastened to prevent leakage

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1601.5a Preparation	Surrounding insulation will be cleared to expose joints being sealed; salvage for reuse if possible Duct surface to receive sealant will be cleaned	Gain access while maintaining insulation value Achieve proper adhesion for airtight seal when needed to ensure a tight fit to the framing structure and ensure the register can be removed and reinstalled by the dwelling occupant		4118
3.1601.5b Metal to metal	Ducts will be fastened with a minimum of three equally spaced screws	Ensure durable joints		4119
3.1601.5c Flex to metal	Joints will be fastened with tie bands using a tie band tensioning tool For oval flexible duct to metal connections, tie bands cannot be used; appropriate mechanical fastener will be used All connections, regardless of fastener, will be sealed	Ensure durable joints		4120
3.1601.5d Duct board to duct board	Joints will be fastened with outward clinching (stitch) staples and c-channels if possible	Ensure durable joints		4121
3.1601.5e Duct board to flexible duct	Metal take-off collar specifically designed for the thickness of the duct board will be used All finger tabs will be bent down securely Finger tabs will be longer than the thickness of the duct board and the shank will not extend beyond the thickness of the duct board There will be an internal metal backer inside the duct board through which three evenly spaced screws can be secured; the metal backer will not interfere with air flow	Ensure durable joints Prevent the collar from moving into or out of the duct board or slipping		4122

3.1601.5f Duct board plenum to air handler cabinet	Flange/c-channel will be fastened with screws with the duct board installed between c-channel flanges Duct board plenum will be connected to air handler plenum with flexible duct in upflow units	Ensure durable joints		4123
3.1601.5g Boot to wood	Predrill for screws or use ring shanked nails to fasten boot to wood	Ensure durable joints		4124
3.1601.5h Boot to gypsum	If accessible, boot hanger will be fastened to adjacent framing with screws or nails Boot will be connected to boot hanger with screws If inaccessible, boot will be fastened to gypsum with a durable, adhesive sealant	Ensure durable joints		4125
3.1601.5i Duct board to flex	Metal take-off collar with a hip and an internal metal backer will be used Take-offs will be in accordance code requirements	Ensure durable joints		4126

3.1602.10 Hard and Flex Branch Ducts

Topic: Ducts

Subtopic: Duct Sealing

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.10a Work assessment	Installer prework assessment will be conducted to determine: • Location • Connection types • Leakage points Access holes will be created for the work done at each location	Verify scope of work Gain access to duct connections		4143

3.1602.10b Reduce excess flex duct length	Excess flex duct will be removed between the takeoff at trunk and floor register boot	Improve air flow		4144
3.1602.10c Duct connection repairs	Hard and flex duct branch connections will be rebuilt or repaired using compatible materials and will be mechanically fastened and sealed Ends will be sealed	Ensure lasting durable connections Minimize air leakage Maximize air flow and distribution		4145
3.1602.10d Repair work access	Access hole in the trunk/branch duct will be repaired and sealed Insulation will be reinstalled Bottom liner/belly will be repaired	Repair work access Minimize heat transfer		4146
3.1602.10e Combustion Appliance Zone (CAZ) testing	CAZ testing will be performed where combustion appliances are utilized	Identify unsafe equipment operating conditions		4147
3.1602.10f Performance testing	Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and results will be documented and reported to the homeowner and/or program	Document post-retrofit duct leakage test has been performed		4148

3.1602.11 Air Sealing System

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums sealed to prevent leakage

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.11a New component to new component sealant selection	Any closure system used will meet or exceed applicable standards	Ensure effectiveness of air sealing system		4149

3.1602.11b New component to existing component	Duct surface to receive sealant will be cleaned Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using fiberglass mesh and mastic Mastic alone will be acceptable for holes less than ¼" that are more than 10' from air handler Holes greater than ¾" will be patched with metal or joint will be rebuilt to reduce the gap size Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages: • They will be backed using temporary tape (e.g., foil tape) as a support before sealing • They will be sealed using fiberglass mesh and mastic	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct Reinforce seal Support mastic and fiberglass mesh during curing		4150
3.1602.11c Existing component to existing component	Duct surface to receive sealant will be cleaned Fiberglass mesh and mastic will overlap temporary tape by at least 1" on all sides Seams, cracks, joints, holes, and penetrations larger than ¾" will be repaired using rigid duct material Fiberglass mesh and mastic will overlap repair joint by at least 1" on all sides Fiberglass mesh and mastic will be the primary seal	Eliminate air leakage into or out of ducts and plenums Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct Reinforce seal Support mastic and fiberglass mesh during curing		4151
3.1602.11d Performance testing	Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and results will be documented and	Document post-retrofit duct leakage performed		4152

	reported to the homeowner and/or program			

3.1602.12 Air Sealing System Components

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums sealed to prevent leakage

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.12a Duct boot to interior surface	Gaps between boot and gypsum less than a ¼" will be sealed using mastic or appropriate flexible caulking Gypsum edge will be wetted before applying mastic	Prevent air leakage		4153
3.1602.12b Air handler cabinet outside conditioned space	Joints will be sealed and cracks/holes not needed for proper function of unit will be sealed using removable sealant (e.g., foil tape)	Reduce air leakage while maintaining accessibility		4154
3.1602.12c Performance testing	Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and results will be documented and reported to the homeowner and/or program	Document post-retrofit duct leakage test has been performed		4155

3.1602.13 Return—Framed Platform

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: The return duct is installed to prevent air leakage

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.13a Preparation	Debris and dirt will be cleaned out of the return platform	Allow for the application of rigid materials and sealants		4156

3.1602.13b Infill and backing	Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space Backing or infill will not bend, sag, or move once installed Material will be rated for use in return duct systems	Minimize hole size to ensure successful use of sealant Ensure closure is permanent and supports all loads (e.g., return air pressure) Ensure sealant does not fall out		4157
3.1602.13c Sealant selection	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Select permanent sealant Ensure sealant meets or exceeds the performance characteristics of the surrounding materials		4158

3.1602.2 Duct Spray Polyurethane Foam (SPF) Installation

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Exposed ductwork in unconditioned spaces insulated and sealed

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.2a Installation	Insulation will be installed according to manufacturer specifications and all provisions of the IRC SPF will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer Sufficient insulation will be applied to all joints and around all penetrations to the conditioned space through walls, floors, and ceilings SPF will be covered with proper fire protective coverings or coatings appropriate for location of ductwork and type of foam used, and provisions of the IRC and local codes	Insulate and seal all exposed ductwork in unconditioned spaces Manage moisture condensation on ductwork that carries cooled air in warm, moist climates Provide adequate fire protection for exposed SPF		4127

	If ducts are used for air-conditioning, an appropriate vapor retarder will be applied on the SPF if open-cell SPF used If 2" or more of closed-cell SPF is used, follow manufacturer specification to determine if additional vapor retarder is needed The flame spread index will not be greater than 25 and the smoke-developed index will not be greater than 450 at the specified installed thickness The foam plastic will be protected with an ignition barrier			

3.1602.3 Proprietary Spray Application

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Ducts and plenums sealed to prevent leakage

For supporting material, see Referenced Standards, Calculation of the Infiltration Credit and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.3a Internal or external application	Sealant will be applied in accordance with manufacturer specifications, as well as UL 181M, NFPA 90A, and NFPA 90B	Reduce duct leakage		4128

3.1602.8 Supply Plenum (Furnace to Trunk Duct Connection) in Both Upflow and Downflow Air Handler Configurations

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Deliver all air from air handler to the trunk duct without leakage or restriction

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

3.1602.8a Work assessment	Installer prework assessment will be conducted to determine: • Size of plenum • Alignment • Connection method • Existing sealing	Ensure an efficient and effective way to accomplish work Verify scope of work		4129
3.1602.8b Preparation	Debris will be removed Surface will be prepared for work (e.g., remove tape, oil) Floor will be prepared to receive the appropriately sized plenum	Provide unobstructed path for work access and air flow Ensure adhesion of materials to be installed Provide a properly sized plenum to maximize distribution of air flow (equal to the furnace discharge)		4130
3.1602.8c Plenum rebuild or repair	Plenum will be rebuilt or repaired using compatible materials and will be: • Mechanically fastened • Sealed • Durable • Structurally sound • Insulated • Equipped with a vapor retarder where climate appropriate If possible, flow diverter or turning vanes will be installed for air flow and/or balancing (e.g., bullhead Ts, offset air handler)	Minimize restrictions Maximize air flow and air distribution Minimize moisture issues Prevent condensation on plenum		4131
3.1602.8d Repair work access	Point of access options include: Option 1: Through the trunk duct • Repair and seal access hole in the trunk duct • Install insulation • Repair belly/bottom liner	Repair work access Prevent condensation Minimize heat loss and heat gain from plenum		4132

	Option 2: Remove crossover duct • Reattach crossover duct • Seal and insulate crossover duct • Repair belly/bottom liner Option 3: Remove air handler • Install new gasket, if necessary • Mechanically attach furnace to the structure • Reconnect utilities • Replace and seal panels Option 4: Through the furnace panel • Replace and seal panels			
3.1602.8e Safety testing	Equipment will be cycled Combustion Appliance Zone (CAZ) test will be performed where combustion appliances are utilized	Verify operation Identify unsafe equipment operating conditions		4133
3.1602.8f Performance testing	Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and results will be documented and reported to the homeowner and/or program	Document post-retrofit duct leakage test has been performed		4134

3.1602.9 Crossover Ducts

Topic: Ducts

Subtopic: Duct Sealing

Desired Outcome: Deliver all air from trunk to trunk without leakage or restriction

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1602.9a Work assessment	Installer prework assessment will be conducted to determine: • Location	Verify scope of work		4135

	• Types • Leakage points			
3.1602.9b Flexible crossover duct connections	Flexible crossover duct connections will be added, rebuilt, or repaired using compatible materials and will be: • Mechanically fastened at both inner and outer liner • Sealed using UL-listed sealant that is durable, structurally sound, insulated • Equipped with a vapor retarder Whenever possible, rigid elbow or equivalent will be installed in crawl space crossover ducts Floor insulation will be in contact with the outer liner of the crossover duct Crossover duct vapor retarder will be sealed to the bottom liner (e.g., belly fabric) New flex duct installation will be insulated to a minimum of R-8 When feasible, 26-gauge hard duct should be installed If a new crossover is required, it must be insulated to at least R-8 and be air sealed	Ensure lasting durable connections Minimize air leakage and heat transfer Maintain duct diameter around the turns Maximize air flow and distribution		4136
3.1602.9c Support	Crossover ducts will be installed so they are not in contact with the ground Crossover ducts will be supported in accordance with flex duct manufacturer specifications, local codes Support materials will be applied in accordance with manufacturer specifications for interior dimensions	Maximize air flow and distribution Minimize condensation Minimize air leakage and heat transfer		4137

	and will not crimp ductwork, dip, or sag			
3.1602.9d Through-the-rim crossover duct	Through-the-rim crossover ducts will be located and accessed through the bottom liner and branch duct; all branch crossover duct connections and end caps will be located and accessed Hole size (air pathway) will be maximized between branch crossover and trunk All connections will be mechanically fastened and sealed inside duct End caps will be sealed	Ensure all connections are identified Maximize air flow and distribution Ensure lasting durable connections Minimize air leakage		4138
3.1602.9e Repair work access for through-the-rim crossover	Access hole in the trunk duct will be repaired and sealed Insulation will be reinstalled Bottom liner/belly will be repaired	Repair work access Minimize heat transfer		4139
3.1602.9f Attic crossover	Access to the attic will be created for all attic areas that contain crossover ducts, where feasible Plenum boxes and crossover duct connections will be rebuilt, mechanically fastened, and sealed Access holes will be repaired	Ensure lasting durable connections Minimize air leakage Maximize air flow and distribution Repair work access		4140
3.1602.9g Combustion Appliance Zone (CAZ) testing	CAZ testing will be performed where combustion appliances are utilized	Identify unsafe equipment operating conditions		4141
3.1602.9h Performance testing	Pre- and post-retrofit duct leakage will be performance tested using a duct blaster or pressure pan, and results will be documented and reported to the homeowner and/or program	Document post-retrofit duct leakage test has been performed		4142

3.1701.1 Holes, Penetrations, and Connection Seam

Topic: Additions

Subtopic: Attached Additions

Desired Outcome: The exterior of the seam is weathertight and connection between house and addition is properly sealed to minimize air leakage and moisture movement between unconditioned and conditioned space

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
3.1701.1a Work assessment	Installer prework assessment will be conducted to determine: • Structural integrity • Roof leaks • Insect infestation • Accessibility • Mechanical attachment • Location of marriage wall seams • Number, type, size, and location of penetrations	Ensure work space is safe and ready for air sealing Verify scope of work		4159
3.1701.1b Hole, seam, line, and penetration sealing	Marriage wall seams will be sealed continuously at walls, floors, and ceiling connection All accessible holes and penetrations in the addition envelope will be sealed Backing or infill will be provided as needed, when accessible	Minimize air leakage Maintain durability and/or flexibility Ensure sealant is effective and durable		4160
3.1701.1c Materials	Materials will be used or installed in accordance with product manufacturer specifications	Select materials to ensure durable and permanent repair		4161
3.1701.1d Addition exterior wall air sealing	All holes and penetrations on exterior surface of exterior walls will be sealed to ensure resistance to outdoor elements Intentionally ventilated walls will not be sealed at vent locations (e.g., weep holes)	Minimize air leakage Maintain durability Ensure resulting closure is permanent and supports expected wind and mechanical pressure loads Ensure sealant is effective and durable		4162

	All holes and penetrations on the interior surface of exterior walls will be repaired Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration			
3.1701.1e Addition interior wall air sealing	All accessible holes and penetrations in top and bottom plates will be sealed Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration	Minimize air leakage Maintain durability Ensure resulting closure is permanent and supports expected load Ensure sealant is effective and durable		4163
3.1701.1f Addition floor air sealing (decking, subfloor, floor decking)	Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration The backing or infill will not bend, sag, or move once installed	Ensure resulting closure is permanent and supports expected wind and mechanical pressure loads Ensure sealant is effective and durable		4164
3.1701.1g Sealant selection	Sealants will be used to fill holes no larger than recommended by manufacturer specifications Sealants will be compatible with all adjoining surfaces Sealants will be continuous and meet fire barrier specifications, if required	Create a permanent seal Ensure sealant meets or exceeds the performance characteristics of the surrounding materials		4165
3.1701.1h Floor repair	Floor repair material will meet or exceed strength of existing floor material Repair will span from joist to joist and blocking added as needed to support floor Patches smaller than 144 square inches will not require repairs from joist to joist	Ensure floor is structurally sound Minimize air leakage		4166

	Floor repair material will be glued, fastened, and air sealed			
3.1701.1i Structural materials	Materials will be used or installed in accordance with product manufacturer specifications	Select materials to ensure durable and permanent repair		4167
3.1701.1j Ceiling hole repair	Ceiling repair material must meet or exceed strength of existing ceiling material Ceiling repair must span from truss to truss or add blocking as needed for support The backing or infill will not bend, sag, or move once installed All accessible damaged vapor barriers will be repaired Penetrations through the air barrier must be repaired	Ensure ceiling is structurally sound Minimize air leakage Ensure closure is permanent and supports expected wind and mechanical pressure loads Ensure sealant does not fall out		4168
3.1701.1k High temperature application	Only noncombustible materials will be used in contact with chimneys, vents, and flues	Prevent a fire hazard		4169

Section 4: Insulation

4.1002.1 Above Roof Deck Insulation: Preparation

Topic: Attics

Subtopic: Above Roof Deck Insulation

Desired Outcome: Roof covering removed and replaced to expose roof deck for installation of above roof deck insulation

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1002.1b Roof covering replacement	New roof covering will be installed in accordance with manufacturer specifications and local building code requirements after installation of above roof deck insulation	Install roof covering correctly Meet local code requirements		2025

4.1002.2 Above Deck Roof Deck Insulation: Installation

Topic: Attics

Subtopic: Above Roof Deck Insulation

Desired Outcome: Properly installed roof deck insulation

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1002.2a Sealing	Holes, gaps, and penetrations in existing roof deck will be sealed	Prevent air leaks		2026
4.1002.2b Installation	Insulation will be installed according to manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to prescribed R-value	Install insulation properly		2027
4.1002.2c Occupant education	A dated receipt signed by the installer will be provided that includes: ☐ Insulation type ☐ Coverage area ☐ R-value ☐ Installed thickness and settled thickness (settled thickness required for loose-fill only) ☐ Number of bags installed in accordance with manufacturer specifications (for loose-fill only)	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17		2028

4.1003.10 Installing Fiberglass Blown Insulation for Flat, Bowed, or Vaulted Ceilings (via Interior Access Through the Ceiling)

Topic: Attics

Subtopic: Attic Ceilings

For supporting material, see Building America Solution Center.

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1003.10a Attic, ceiling,	All combustion appliance flues will be terminated to the exterior of the	Ensure occupant and worker safety		4182

and roof verification	house and terminations will maintain proper clearance above snow loads A distance no less than 2" will be maintained between any combustion appliance flue and combustible materials, unless zero clearance flue is in place All ventilation systems will maintain a continuous connection and terminate to the outdoors All broken mushroom vents will be replaced or removed and sealed All plumbing stacks will be terminated to the outdoors Non-IC rated light fixtures will be replaced with airtight IC-rated fixtures, if feasible and only when installed measures will compromise the fire rating of the fixture All recessed lights will be labeled as having an air leakage rate no more than 2.0 CFM when tested in accordance with ASTM E 283 at a 75 pascals pressure differential All obvious ceiling penetrations will be sealed The space between combustion appliance flues and the ceiling will be sealed with fire-rated materials All roof, attic, and ceiling assemblies will be structurally sound: • Loose ceiling panels will be secured • Temporary ceiling bracing will be recommended while installing installation Dishing and pooling issues that allow standing water will be addressed	Verify attic space is ready to insulate Ensure structural integrity of the roof and ceiling assembly Prevent intrusion of bulk moisture Prevent damage while installing insulation		

	All known roof water leaks will be repaired before installing installation			
4.1003.10b Construction prep	Special precautions will be taken to limit fiberglass and construction dust exposure to the occupant and occupant belongings	Protect occupant health and safety Protect occupant belongings		4183
4.1003.10c Attic access	Equidistant holes will be drilled in a straight row parallel to the longitudinal exterior wall of the ceiling If a longitudinal ceiling trim piece exists, trim piece will be removed and holes will be drilled behind the trim Hole location and size will be placed to provide access to allow for consistent and uniform coverage of installed insulation throughout the attic assembly There will be, at a minimum, one hole between each roof truss Holes will be large enough to accommodate the chosen fill tube without damaging the ceiling material during installation If a vapor barrier or ceiling-mounted insulation is present, access will be gained through them Attic will be visually inspected for the location of existing insulation, obstructions, hazards, and construction type	Create access to the full attic cavity Determine insulation installation technique Prevent damage to ceiling Create a professionally finished ceiling		4184
4.1003.10d Blowing machine set up	Blowing machine pressure test will be performed with air on full, feed off, and gate closed Hose outlet pressure will be set in accordance with manufacturer specifications	Ensure machine is capable of delivering uniform insulation density and coverage		4185

4.1003.10e Fiberglass blown insulation installation	Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot Using fill tube, 100% of each cavity will be filled to a consistent density Fill tube will be inserted within 6" of the end of each attic cavity Insulation will be installed into the void of the attic cavity: • If existing insulation is roof-mounted, insulation will be blown below • If existing insulation is ceiling-mounted, insulation will be blown above • If existing insulation is mounted at both locations, insulation will be blown in between Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84	Fill entire attic cavity to the prescribed R-value to reduce air infiltration Avoid clogging of the cavity and the fill tube Prevent damage to the ceiling Fire safety will be maintained		4186
4.1003.10f Patching and sealing holes	Holes will be plugged or covered and sealed to be aesthetically pleasing If existing trim was removed, it will be reinstalled	Create an airtight seal Create a visually acceptable ceiling finish		4187
4.1003.10g Verification of details	Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process	Verify the integrity of the house has been maintained		4188
4.1003.10h Onsite Documentation	A dated receipt signed by the installer will be provided that includes:	Document job completion to contract specifications		6774

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

4.1003.11 Installing Fiberglass Blown Insulation in Roof-Over Constructions

Topic: Attics

Subtopic: Attic Ceilings

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1003.11a Roof-over overview	If occupant will allow access from interior, installation through the ceiling is preferred Attic space created by the roof-over will be accessed in accordance with the Single-Family Attic Access SWS If the roof-over does not allow physical access to the roof-over attic, access to the original attic will be gained through roof venting If existing insulation height in the attic is less than the height of the heel plate (original attic), access will be made through the original roof and the original attic cavities will be filled before blowing insulation over the original roof At a minimum, the access holes to the original attic cavities will be sealed to prevent air leakage	Gain access to the combined attic spaces Address thermal bridging Correctly insulate the combined attic spaces		4189

	If existing insulation height is equal to or greater than the height of the heel plate (original attic), the insulation will be installed in the end cavities before blowing on top of the original roof Access to the end cavities will be gained and insulation will be installed At a minimum, the access holes to the original attic cavities will be sealed to prevent air leakage Insulation will not be installed on top of the original roof until the end cavities are insulated and air sealed in original attic If insulation is installed on top of the original roof, it will be installed in accordance with the Single-Family SWS Loose Fill Blown Fiberglass Insulation Installation			
4.1003.11b Onsite documentation	A dated receipt signed by the installer will be provided that includes: • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications Confirm amount of insulation installed Ensure ability to match bags required for total area completed Comply with 16 CFR 460.17		6776

4.1003.15 Installing Fiberglass Blown Insulation for Flat, Bowed, or Vaulted Ceilings (via Gable End Access)

Topic: Attics

Subtopic: Attic Ceilings

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
4.1003.15a Attic, ceiling, and roof verification	All combustion appliance flues will be terminated to the outdoors and terminations will maintain proper clearance above snow loads A distance no less than 2" will be maintained between any combustion appliance flue and combustible materials, unless zero clearance flue is in place All ventilation systems will maintain a continuous connection and terminate to the outdoors All broken mushroom vents will be replaced or removed and sealed All plumbing stacks will be terminated to the outdoors Non- *IC* rated light fixtures will be replaced with airtight *IC* -rated fixtures All recessed lights will be labeled as having an air leakage rate not more than 2.0 *CFM* when tested in accordance with *ASTM* E 283 at a 75 pascals pressure differential All obvious ceiling penetrations will be sealed The space between combustion appliance flues and the ceiling will be sealed with fire-rated materials All roof, attic, and ceiling assemblies will be structurally sound: • Loose ceiling panels will be secured • Temporary ceiling bracing will be recommended during	Ensure occupant and worker safety Verify attic space is ready to insulate Ensure structural integrity of the roof and ceiling assembly Prevent intrusion of bulk moisture Prevent damage while installing insulation	6982

	the insulation installation process Dishing and pooling issues that allow standing water will be addressed All known roof water leaks will be repaired before installing installation			
4.1003.15b Attic access	Access to the attic cavity will be created through the gable vents. Attic will be visually inspected for the location of existing insulation, wiring, flues, obstructions, hazards, and construction type	Create access to the full attic cavity Maintain the integrity of the roof truss Determine technique for installing insulation		6984
4.1003.15c Blowing machine set up	Blowing machine pressure test will be performed with air on full, feed off, and gate closed Hose outlet pressure will be set in accordance with manufacturer specifications	Ensure machine is capable of delivering uniform insulation density and coverage		6985
4.1003.15d Fiberglass blown insulation installation	Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot Using fill tube, 100% of each roof cavity will be filled to a consistent density Insulation will be installed into the void of the attic cavity: • If existing insulation is roof-mounted, insulation will be blown below • If existing insulation is ceiling-mounted, insulation will be blown above • If existing insulation is mounted at both locations, insulation will be blown in between Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a	Fill entire attic cavity to the prescribed R-value to reduce air *infiltration* Avoid clogging of the cavity and the fill tube Prevent damage to the ceiling Fire safety will be maintained		6986

	smoke development rating of 450 or less when tested in accordance with *ASTM* E84			
4.1003.15e Replace Gable End Vent Covers	Reinstall the gable end vents	Prevent pest intrusion into attic Protect installed insulation		6987
4.1003.15f Verification of details	Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process	Verify the integrity of the house has been maintained		6988
4.1003.15g Onsite documentation	A dated receipt signed by the installer will be provided that includes: • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications Confirm amount of insulation installed Ensure ability to match bags required for total area complete Comply with 16 CFR 460.17		6989

4.1003.8 Installing Fiberglass Blown Insulation for Flat, Bowed, or Vaulted Ceilings (via Roof Side Lift)

Topic: Attics

Subtopic: Attic Ceilings

For supporting material, see Building America Solution Center.

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1003.8a Attic, ceiling,	All combustion appliance flues will be terminated to the outdoors and	Ensure occupant and worker safety		4170

and roof verification	terminations will maintain proper clearance above snow loads A distance no less than 2" will be maintained between any combustion appliance flue and combustible materials, unless zero clearance flue is in place All ventilation systems will maintain a continuous connection and terminate to the outdoors All broken mushroom vents will be replaced or removed and sealed All plumbing stacks will be terminated to the outdoors Non-IC rated light fixtures will be replaced with airtight IC-rated fixtures All recessed lights will be labeled as having an air leakage rate no more than 2.0 CFM when tested in accordance with ASTM E 283 at a 75 pascals pressure differential All obvious ceiling penetrations will be sealed The space between combustion appliance flues and the ceiling will be sealed with fire-rated materials All roof, attic, and ceiling assemblies will be structurally sound; loose ceiling panels will be secured Temporary ceiling bracing will be recommended during the insulation installation process Dishing and pooling issues that allow standing water will be addressed All known roof water leaks will be repaired before insulation installation	Verify attic space is ready to insulate Ensure structural integrity of the roof and ceiling assembly Prevent intrusion of bulk moisture Prevent damage during the insulation installation process		

4.1003.8b Attic access	Fasteners will be removed from the J channel and the roof edge on the most easily accessible side of the house Roof will be separated from the heel plate and siding roof will be lifted and propped to accommodate fill tube Length of opening will be enough to allow ease of access and reattachment while minimizing potential damage from high winds If subsheathing is present, access will be gained through subsheathing Attic will be visually inspected for the location of existing insulation, obstructions, hazards, and construction type	Create access to the full attic cavity Protect roof from wind damage during installation Ensure ease of roof reattachment Determine insulation installation technique		4171
4.1003.8c Blowing machine set up	Blowing machine pressure test will be performed with air on full, feed off, and gate closed Hose outlet pressure will be set in accordance with manufacturer specifications	Ensure machine is capable of delivering uniform insulation density and coverage		4172
4.1003.8d Fiberglass blown insulation installation	Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot Using fill tube, 100% of each cavity will be filled to a consistent density Fill tube will be inserted within 6" of the end of each attic cavity Insulation will be installed into the void of the attic cavity: • If existing insulation is roof-mounted, insulation will be blown below • If existing insulation is ceiling-mounted, insulation will be blown above	Fill entire attic cavity to the prescribed R-value to reduce air infiltration Avoid clogging of the cavity and the fill tube Prevent damage to the ceiling Allow roof to be returned to original position Fire safety will be maintained		4173

	• If existing insulation is mounted at both locations, insulation will be blown in between Avoid overfilling of roof edges and above attic trusses Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84			
4.1003.8e Roof reattachment	If existing J channel is damaged, it will be replaced Existing sealant will be removed from the roof edge and J channel At a minimum, new sealant will be reinstalled at the original location Roof and J channel will be fastened to the original location with new screws All seams, edges, and penetrations will be sealed as necessary	Prepare roof edge and J channel for reattachment Reattach roof edge and J channel without leaks		4174
4.1003.8f Verification of details	Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process	Verify the integrity of the house has been maintained		4175
4.1003.8g Onsite documentation	A dated receipt signed by the installer will be provided that includes: • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications Confirm amount of insulation installed Ensure ability to match bags required for total area completed Comply with 16 CFR 460.17		6782

4.1003.9 Installing Fiberglass Blown Insulation for Flat, Bowed, or Vaulted Ceilings (via Exterior Access from Top of Roof)

Topic: Attics

Subtopic: Attic Ceilings

For supporting material, see Building America Solution Center.

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
4.1003.9a Attic, ceiling, and roof verification	All combustion appliance flues will be terminated to the outdoors and terminations will maintain proper clearance above snow loads A distance no less than 2" will be maintained between any combustion appliance flue and combustible materials, unless zero clearance flue is in place All ventilation systems will maintain a continuous connection and terminate to the outdoors All broken mushroom vents will be replaced or removed and sealed All plumbing stacks will be terminated to the outdoors Non-IC rated light fixtures will be replaced with airtight IC-rated fixtures All recessed lights will be labeled as having an air leakage rate not more than 2.0 CFM when tested in accordance with ASTM E 283 at a 75 pascals pressure differential All obvious ceiling penetrations will be sealed The space between combustion appliance flues and the ceiling will be sealed with fire-rated materials	Ensure occupant and worker safety Verify attic space is ready to insulate Ensure structural integrity of the roof and ceiling assembly Prevent intrusion of bulk moisture Prevent damage while installing insulation	4176

	All roof, attic, and ceiling assemblies will be structurally sound: • Loose ceiling panels will be secured • Temporary ceiling bracing will be recommended during the insulation installation process Dishing and pooling issues that allow standing water will be addressed All known roof water leaks will be repaired before installing installation			
4.1003.9b Attic access	Access to the attic cavity will be created through the gable vents. Attic will be visually inspected for the location of existing insulation, wiring, flues, obstructions, hazards, and construction type	Create access to the full attic cavity Maintain the integrity of the roof truss Determine technique for installing insulation		4177
4.1003.9c Blowing machine set up	Blowing machine pressure test will be performed with air on full, feed off, and gate closed Hose outlet pressure will be set in accordance with manufacturer specifications	Ensure machine is capable of delivering uniform insulation density and coverage		4178
4.1003.9d Fiberglass blown insulation installation	Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot Using fill tube, 100% of each cavity will be filled to a consistent density Fill tube will be inserted within 6" of the end of each attic cavity Insulation will be installed into the void of the attic cavity: • If existing insulation is roof-mounted, insulation will be blown below	Fill entire attic cavity to the prescribed R-value to reduce air infiltration Avoid clogging of the cavity and the fill tube Prevent damage to the ceiling Allow roof to be returned to original position Fire safety will be maintained		4179

	• If existing insulation is ceiling-mounted, insulation will be blown above • If existing insulation is mounted at both locations, insulation will be blown in between Insulation will be filled no higher than the top of the truss Flame spread and smoke-developed index for insulation will be a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84			
4.1003.9e Patching and sealing openings	If the roof is sliced: • A solid metal ridge cap will be centered over the slice • A flexible and durable sealant will be sandwiched between the roof and the ridge cap • Screws will be installed to prevent wrinkles and create a permanent seal • Screws will not go into any wood framing • A durable and flexible final coating will be applied over the screws and edge of the ridge cap to create a continuous seal between the roof and the perimeter of the ridge cap For holes that are drilled or cut, the initial patch will be applied using the following procedure: • At least 6" of surface surrounding the opening will	Effectively patch and seal all openings Create a durable patch that will prevent roof leaks		4180

	be cleaned before patch is installed • Sealant will be continuous and applied in between the patch and the roof • Sealant will be an all-weather adhesive that is flexible and durable If a metal patch is used: • Patch will overlap the opening by 2" on all sides • Gauge will be equal to or greater than the roof material • Fasteners will be installed to prevent wrinkles and create a permanent seal • If a plug is used, it will be flanged and have a tight fit • Screws will not go into any wood framing A durable and flexible 45 mil adhesive patch will be applied in accordance to manufacturer specifications over the initial patch and will have at a minimum: • Tear strength of 640g • Elongation of 380% • Application temperature no lower than 55°F and no greater than 110°F • Services temperature no less than -25°F and no greater than 150°F • Adhesive patch will overlap the initial patch by 2" on all sides • A durable and flexible final coating will be applied over			

	the adhesive patch to create a continuous seal between the roof and the perimeter of the patch • All remaining seams, edges, and penetrations will be sealed as necessary			
4.1003.9f Verification of details	Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process	Verify the integrity of the house has been maintained		4181
4.1003.9g Onsite documentation	A dated receipt signed by the installer will be provided that includes: • Insulation type • Coverage area • R-value • Installed thickness and minimum settled thickness • Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications Confirm amount of insulation installed Ensure ability to match bags required for total area complete Comply with 16 CFR 460.17		6784

4.1088.6 Installing Insulation at Flat and Cathedral Ceiling Transition Wall

Topic: Attics

Subtopic: Special Considerations

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1088.6a Insulation installation verification	A visual inspection of the highest point of the transition wall will be completed	Verify the height and the accessibility of the attic		4190

	Access points will be determined from the gable end, roof, ceiling, or interior paneling			
4.1088.6b Access attic	Attic will be accessed through the location that allows the most efficient and effective insulation coverage	Gain access to the flat and cathedral ceiling transition wall		4191
4.1088.6c Blowing	Blowing machine pressure test will be performed with air on full, feed off, and gate closed Insulation will be blown against the transition wall until the wall is covered	Ensure machine is capable of delivering uniform insulation density and coverage to meet manufacturer specifications for loose blown insulation Create a thermal barrier at the transition wall		4192
4.1088.6d Spray two-part foam	Insulation will be installed to prescribed R-value in accordance with manufacturer specifications Spray polyurethane foam (SPF) will be applied to desired thickness, using pass thickness maximum as indicated by manufacturer	Insulate and seal transition wall		4193
4.1088.6e Batt	Batt insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions Insulation will be installed to the prescribed R-value Vapor barrier will be installed based on regional considerations	Insulate to prescribed R-value		4194
4.1088.6f Patching and sealing access points	Created access points will be covered and sealed in an aesthetically pleasing manner Existing access points (e.g., gable vent) will be returned to the original condition If existing trim was removed, it will be reinstalled	Create an airtight seal Create an aesthetically pleasing finish		4195

4.1088.6g Verification of details	Installation process will be considered complete when installer has verified that damage has not occurred to the roof or ceiling assemblies during the installation process	Verify the integrity of the house has been maintained		4196
4.1088.6h Onsite Documentation	A dated receipt signed by the installer will be provided that includes: • Insulation type • Coverage area • R-value • Installed thickness and settled thickness (settled thickness required for loose-fill only) • Number of bags installed in accordance with manufacturer specifications (for loose-fill only)	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17		6794

4.1101.5 Exterior Wall Dense Packing

Topic: Walls

Subtopic: Preparation

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1101.5a Preparation	Lead safety procedures will be followed Cavities will be free of hazards, intact, and able to support dense pack pressures Drilling hazards (e.g., wiring, venting, fuel piping) will be located Blocking will be installed around: • All openings to inside of the crawl space and basement for fibrous material	Prevent damage to the house Provide a clean work space Provide thorough access to allow 100% coverage Ensure proper equipment and process results in consistent density Prevent settling and retard air flow through cavities Protect worker and occupant health		4197

	• High temperature fire-rated materials • Wiring and electrical hazards • Heat sources Access to exterior wall cavities will be gained, sheathing will be drilled as needed and probed to locate each cavity, wall studs, and blockers When accessing wall cavities, the interior will be masked to control dust during drilling Electricity supply will be confirmed and will support blowing machine power demand Blowing machine pressure test will be performed with air on highest level, feed off, and gate closed Hose outlet pressure will be at least 80 IWC or 2.9 psi for cellulose insulation; for other types of dense pack insulation, check manufacturer specification for blowing machine set up			
4.1101.5b Exterior dense pack	Using fill tube, 100% of each cavity will be filled to a consistent density: • Blown fiberglass, mineral fiber, rock and slag wool, or spray foam 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 cubic feet per minute per square foot at 50 pascals • Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot when the wall sheathing and interior	Eliminate voids and settling Minimize framing cavity air flows		4198

	cladding will endure this level of pressure • Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density in accordance with manufacturer specifications • The number of bags installed will be confirmed and will match the number to achieve 1.5-1.6 pounds per cubic foot • Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference			

4.1104.1 Stuffing Wall Cavities with Fiberglass Batts

Topic: Walls

Subtopic: Manufactured Housing Wall Insulation

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1104.1a Access wall cavities	If skirting overlaps siding, skirting will be detached to allow access to the wall cavity Fasteners will be removed from the bottom of the siding, working upward until the siding can be pulled away from the framing approximately 6" without damaging the siding Temporary fasteners will be installed near the bottom of the siding panels at the seams to prevent separation If a subsheathing is present under the siding, access through the subsheathing will be required	Gain access to the wall cavity without damaging or separating the siding		4199

4.1104.1b Exterior wall cavity inspection	Wall cavities will be inspected for moisture damage, pest locations, and integrity of the wiring, and holes to the interior Siding will be repaired as necessary Location of belt rails, obstructions, and existing insulation will be identified All interior surfaces of exterior walls will be inspected for loose paneling joints, occupant wall hangings, location of switches and outlets, and other wall obstructions Objects will be removed from the interior surfaces of the walls being insulated Interior paneling will be repaired as necessary	Prepare wall cavity for insulation Prevent water leaks from occurring		4200
4.1104.1c Fiberglass batt installation tool (stuffer)	A sheet of polycarbonate, such as Lexan, will be cut to the following specifications to create a stuffer tool: • Approximately 1' x 8' x ¼" with a 5 degree bend 7' ½" from the bottom • All corners of the Lexan (polycarbonate) will be rounded and all edges will be sanded Other clear sheet plastics will not be used due to a tendency to shatter under stress	Create a tool to install a fiberglass batt into the cavity Ensure worker safety		4201
4.1104.1d Fiberglass batt installation	Thickness of the batt will fill the void without deforming siding or damaging structure Fiberglass batts will fill the cavity (e.g., batt may be cut approximately 1" longer to ensure proper fill and allow for lap at the top)	Maintain integrity of the batt Aid in the installation process		4202

	Flexible membrane will have an appropriate perm rating for the region Flexible membrane will be cut 2" wider than the cavity and approximately 1' longer than the batt Stuffer tool, membrane, and fiberglass batt will be aligned for installation Stuffer tool will be used to install the fiberglass batt and membrane at the same time Excess fiberglass batt and membrane vapor retarder extending below the cavity will be rolled and tucked into the cavity A poly-encased fiberglass batt may be used in place of the fiberglass batt and membrane assembly The membrane will be installed in contact with the side of the wall that is compatible with the local climate zone			
4.1104.1e Sub-sheathing patch and repair	Subsheathing will be patched or repaired as necessary	Ensure the integrity of the drainage plane		4203
4.1104.1f Reattachment	If skirting was removed, skirting will be reinstalled to shed water to the outside of the skirting Siding will be reattached with new fasteners Siding will be reattached without bulges or wrinkles	Ensure the integrity of the drainage plane Return siding to existing conditions without damage		4204
4.1104.1g Onsite documentation	A dated receipt signed by the installer will be provided that includes: • Coverage area • Thickness	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17		6806

	• R-value			

4.1104.2 Fiberglass Blown Insulation Installation (Lifting Siding)

Topic: Walls

Subtopic: Manufactured Housing Wall Insulation

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1104.2a Access wall cavities	If skirting overlaps siding, skirting will be removed Fasteners will be removed from the bottom of the siding, working upward until the siding can be pulled away from the framing approximately 6" without damaging the siding Temporary fasteners will be installed near the bottom of the siding panels at the seams If a subsheathing is present under the siding, access through the subsheathing will be required	Gain access to the wall cavity without causing damage or separation of the siding		4205
4.1104.2b Exterior wall cavity inspection	Installer prework assessment will be conducted to determine: • Moisture damage • Presence of infestation or pests • Location and integrity of wiring • Holes to the interior and exterior • Loose paneling or siding • Location of belt rails	Prepare wall cavity for insulation Prevent water leaks		4206

	• Location of wall obstructions (switches, outlets) • Existing insulation • Wall hangings for removal during work Problems will be corrected before work begins			
4.1104.2c Blowing machine set up	Blowing machine pressure test will be performed with air on full, feed off, and gate closed Hose outlet pressure will be set according to manufacturer specifications	Achieve uniform insulation density and coverage		4207
4.1104.2d Fiberglass blown insulation installation	Insulation will meet a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84 Insulation will be installed to a density of 1.5 to-1.6 pounds per cubic foot Using fill tube, 100% of each cavity will be filled to a consistent density Special precaution will be taken not to overfill the bottom of the cavity Fill tube will be inserted from the bottom of the wall cavity within 6" of the top of the cavity between the interior paneling and any existing insulation	Fire safety maintained Fill entire wall cavity to the prescribed R-value to reduce air infiltration Ensure bottom portion of siding will reattach properly Avoid clogging of the cavity and the fill tube		4208
4.1104.2e Subsheathing patch and repair	Subsheathing will be patched or repaired as necessary	Ensure the integrity of the drainage plane		4209
4.1104.2f Reattachment	If skirting was removed, skirting will be reinstalled to shed water to the outside of the skirting	Ensure the integrity of the drainage plane Reattach siding without damage		4210

	Siding will be reattached with new fasteners Siding will be reattached without bulges or wrinkles			
4.1104.2g 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		6808

4.1104.3 Fiberglass Blown Insulation Installation (via Penetrations Through or Behind the Siding)

Topic: Walls

Subtopic: Manufactured Housing Wall Insulation

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1104.3a Access wall cavities	With T-111, OSB, or plywood type siding: • Access to exterior wall cavities will be gained and sheathing will be drilled as needed and probed to locate each cavity, wall studs, and blockers • Drilled holes will be large enough to accommodate an appropriately sized fill tube • Holes will be drilled around the perimeter of the home, parallel to the bottom plate and an equal distance apart • The line of holes will be located under the lowest window sill when possible	Gain access to the wall cavity Ensure holes are easily covered with an aesthetically pleasing trim strip		4211

	With lap siding: • Course of siding will be unhooked or removed • Holes sufficiently large for the fill tube will be drilled in every wall cavity			
4.1104.3b Exterior wall cavity inspection	Installer prework assessment will be conducted to determine: • Moisture damage • Presence of infestation or pests • Location and integrity of wiring • Holes to the interior and exterior • Loose paneling or siding • Location of belt rails • Location of wall obstructions (switches, outlets) • Existing insulation • Wall hangings for removal during work Problems will be corrected before work begins	Prepare wall cavity for insulation Prevent water leaks		4212
4.1104.3c Blowing machine set up	Blowing machine pressure test will be performed with air on full, feed off, and gate closed Hose outlet pressure will be set in accordance with manufacturer specifications	Ensure machine is capable of delivering uniform insulation density and coverage		4213
4.1104.3d Fiberglass blown insulation installation	Flame spread and smoke-developed index for insulation will meet a flame spread rating of 25 or less and a smoke development rating of 450 or less when tested in accordance with ASTM E84	Fill entire wall cavity to the prescribed R-value to reduce air infiltration Avoid clogging of the cavity and the fill tube Fire safety will be maintained		4214

	Insulation will be installed to a density of 1.5 to 1.6 pounds per cubic foot Using fill tube, 100% of each cavity will be filled to a consistent density Fill tube will be inserted within 6" of the top of the cavity between the interior paneling and any existing insulation			
4.1104.3e Plug and seal holes	Holes will be plugged and sealed	Ensure the integrity of the drainage plane		4215
4.1104.3f Final wall assembly	For T-111 and equivalent siding: • A preprimed trim will be centered and installed over the holes • Height of the trim will span from 1" above to 1" below the hole • A continuous caulk seal will be applied between the trim and siding • Caulk seal will be above the holes • Top edge of the trim will be sealed to the siding with a continuous caulk seal For lap siding: • Siding will be reattached without bulges or wrinkles • Siding will be hooked into the original position	Ensure the integrity of the drainage plane Return siding to existing conditions without damage		4216
4.1104.3g Onsite documentation	A dated receipt signed by the installer will be provided that includes: • Coverage area • Thickness	Document job completion to contract specifications Confirm amount of insulation installed Comply with 16 CFR 460.17		6810

	• R-value			

4.1104.4 Spray Foam Insulation Installation in Cavities above Doors and Windows

Topic: Walls

Subtopic: Manufactured Housing Wall Insulation

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1104.4a Access wall cavities above doors and windows	All interior surfaces of the cavities planned to be insulated will be inspected for loose paneling joints, occupant wall hangings, and other wall obstructions Objects will be removed from the interior surfaces of the exterior walls as needed Interior paneling will be repaired and secured as necessary Holes will be drilled from the interior of the house A hole no larger than the spray nozzle will be drilled in each cavity above the door or window When possible, the hole will be drilled in the panel groove	Prepare wall cavity for insulation Prevent damage from overspray to occupant possessions		4217
4.1104.4b Cavity inspection	Cavity will be probed to assess conditions and volume of cavity	Determine the approximate amount of foam to be installed in the cavity		4218
4.1104.4c Insulation installation	Flame spread index of foam insulation will not exceed 75 and a smoke- developed index of no more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E84 or UL 723	Fill entire wall cavity to the prescribed R-value to reduce air infiltration Fire safety will be maintained		4219

	Foam insulation will be separated from the interior of the building by an approved thermal barrier at a minimum of 1/2" gypsum wallboard or a material that is tested in accordance with the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275 Two-part foam selection will be based on regional considerations 100% of each cavity will be filled to a consistent density without bulging of panels or siding			
4.1104.4d Final wall assembly	A color-corresponding sealant will be applied to the access hole	Ensure wall is aesthetically pleasing		4220
4.1104.4e 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		6812

4.1302.1 Prepare Belly Floor Cavity for Insulation

Topic: Floors

Subtopic: Manufactured Housing Belly Preparation

Desired Outcome: Belly floor cavity ready for insulation

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1302.1a Work assessment	Gas, water, waste, and electrical lines will be checked for: • Plumbing leaks • Gas/oil leaks • Attachment • Standing water	Ensure that floor space is safe and ready for work Verify scope of work		4221

	• Raw sewage • Pests			
4.1302.1b Preparation	Where bottom board/rodent barrier is missing or damaged and accessible, the following will be ensured: • Duct sealing completed • Gas, water, and electrical lines secured at least every 4' to a floor joist or framing member • Water line will be located on the warm side of the insulation; if not, the water lines will be insulated appropriately • No water or gas leaks are present • Waste lines are sloped to ¼" per foot • Bottom board/rodent barrier is sound/strong enough to support insulation When bottom board is intact, the following will be ensured: • Holes and penetrations in the bottom board and decking sealed • Duct sealing completed • No water or gas leaks present • Bottom board is sound/strong enough to support insulation • Water lines are secured to the floor joists/warm side of the insulation; if not, the water lines will be insulated appropriately	Ensure problems are corrected before floor cavity insulation work begins Keep pipes from freezing		4222

	Problems will be corrected before floor cavity insulation work begins			

4.1303.1 Insulation of Floor Cavity with Blown Material

Topic: Floors

Subtopic: Manufactured Housing Floor Cavity Insulation

Desired Outcome: Consistent *thermal boundary* between conditioned and unconditioned space that reduces heat flow

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1303.1a R-value	Insulation will be installed in accordance with recommended R-value and density	Insulate to prescribed R-value for the climate zone		4223
4.1303.1b Work assessment	Road and rodent barrier must be intact and free from holes and capable of supporting the insulation	Ensure bottom board is intact Ensure insulation is supported Protect cavity from infestation		4224
4.1303.1c Insulate floors	Each cavity will be insulated to specified R-value and density The number of bags installed will be confirmed and will match the number required on the coverage chart	Eliminate voids and settling		4225
4.1303.1d Materials	Flame spread index of selected materials will not exceed 25 with an accompanying smoke-developed index not to exceed 450 when tested in accordance with ASTM E84 or UL 723 Flame spread index of foam insulation will not exceed 75 and a smoke-developed index of no more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E84 or UL 723 Foam insulation will be separated from the interior of the building by an approved thermal barrier at a minimum of 1/2" gypsum or a material that is tested in accordance	Ensure durability Prevent moisture damage Fire safety will be maintained		4226

	with the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275 Selected material will be of minimal water absorbency Selected material will be noncorrosive			
4.1303.1e Occupant education	A dated receipt signed by the installer will be provided that includes: □ Insulation type □ Coverage area □ R-value □ Installed thickness and minimum settled thickness □ Number of bags installed in accordance with manufacturer specifications	Document job completion to contract specifications Confirm amount of insulation installed Ensure ability to match bags required for total area completed Comply with 16 CFR 460.17		4227

4.1303.2 Insulation of Floor Cavity with Batt Material

Topic: Floors

Subtopic: Manufactured Housing Floor Cavity Insulation

Desired Outcome: Consistent *thermal boundary* between conditioned and unconditioned space that reduces heat flow

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1303.2a R-value	Insulation will be installed in accordance with recommended R-value and density	Insulate to prescribed R-value for the climate zone		4228
4.1303.2b Work assessment	Ensure complete accessibility of floor cavity Clean floor cavities Remove all remnants of previous insulation and bottom board	Ensure work area is clean, safe, and ready to accept insulation		4229
4.1303.2c Insulate floors	Each cavity will be insulated to specified R-value and density	Eliminate voids		4230

	If insulation has facing, facing will be in contact with the heated side Insulation will be in contact with subfloor Insulation will not have gaps, voids, or be compressed Insulation will be supported (e.g., metal insulation supports) to maintain a permanent contact with subfloor Insulation will be notched around all wires, pipes, and blocks Ducts and water lines will be insulated for climate conditions Water lines will be located above the warm side of the insulation (toward the conditioned space), when feasible A rigid air barrier will be installed in contact with the bottom of the joists, when feasible Rigid air barrier will be fastened as to not sag, bend, or fall off Seams, holes, and joints in the air barrier will be sealed In cases where HVAC ducts hang below the level of the rigid air barrier and insulation, the ducts will be insulated and air barrier provided that is sealed to the rigid air barrier	Minimize conductive heat transfer across the floor system Ensure durability Minimize convective heat transfer Keep pipes from freezing		
4.1303.2d Materials	Insulation materials will be of minimal water absorbency and flame spread, and smoke-developed index for insulation will be in accordance with IRC Foam plastic insulation will comply with IRC Fasteners will be corrosion resistant	Ensure durability Prevent moisture damage		4231

4.1303.2e Occupant education	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		4232

4.1303.3 Insulation of Floor Cavity with Spray Foam Material

Topic: Floors

Subtopic: Manufactured Housing Floor Cavity Insulation

Desired Outcome: Installation of a consistent *thermal boundary* between conditioned and unconditioned space that reduces heat flow

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1303.3a R-value	Insulation will be installed in accordance with recommended R-value	Insulate to prescribed R-value for the climate zone		4233
4.1303.3b Work assessment	Ensure complete accessibility of floor cavity	Ensure work area is clean, safe, and ready to accept insulation		4234
4.1303.3c Preparation	All floor areas will be open and accessible for spray foam application Any openings in the subfloor larger than ¼" will be covered with appropriate materials Insulation dams or end blockers will be installed where needed All surfaces where spray foam 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 below 19%; if tested at or above this percent	Prepare all substrate surfaces for the application of spray foam		4235

	of moisture, insulating the floor will be deferred until moisture level is corrected Clean floor cavities Remove all remnants of previous insulation and bottom board			
4.1303.3d Installation	Insulation will be installed to prescribed R-value in accordance with manufacturer specifications In accordance with manufacturer specifications, spray foam will be applied to desired thickness using the maximum pass thickness onto subfloor between floor joists and all rim/band joists Rim/band joist will be sealed When desired, underside of joists will be covered with spray foam to provide a layer of continuous insulation Each cavity will be insulated to specified R-value Insulation must be in contact with subfloor Insulation will not have gaps or voids Ducts and water lines will be insulated for climate conditions	Insulate and seal floors Eliminate voids Minimize conductive and convective heat transfer across the floor system Ensure durability		4236
4.1303.3e Materials	Insulation will be installed in accordance with manufacturer specifications Flame spread index of selected materials will not exceed 25 with an accompanying smoke-developed index not to exceed 450 when tested in accordance with ASTM E 84 or UL 723 Flame spread index of foam insulation will not exceed 75 and a smoke- developed index of no more	Ensure durability Ensure worker safety Ensure proper installation Fire safety will be maintained		4237

	than 450 when tested in the maximum thickness intended for use in accordance with ASTM E 84 or UL 723 Foam insulation will be separated from the interior of the building by an approved thermal barrier at minimum 1/2" gypsum or a material that is tested in accordance with the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275			
4.1303.3f Fire protection	Spray foam will be separated from the occupied space of the building with a 15-minute thermal barrier (typically 15/32" sheathing, 1/2" gypsum board, or approved thermal barrier coating) or as approved by ASTM E84 requirements Spray foam designed to be used as a fire block does not require a thermal barrier installed prior to application	Provide necessary fire protection for combustible spray foam insulation		4238
4.1303.3g Occupant education	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		4239

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

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

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		4240
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		4241
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		4242

4.1402.3 Basement Wall Insulation—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

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1402.3a Drainage	A continuous drainage plane at the interior surface of the exterior basement wall will be created from the top of the wall to a drainage field at the bottom of the wall or sub-slab Drainage field will be run to daylight or pumped to the outside	Remove moisture on the surface of the exterior basement wall		4243
4.1402.3b Rough finish walls (e.g., rubble walls)	Drainage plane will be replaced with a waterproof membrane Only a nonabsorbent insulation that complies with ASTM C665-06 will be applied Insulation will adhere to the waterproof membrane without voids Drainage field will be run to daylight or pumped to the outside	Create an air and moisture barrier on the interior side of the exterior basement wall and allow the insulation to conform to the irregularity of the surface Improve thermal performance of the basement and the living space		4244

4.1402.3c Thermal barrier, insulation	A nonabsorbent insulation will be used with a minimum expected service life of 10 years A fire-rated material will be used if the insulation is left exposed	Improve thermal performance of the basement and the living space		4245
4.1402.3d Location	Insulation will be installed continuously from the top of the band joist to the top of the slab	Maintain a continuous thermal boundary on the interior side of the exterior basement wall		4246
4.1402.3e Termite protection	Where termite pressure exists, if subslab drainage is installed, termite treatment will be performed before reinstalling the slab	Provide termite protection		4247
4.1402.3f Insulation attachment	Insulation will be attached with a durable connection equal to or better than the manufacturer specifications, whichever is more durable A minimum expected service life of 10 years will be ensured	Secure thermal boundary without compromising the insulation		4248
4.1402.3g R-value	Regional IECC will be followed for required R-value	Improve thermal performance of the basement and living space		4249
4.1402.3h Sealing	A continuous air barrier on the warm side of the thermal boundary will be installed, including floor-to-wall and wall-to-ceiling connections	Prevent convective air leakage from the basement, through the drainage plane, and back into the basement		4250
4.1402.3i Finish wall requirements	International Residential Code (IRC) will be followed for finished wall details in basements	Install a durable, finished wall		4251
4.1402.3j 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		6821

4.1488.1 Climate Considerations for Insulating Water Lines Located Between Bottom Board and Ground

Topic: Basements and Crawl Spaces

Subtopic: Special Considerations

Desired Outcome: Water supply line does not freeze in cold climates

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1488.1a Work assessment	Installer prework assessment will be conducted to determine: • Water leaks do not exist • Accessibility Water leaks will be repaired before installation	Verify scope of work Ensure that work space is safe and ready for work		4252
4.1488.1b Installation	Pipe freeze protection system will have thermostatic heat control and circuit protection Insulation will be installed over pipe freeze protection system when necessary Pipe will be protected from wind	Ensure fire safety Protect supply pipe from freezing		4253
4.1488.1c Occupant education	Occupants will be educated on efficient and safe operation and maintenance of heat tape	Ensure safe and durable protection of water line		4254

4.1601.3 Insulation and Vapor Barrier

Topic: Ducts

Subtopic: Insulating Ducts

For supporting material, see Building America Solution Center.

Desired Outcome: Minimize condensation

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1601.3a Ducts in unconditioned spaces (e.g., crawl space, attic, unconditioned basements)	Ducts will have continuous insulation and vapor barrier Insulation will be sufficient to prevent dew point on surface of ducts	Minimize condensation		4255

4.1601.3b Ducts within floor assemblies	Inspection and/or testing will be conducted to determine whether ducts are within thermal, pressure, and vapor boundary If ducts are within thermal, pressure, and vapor boundary, no action will be required If ducts are not within thermal, pressure, and vapor boundary, continuous air barrier, insulation, and vapor retarder will be installed either on the ducts or at the belly liner	Minimize condensation		4256
4.1601.3c Exposed metal	All exposed metal will have continuous insulation and vapor retarder	Minimize condensation		4257

4.1601.4 Insulating Flex Ducts

Topic: Ducts

Subtopic: Insulating Ducts

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1601.4a Removal of existing flexible ducting	All accessible low R-value flexible ducting will be removed from premises	Ensure installation of proper R-value ducts		4258
4.1601.4b Selection of new flexible ducting	All flexible ducting will have a minimum of R-8	Minimize thermal conductance through the duct system		4259
4.1601.4c Sizing of new flex	Duct-sizing procedures will be conducted when replacing flex duct	Improve comfort in rooms Improve fan performance		4260
4.1601.4d Installation of flex	Flex duct will be supported in accordance with flex duct manufacturer's directions or local codes	Prevent sags, drops, or other bends that may interfere with correct air flow		4261

	Beaded rigid elbow or equivalent will be installed in duct runs whenever change in direction is required	Maintain duct diameter around the turns Maximize air flow and distribution		
4.1601.4e Interior liner attachment	Interior liner of the flex-to-metal connection will be fastened with tie bands using a tie band tensioning tool For oval flexible duct-to-metal connections, tie bands cannot be used; appropriate mechanical fasteners will be used	Create a strong, secure attachment		4262
4.1601.4f Sealing of interior liner	UL 181 B-M-listed mastic product will be used to seal the connection	Create an airtight connection		4263
4.1601.4g Attachment of exterior liner	Liner will be pulled up onto the metal duct as far as possible before securing The exterior liner of the flex duct will be fastened with tie bands using a tie band tensioning tool	Create a strong, durable attachment		4264
4.1601.4h Sealing of all accessible ducts	All accessible joints, seams, and connections will be sealed with UL 181 approved mastics	Minimize duct leakage		4265
4.1601.4i Insulation of all fittings	All metal fittings, including boots, elbows, and takeoffs, will be insulated separately using a minimum of R-8 duct wrap with a vapor barrier mechanically fastened (e.g., stitch staples, tie bands) and sealed with no exposed metal	Minimize thermal conductance of the duct system Minimize condensation		4266
4.1601.4j Completeness of vapor barrier	Vapor barrier of all duct insulation will be taped to the flex duct using the taping system required by the manufacturer of the duct insulation Vapor barrier will be sealed to the belly liner	Ensure a complete vapor barrier		4267

4.1601.4k Vermin proofing	Vermin access points will be identified and treated appropriately (e.g., seal access holes)	Ensure long-term durability of the building materials		4268
4.1601.4l CAZ testing	CAZ testing will be performed where combustion appliances are utilized	Identify unsafe equipment operating conditions		4269

4.1601.5 Insulating Metal Ducts

Topic: Ducts

Subtopic: Insulating Ducts

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
4.1601.5a Selection of duct insulation material	Duct insulation will be a minimum of R-8, in accordance with local code or buried under attic insulation, whichever is a greater R-value, and have an attached and continuous vapor barrier Hot humid and warm coastal regions will not bury ducts	Decrease heat loss and condensation problems		4270
4.1601.5b Duct sealing	All accessible ducts will be sealed with a UL-181 mastic before insulation is applied	Minimize duct leakage		4271
4.1601.5c Attachment of duct insulation	Duct insulation will be mechanically fastened (e.g., stitch staples, tie bands) and sealed with no exposed metal Duct insulation will be secured to the duct system using metal wire or rot-proof nylon twine Pattern of the wire or twine will be sufficient to securely hold the duct insulation tight to the duct Mechanical fastening will be sufficient to securely hold the duct insulation in place and tight to the duct	Ensure a secure connection between the duct system and the duct insulation Ensure performance of the installed material Minimize condensation		4272

4.1601.5d Taping of the vapor barrier	Using a tape approved by the manufacturer, all seams and connection of the vapor barrier will be taped so that no metal is exposed No gaps will exist between pieces of duct insulation	Prevent gaps in the vapor barrier of the insulation		4273
4.1601.5e Vermin proofing	Vermin access points will be identified and treated appropriately (e.g., seal access holes)	Ensure long-term durability of the building materials		4274

Section 5: Heating and Cooling

5.3001.1 Load Calculation and Equipment Selection

Topic: Forced Air

Subtopic: Design

Desired Outcome: Equipment sized properly and operates efficiently

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3001.1a Load calculation	Load calculation will be performed in accordance with ANSI/ACCA 2 Manual J (Residential Load Calculation) and manufacturer specifications	Properly size equipment for load		2222
5.3001.1b Equipment selection	Equipment selection will be performed in accordance with ANSI/ACCA Manual S and manufacturer specifications	Ensure equipment is able to heat, cool, and dehumidify the house		2223
5.3001.1c Air filtration	New central forced air HVAC systems will have minimum MERV 6 filtration with no air bypass around the filters	Particle removal to protect equipment and help maintain indoor air quality		2224

5.3001.3 Replace Return Air Systems that Incorporate Floor Cavity (Belly) and/or Attic as the Return Air Pathway

Topic: Forced Air

Subtopic: Design

For supporting material, see Building America Solution Center.

Desired Outcome: Effective, efficient, safe, and durable return air system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3001.3a Close return air openings	Existing return air openings will be closed off and sealed with a durable material equivalent in strength to the surrounding material Disturbed materials suspected to contain asbestos or lead content will be assessed and removed in accordance with EPA regulations	Minimize air leakage Improve indoor environmental quality Ensure safe and legal renovation		3473
5.3001.3b Alternate return air system	Alternate return air opening will be provided to the furnace closet (e.g., replace louvered door or install grilles); whenever possible, follow manufacturer specifications for amount needed Return duct design will be in accordance with ANSI/ACCA 1 Manual D Residential Duct Systems A continuous and adequate return air pathway to the air handler will be installed	Ensure sufficient return air is provided to the system		3474
5.3001.3c Zone pressure test	Pressures will be measured with the furnace fan operating across interior doors that can be closed and have a supply and/or return behind them Rooms should not exceed 3 pascals of pressure Pressure testing will be performed with all interior doors closed and the air handler running	Ensure sufficient return air is provided to the system Minimize moisture intrusion from negative pressures Improve indoor air quality		3475
5.3001.3d Combustion Appliance Zone (CAZ) testing	CAZ testing will be performed where combustion appliances are utilized	Identify unsafe equipment operating conditions		3476

5.3001.3e Occupant education	Occupant will be educated on changes, how to operate and maintain the system, and any potential health concerns (e.g., lead, asbestos)	Ensure occupant is educated		3477

5.3003.1 Data Plate Verification

Topic: Forced Air

Subtopic: System Assessment and Maintenance

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.1a Data plate verification	Equipment will be visually inspected Information will be recorded from the equipment data plates indoors and outdoors where available	Ensure technician has equipment data necessary for commissioning and future service work		2233

5.3003.11 Heating and Cooling Controls

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Heating and cooling controls installed and set properly

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.11a Removal of mercury-based thermostats	Mercury-based thermostat will be removed safely and disposed of in accordance with EPA regulations	Protect workers and occupants from injury Protect environment from damage		3924
5.3003.11b Removal of existing controls	Existing controls will be removed in accordance with EPA lead safe work rules	Protect workers and occupants from injury Protect environment from damage		3925
5.3003.11c Penetrations	Penetrations for control wiring will be sealed with a durable sealant (e.g., caulk, silicone, foam) at both the interior (e.g., floor, sheetrock) and exterior air barriers (e.g., bottom liner, side walls)	Ensure controls operate as designed Minimize infiltration and exfiltration from house		3926

5.3003.11d Thermostat location	Thermostats will be installed to reflect the temperature of the zone in which they are installed Mounting location for air leakage and conductance that would affect the thermostat operation (e.g., marriage walls, exterior walls) will be accessed Thermostats will not be exposed to extreme temperatures, radiant heat sources, and drafts	Ensure controls operate as designed		3927
5.3003.11e Blower speed	Blower speed will be set for equipment in accordance with manufacturer specifications	Ensure equipment has correct air flow		3929
5.3003.11f Thermostat selection: heat pump	A thermostat with supplementary heat lockout that can interface with an outdoor temperature sensor will be selected	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load		3931
5.3003.11g Heat pump: supplementary heat	Supplementary heat lockout on air-to-air heat pumps will be set to the economical balance point ANSI/ACCA 3 Manual S Residential Equipment Selection will be referenced for set points when using different types of heat pumps	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load		3933
5.3003.11h Heat pump: low ambient compressor lockout	For air-to-air heat pumps, low ambient compressor lockout will be set to 0°F outdoor temperature or ambient compressor lockout will be disabled ANSI/ACCA 3 Manual S Residential Equipment Selection will be referenced for low ambient compressor lockout when using different types of heat pumps	Ensure supplementary heater operation is prevented when the heat pump is capable of meeting the load		3935
5.3003.11i Heat pump: outside temperature sensor	An outdoor temperature sensor will be installed in accordance with manufacturer specifications	Ensure equipment operates as designed		3937

5.3003.11j Heat pump: supplementary heat wiring	Supplementary heat will be wired onto second stage heating terminal in accordance with manufacturer specifications	Do not operate supplementary heat in stage one heating		3939
5.3003.11k Thermostat: installer programming	The installer options will be set to match the thermostat to the equipment and control board settings	Ensure equipment operates as designed		3941
5.3003.11l Time delay settings	Time delay for equipment will be set in accordance with manufacturer specifications and as appropriate for the climate zone (e.g., no time delay for hot humid climates)	Maximize transfer of heat without adversely affecting indoor humidity levels		3943
5.3003.11m Humidistat: location	Humidistat will be installed to reflect humidity of the zone in which it is installed Humidistat will be installed in a dry location	Ensure controls operate as designed		3944
5.3003.11n Ventilation control	Ventilation controls will be connected to operational control system, as originally designed in the factory Powered ventilation system alarm will be set to "on;" controls will be reset to factory settings	Ensure proper operation of the mechanically dampered and powered ventilation systems		3945
5.3003.11o Occupant education	Occupants will be educated on proper use of thermostat, including: • Proper use of setbacks for air conditioners and heat pumps • Allowing occupant comfort to determine setback for combustion heating appliances • Using emergency heat appropriately • Educate property manager/occupant about fan on/auto or vent/auto operations	Ensure equipment and controls operate as designed Provide comfort throughout house Ensure property manager/occupant knows how to operate the system Minimize moisture problems		3947

	• Educate the property manager/occupant about ventilation, as it applies to controls • Instruct the property manager/occupant to never leave the fan set to "on" or "vent" in humid climates • Educate property manager/occupant about possible moisture problems when thermostat is set low for extended periods of time during the summer			

5.3003.12 Package Units—Repair and Service

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Maximize efficiency and performance of existing system, when required by the authority having jurisdiction

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.12a Work assessment	Assessment will be performed to identify problems with air, refrigerant, electrical, load, safety, indoor environmental quality (IEQ), and/or other needed repairs If new installation or replacement is necessary, ACCA Manual J, Manual S, and/or Manual D will be referenced to determine if the existing duct system is adequate for the sizing of the furnace, and the procedures outlined in ANSI/ACCA 5 QI HVAC Quality Installation Specification will be followed	Determine the scope of repair, service, and level of expertise required to perform the work		3950
5.3003.12b Remove existing system components	Nonsalvageable components and waste will be removed and disposed of properly	Prepare for installation of new equipment or components Ensure environmental and legal compliance		3952

	Refrigerant will be removed in accordance with EPA requirements			
5.3003.12c Repairs	Repairs will be performed by qualified specialist as identified in the assessment Maintenance will be done in accordance with ANSI/ACCA 4 Maintenance of Residential HVAC Systems and ANSI/ACCA 6 HVAC System Cleanliness	Optimize performance of the system		3953
5.3003.12d Service existing components	Service will be performed by qualified personnel as identified in the assessment Maintenance will be done in accordance with ANSI/ACCA 4 Maintenance of Residential HVAC Systems and ANSI/ACCA 6 HVAC System Cleanliness	Optimize performance of the system		3954
5.3003.12e Commissioning	Equipment will be fully tested for proper operation following procedures outlined in ANSI/ACCA 5 QI Property manager/occupant will be educated on how to operate and maintain system, including thermostat operation and system changes	Ensure proper system operation Ensure property manager/occupant is educated		3955

5.3003.13 Refrigerant Charge Evaluation

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Properly charged system

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.13a Prerequisite	Leak detection, air flow, and refrigerant line inspection will be checked and repaired to determine need for refrigerant charge	Eliminate possible sources of other problems before addressing refrigerant charging		3958

5.3003.13b Qualified contractor	Charge will be tested and work performed by a qualified contractor Refrigerant charge will be in accordance with ANSI/ACCA 5 QI HVAC Quality Installation Specification refrigerant charging requirements for mixed humid, hot humid, marine, and hot dry climates	Ensure compliance with codes and environmental regulations Ensure proper equipment charge		3959
5.3003.13c Documentation	Contractor will provide documentation of work performed	Maintain record of work performed		3960
5.3003.13d Quality assurance	External static pressure will be measured and documented EPA refrigerant charge log will be provided	Ensure external static pressure is within range in accordance with manufacturer specifications Ensure quality workmanship		3961

5.3003.14 Combustion Analysis of Gas-Fired Appliances (LP and Natural Gas)

Topic: Forced Air

Subtopic: System Assessment and Maintenance

For supporting material, see Building America Solution Center.

Desired Outcome: Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.14a Gas Pressure	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		3967
5.3003.14b 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		3970

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		3971
5.3003.14d 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		3972
5.3003.14e 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		6957

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.15a Oil system: smoke test	Smoke test will be conducted before any combustion testing is completed Smoke spot reading will be in accordance with burner manufacturer specifications	Ensure equipment: • Operates as designed • Operates safely • Operates efficiently • Is durable		2951
5.3003.15c Oil filter	Filter will be present, clean, and leak free	Ensure equipment: • Operates as designed		2953

		• 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		2954
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		2955
5.3003.15f Net stack temperature	Net stack temperature will be measured and verified in accordance with manufacturer specifications	Ensure equipment: • Operates as designed • Operates safely • Operates efficiently • Is durable		2956
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		2957
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		2958
5.3003.15i CO in flue gas	CO in the undiluted flue gas will be less than 400 ppm air-free	Ensure equipment:		2959

		• Operates as designed • Operates safely • Operates efficiently • Is durable		
5.3003.15j Testing/inspection holes	All testing and inspection holes will be sealed as approved by the authority having jurisdiction	Ensure equipment: • Operates as designed • Operates safely • Operates efficiently • Is durable		2960

5.3003.16 Evaluating Electrical Service

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Electrical components properly tested

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.16a Service entrance	Homes will have a four-wire service entrance to the panel box to ensure a wiring system that is nominally rated at 120/240 volts and allows for proper grounding Grounding at the service entrance will be checked to determine proper grounding of the home	Ensure occupant and worker safety		2961
5.3003.16b Polarity	Polarity of equipment will be verified by a qualified technician if wiring is to be modified or repaired	Ensure equipment: • Operates as designed • Operates safely		2962
5.3003.16c Voltage: incoming power	Voltage will be in accordance with manufacturer specifications	Ensure equipment operates as designed		2963
5.3003.16d Voltage: contactor	Voltage drop will be within acceptable range in accordance with manufacturer specifications	Ensure contactor does not overheat Ensure equipment operates as designed		2964

5.3003.16e Grounding	Grounding will be connected in compliance with local code requirements, ANSI/NEMA GR 1-2007, and NFPA 70 National Electric Code Frames of home sections will be bonded with copper wire Bonding lug will be selected to prevent corrosion due to dissimilar metals	Ensure equipment: • Operates as designed • Operates safely Ensure ground continuity among sections		2965
5.3003.16f Blower amperage	Amperage will not exceed manufacturer full load amperage	Ensure equipment: • Operates as designed • Operates efficiently • Operates safely		2966
5.3003.16g Compressor amperage	Amperage will not exceed manufacturer full load amperage	Ensure equipment: • Operates as designed • Operates efficiently • Operates safely		2967
5.3003.16h Door switch operation	Blower compartment safety switch operation will be verified, if present	Ensure blower: • Does not operate during service • Cannot backdraft a flue when the door is off		2968
5.3003.16i Heat pump: emergency heat	Emergency heat circuit functions will be verified	Ensure system delivers heat in case of compressor failure		2969

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 detailIf new installation or replacement is necessary, ANSI / ACCA 5 QI HVAC Quality Installation Specification will be followed

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

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	2234
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	2235
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	2236
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	2237
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 If smoke test is more than actionable levels, specify a clean and tune	Determine whether equipment is operating within acceptable range according to smoke test and call for action if needed	2238
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	2239
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	2240

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		2241
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		6969
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		6970
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		6971

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.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.3a Total air flow	Total system air flow will be measured by one of the following methods: • Temperature rise • Flow plate • Fan depressurization device(e.g., Duct Blaster®, DucTester®)	Ensure equipment: • Operates as designed • Operates efficiently • Provides comfort • Operates safely • Is durable		3879

5.3003.3b External static pressure	External static pressure will be in accordance with manufacturer specifications	Ensure equipment: • Operates as designed • Operates efficiently • Provides comfort • Operates safely • Is durable		3880
5.3003.3c Pressure	Pressure drop across cooling coils will be in accordance with manufacturer specifications	Ensure equipment: • Operates as designed • Operates efficiently • Provides comfort • Operates safely • Is durable		3881
5.3003.3d Filter Inspection	Visual inspection to verify filter type is per manufacturer specifications, and is clean	Ensure equipment: • Operates as designed • Operates efficiently • Provides comfort • Operates safely • Is durable		3882
5.3003.3e Balancing room flow: new ductwork	Proper air flow delivery to each room will be ensured by one of the following: Measuring air flow at each register OR Measuring heat rise, room pressures, and interviewing residents to ensure their comfort.	Ensure equipment: • Operates as designed • Operates efficiently • Provides comfort • Operates safely • Is durable		3883
5.3003.3f Supply wet bulb and dry bulb	Supply and return wet bulb (wet bulb temperature is measured for cooling systems only) and dry bulb air temperatures will be recorded	Ensure equipment: • Operates as designed • Operates efficiently • Provides comfort • Operates safely		3884

		• 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 • Operates efficiently • Provides comfort • Operates safely • Is durable		3886

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.

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.5a Insulation	All suction or vapor refrigerant lines, will be insulated to a minimum of R-4 High-side or liquid refrigerant lines will not be insulated unless specified by the equipment's manufacturer	Ensure refrigerant lines do not gain excessive heat, or cause condensation to occur inside the building envelope		2258
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, IRC or local code	Install insulation so it does not degrade		3888
5.3003.5c Sizing	Refrigerant lines will be sized to meet manufacturer specifications for the installed equipment	Ensure system moves appropriate volume of refrigerant		3890
5.3003.5d Installation quality	Refrigerant lines will be installed without kinks, crimps, or excessive bends	Ensure system moves appropriate volume of refrigerant		3892

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		3894

5.3003.6 Evaluating Sequence of Operation

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Sequence of operation of the system verified

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.6a Verification	The sequence of operation of the system will be verified in accordance with the manufacturer installation, operation, and maintenance manual. If every effort to secure the manufacturer's manual proves unsuccessful, the technician will rely on standard industry testing protocols.	Ensure system components function and operate in the correct sequence		2263

5.3003.7 Occupant Education

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Occupants understand their role and responsibility in the safe, effective, and efficient operation of the equipment

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.7a Basic operation	Basic operation of the equipment will be explained to the occupant (e.g., design conditions, efficiency measures, differences from previous system or situation)	Ensure occupant has a reasonable expectation of the equipment's capability		3907
5.3003.7b System controls (e.g.,	Proper operation and programming of system controls to achieve	Ensure occupant can operate system controls		3908

thermostat, humidistat)	temperature and humidity control will be explained to the occupant			
5.3003.7c System disconnects	Indoor and outdoor electrical disconnects and fuel shut-offs will be demonstrated to occupant	Ensure occupant can shut off equipment in emergencies		3909
5.3003.7d Combustion air inlets	Location of combustion air inlets will be identified for occupant in accordance with NFPA 31, 54, and 58 Importance of not blocking inlets will be explained to occupant	Ensure occupant does not block combustion air inlets		3910
5.3003.7e Blocking air flow	Importance of cleaning dust and debris from return grilles will be explained to occupant Proper placement of interior furnishings with respect to registers will be explained to occupant Negative consequences of closing registers will be explained to occupant Importance of leaving interior doors open as much as possible will be explained to occupant	Ensure occupant does not prevent equipment from operating as designed		3911
5.3003.7f Routine maintenance	Proper filter selection and how to change the filter will be explained to occupant Importance of keeping outside unit clear of debris, vegetation, decks, and other blockage will be explained to occupant Importance and timing of routine professional maintenance will be explained to occupant	Ensure equipment operates as designed		3913
5.3003.7g Calling heating, ventilation, and air conditioning (HVAC) contractor	Situations when the occupant should contact the HVAC contractor will be explained, including: • Fuel odors • Water draining from secondary drain line	Notify occupant to contact installer when system is not operating as designed		3915

	• Emergency heat indicator always on for a heat pump system • System blowing cold air during heating season and vice versa • Icing of the evaporator coil during cooling mode • Outside unit never defrosts • Unusual noises • Unusual odors			
5.3003.7h Carbon monoxide (CO)	A carbon monoxide (CO) alarm will be installed	Occupant will be made aware of operation of CO alarm		3917
5.3003.7i Warranty and service	Occupant will be provided with relevant manuals and warranties The labor warranty will be explained and the occupant will be given a phone number to call for warranty service	Provide manuals and warranties for future servicing		3919

5.3003.8 Evaporative Cooler Maintenance and Repairs

Topic: Forced Air

Subtopic: System Assessment and Maintenance

Desired Outcome: Evaporative cooler evaluated and maintained as needed

For supporting material, see Referenced Standards and Calculation of the Infiltration Credit.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3003.8a Assessment and diagnosis	The following system elements will be assessed: • Pump • Pan • Spider • Float	Ensure all components function properly		3921

	• Damper • Roof jack support • Water line • Water valve • Electrical • Pads • Motor • Fan Elements will be repaired or replaced as needed in accordance with manufacturer instructions			
5.3003.8b Repair and maintenance	Calcium deposits will be removed Pads will be replaced Any additional repairs or replacements will be made as necessary in accordance with manufacturer's instructions	Protect the potable water supply from cross-contamination Ensure evaporative cooler functions properly		3922
5.3003.8c Occupant education	A regular service schedule will be recommended to occupant Issues regarding multiple systems running will be discussed with occupant	Ensure the occupant understands basic operation and the importance of regular maintenance		3923

5.3201.1 Indigenous Shading

Topic: Shading

Subtopic: Landscaping

Desired Outcome: Heat gain and loss reduced through use of indigenous plants

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3201.1a Plant selection	All plants intended for shading will be indigenous and drought resistant	Ensure plantings survive in local conditions using a minimum amount of water		2970
5.3201.1b Plant size	No plant will be chosen that will grow to a height that would cause damage to	Reduce possibility of damage to the house		2971

	the home if it or any part of it fell on the home			

5.3202.1 Reflective Coatings on Metal Roofs

Topic: Shading

Subtopic: Reflective Roofs

Desired Outcome: Reduce solar heat gain for manufactured homes

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
5.3202.1a Assessment	Existing roof coating will be assessed for hazardous material	Ensure worker and occupant safety		2972
5.3202.1b Preparation	Roof will be stripped of all debris, algae, and peeled and loose coating Repairs to roof and penetrations will be made before application	Ensure roof is clean, dry, and structurally sound for proper adhesion of new coating		2973
5.3202.1c Materials selection	Material will be approved for application to metal and existing roof coating Material will be an ENERGY STAR qualified reflective coating Roof coating will be durable, flexible, reflective, and meet ASTM D412, ASTM D1737, and UL 790 Class A	Provide proper reflective coating		2974
5.3202.1d Application	Roof-coating material will be applied in accordance with manufacturer specifications	Ensure proper application		2975
5.3202.1e Occupant education	Occupant will be educated on the maintenance of reflective coating per manufacturer specifications, including annual inspection and cleaning	Preserve integrity and effectiveness of reflective coating		2976

Section 6: Ventilation

6.6002.3 Exhaust-Only Ventilation—Fan Intake Grille Location

Topic: Exhaust

Subtopic: Components

Desired Outcome: Exhaust grille location optimizes either primary or local ventilation

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
6.6002.3a Primary whole house ventilation	Fan intake grille will be installed in a central location within the main body of the house Ensure it is accessible for filter change and cleaning	Provide whole house air exchange	2977
6.6002.3b Local ventilation	Fan intake grille will be installed in the space where odor, moisture vapor, or other contaminants are generated	Remove contaminated air at the source	2978

6.6002.4 Ducts (Exhaust Fans)

Topic: Exhaust

Subtopic: Components

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	
6.6002.4a Duct design and configuration	Consideration will be given to: • Vent termination location • Amount of space for duct run • Roof condition, type, and access (e.g., metal, shingle, bow string, flat) • Duct insulation When applicable, pitch duct to remove condensation to outdoors Ducts will be as straight as possible, fully extended, and have the shortest run possible Turns will be made so the radius at the centerline is no less than one duct diameter Duct diameter will be equal to or greater than the exhaust fan outlet	Effectively move the required volume of air	2979

	Fan flow will be verified by flow measurement to meet ASHRAE Standard 62.2			
6.6002.4b Duct insulation	Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or in accordance with local codes	Prevent condensation from forming or collecting inside or outside of the ductwork		2980
6.6002.4c Duct support	Horizontal runs will be supported in accordance with flex duct manufacturer specifications and local codes Supports with a width of at least 1 ½" will be used or adequate metal support	Effectively move the required volume of air Preserve the integrity of the duct system		2981
6.6002.4d Duct connections	Metal-to-metal or metal-to-PVC connections will be fastened with a minimum of three equally spaced screws Flexible duct-to-metal or flexible duct-to-PVC connections will be fastened with tie bands using a tie band tensioning tool PVC-to-PVC connections will be fastened with approved PVC cement Other specialized duct fittings will be fastened in accordance with manufacturer specifications In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Effectively move the required volume of air Preserve the integrity of the duct system		2982
6.6002.4e Duct materials	Flexible materials will be UL 181 listed or Air Diffusion Council approved Rigid, smooth metal of 30-gauge wall thickness or thicker will be used PVC material may be used	Effectively move the required volume of air Preserve the integrity of the duct system		2983
6.6002.4f Total	Total exhaust system ventilation airflow will be measured	Ensure air flow is as designed		2984

exhaust airflow				

6.6003.1 Surface-Mounted Ducted

Topic: Exhaust

Subtopic: Fans

Desired Outcome: Surface-mounted ducted fans installed to specification

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

For supporting material, see Referenced Standards, Calculation of the Infiltration Credit and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6003.1a Hole through interior surface	A hole no greater than a 1/4" greater than the assembly will be cut to accommodate fan assembly	Minimize repair work Ensure a secure installation		2985
6.6003.1b Wiring	Wiring will be installed by a properly licensed contractor, as required by the authority having jurisdiction Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard		2986
6.6003.1c Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications	Ensure short duct run to achieve optimum air flow Ensure a secure installation Ensure fan housing does not shake, rattle, or hum when operating		2987
6.6003.1d Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off		2988

6.6003.1e Duct-to-fan connection	Duct-to-fan outlet will be connected and sealed as follows: • Round metal-to-metal or metal-to-PVC connections will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • Flexible duct-to-metal or flexible duct-to-PVC connections will be fastened with tie bands using a tie band tensioning tool • PVC-to-PVC connections will be fastened with approved PVC cement • Other specialized duct fittings will be fastened according to manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Exhaust to outside		2989
6.6003.1f Fan housing seal	Gaps and holes in fan housing will be sealed with caulk or other sealants in accordance with manufacturer recommendations Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage through fan housing Ensure a permanent seal Prevent a fire hazard		2990
6.6003.1g Fan to	Sealants will be compatible with their intended surfaces	Prevent air leakage between house and fan		2991

interior surface seal	Sealants will be continuous and meet fire barrier specifications			
6.6003.1h Air flow	Air flows in cubic feet per minute (CFM) will be measured and adjusted to meet the whole house upgrade design requirements	Exhaust sufficient air from desired locations to outside		2992
6.6003.1i Preventing air leakage caused by exhaust fans	Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety		2993
6.6003.1j Combustion safety	Pressure effects will be assessed and corrected on all combustion appliances	Ensure safe operation of combustion appliances		2994

6.6003.2 Inline

Topic: Exhaust

Subtopic: Fans

Desired Outcome: Inline fans installed to specification

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

For supporting material, see Referenced Standards and Calculation of the Infiltration Credit.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6003.2a Wiring	Wiring will be installed by a properly licensed contractor, as required by the authority having jurisdiction Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard		2995
6.6003.2b Access	Fan and service switch will be accessible for maintenance according to NFPA 70 National Electric Code or local authority having jurisdiction	Fan and service switch will be accessible for maintenance		2996

6.6003.2c Fan mounting	Fan outlet will be oriented toward the final termination location Fan will be oriented so the equivalent length of the duct run is as short as possible Fan will be mounted securely in accordance with manufacturer specifications Fan will be isolated from the building framing unless specifically designed to be directly attached Fan will be installed remotely by installing ducting from intake grille	Ensure short duct run to achieve optimum air flow Ensure fan is installed securely Ensure fan housing or building framing does not shake, rattle, or hum when operating Minimize noise		2997
6.6003.2d Backdraft damper	A backdraft damper will be installed between the outlet side of the fan and the exterior	Prevent reverse air flow when the fan is off		2998
6.6003.2e Duct connections	Ducts will be connected and sealed to the intake fan and termination fitting as follows: • Round metal-to-metal or metal-to-PVC connections will be fastened with a minimum of three equally spaced screws • Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems or tapes • Flexible duct-to-metal or flexible duct-to-PVC connections will be fastened with tie bands using a tie band tensioning tool • PVC-to-PVC connections will be fastened with approved PVC cement	Exhaust from desired location to outside Preserve integrity of the duct system and building envelope		2999

	• Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material			
6.6003.2f Boot to interior surface seal	Sealants will be compatible with their intended surfaces Sealants will be continuous and meet fire barrier specifications	Prevent air leakage around intake housing Prevent a fire hazard		3000
6.6003.2g Air flow	Air flows in CFM will be measured and adjusted to meet the design requirements	Exhaust sufficient air from desired locations to outside		3001
6.6003.2h Preventing air leakage caused by exhaust fans	Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)	Ensure occupant health and safety		3002
6.6003.2i Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief	Ensure safe operation of combustion appliances		3003

6.6003.5 Garage Exhaust Fan

Topic: Exhaust

Subtopic: Fans

Desired Outcome: Contaminants properly removed from house

For supporting material, see Referenced Standards and Calculation of the Infiltration Credit.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)	

6.6003.5a System selection	Ventilation for garage will be exhaust only and provide a minimum installed capacity of 100 CFM of ventilation per vehicle bay and will vent directly outdoors Garage exhaust fan will be wired for continuous operation or installed with automatic controls that activate the fan whenever the garage is occupied and for at least 15 minutes after the garage has been vacated If a ducted fan (not through-the-wall) is used, measure and verify the minimum air flow and adjust as necessary	Remove contaminants from garage Reduce contaminant migration from garage to house Ensure occupant health and safety		3004
6.6003.5b Air leakage	Air leakage between the house and garages will be prevented by sealing and weatherstripping	Ensure occupant health and safety Reduce conditioned air being drawn from the house Reduce contaminant migration from garage to house		3005
6.6003.5c Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards Exhaust fans and other exhausting systems shall be provided with makeup air or other pressure relief	Ensure safe operation of combustion appliances Ensure occupant health and safety		3006

6.6003.6 Fan Placement (Whole House/Common Space Exhaust Only)

Topic: Exhaust

Subtopic: Fans

Desired Outcome: Provide primary ventilation for common spaces

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6003.6a Clearance	Clearance for size of the fan recommended will be determined	Ensure access for installation, operation, and maintenance Ensure occupant safety		3007

	Consideration will be given for adequate head clearance			
6.6003.6b Power source	Power source load will be determined as adequate Consideration will be given to power source location	Provide accessible and adequate power source		3008
6.6003.6c Location	No resistance greater than 3 pascals will exist between fan intake location with reference to the common area	Allow fresh air distribution to common areas		3009
6.6003.6d Duct/vent	Consideration will be given to: • Vent termination location • Amount of space for duct run • Roof condition and type (e.g., metal, shingle, bow string, flat) • Duct insulation When applicable, pitch duct to remove condensation to outdoors Ducts will be as straight as possible, fully extended, and have the shortest run possible To the extent possible, turns will be made so that the radius at the centerline is no less than one duct diameter Duct diameter will be equal to or greater than the exhaust fan outlet Fan flow will be verified by flow measurement to meet ASHRAE standard 62.2	Effectively move the required volume of air		3010
6.6003.6e Attachment	Fan will be secured to a structural component Structural integrity of the manufactured home will be maintained (e.g., roof trusses, walls, floor joists)	Maintain structural integrity Maintain fan attachment		3011

6.6003.6f Total exhaust airflow	Total exhaust system airflow will be measured	Ensure exhaust airflow is as designed		3012

6.6005.1 Clothes Dryer

Topic: Exhaust

Subtopic: Appliance Exhaust Vents

Desired Outcome: Dryer air exhausted efficiently and safely

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6005.1a Clothes dryer ducting	Clothes dryers will be ducted to the outdoors, which does not include unconditioned spaces, such as attics and crawl spaces that are ventilated with the outdoors As short a run as practical of rigid sheet metal or semi-rigid sheet metal venting material will be used in accordance with manufacturer specifications Dryer ducts exceeding 35' in duct equivalent length will have a dryer booster fan installed Plastic venting material will not be used Uninsulated clothes dryer duct will not pass through unconditioned spaces, such as attics and crawl spaces, except where allowed by the authority having jurisdiction Ducts will be connected and sealed as follows: • UL-listed foil type or semi-rigid sheet metal to rigid metal will be fastened with clamp	Preserve integrity of building envelope Effectively move air from clothes dryer to outside		3013

	• Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material In addition, • Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used • Condensing dryers will be plumbed to a drain			
6.6005.1b Termination fitting	Termination fitting manufactured for use with dryers will be installed A backdraft damper will be included, as described in termination fitting detail	Preserve integrity of building envelope Effectively move air from clothes dryer to outside		3014
6.6005.1c Makeup air	If natural draft combustion appliances are present and if worst-case *CAZ* and/or other performance based testing is conducted and indicates a need for make-up air, make-up air will be provided in accordance with the current version of *ASHRAE* 62.2 and in compliance with the authority having jurisdiction. If natural draft combustion appliances are present and if no performance based testing is conducted, make-up air will be provided prescriptively in accordance with the current version of *ASHRAE* 62.2 and in compliance with the authority having jurisdiction.	Preserve integrity of building envelope Effectively move air from clothes dryer to outside		3015
6.6005.1d Combustion safety	Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards	Ensure safe operation of combustion appliances Ensure occupant health and safety		3016

6.6005.1e Occupant education	Occupant will be instructed to keep lint filter and termination fitting clean Occupant will be instructed to keep dryer booster fan clean, if present Occupant will be instructed on clothes dryer operation safety, including information on items that must not be placed in the clothes dryer (items with any oil or other flammable liquid on it, foam, rubber, plastic or other heat-sensitive fabric, glass fiber materials)	Effectively move air from clothes dryer to outside		3017

6.6005.2 Kitchen Range

Topic: Exhaust

Subtopic: Appliance Exhaust Vents

Desired Outcome: Kitchen range fan installed to specification

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

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6005.2a Wiring	Wiring will be installed in accordance with local regulations or the IRC in the absence of such regulations or where those regulations are not as stringent as the IRC Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes Wiring will be installed by a licensed electrician	Prevent an electrical hazard		3018
6.6005.2b Fan venting	Kitchen range fans will be vented to the outdoors Recirculating fans will not be used as a ventilating device	Remove cooking contaminants from the house Preserve integrity of building envelope		3019

6.6005.2c Fan ducting	Kitchen range fans will be ducted to the outdoors As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications Ducting will be connected and sealed as follows: • Metal-to-metal connections will be fastened with a minimum of three equally spaced screws • Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes • For down-draft exhaust systems, PVC-to-PVC connections will be fastened with approved PVC cement • Other specialized duct fittings will be fastened in accordance with manufacturer specifications • In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material	Preserve integrity of building envelope Effectively move air from range to outside		3020
6.6005.2d Termination fitting	Termination fitting will be installed including a backdraft damper, as described in termination fitting detail	Ensure safe operation of combustion appliances Ensure occupant health and safety		3021
6.6005.2e Makeup air	Makeup air will be provided for kitchen range fans exhausting more than 200 CFM	Ensure safe operation of combustion appliances Ensure occupant health and safety		3022
6.6005.2f Combustion safety	Pressure effects caused by fans will be assessed and corrected when found	Ensure safe operation of combustion appliances Ensure occupant health and safety		3023

	outside of combustion safety standards			
6.6005.2g Occupant education	Occupant will be instructed to keep grease filters and termination fitting clean	Effectively move air from kitchen range to outdoors		3024

6.6102.4 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.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6102.4a Forced air system requirements	Existing forced air system leakage to the outside will be less than 10% of the air handler flow when measured at 25 pascals with reference to the outside Any portion of the return located inside the Combustion Appliance Zone will be air sealed	Reduce migration of pollutants		3025
6.6102.4b Wiring	Wiring will be installed by a properly licensed contractor, as required by the authority having jurisdiction Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes	Prevent an electrical hazard		3026
6.6102.4c Access	Motorized damper and service switch will be accessible for maintenance in accordance with required code or authority having jurisdiction	Ensure accessibility for maintenance		3027
6.6102.4d Mounting intake duct	Ventilation duct will be attached as close to the HVAC system's fan as possible while remaining in	Ensure short duct run to achieve optimum air flow		3028

	compliance with HVAC manufacturer specifications Filtration of ventilation air will be provided before reaching the thermal conditioning components Filtration will be accessible and serviceable Duct will be connected to intake fitting Connection and seal will be performed in accordance with supply duct detail	Preserve integrity of the duct system and building envelope		
6.6102.4e Motorized damper	A motorized damper or equivalent technology will be installed between the intake fitting and the return side of the air handler Air flow will be provided by sequenced operation of the damper or equivalent technology	Prevent air flow when none is desired		3029
6.6102.4f Intake filter	An accessible filter will be installed Filter will be able to remove contaminants consistent with at least minimum efficiency reporting value (MERV) 6 or better when tested in accordance with ANSI/ASHRAE 52.2 Filter or air cleaning systems that intentionally produce ozone will not be allowed	Ensure occupant health and safety Preserve integrity of the building envelope		3030
6.6102.4g Occupant education	Occupant will be educated on how and when to change filter	Ensure occupant health and safety Preserve integrity of the building envelope		3031
6.6102.4h Intake ventilation airflow	Total intake ventilation airflow will be measured	Ensure airflow is as designed		3032

6.6188.2 Removing Supply Vents from Garages

Topic: Supply

Subtopic: Special Considerations

Desired Outcome: Safe removal of garage supply vents

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6188.2a Removal of supply/return in garage	Supply run feeding the register will be truncated as near to the supply plenum as possible If directly connected to the plenum, the supply run will be truncated at the plenum If connected to a Y or T branch system, the supply run will be truncated at the Y or T Return grille located in garage will be removed in the same manner as supply	Minimize duct leakage		3033
6.6188.2b Patching of the hole in the duct system created by removal	All holes in sheet metal ducts will be patched with sheet metal and secured with sufficient screws to hold the patch flat without gaps Holes left in any Y or T will be capped with sheet metal caps and fastened with at least three screws	Ensure a secure and strong patch		3034
6.6188.2c Sealing of the patch	All patches will be sealed with mastic meeting UL 181 and in accordance with manufacturer specifications	Ensure an airtight patch		3035
6.6188.2d Removal of discarded ducts	All abandoned ductwork will be removed from work area	Provide a clean work site		3036
6.6188.2e Patching of the register hole in garage	Holes created by the removal of the register and boot will be patched and taped using material meeting local codes	Prevent a fire hazard		3037
6.6188.2f External static	Units will be tested for external static pressure (ESP) before and after work	Ensure correct fan performance		3038

pressure testing	If there is a significant rise in ESP, air flow testing will be required			
6.6188.2g CAZ testing	CAZ testing will be performed where combustion appliances are utilized	Identify possible conditions that can cause unsafe equipment operating conditions		3039

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

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		3040
6.6204.1b Equipment inspection	Visually inspect and document status of: • Electrical connections • Name plate (rated sone and flow) • Motor cleanliness	Evaluate equipment		3041
6.6204.1c Pathway inspection	Visually inspect and document status of ducting or other airflow pathways to ensure proper: • Conections (proper materials, sealed and connected) • Insulation • Support • Sizing, and	Preserve integrity of building envelope Effectively move air along selected pathways		3042

	• Termination locations and fittings Verify proper damper operation			
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		3043
6.6204.1e Work order	Develop work order as necessary to correct deficiencies identified during inspections and measurement	Correct deficiencies Ensure proper operation		6952
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		6953

6.6205.1 Manufactured Housing Exhaust-Only Strategies

Topic: Whole Building Ventilation

Subtopic: Exhaust-Only System

Desired Outcome: Provide primary ventilation for common spaces

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6205.1a Assessment	Assessment will be done using ASHRAE 62.2 standard: • Blower door test • Fan flow measurements • Calculations	Determine the ventilation needs of the whole house		3044
6.6205.1b Selection	Fan type will be capable of continuous operation and selected in accordance with ASHRAE 62.2 for: • Sizing • Climate considerations	Determine proper fan selection Minimize energy consumption during fan operation		3045

	• 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		3046
6.6205.1d Climate considerations	ASHRAE 62.2 will be referenced for climate considerations Whole house mechanical net exhaust flow for hot-humid climate will not exceed 7.5 cubic feet per minute/100 square feet	Maintain building durability Protect occupant health		3047
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		3048
6.6205.1f Occupant education	Occupant will be educated on: • Purpose of the ventilation system • 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	Ensure occupant is educated on the safe and efficient operation of the system Deliver intended air exchange		3049
6.6205.1g Total exhaust airflow	Total exhaust system airflow will be measured	Ensure exhaust airflow is as designed		3050

6.6206.1 Decommissioning Existing Exhaust or Supply Ventilation Systems

Topic: Whole Building Ventilation

Subtopic: Equipment Removal

Desired Outcome: Safely and properly eliminate fan

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6206.1a Power supply	Power supply will be disconnected and properly terminated in visible junction box	Safe removal of equipment Ensure worker safety		3051
6.6206.1b Removal	Fan components will be removed and disposed of lawfully Duct work will be removed if necessary OR Fan housing will be left in place, ducts will be removed, and leakage points will be air sealed Hole will be sealed and insulated to preserve the thermal and pressure boundary	Remove fan Preserve aesthetics, and thermal and pressure boundary		3052
6.6206.1c Repair	Fan opening will be sealed and insulated If necessary, the void from the duct work removal will be insulated Fan termination will be sealed	Maximize energy efficiency Preserve the thermal and pressure boundary		3053
6.6206.1d Combustion Appliance Zone (CAZ) testing	Combustion safety test will be performed where combustion appliances are utilized	Identify possible conditions that can cause unsafe equipment operating conditions		3054

6.6288.2 Sound Ratings—New Fan Installation

Topic: Whole Building Ventilation

Subtopic: Special Considerations

Desired Outcome: Systems operate as quietly as possible

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.6288.2a Primary ventilation system/continuously operating fan	System will be rated at a sound no greater than 1.0 sone	Minimize noise Maximize fan use		3055
6.6288.2b Intermittent spot ventilation system	Spot ventilation (local mechanical exhaust systems operated as needed by the occupant; e.g., range hood, bath fans) will be rated at a sound no greater than 3.0 sone	Minimize noise Maximize fan use		3056

6.9901.1 Supplemental Ventilation Information—ASHRAE 62.2

Topic: Additional Resources

Subtopic: Codes and Standards Resources

Desired Outcome: To provide supplemental ventilation information—ASHRAE 62.2

For supporting material, see Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
6.9901.1a Ventilation fan flow rate	ASHRAE Standard 62.2 and the calculation of the infiltration credit allow adjustments to primary ventilation fan flow rates for existing houses using a single fan.	To provide supplemental ventilation information--ASHRAE 62.2		4283

Section 7: Baseload

7.8001.1 Refrigerator and Freezer Replacement

Topic: Plug Load

Subtopic: Refrigerators/Freezers

Desired Outcome: A more energy efficient appliance installed

For supporting material, see Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)

7.8001.1a Selection	Appliance shall be ENERGY STAR® qualified or at least as energy efficient Appliance will fit in the available space without blocking access to light switches, cabinets, etc. Appliance will carry a minimum one-year warranty that will provide a replacement appliance if repeated issues relating to health, safety, or performance occur	Ensure occupant satisfaction with appliance		3057
7.8001.1b Installation	Appliance will be installed in accordance with manufacturer specifications and local codes Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Energy-related appliance controls will be demonstrated to the occupant Specific information on the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant	Achieve intended appliance function Preserve food at low energy use Educate occupant on how to operate and maintain the appliance		3058
7.8001.1c Decommissioning	Appliances replaced by new units will be recycled or disposed of in accordance with federal, state, or local regulations Appliances infested with pests will be enclosed before moving	Prevent reuse of inefficient equipment and components Protect the environment Protect worker safety		3059

7.8001.2 Cleaning and Tuning Existing Refrigerators and Freezers

Topic: Plug Load

Subtopic: Refrigerators/Freezers

Desired Outcome: Energy used for food preservation reduced

For supporting material, see Referenced Standards and Calculation of the Infiltration Credit.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8001.2a Clean and tune	Dirty or clogged coils will be cleaned Air flow to the coils will be provided in accordance with manufacturer specifications Appliance will be located away from heat sources (e.g., supply registers, direct sunlight) if possible Interior temperatures will be measured, and the appliance must maintain: • Freezer temperature at 0° • Fresh food at 35-40° Specific information about the proper maintenance of the equipment will be provided to the occupant Condensation control switch will be left in the appropriate position, given occupant preference and moisture load in the house	Reduce energy use Improve performance Educate occupant on how to operate and maintain the appliance		3060

7.8002.1 Entertainment and Computer Systems and Components Replacement

Topic: Plug Load

Subtopic: Electronics

Desired Outcome: Energy used for electronic entertainment and computer use reduced while effective performance is maintained

For supporting material, see Referenced Standards, Calculation of the Infiltration Credit and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8002.1a Selection	Category of equipment selected will meet occupant preferences and have the lowest available energy use [e.g., plasma vs. light-emitting diode (LED)]	Reduce energy use Ensure occupant satisfaction with appliance		3061

	Equipment will have a minimum energy efficiency level of ENERGY STAR Equipment will be selected that does not have to be left on during non-use periods for updates (e.g., gaming systems, set-top boxes) Standby losses for system will be one watt or less			
7.8002.1b Installation	Equipment will be installed in accordance with manufacturer specifications (e.g., air circulation) and meet all applicable codes Any penetrations to the exterior of the home created by the installation of the equipment will be sealed All energy saving features will be enabled unless specifically directed otherwise by the occupant A readily accessible means of disconnection (e.g., power strip, timer) will be provided for equipment that must be disconnected from the power source to avoid standby losses and whose performance will not be damaged by being disconnected All equipment controls will be demonstrated to the occupant Specific information about the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant	Reduce energy use Ensure equipment is available for use when needed Ensure equipment is convenient to turn off when not in use Educate occupant on how to operate and maintain equipment		3062
7.8002.1c Decommissioning	Equipment will be recycled or disposed of using Environmental Protection Agency (EPA)	Prevent reuse of inefficient equipment and components Reduce waste		3063

	Responsible Recycling (R2) initiative principles	Properly dispose of hazardous materials		

7.8003.1 Lighting Upgrade

Topic: Plug Load

Subtopic: Lighting

Desired Outcome: Energy used for lighting reduced while maintaining adequate and safe lighting levels

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

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 Active and passive daylighting will be properly oriented, designed, and installed where appropriate	Reduce energy use without negative consequences (e.g., glare, unintentional heating)		3064
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) All bulbs, fixtures, and controls will be selected to provide the brightness and light quality required in that application (e.g., task lighting, trip-and- fall hazards, nightlights) Selected equipment should have the highest level of efficiency within a technology [e.g., compact fluorescent lamp (CFL), LED] All bulbs, fixtures, and controls will be ENERGY STAR rated where applicable When possible, bulbs, fixtures, and controls will be selected that will facilitate the use of future lighting technologies (e.g., LEDs)	Provide improved lighting quality at lower energy use Select equipment that will not be an unnecessary barrier to future technologies Avoid inferior products and unsatisfied occupants		3065

	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			

7.8004.1 Washing Machine

Topic: Plug Load

Subtopic: Laundry

Desired Outcome: Energy and environmental impact for washing clothes reduced

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

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8004.1a Selection	Minimum appliance efficiency will be ENERGY STAR and Water Sense or better	Reduce energy use Ensure occupant satisfaction with appliance		3066

	Classes within ENERGY STAR standards will be considered so as to achieve greater savings Adequate clearance will be maintained around appliance when fit into available space so access to cabinets and light switches are not blocked Appliance will be covered by a minimum one-year warranty Equipment will be selected with features that reduce peak electric demand, absolute energy use, and water use Standby losses for equipment will be one watt or less			
7.8004.1b Installation	Appliance will be installed in accordance with manufacturer specifications (e.g., leveling, plumbing connection, electrical connection, interior lighting) and meet all applicable codes Shut-off valves will be installed by a licensed plumber or other qualified contractor in accordance with the authority having jurisdiction, if not already present Hoses that can withstand water pressure at the location will be installed If located in conditioned or finished area, overflow pan will be installed and drained to a safe location Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Energy-related appliance controls will be demonstrated to the occupant	Ensure equipment functions as designed Reduce water consumption Prevent water damage Educate occupants on how to maintain washer to ensure savings		3067

	Specific information about proper maintenance of the equipment will be provided to the occupant Water quality will be evaluated using a pH and hardness tests, and the occupant will be informed on detergent levels and type to optimize performance Warranty information, operation manuals, and installer contact information will be provided to the occupant			
7.8004.1c Decommissioning	Replaced appliances will be recycled or removed in accordance with local regulations, including older equipment switches containing mercury	Prevent the reuse of inefficient equipment and its components Reduce waste Ensure occupant health		3068

7.8004.2 Clothes Dryer Replacement

Topic: Plug Load

Subtopic: Laundry

Desired Outcome: Energy and environmental impact for drying clothes reduced

For supporting material, see Calculation of the Infiltration Credit, Referenced Standards and Building America Solution Center.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8004.2a Selection	Total energy use will be factored into the selection process if fuel switching is being considered Dryer will be equipped with moisture sensor Equipment will be selected with energy features that reduce both peak electric demand and absolute energy use Standby losses for equipment will be one watt or less	Reduce energy use Avoid increasing total energy use (gas and electric) when fuel switching		3069

	A dryer best matched to the venting options will be selected (e.g., central location, length of vent, cost of venting) Appliance will be covered by a minimum one-year warranty			
7.8004.2b Installation	Appliance will be installed in accordance with manufacturer specifications (e.g., leveling, plumbing connection, electrical connection, interior lighting) and meet all applicable codes If existing venting does not meet the following criteria (as well as manufacturer specifications and applicable codes), new venting will be installed using the following specifications: • Appliance will be vented to the outside using metal-to-metal or UL-listed foil-type venting material • Venting design will meet standards for optimal venting • Venting will not be constricted or blocked • Only screws will be used to connect metal-to-metal and must not catch lint inside venting material • Only clamps will be used on semi-rigid metal and UL-listed foil-type venting materials • At least 3' of the vent closest to the exterior of the house will be insulated with a minimum of R-6	Ensure equipment functions as designed Install appliance safely and effectively Ensure house as a whole system is not adversely affecting the proper functioning/venting of equipment Reduce energy use In case of fuel switching, reduce cost		3070

	All dryers, other than condensing dryers, will be vented to the outdoors If a combustion appliance is used, combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single-Family Housing or other equivalent practice Any penetrations to the exterior of the home created by the installation of the appliance will be sealed Energy-related appliance controls will be demonstrated to the occupant Specific information of the proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant			
7.8004.2c Decommissioning	Replaced appliances will be recycled or removed and disposed of in accordance with local regulations, including older equipment switches containing mercury	Prevent the reuse of inefficient equipment and its components Reduce waste Ensure occupant health		3071

7.8101.1 Shower Head and Faucet Aerator

Topic: Water Heating

Subtopic: Water Use Reduction

Desired Outcome: Energy and water use reduced while occupant needs for water flow maintained

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

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8101.1a Work assessment	Installer prework assessment will be conducted to determine if plumbing needs corrected before installing high-efficiency shower head or faucet	Verify scope of work		3072
7.8101.1b Selection	The rated flow of new shower heads will be 2.5 gallons per minute (GPM) or less If multiple heads are provided, the total flow rate will not exceed 2.5 GPM Aerator flow rate will be 2.2 GPM or less All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards	Reduce water and energy consumption Ensure occupant satisfaction		3073
7.8101.1c Installation	Equipment will be installed in accordance with manufacturer specifications and meet all applicable building codes Water quality will be evaluated for debris that may clog the equipment Once installed, high-efficiency shower heads or faucet aerators will be tested to determine if equipment is tightened adequately to prevent leakage at the point of connection If needed, shower diverter will be repaired or replaced Any penetrations to the exterior of the home created by the installation of the equipment will be sealed Any damage done to the house during installation will be repaired	Reduce water and energy consumption Ensure occupant satisfaction with water flow Eliminate water leakage Prevent water damage		3074

	Specific information about proper maintenance of the equipment will be provided to the occupant Warranty information, operation manuals, and installer contact information will be provided to the occupant Water flow that satisfies the occupant will be provided by all shower heads and faucet aerators Occupant's acceptance of the shower head and/or aerator will be documented			
7.8101.1d Decommissioning	Replaced shower heads and faucet aerators will be recycled or disposed of properly	Prevent the reuse of inefficient equipment and components		3075

7.8102.1 Water Heater Selection

Topic: Water Heating

Subtopic: Installation and Replacement

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

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.1a Selection parameters	Equipment will provide sufficient, affordable, safe, and healthy hot water for the occupant in accordance with IRC Potential for solar hot water heating or other renewable energy systems will be assessed in selecting the hot water equipment Potential for health and safety hazards (e.g., back drafting, flame rollout, obstructions) will be assessed in selecting equipment, and the cost of remedying such problems will be	Save energy and water Protect the environment Identify appliance options based on the needs and wants of the occupant		3076

	included in any cost and benefit calculations If a combustion-based system is selected, it will be either direct vented or power vented, and ENERGY STAR® qualified or an Energy Factor (EF) of 0.58 or higher If combustion equipment is selected, a low nitrogen oxide burner will be included Equipment will be functional at high efficiency under all load conditions Standby losses will be reduced to maximum potential Fuel type will be selected based on affordability to occupant Equipment will be freeze resistant or installed in a conditioned space Efficiency of equipment will be maintained throughout life of system Occupant control of hot water temperature will be provided on the equipment The following will be determined from the occupant: • Lifestyle • Current and future needs • Space considerations • Fuel options • Health and safety considerations • Appliance options • Maintenance and operation cost • Return on investment concerns			

7.8102.1b Product selection	Water heater will be selected based on performance requirements of the occupant, available fuel sources, energy efficiency, and total life cycle cost In very cold climates, on-demand water heaters will be sized to meet the demand of water flow at very low water intake temperatures When evaluating an existing thermal solar water heating system, a solar expert should be consulted The proper installation and maintenance of solar hot water systems is provided in the Uniform Solar Energy Code (USEC) and IRC	Ensure equipment meets the occupant's expectations while providing efficient energy and water use		3077

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.

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

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 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	Remediate health hazards using EPA- certified contractors		3078

	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: • Remove old water heater and associated components in accordance with IRC or authority having jurisdiction • Seal any unused chimney openings and penetrations in accordance with IRC or authority having jurisdiction • Remove unused oil tank, lines, valves, and associated equipment in accordance with IRC or authority having jurisdiction All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner		3079
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 IRC and manufacturer specifications The system will be installed to be freeze resistant Any existing water leaks will be repaired before installation begins Any penetrations to the exterior of the home created by the installation of the equipment will be sealed	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner		3080
7.8102.2d Emergency drain pan	An emergency drain pan will be installed with sides that extend a minimum of 4" above floor if	Collect and safely dispose of water escaping from the storage tank		3081

	leakage would cause damage to the home and in accordance with IRC A ¾" drain line or larger will be connected to tapping on pan and terminated in accordance with IRC			
7.8102.2e Expansion tank	Expansion tanks will be installed where required and in accordance with the AHJ	Protect the storage tank from expansion		3082
7.8102.2f Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with IRC and according to manufacturer specifications Temperature and pressure relief valve discharge tube will be installed in accordance with IRC	Discharge excessive energy (pressure or temperature) from storage tank to safe location		3083
7.8102.2g Dielectric unions	Dielectric unions will be installed in accordance with the IRC, authority having jurisdiction, and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank		3084
7.8102.2h Backflow prevention	Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes	Protect water supply from contamination		3085
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 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 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.	Reduce standby loss from near tank piping and storage tank Ensure insulation does not make contact with flue gas venting		3086

	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		3087
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		3088
7.8102.2l Commissioning of system	The following will be checked once the system has been filled and purged: • Safety controls • 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	Ensure safe system function Keep cost of ownership as low as possible		3089
7.8102.2m Occupant safety	All homes will have a functioning CO alarm If determined to be more than 5 years old, CO detector/alarm will be replaced 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	Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate		3090

	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)			
7.8102.2n Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature and target temperature in accordance with local code • Periodic drain and flush • Expansion tank and backflow preventer (no occupant maintenance required) • Periodic inspection, maintenance, or replacement	Ensure occupant is informed of the safe, efficient operation and maintenance of the system		3091

7.8102.3 On-Demand 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.

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8102.3a Hazardous material removal	Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified Written notification will be provided to occupants of the discovery of	Remediate health hazards using EPA- certified contractors		3092

	hazardous material, including contact information for regional EPA asbestos coordinator Occupants will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)			
7.8102.3b Equipment removal	Accepted industry procedures and practices will be followed to: • Remove old water heater and associated components in accordance with IRC • Seal any unused chimney openings and penetrations in accordance with IRC • Remove unused oil tank, lines, valves, and associated equipment in accordance with IRC All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner		3093
7.8102.3c New equipment installation	A new water heater and associated components will be installed to accepted industry standards, in accordance with the IRC, authority having jurisdiction, and manufacturer specifications All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction	Ensure the safety of the workers and occupants Preserve integrity of the building Remove old equipment in a timely and efficient manner		3094
7.8102.3d Emergency drain pan	An emergency drain pan and drain line shall be installed in accordance with the *IRC*	Collect and safely dispose of water escaping from the storage tank		3095

7.8102.3e Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with IRC and according to manufacturer specifications Temperature and pressure relief valve discharge tube will be installed in accordance with IRC	Discharge excessive energy (pressure or temperature) from storage tank to safe location		3096
7.8102.3f Dielectric unions	Dielectric unions will be installed to accepted industry standards, in accordance with the IRC, and according to manufacturer specifications	Break the stray voltage electrical circuit through the storage tank		3097
7.8102.3g Backflow prevention and pressure regulator	Backflow prevention will be installed in accordance with manufacturer specifications House water pressure and volume will be verified as sufficient to be in accordance with manufacturer specifications All applicable codes will be followed	Protect the water supply from contamination Provide for sufficient volume and pressure		3098
7.8102.3h Thermal efficiency	Any accessible hot water lines at the appliance will be insulated to meet IRC or local requirements, whichever is greater	Reduce line losses		3099
7.8102.3i Required combustion air	Recommendations will be made to install all on-demand appliances as sealed combustion If not possible: Combustion and ventilation (excess air) requirements of gas-fired appliances, including provision of outside and inside air to account for building tightness, will be provided The minimum required volume shall be 50 cubic feet per 1,000 Btu/h in accordance with IRC If needed, additional combustion air will be provided in accordance with IRC	Ensure adequate combustion air for operation of the appliance		3100

7.8102.3j Venting of flue gases	Combustion byproducts will be removed in accordance with IRC and manufacturer specifications	Ensure the safety and durability of the venting system		3101
7.8102.3k Flue gas testing	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T If combustion is not in compliance with BPI-1100-T, diagnostics and adjustments will be done to manufacturer specifications or local codes	Confirm that combustion is occurring safely with maximum efficiency		3102
7.8102.3l Electric and fossil fuel supply	Electric or fossil fuel supply components will be installed to accepted industry standards as per IRC, the NFGC, NFPA 31, 54, and 58 for gas and oil, or NFPA 70 National Electric Code for electric Energy input required by the appliance will be in accordance with manufacturer specifications	Provide sufficient fuel to the water heater burner or element		3103
7.8102.3m Cold water supply	The volume and pressure of the water supplied to the appliance will be in accordance with manufacturer specifications	Provide sufficient volume and pressure of water to the appliance		3104
7.8102.3n Discharge temperature	Discharge temperature will be set in accordance with manufacturer instructions and in compliance with local codes Use extreme caution when temperature setting is above 120°F	Ensure safe hot water supply temperature to fixtures		3105
7.8102.3o Commissioning of system	The following will be checked once the system has been connected and filled: • Safety controls • Combustion safety and efficiency • Operational controls • Fuel and water leaks	Ensure system functions safely with lowest possible cost of ownership		3106

	• Cycle unit • Local code requirements Manufacturer specifications and all relevant industry standards will be met in commissioning			
7.8102.3p Ambient CO	All homes with combustion appliances or an attached garage will have a carbon monoxide (CO) alarm	Ensure occupant health and safety		3107
7.8102.3q Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature and target temperature in accordance with local code • Operation of backflow preventer and pressure regulator (no occupant maintenance required) • Importance of keeping operating manuals accessible	Ensure occupant is informed of the safe, efficient operation and maintenance of the system		3108

7.8103.1 Storage-Type Appliance

Topic: Water Heating

Subtopic: Maintenance/Inspection

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

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

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)

7.8103.1a Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single-Family Housing or other equivalent practice Electrical components will be verified to comply with NEC (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)	Identify potential health and safety issues		4284
7.8103.1b Visual inspection	Inspection will be conducted to show compliance with the IRC, including but not limited to: • Water or fuel leaks • Damaged wiring • Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components	Determine needed repairs or maintenance		4285
7.8103.1c Thermal efficiency	Water heater storage tanks shall have a minimum R-value of R-24 Added insulation will not obstruct the unit's draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates The first 6' of inlet and outlet piping will be insulated in accordance with IRC or local requirements, whichever is greater	Reduce standby losses from near tank piping and storage tank Ensure insulation does not make contact with flue gas venting		4286
7.8103.1e Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with IRC and according to manufacturer specifications	Discharge excessive energy (pressure or temperature) from storage tank to safe location		4288

	Temperature and pressure relief valve discharge tube will be installed in accordance with IRC			
7.8103.1f Maintenance records	Occupants will be advised to keep records of all maintenance done to their system Copies of or access to installation and operation manuals will be provided	Provide a history of system installation and maintenance to improve chance of successful future maintenance or repair		4289
7.8103.1g Occupant safety	Carbon monoxide alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction Occupant will be provided information regarding the health effects and risk of high CO concentrations, as well as a list of monitors that can provide more detail regarding CO levels	Ensure occupant life safety Inform occupant regarding possible CO hazards		4290
7.8103.1h Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature and target temperature in accordance with local code • Periodic drain and flush • Periodic inspection, maintenance, or replacement of anode rod	Ensure occupant is informed of the safe, efficient operation and maintenance of the system		4291

7.8103.2 On-Demand Appliance

Topic: Water Heating

Subtopic: Maintenance/Inspection

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

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

For supporting material, see Calculation of the Infiltration Credit and Referenced Standards.

TITLE	SPECIFICATION(S)	OBJECTIVE(S)		
7.8103.2a Health and safety	Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single-Family Housing or other equivalent practice Electrical components will be verified to comply with NFPA 70 National Electric Code (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)	Identify potential health and safety issues		3117
7.8103.2b Visual inspection	Inspection will be conducted to show compliance with the IRC, including but not limited to: • Water or fuel leaks • Damaged or missing pipe insulation and tank insulation, where applicable • Damaged wiring • Venting issues with draft and condensation (e.g., soot, rusting of flue pipe, burned paint or wires, efflorescence) • Corrosion (e.g., rust, mineral deposits) • General condition of components	Determine needed repairs or maintenance		3118
7.8103.2c Temperature and pressure relief valve	Correct temperature and pressure relief valve will be installed in compliance with IRC and according to manufacturer specifications Temperature and pressure relief valve discharge tube will be installed in accordance with IRC	Discharge excessive energy (pressure or temperature) from storage tank to safe location		3119

7.8103.2d Flue gas testing	Undiluted flue gases will be checked with a calibrated combustion analyzer in accordance with BPI-1100-T If combustion is not in compliance with BPI-1100-T, diagnostics and adjustments will be done to manufacturer specifications or local codes	Perform combustion testing		3120
7.8103.2e Required combustion air	If sealed combustion has not been installed: • Combustion and ventilation (excess air) requirements of gas-fired appliances, including provision of outside and inside air to account for building tightness, will be provided • The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with 2012 IRC G2407.5.1 • If needed, additional combustion air will be provided in accordance with IRC	Ensure adequate combustion air for operation of the appliance		3121
7.8103.2f Venting of flue gases	Condition of venting will be inspected in accordance with Section 504 IFGC, NFPA 54, or NFPA 58 for gas water heaters or NFPA 31 for oil water heaters, and authority having local jurisdiction	Verify proper venting of flue gases		3122
7.8103.2g Fuel supply	Condition of fuel supply components will be checked in accordance with NFPA 31 for oil, NFPA 54 for gas, NFPA 58 for propane, or NFPA 70 National Electric Code for electric, and authority having jurisdiction	Verify sufficient fuel to the water heater burner and element		3123
7.8103.2h Cold water supply	Water supplied to the appliance will be of sufficient volume and pressure to be in accordance with manufacturer specifications	Verify sufficient volume and pressure of water to the appliance		3124

7.8103.2i Discharge temperature	Discharge temperature will be set not to exceed 120°F or in accordance with local code, whichever is lower	Ensure safe hot water supply temperature to fixtures		3125
7.8103.2j Test the system safety and operation	The following will be tested: • Safety controls (e.g., water, air pressure switches) • Combustion safety and efficiency • Operational controls • Fuel and water leaks • Unit runs through complete cycle • Local code requirements Manufacturer specifications and all relevant industry standards will be met	Ensure system functions safely with lowest possible cost of ownership		3126
7.8103.2k Maintenance records	Occupants will be advised to keep records of all maintenance done to their system Copies of or access to installation and operation manuals will be provided	Improve chance of successful future maintenance or repair		3127
7.8103.2l Occupant health and safety	All homes will have a carbon monoxide (CO) alarm	Ensure occupant health and safety		3128
7.8103.2m Occupant education	Completed work will be reviewed Occupants will be educated on the safe and efficient operation and maintenance of the system, including: • Adjustment of water temperature • Target temperature in accordance with local code	Ensure occupant is informed of the safe, efficient operation and maintenance of the system		3129

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